

## RIT VEXU Core API

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# Chapter 1

## Core

This is the host repository for the custom VEX libraries used by the RIT VEXU team

Automatically updated documentation is available at [here](#). There is also a downloadable [reference manual](#).

### 1.1 Getting Started

In order to simply use this repo, you can either clone it into your VEXcode project folder, or download the .zip and place it into a core/ subfolder. Then follow the instructions for setting up compilation at [Wiki/BuildSystem](#)

If you wish to contribute, follow the instructions at [Wiki/ProjectSetup](#)

### 1.2 Features

Here is the current feature list this repo provides:

Subsystems (See [Wiki/Subsystems](#)):

- Tank drivetrain (user control / autonomous)
- Mecanum drivetrain (user control / autonomous)
- Odometry
- [Flywheel](#)
- [Lift](#)
- Custom encoders

Utilities (See [Wiki/Utilites](#)):

- [PID](#) controller
- [FeedForward](#) controller
- Trapezoidal motion profile controller
- Pure Pursuit
- Generic auto program builder
- Auto program UI selector
- Mathematical classes ([Vector2D](#), Moving Average)



## Chapter 2

# Hierarchical Index

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## Chapter 3

# Class Index

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<a href="#">Branch</a> chooses from multiple options at runtime. the function decider returns an index into the choices vector If you wish to make no choice and skip this section, return NO_CHOICE; any choice that is out of bounds set to NO_CHOICE	25
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Page that shows odometry position and rotation and a map (if an sd card with the file is on)	98
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Parallel runs multiple commands in parallel and waits for all to finish before continuing. if none finish before this command's timeout, it will call on_timeout on all children continue	107
parallel_runner_info	108
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Serializer	
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<a href="#">screen::SliderWidget</a>	
Widget that updates a double value. Updates by reference so watch out for race conditions cuz the screen stuff lives on another thread	133
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Draws motor stats and battery stats to the screen	136
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A velocity controller	138
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<a href="#">TurnDegreesCommand</a>	156
<a href="#">TurnToHeadingCommand</a>	158
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<a href="#">WaitUntilCondition</a>	
Waits until the condition is true	163
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# Chapter 4

## File Index

### 4.1 File List

Here is a list of all documented files with brief descriptions:

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include/utils/controls/feedback_base.h	184
include/utils/controls/feedforward.h	184
include/utils/controls/motion_controller.h	185
include/utils/controls/pid.h	185
include/utils/controls/pidff.h	186
include/utils/controls/take_back_half.h	187
include/utils/controls/trapezoid_profile.h	187

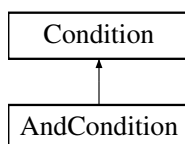


## Chapter 5

# Class Documentation

### 5.1 AndCondition Class Reference

Inheritance diagram for AndCondition:



#### Public Member Functions

- **AndCondition** ([Condition](#) \*A, [Condition](#) \*B)
- bool [test](#) () override

#### Public Member Functions inherited from [Condition](#)

- [Condition](#) \* **Or** ([Condition](#) \*b)
- [Condition](#) \* **And** ([Condition](#) \*b)

#### 5.1.1 Member Function Documentation

##### 5.1.1.1 [test\(\)](#)

```
bool AndCondition::test ( ) [inline], [override], [virtual]
```

Implements [Condition](#).

The documentation for this class was generated from the following file:

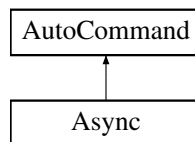
- src/utls/command\_structure/auto\_command.cpp

## 5.2 Async Class Reference

[Async](#) runs a command asynchronously will simply let it go and never look back THIS HAS A VERY NICHE USE CASE. THINK ABOUT IF YOU REALLY NEED IT.

```
#include <auto_command.h>
```

Inheritance diagram for Async:



### Public Member Functions

- **Async** ([AutoCommand](#) \*cmd)
- bool [run](#) () override

### Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* **withTimeout** (double t\_seconds)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

#### 5.2.1 Detailed Description

[Async](#) runs a command asynchronously will simply let it go and never look back THIS HAS A VERY NICHE USE CASE. THINK ABOUT IF YOU REALLY NEED IT.

## 5.2.2 Member Function Documentation

### 5.2.2.1 run()

```
bool Async::run ( ) [override], [virtual]
```

Executes the command Overridden by child classes

#### Returns

true when the command is finished, false otherwise

Reimplemented from [AutoCommand](#).

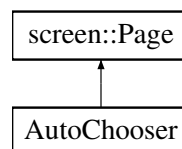
The documentation for this class was generated from the following files:

- include/utils/command\_structure/auto\_command.h
- src/utils/command\_structure/auto\_command.cpp

## 5.3 AutoChooser Class Reference

```
#include <auto_chooser.h>
```

Inheritance diagram for AutoChooser:



### Classes

- struct [entry\\_t](#)

### Public Member Functions

- [AutoChooser](#) (std::vector< std::string > paths, size\_t def=0)
- void [update](#) (bool was\_pressed, int x, int y)  
*collect data, respond to screen input, do fast things (runs at 50hz even if you're not focused on this Page (only drawn page gets touch updates))*
- void [draw](#) (vex::brain::lcd &, bool first\_draw, unsigned int frame\_number)  
*draw stored data to the screen (runs at 10 hz and only runs if this page is in front)*
- size\_t [get\\_choice](#) ()

### Protected Attributes

- size\_t [choice](#)
- std::vector< [entry\\_t](#) > [list](#)

## Static Protected Attributes

- static const size\_t **width** = 380
- static const size\_t **height** = 220

### 5.3.1 Detailed Description

Autochooser is a utility to make selecting robot autonomous programs easier source: RIT VexU Wiki During a season, we usually code between 4 and 6 autonomous programs. Most teams will change their entire robot program as a way of choosing autonomi but this may cause issues if you have an emergency patch to upload during a competition. This class was built as a way of using the robot screen to list autonomous programs, and the touchscreen to select them.

### 5.3.2 Constructor & Destructor Documentation

#### 5.3.2.1 AutoChooser()

```
AutoChooser::AutoChooser (
    std::vector< std::string > paths,
    size_t def = 0 )
```

Initialize the auto-chooser. This class places a choice menu on the brain screen, so the driver can choose which autonomous to run.

#### Parameters

<i>brain</i>	the brain on which to draw the selection boxes
--------------	--

### 5.3.3 Member Function Documentation

#### 5.3.3.1 draw()

```
void AutoChooser::draw (
    vex::brain::lcd & screen,
    bool first_draw,
    unsigned int frame_number ) [virtual]
```

draw stored data to the screen (runs at 10 hz and only runs if this page is in front)

#### Parameters

<i>first_draw</i>	true if we just switched to this page
<i>frame_number</i>	frame of drawing we are on (basically an animation tick)

Reimplemented from [screen::Page](#).



### 5.3.3.2 get\_choice()

```
size_t AutoChooser::get_choice ( )
```

Get the currently selected auto choice

#### Returns

the identifier to the auto path

Return the selected autonomous

### 5.3.3.3 update()

```
void AutoChooser::update (
    bool was_pressed,
    int x,
    int y ) [virtual]
```

collect data, respond to screen input, do fast things (runs at 50hz even if you're not focused on this Page (only drawn page gets touch updates))

#### Parameters

<i>was_pressed</i>	true if the screen has been pressed
<i>x</i>	x position of screen press (if the screen was pressed)
<i>y</i>	y position of screen press (if the screen was pressed)

Reimplemented from [screen::Page](#).

## 5.3.4 Member Data Documentation

### 5.3.4.1 choice

```
size_t AutoChooser::choice [protected]
```

the current choice of auto

### 5.3.4.2 list

```
std::vector<entry_t> AutoChooser::list [protected]
```

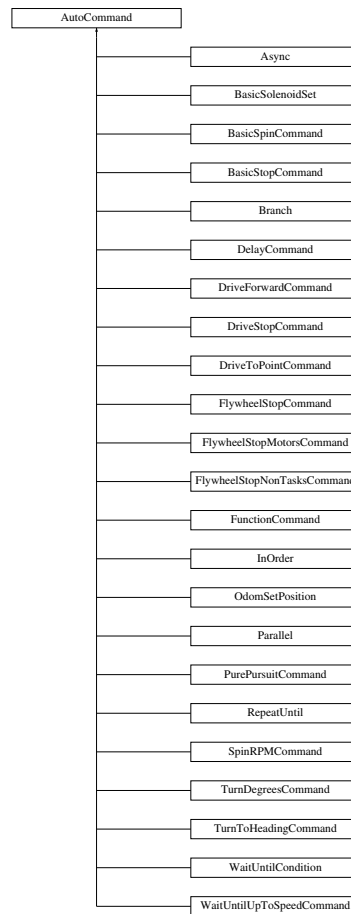
< a list of all possible auto choices

The documentation for this class was generated from the following files:

- include/utils/auto\_chooser.h
- src/utils/auto\_chooser.cpp

## 5.4 AutoCommand Class Reference

Inheritance diagram for AutoCommand:



### Public Member Functions

- virtual bool [run](#) ()
- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* **withTimeout** (double t\_seconds)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \*true\_to\_end)

### Public Attributes

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes

- static constexpr double **default\_timeout** = 10.0

## 5.4.1 Member Function Documentation

### 5.4.1.1 on\_timeout()

```
virtual void AutoCommand::on_timeout ( ) [inline], [virtual]
```

What to do if we timeout instead of finishing. timeout is specified by the timeout seconds in the constructor

Reimplemented in [InOrder](#), [Parallel](#), [Branch](#), [RepeatUntil](#), [DriveForwardCommand](#), [TurnDegreesCommand](#), [TurnToHeadingCommand](#), [PurePursuitCommand](#), and [DriveStopCommand](#).

### 5.4.1.2 run()

```
virtual bool AutoCommand::run ( ) [inline], [virtual]
```

Executes the command Overridden by child classes

#### Returns

true when the command is finished, false otherwise

Reimplemented in [FunctionCommand](#), [WaitUntilCondition](#), [InOrder](#), [Parallel](#), [Branch](#), [Async](#), [RepeatUntil](#), [BasicSpinCommand](#), [BasicStopCommand](#), [BasicSolenoidSet](#), [DelayCommand](#), [DriveForwardCommand](#), [TurnDegreesCommand](#), [DriveToPointCommand](#), [TurnToHeadingCommand](#), [PurePursuitCommand](#), [DriveStopCommand](#), [OdomSetPosition](#), [SpinRPMCommand](#), [WaitUntilUpToSpeedCommand](#), [FlywheelStopCommand](#), and [FlywheelStopMotorsCommand](#).

## 5.4.2 Member Data Documentation

### 5.4.2.1 timeout\_seconds

```
double AutoCommand::timeout_seconds = default_timeout
```

How long to run until we cancel this command. If the command is cancelled, [on\\_timeout\(\)](#) is called to allow any cleanup from the function. If the timeout\_seconds  $\leq 0$ , no timeout will be applied and this command will run forever. A timeout can come in handy for some commands that can not reach the end due to some physical limitation such as

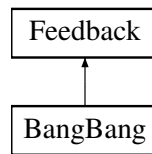
- a drive command hitting a wall and not being able to reach its target
- a command that waits until something is up to speed that never gets up to speed because of battery voltage
- something else...

The documentation for this class was generated from the following file:

- include/utils/command\_structure/auto\_command.h

## 5.5 BangBang Class Reference

Inheritance diagram for BangBang:



### Public Member Functions

- **BangBang** (double threshold, double low, double high)
- void **init** (double start\_pt, double set\_pt, double start\_vel=0.0, double end\_vel=0.0) override
- double **update** (double val) override
- double **get** () override
- void **set\_limits** (double lower, double upper) override
- bool **is\_on\_target** () override

### 5.5.1 Member Function Documentation

#### 5.5.1.1 get()

```
double BangBang::get ( ) [override], [virtual]
```

#### Returns

the last saved result from the feedback controller

Implements [Feedback](#).

#### 5.5.1.2 init()

```
void BangBang::init (
    double start_pt,
    double set_pt,
    double start_vel = 0.0,
    double end_vel = 0.0 ) [override], [virtual]
```

Initialize the feedback controller for a movement

#### Parameters

<i>start_pt</i>	the current sensor value
<i>set_pt</i>	where the sensor value should be
<i>start_vel</i>	Movement starting velocity
<i>end_vel</i>	Movement ending velocity

Implements [Feedback](#).

#### 5.5.1.3 is\_on\_target()

```
bool BangBang::is_on_target ( ) [override], [virtual]
```

##### Returns

true if the feedback controller has reached it's setpoint

Implements [Feedback](#).

#### 5.5.1.4 set\_limits()

```
void BangBang::set_limits (
    double lower,
    double upper ) [override], [virtual]
```

Clamp the upper and lower limits of the output. If both are 0, no limits should be applied.

##### Parameters

<i>lower</i>	Upper limit
<i>upper</i>	Lower limit

Implements [Feedback](#).

#### 5.5.1.5 update()

```
double BangBang::update (
    double val ) [override], [virtual]
```

Iterate the feedback loop once with an updated sensor value

##### Parameters

<i>val</i>	value from the sensor
------------	-----------------------

##### Returns

feedback loop result

Implements [Feedback](#).

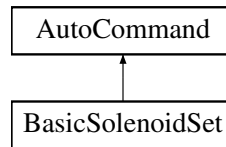
The documentation for this class was generated from the following files:

- include/utls/controls/bang\_bang.h
- src/utls/controls/bang\_bang.cpp

## 5.6 BasicSolenoidSet Class Reference

```
#include <basic_command.h>
```

Inheritance diagram for BasicSolenoidSet:



### Public Member Functions

- [BasicSolenoidSet](#) (vex::pneumatics &solenoid, bool setting)  
*Construct a new [BasicSolenoidSet](#) Command.*
- bool [run](#) () override  
*Runs the [BasicSolenoidSet](#) Overrides run command from [AutoCommand](#).*

### Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

#### 5.6.1 Detailed Description

[AutoCommand](#) wrapper class for [BasicSolenoidSet](#) Using the Vex hardware functions

#### 5.6.2 Constructor & Destructor Documentation

##### 5.6.2.1 BasicSolenoidSet()

```
BasicSolenoidSet::BasicSolenoidSet (
    vex::pneumatics & solenoid,
    bool setting )
```

Construct a new [BasicSolenoidSet](#) Command.

## Parameters

<i>solenoid</i>	Solenoid being set
<i>setting</i>	Setting of the solenoid in boolean (true,false)

### 5.6.3 Member Function Documentation

#### 5.6.3.1 run()

```
bool BasicSolenoidSet::run ( ) [override], [virtual]
```

Runs the [BasicSolenoidSet](#) Overrides run command from [AutoCommand](#).

## Returns

True Command runs once

Reimplemented from [AutoCommand](#).

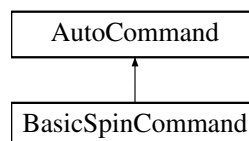
The documentation for this class was generated from the following files:

- include/utlis/command\_structure/basic\_command.h
- src/utlis/command\_structure/basic\_command.cpp

## 5.7 BasicSpinCommand Class Reference

```
#include <basic_command.h>
```

Inheritance diagram for BasicSpinCommand:



### Public Types

- enum **type** { **percent** , **voltage** , **veocity** }

### Public Member Functions

- [BasicSpinCommand](#) (vex::motor &motor, vex::directionType dir, BasicSpinCommand::type setting, double power)  
Construct a new [BasicSpinCommand](#).
- bool [run](#) () override  
Runs the [BasicSpinCommand](#) Overrides run from Auto Command.

## Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.7.1 Detailed Description

[AutoCommand](#) wrapper class for [BasicSpinCommand](#) using the vex hardware functions

### 5.7.2 Constructor & Destructor Documentation

#### 5.7.2.1 BasicSpinCommand()

```
BasicSpinCommand::BasicSpinCommand (
    vex::motor & motor,
    vex::directionType dir,
    BasicSpinCommand::type setting,
    double power )
```

Construct a new [BasicSpinCommand](#).

a BasicMotorSpin Command

#### Parameters

<i>motor</i>	Motor to spin
<i>direc</i>	Direction of motor spin
<i>setting</i>	Power setting in volts,percentage,velocity
<i>power</i>	Value of desired power
<i>motor</i>	Motor port to spin
<i>dir</i>	Direction for spinning
<i>setting</i>	Power setting in volts,percentage,velocity
<i>power</i>	Value of desired power



### 5.7.3 Member Function Documentation

#### 5.7.3.1 run()

```
bool BasicSpinCommand::run ( ) [override], [virtual]
```

Runs the [BasicSpinCommand](#) Overrides run from Auto Command.

Run the [BasicSpinCommand](#) Overrides run from Auto Command.

#### Returns

- True [Async](#) running command
- True Command runs once

Reimplemented from [AutoCommand](#).

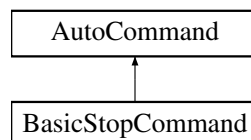
The documentation for this class was generated from the following files:

- include/utils/command\_structure/basic\_command.h
- src/utils/command\_structure/basic\_command.cpp

## 5.8 BasicStopCommand Class Reference

```
#include <basic_command.h>
```

Inheritance diagram for BasicStopCommand:



#### Public Member Functions

- [BasicStopCommand](#) (vex::motor &motor, vex::brakeType setting)  
*Construct a new BasicMotorStop Command.*
- bool [run](#) () override  
*Runs the BasicMotorStop Command Overrides run command from [AutoCommand](#).*

#### Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

## 5.8.1 Detailed Description

[AutoCommand](#) wrapper class for [BasicStopCommand](#) Using the Vex hardware functions

## 5.8.2 Constructor & Destructor Documentation

### 5.8.2.1 BasicStopCommand()

```
BasicStopCommand::BasicStopCommand (
    vex::motor & motor,
    vex::brakeType setting )
```

Construct a new BasicMotorStop Command.

Construct a BasicMotorStop Command.

#### Parameters

<i>motor</i>	The motor to stop
<i>setting</i>	The brake setting for the motor
<i>motor</i>	Motor to stop
<i>setting</i>	Braketype setting brake,coast,hold

## 5.8.3 Member Function Documentation

### 5.8.3.1 run()

```
bool BasicStopCommand::run ( ) [override], [virtual]
```

Runs the BasicMotorStop Command Overrides run command from [AutoCommand](#).

Runs the BasicMotorStop command Ovverides run command from [AutoCommand](#).

### Returns

True Command runs once

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

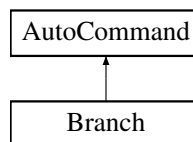
- include/utils/command\_structure/basic\_command.h
- src/utils/command\_structure/basic\_command.cpp

## 5.9 Branch Class Reference

[Branch](#) chooses from multiple options at runtime. the function decider returns an index into the choices vector If you wish to make no choice and skip this section, return NO\_CHOICE; any choice that is out of bounds set to NO\_CHOICE.

```
#include <auto_command.h>
```

Inheritance diagram for Branch:



### Public Member Functions

- **Branch** ([Condition](#) \*cond, [AutoCommand](#) \*false\_choice, [AutoCommand](#) \*true\_choice)
- bool [run](#) () override
- void [on\\_timeout](#) () override

### Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* **withTimeout** (double t\_seconds)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

### 5.9.1 Detailed Description

[Branch](#) chooses from multiple options at runtime. the function decider returns an index into the choices vector If you wish to make no choice and skip this section, return NO\_CHOICE; any choice that is out of bounds set to NO\_CHOICE.

### 5.9.2 Member Function Documentation

#### 5.9.2.1 on\_timeout()

```
void Branch::on_timeout ( ) [override], [virtual]
```

What to do if we timeout instead of finishing. timeout is specified by the timeout seconds in the constructor

Reimplemented from [AutoCommand](#).

#### 5.9.2.2 run()

```
bool Branch::run ( ) [override], [virtual]
```

Executes the command Overridden by child classes

#### Returns

true when the command is finished, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utls/command\_structure/auto\_command.h
- src/utls/command\_structure/auto\_command.cpp

## 5.10 screen::ButtonWidget Class Reference

Widget that does something when you tap it. The function is only called once when you first tap it.

```
#include <screen.h>
```

### Public Member Functions

- [ButtonWidget](#) (std::function< void(void)> onpress, [Rect](#) rect, std::string name)  
*Create a Button widget.*
- [ButtonWidget](#) (void(\*onpress)(), [Rect](#) rect, std::string name)  
*Create a Button widget.*
- bool [update](#) (bool was\_pressed, int x, int y)  
*responds to user input*
- void [draw](#) (vex::brain::lcd &, bool first\_draw, unsigned int frame\_number)  
*draws the button to the screen*

### 5.10.1 Detailed Description

Widget that does something when you tap it. The function is only called once when you first tap it.

### 5.10.2 Constructor & Destructor Documentation

#### 5.10.2.1 ButtonWidget() [1/2]

```
screen::ButtonWidget::ButtonWidget (
    std::function< void(void)> onpress,
    Rect rect,
    std::string name ) [inline]
```

Create a Button widget.

##### Parameters

<i>onpress</i>	the function to be called when the button is tapped
<i>rect</i>	the area the button should take up on the screen
<i>name</i>	the label put on the button

#### 5.10.2.2 ButtonWidget() [2/2]

```
screen::ButtonWidget::ButtonWidget (
    void(*)() onpress,
    Rect rect,
    std::string name ) [inline]
```

Create a Button widget.

##### Parameters

<i>onpress</i>	the function to be called when the button is tapped
<i>rect</i>	the area the button should take up on the screen
<i>name</i>	the label put on the button

### 5.10.3 Member Function Documentation

#### 5.10.3.1 update()

```
bool screen::ButtonWidget::update (
    bool was_pressed,
    int x,
    int y )
```

responds to user input

## Parameters

<i>was_pressed</i>	if the screen is pressed
<i>x</i>	x position if the screen was pressed
<i>y</i>	y position if the screen was pressed

## Returns

true if the button was pressed

The documentation for this class was generated from the following files:

- include/subsystems/screen.h
- src/subsystems/screen.cpp

## 5.11 CommandController Class Reference

```
#include <command_controller.h>
```

## Public Member Functions

- **CommandController ()**  
Create an empty [CommandController](#). Add Command with [CommandController::add\(\)](#)
- **CommandController (std::initializer\_list< [AutoCommand](#) \* > cmds)**  
Create a [CommandController](#) with commands pre added. More can be added with [CommandController::add\(\)](#)
- void **add** (std::vector< [AutoCommand](#) \* > cmds)
- void **add** ([AutoCommand](#) \*cmd, double timeout\_seconds=10.0)
- void **add** (std::vector< [AutoCommand](#) \* > cmds, double timeout\_sec)
- void **add\_delay** (int ms)
- void **add\_cancel\_func** (std::function< bool(void)> true\_if\_cancel)  
*add\_cancel\_func specifies that when this func evaluates to true, to cancel the command controller*
- void **run** ()
- bool **last\_command\_timed\_out** ()

### 5.11.1 Detailed Description

File: [command\\_controller.h](#) Desc: A [CommandController](#) manages the AutoCommands that make up an autonomous route. The AutoCommands are kept in a queue and get executed and removed from the queue in FIFO order.

### 5.11.2 Constructor & Destructor Documentation

#### 5.11.2.1 CommandController()

```
CommandController::CommandController (
    std::initializer_list< AutoCommand * > cmds ) [inline]
```

Create a [CommandController](#) with commands pre added. More can be added with [CommandController::add\(\)](#)

## Parameters

<i>cmds</i>	
-------------	--

### 5.11.3 Member Function Documentation

#### 5.11.3.1 add() [1/3]

```
void CommandController::add (
    AutoCommand * cmd,
    double timeout_seconds = 10.0 )
```

File: command\_controller.cpp Desc: A [CommandController](#) manages the AutoCommands that make up an autonomous route. The AutoCommands are kept in a queue and get executed and removed from the queue in FIFO order. Adds a command to the queue

## Parameters

<i>cmd</i>	the <a href="#">AutoCommand</a> we want to add to our list
<i>timeout_seconds</i>	the number of seconds we will let the command run for. If it exceeds this, we cancel it and run on_timeout

#### 5.11.3.2 add() [2/3]

```
void CommandController::add (
    std::vector< AutoCommand * > cmds )
```

Adds a command to the queue

## Parameters

<i>cmd</i>	the <a href="#">AutoCommand</a> we want to add to our list
<i>timeout_seconds</i>	the number of seconds we will let the command run for. If it exceeds this, we cancel it and run on_timeout. if it is <= 0 no time out will be applied

Add multiple commands to the queue. No timeout here.

## Parameters

<i>cmds</i>	the AutoCommands we want to add to our list
-------------	---

#### 5.11.3.3 add() [3/3]

```
void CommandController::add (
    std::vector< AutoCommand * > cmds,
    double timeout_sec )
```

Add multiple commands to the queue. No timeout here.



## Parameters

<i>cmds</i>	the AutoCommands we want to add to our list Add multiple commands to the queue. No timeout here.
<i>cmds</i>	the AutoCommands we want to add to our list
<i>timeout_sec</i>	timeout in seconds to apply to all commands if they are still the default

Add multiple commands to the queue. No timeout here.

## Parameters

<i>cmds</i>	the AutoCommands we want to add to our list
<i>timeout</i>	timeout in seconds to apply to all commands if they are still the default

## 5.11.3.4 add\_cancel\_func()

```
void CommandController::add_cancel_func (
    std::function< bool(void)> true_if_cancel )
```

add\_cancel\_func specifies that when this func evaluates to true, to cancel the command controller

## Parameters

<i>true_if_cancel</i>	a function that returns true when we want to cancel the command controller
-----------------------	--

## 5.11.3.5 add\_delay()

```
void CommandController::add_delay (
    int ms )
```

Adds a command that will delay progression of the queue

## Parameters

<i>ms</i>	- number of milliseconds to wait before continuing execution of autonomous
-----------	--

## 5.11.3.6 last\_command\_timed\_out()

```
bool CommandController::last_command_timed_out ( )
```

last\_command\_timed\_out tells how the last command ended Use this if you want to make decisions based on the end of the last command

## Returns

true if the last command timed out. false if it finished regularly

### 5.11.3.7 run()

```
void CommandController::run ( )
```

Begin execution of the queue Execute and remove commands in FIFO order

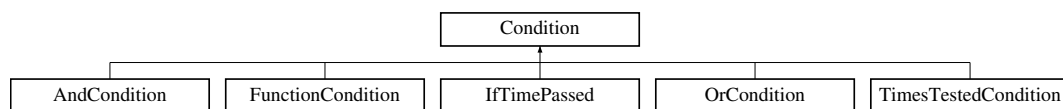
The documentation for this class was generated from the following files:

- include/utls/command\_structure/command\_controller.h
- src/utls/command\_structure/command\_controller.cpp

## 5.12 Condition Class Reference

```
#include <auto_command.h>
```

Inheritance diagram for Condition:



### Public Member Functions

- [Condition](#) \* **Or** ([Condition](#) \*b)
- [Condition](#) \* **And** ([Condition](#) \*b)
- virtual bool **test** ()=0

### 5.12.1 Detailed Description

File: [auto\\_command.h](#) Desc: Interface for module-specific commands A [Condition](#) is a function that returns true or false `is_even` is a predicate that would return true if a number is even For our purposes, a [Condition](#) is a choice to be made at runtime `drive_sys.reached_point(10, 30)` is a predicate `time.has_elapsed(10, vex::seconds)` is a predicate extend this class for different choices you wish to make

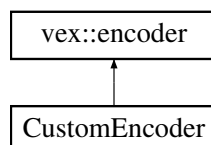
The documentation for this class was generated from the following files:

- include/utls/command\_structure/auto\_command.h
- src/utls/command\_structure/auto\_command.cpp

## 5.13 CustomEncoder Class Reference

```
#include <custom_encoder.h>
```

Inheritance diagram for CustomEncoder:



## Public Member Functions

- [CustomEncoder](#) (vex::triport::port &port, double ticks\_per\_rev)
- void [setRotation](#) (double val, vex::rotationUnits units)
- void [setPosition](#) (double val, vex::rotationUnits units)
- double [rotation](#) (vex::rotationUnits units)
- double [position](#) (vex::rotationUnits units)
- double [velocity](#) (vex::velocityUnits units)

### 5.13.1 Detailed Description

A wrapper class for the vex encoder that allows the use of 3rd party encoders with different tick-per-revolution values.

### 5.13.2 Constructor & Destructor Documentation

#### 5.13.2.1 CustomEncoder()

```
CustomEncoder::CustomEncoder (
    vex::triport::port & port,
    double ticks_per_rev )
```

Construct an encoder with a custom number of ticks

##### Parameters

<i>port</i>	the triport port on the brain the encoder is plugged into
<i>ticks_per_rev</i>	the number of ticks the encoder will report for one revolution

### 5.13.3 Member Function Documentation

#### 5.13.3.1 position()

```
double CustomEncoder::position (
    vex::rotationUnits units )
```

get the position that the encoder is at

##### Parameters

<i>units</i>	the unit we want the return value to be in
--------------	--

##### Returns

the position of the encoder in the units specified

### 5.13.3.2 rotation()

```
double CustomEncoder::rotation (
    vex::rotationUnits units )
```

get the rotation that the encoder is at

#### Parameters

<i>units</i>	the unit we want the return value to be in
--------------	--

#### Returns

the rotation of the encoder in the units specified

### 5.13.3.3 setPosition()

```
void CustomEncoder::setPosition (
    double val,
    vex::rotationUnits units )
```

sets the stored position of the encoder. Any further movements will be from this value

#### Parameters

<i>val</i>	the numerical value of the position we are setting to
<i>units</i>	the unit of val

### 5.13.3.4 setRotation()

```
void CustomEncoder::setRotation (
    double val,
    vex::rotationUnits units )
```

sets the stored rotation of the encoder. Any further movements will be from this value

#### Parameters

<i>val</i>	the numerical value of the angle we are setting to
<i>units</i>	the unit of val

### 5.13.3.5 velocity()

```
double CustomEncoder::velocity (
    vex::velocityUnits units )
```

get the velocity that the encoder is moving at

## Parameters

<i>units</i>	the unit we want the return value to be in
--------------	--

## Returns

the velocity of the encoder in the units specified

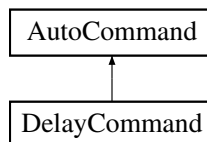
The documentation for this class was generated from the following files:

- include/subsystems/custom\_encoder.h
- src/subsystems/custom\_encoder.cpp

## 5.14 DelayCommand Class Reference

```
#include <delay_command.h>
```

Inheritance diagram for DelayCommand:



## Public Member Functions

- [DelayCommand](#) (int ms)
- bool [run](#) () override

Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.14.1 Detailed Description

File: [delay\\_command.h](#) Desc: A [DelayCommand](#) will make the robot wait the set amount of milliseconds before continuing execution of the autonomous route

### 5.14.2 Constructor & Destructor Documentation

#### 5.14.2.1 DelayCommand()

```
DelayCommand::DelayCommand (
    int ms ) [inline]
```

Construct a delay command

##### Parameters

<i>ms</i>	the number of milliseconds to delay for
-----------	---

### 5.14.3 Member Function Documentation

#### 5.14.3.1 run()

```
bool DelayCommand::run ( ) [inline], [override], [virtual]
```

Delays for the amount of milliseconds stored in the command Overrides run from [AutoCommand](#)

##### Returns

true when complete

Reimplemented from [AutoCommand](#).

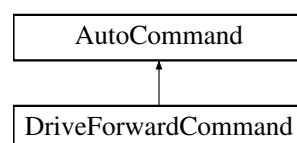
The documentation for this class was generated from the following file:

- `include/utlis/command_structure/delay_command.h`

## 5.15 DriveForwardCommand Class Reference

```
#include <drive_commands.h>
```

Inheritance diagram for DriveForwardCommand:



**Public Member Functions**

- [DriveForwardCommand](#) ([TankDrive](#) &drive\_sys, [Feedback](#) &feedback, double inches, directionType dir, double max\_speed=1, double end\_speed=0)
- bool [run](#) () override
- void [on\\_timeout](#) () override

**Public Member Functions inherited from [AutoCommand](#)**

- [AutoCommand](#) \* **withTimeout** (double t\_seconds)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \*true\_to\_end)

**Additional Inherited Members****Public Attributes inherited from [AutoCommand](#)**

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

**Static Public Attributes inherited from [AutoCommand](#)**

- static constexpr double **default\_timeout** = 10.0

**5.15.1 Detailed Description**

[AutoCommand](#) wrapper class for the drive\_forward function in the [TankDrive](#) class

**5.15.2 Constructor & Destructor Documentation****5.15.2.1 DriveForwardCommand()**

```
DriveForwardCommand::DriveForwardCommand (
    TankDrive & drive_sys,
    Feedback & feedback,
    double inches,
    directionType dir,
    double max_speed = 1,
    double end_speed = 0 )
```

File: [drive\\_commands.h](#) Desc: Holds all the [AutoCommand](#) subclasses that wrap (currently) [TankDrive](#) functions

Currently includes:

- [drive\\_forward](#)
- [turn\\_degrees](#)
- [drive\\_to\\_point](#)
- [turn\\_to\\_heading](#)
- [stop](#)

Also holds [AutoCommand](#) subclasses that wrap [OdometryBase](#) functions

Currently includes:

- [set\\_position](#) Construct a DriveForward Command

## Parameters

<i>drive_sys</i>	the drive system we are commanding
<i>feedback</i>	the feedback controller we are using to execute the drive
<i>inches</i>	how far forward to drive
<i>dir</i>	the direction to drive
<i>max_speed</i>	0 -> 1 percentage of the drive systems speed to drive at

### 5.15.3 Member Function Documentation

#### 5.15.3.1 on\_timeout()

```
void DriveForwardCommand::on_timeout ( ) [override], [virtual]
```

Cleans up drive system if we time out before finishing

reset the drive system if we timeout

Reimplemented from [AutoCommand](#).

#### 5.15.3.2 run()

```
bool DriveForwardCommand::run ( ) [override], [virtual]
```

Run drive\_forward Overrides run from [AutoCommand](#)

## Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

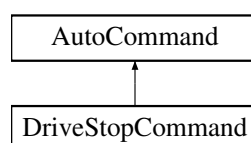
The documentation for this class was generated from the following files:

- include/utills/command\_structure/drive\_commands.h
- src/utills/command\_structure/drive\_commands.cpp

## 5.16 DriveStopCommand Class Reference

```
#include <drive_commands.h>
```

Inheritance diagram for DriveStopCommand:





## Public Member Functions

- [DriveStopCommand](#) ([TankDrive](#) &drive\_sys)
- bool [run](#) () override
- void [on\\_timeout](#) () override

## Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.16.1 Detailed Description

[AutoCommand](#) wrapper class for the stop() function in the [TankDrive](#) class

### 5.16.2 Constructor & Destructor Documentation

#### 5.16.2.1 DriveStopCommand()

```
DriveStopCommand::DriveStopCommand (
    TankDrive & drive_sys )
```

Construct a DriveStop Command

#### Parameters

<i>drive_sys</i>	the drive system we are commanding
------------------	------------------------------------

### 5.16.3 Member Function Documentation

#### 5.16.3.1 on\_timeout()

```
void DriveStopCommand::on_timeout ( ) [override], [virtual]
```

What to do if we timeout instead of finishing. timeout is specified by the timeout seconds in the constructor

Reimplemented from [AutoCommand](#).

### 5.16.3.2 run()

```
bool DriveStopCommand::run ( ) [override], [virtual]
```

Stop the drive system Overrides run from [AutoCommand](#)

#### Returns

true when execution is complete, false otherwise

Stop the drive train Overrides run from [AutoCommand](#)

#### Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

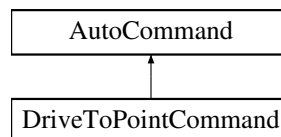
The documentation for this class was generated from the following files:

- include/utils/command\_structure/drive\_commands.h
- src/utils/command\_structure/drive\_commands.cpp

## 5.17 DriveToPointCommand Class Reference

```
#include <drive_commands.h>
```

Inheritance diagram for DriveToPointCommand:



### Public Member Functions

- [DriveToPointCommand](#) ([TankDrive](#) &drive\_sys, [Feedback](#) &feedback, double x, double y, directionType dir, double max\_speed=1, double end\_speed=0)
- [DriveToPointCommand](#) ([TankDrive](#) &drive\_sys, [Feedback](#) &feedback, [point\\_t](#) point, directionType dir, double max\_speed=1, double end\_speed=0)
- bool [run](#) () override

## Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* **withTimeout** (double *t\_seconds*)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \**true\_to\_end*)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double *timeout\_seconds* = *default\_timeout*
- [Condition](#) \* *true\_to\_end* = *nullptr*

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

### 5.17.1 Detailed Description

[AutoCommand](#) wrapper class for the *drive\_to\_point* function in the [TankDrive](#) class

### 5.17.2 Constructor & Destructor Documentation

#### 5.17.2.1 DriveToPointCommand() [1/2]

```
DriveToPointCommand::DriveToPointCommand (
    TankDrive & drive_sys,
    Feedback & feedback,
    double x,
    double y,
    directionType dir,
    double max_speed = 1,
    double end_speed = 0 )
```

Construct a DriveForward Command

#### Parameters

<i>drive_sys</i>	the drive system we are commanding
<i>feedback</i>	the feedback controller we are using to execute the drive
<i>x</i>	where to drive in the x dimension
<i>y</i>	where to drive in the y dimension
<i>dir</i>	the direction to drive
<i>max_speed</i>	0 -> 1 percentage of the drive systems speed to drive at

#### 5.17.2.2 DriveToPointCommand() [2/2]

```
DriveToPointCommand::DriveToPointCommand (
```

```
TankDrive & drive_sys,
Feedback & feedback,
point_t point,
directionType dir,
double max_speed = 1,
double end_speed = 0 )
```

Construct a DriveForward Command

#### Parameters

<i>drive_sys</i>	the drive system we are commanding
<i>feedback</i>	the feedback controller we are using to execute the drive
<i>point</i>	the point to drive to
<i>dir</i>	the direction to drive
<i>max_speed</i>	0 -> 1 percentage of the drive systems speed to drive at

## 5.17.3 Member Function Documentation

### 5.17.3.1 run()

```
bool DriveToPointCommand::run ( ) [override], [virtual]
```

Run drive\_to\_point Overrides run from [AutoCommand](#)

#### Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utls/command\_structure/drive\_commands.h
- src/utls/command\_structure/drive\_commands.cpp

## 5.18 AutoChooser::entry\_t Struct Reference

```
#include <auto_chooser.h>
```

#### Public Attributes

- [Rect](#) rect
- std::string name

### 5.18.1 Detailed Description

[entry\\_t](#) is a datatype used to store information that the chooser knows about an auto selection button

## 5.18.2 Member Data Documentation

### 5.18.2.1 name

```
std::string AutoChooser::entry_t::name
```

name of the auto represented by the block

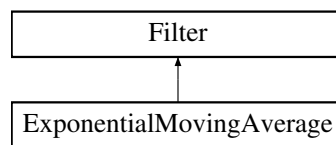
The documentation for this struct was generated from the following file:

- include/utils/auto\_chooser.h

## 5.19 ExponentialMovingAverage Class Reference

```
#include <moving_average.h>
```

Inheritance diagram for ExponentialMovingAverage:



### Public Member Functions

- [ExponentialMovingAverage](#) (int buffer\_size)
- [ExponentialMovingAverage](#) (int buffer\_size, double starting\_value)
- void [add\\_entry](#) (double n)
- double [get\\_value](#) ()
- int [get\\_size](#) ()

### Public Member Functions inherited from [Filter](#)

- virtual double [get\\_value](#) () const =0

### 5.19.1 Detailed Description

#### [ExponentialMovingAverage](#)

An exponential moving average is a way of smoothing out noisy data. For many sensor readings, the noise is roughly symmetric around the actual value. This means that if you collect enough samples those that are too high are cancelled out by the samples that are too low leaving the real value.

A simple moving average lags significantly with time as it has to counteract old samples. An exponential moving average keeps more up to date by weighting newer readings higher than older readings so it is more up to date while also still smoothed.

The [ExponentialMovingAverage](#) class provides an simple interface to do this smoothing from our noisy sensor values.

## 5.19.2 Constructor & Destructor Documentation

### 5.19.2.1 ExponentialMovingAverage() [1/2]

```
ExponentialMovingAverage::ExponentialMovingAverage (
    int buffer_size )
```

Create a moving average calculator with 0 as the default value

## Parameters

<i>buffer_size</i>	The size of the buffer. The number of samples that constitute a valid reading
--------------------	---

**5.19.2.2 ExponentialMovingAverage()** [2/2]

```
ExponentialMovingAverage::ExponentialMovingAverage (
    int buffer_size,
    double starting_value )
```

Create a moving average calculator with a specified default value

## Parameters

<i>buffer_size</i>	The size of the buffer. The number of samples that constitute a valid reading
<i>starting_value</i>	The value that the average will be before any data is added

**5.19.3 Member Function Documentation****5.19.3.1 add\_entry()**

```
void ExponentialMovingAverage::add_entry (
    double n ) [virtual]
```

Add a reading to the buffer Before: [ 1 1 2 2 3 3] => 2 ^ After: [ 2 1 2 2 3 3] => 2.16 ^

## Parameters

<i>n</i>	the sample that will be added to the moving average.
----------	--

Implements [Filter](#).

**5.19.3.2 get\_size()**

```
int ExponentialMovingAverage::get_size ( )
```

How many samples the average is made from

## Returns

the number of samples used to calculate this average

### 5.19.3.3 get\_value()

```
double ExponentialMovingAverage::get_value ( )
```

Returns the average based off of all the samples collected so far

#### Returns

the calculated average. `sum(samples)/numsamples`

How many samples the average is made from

#### Returns

the number of samples used to calculate this average

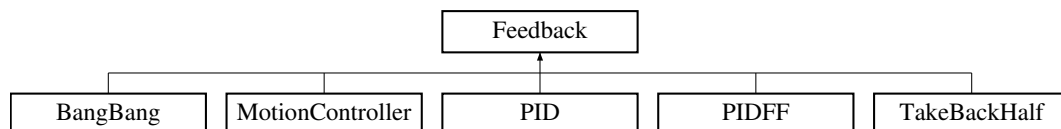
The documentation for this class was generated from the following files:

- `include/utils/moving_average.h`
- `src/utils/moving_average.cpp`

## 5.20 Feedback Class Reference

```
#include <feedback_base.h>
```

Inheritance diagram for Feedback:



### Public Member Functions

- virtual void [init](#) (double start\_pt, double set\_pt, double start\_vel=0.0, double end\_vel=0.0)=0
- virtual double [update](#) (double val)=0
- virtual double [get](#) ()=0
- virtual void [set\\_limits](#) (double lower, double upper)=0
- virtual bool [is\\_on\\_target](#) ()=0

### 5.20.1 Detailed Description

Interface so that subsystems can easily switch between feedback loops

#### Author

Ryan McGee

#### Date

9/25/2022

## 5.20.2 Member Function Documentation

### 5.20.2.1 `get()`

```
virtual double Feedback::get ( ) [pure virtual]
```

#### Returns

the last saved result from the feedback controller

Implemented in [BangBang](#), [MotionController](#), [PID](#), [PIDFF](#), and [TakeBackHalf](#).

### 5.20.2.2 `init()`

```
virtual void Feedback::init (
    double start_pt,
    double set_pt,
    double start_vel = 0.0,
    double end_vel = 0.0 ) [pure virtual]
```

Initialize the feedback controller for a movement

#### Parameters

<i>start_pt</i>	the current sensor value
<i>set_pt</i>	where the sensor value should be
<i>start_vel</i>	Movement starting velocity
<i>end_vel</i>	Movement ending velocity

Implemented in [MotionController](#), [PIDFF](#), [PID](#), [BangBang](#), and [TakeBackHalf](#).

### 5.20.2.3 `is_on_target()`

```
virtual bool Feedback::is_on_target ( ) [pure virtual]
```

#### Returns

true if the feedback controller has reached it's setpoint

Implemented in [BangBang](#), [MotionController](#), [PID](#), [PIDFF](#), and [TakeBackHalf](#).

### 5.20.2.4 `set_limits()`

```
virtual void Feedback::set_limits (
    double lower,
    double upper ) [pure virtual]
```

Clamp the upper and lower limits of the output. If both are 0, no limits should be applied.



## Parameters

<i>lower</i>	Upper limit
<i>upper</i>	Lower limit

Implemented in [BangBang](#), [MotionController](#), [PID](#), [PIDFF](#), and [TakeBackHalf](#).

**5.20.2.5 update()**

```
virtual double Feedback::update (
    double val ) [pure virtual]
```

Iterate the feedback loop once with an updated sensor value

## Parameters

<i>val</i>	value from the sensor
------------	-----------------------

## Returns

feedback loop result

Implemented in [MotionController](#), [PID](#), [BangBang](#), [PIDFF](#), and [TakeBackHalf](#).

The documentation for this class was generated from the following file:

- `include/utils/controls/feedback_base.h`

**5.21 FeedForward Class Reference**

```
#include <feedforward.h>
```

**Classes**

- struct [ff\\_config\\_t](#)

**Public Member Functions**

- [FeedForward](#) ([ff\\_config\\_t](#) &cfg)
- double [calculate](#) (double v, double a, double pid\_ref=0.0)  
*Perform the feedforward calculation.*

### 5.21.1 Detailed Description

#### FeedForward

Stores the feedforward constants, and allows for quick computation. Feedforward should be used in systems that require smooth precise movements and have high inertia, such as drivetrains and lifts.

This is best used alongside a [PID](#) loop, with the form: `output = pid.get() + feedforward.calculate(v, a);`

In this case, the feedforward does the majority of the heavy lifting, and the pid loop only corrects for inconsistencies

For information about tuning feedforward, I recommend looking at this post: <https://www.chiefdelphi.com/t/paper-frc-drivetrain-characterization/160915> (yes I know it's for FRC but trust me, it's useful)

#### Author

Ryan McGee

#### Date

6/13/2022

### 5.21.2 Constructor & Destructor Documentation

#### 5.21.2.1 FeedForward()

```
FeedForward::FeedForward (
    ff_config_t & cfg ) [inline]
```

Creates a [FeedForward](#) object.

#### Parameters

<code>cfg</code>	Configuration Struct for tuning
------------------	---------------------------------

### 5.21.3 Member Function Documentation

#### 5.21.3.1 calculate()

```
double FeedForward::calculate (
    double v,
    double a,
    double pid_ref = 0.0 ) [inline]
```

Perform the feedforward calculation.

This calculation is the equation:  $F = kG + kS \cdot \text{sgn}(v) + kV \cdot v + kA \cdot a$

## Parameters

<i>v</i>	Requested velocity of system
<i>a</i>	Requested acceleration of system

## Returns

A feedforward that should closely represent the system if tuned correctly

The documentation for this class was generated from the following file:

- include/Utils/controls/feedforward.h

## 5.22 FeedForward::ff\_config\_t Struct Reference

```
#include <feedforward.h>
```

## Public Attributes

- double *kS*
- double *kV*
- double *kA*
- double *kG*

### 5.22.1 Detailed Description

*ff\_config\_t* holds the parameters to make the theoretical model of a real world system equation is of the form  $kS$  if the system is not stopped, 0 otherwise

- $kV * \text{desired velocity}$
- $kA * \text{desired acceleration}$
- $kG$

### 5.22.2 Member Data Documentation

#### 5.22.2.1 *kA*

```
double FeedForward::ff_config_t::kA
```

*kA* - Acceleration coefficient: the power required to change the mechanism's speed. Multiplied by the requested acceleration.

### 5.22.2.2 kG

```
double FeedForward::ff_config_t::kG
```

kG - Gravity coefficient: only needed for lifts. The power required to overcome gravity and stay at steady state.

### 5.22.2.3 kS

```
double FeedForward::ff_config_t::kS
```

Coefficient to overcome static friction: the point at which the motor *starts* to move.

### 5.22.2.4 kV

```
double FeedForward::ff_config_t::kV
```

Veclocity coefficient: the power required to keep the mechanism in motion. Multiplied by the requested velocity.

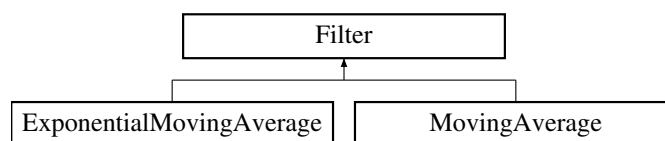
The documentation for this struct was generated from the following file:

- include/utlis/controls/feedforward.h

## 5.23 Filter Class Reference

```
#include <moving_average.h>
```

Inheritance diagram for Filter:



### Public Member Functions

- virtual void [add\\_entry](#) (double n)=0
- virtual double [get\\_value](#) () const =0

### 5.23.1 Detailed Description

Interface for filters Use `add_entry` to supply data and `get_value` to retrieve the filtered value

## 5.23.2 Member Function Documentation

### 5.23.2.1 add\_entry()

```
virtual void Filter::add_entry (
    double n ) [pure virtual]
```

Implemented in [MovingAverage](#), and [ExponentialMovingAverage](#).

### 5.23.2.2 get\_value()

```
virtual double Filter::get_value ( ) const [pure virtual]
```

Implemented in [MovingAverage](#).

The documentation for this class was generated from the following file:

- include/utls/moving\_average.h

## 5.24 Flywheel Class Reference

```
#include <flywheel.h>
```

### Public Member Functions

- [Flywheel](#) (vex::motor\_group &motors, [Feedback](#) &feedback, [FeedForward](#) &helper, const double ratio, [Filter](#) &filt)
- double [get\\_target](#) () const
- double [getRPM](#) () const
- vex::motor\_group & [get\\_motors](#) () const
- void [spin\\_manual](#) (double speed, directionType dir=fwd)
- void [spin\\_rpm](#) (double rpm)
- void [stop](#) ()
- bool [is\\_on\\_target](#) ()  
*check if the feedback controller thinks the flywheel is on target*
- [screen::Page](#) \* [Page](#) () const  
*Creates a page displaying info about the flywheel.*
- [AutoCommand](#) \* [SpinRpmCmd](#) (int rpm)  
*Creates a new auto command to spin the flywheel at the desired velocity.*
- [AutoCommand](#) \* [WaitUntilUpToSpeedCmd](#) ()  
*Creates a new auto command that will hold until the flywheel has its target as defined by its feedback controller.*

### Friends

- class [FlywheelPage](#)
- int [spinRPMTask](#) (void \*wheelPointer)

### 5.24.1 Detailed Description

a [Flywheel](#) class that handles all control of a high inertia spinning disk. It gives multiple options for what control system to use in order to control wheel velocity and functions alerting the user when the flywheel is up to speed. [Flywheel](#) is a set and forget class. Once you create it you can call `spin_rpm` or `stop` on it at any time and it will take all necessary steps to accomplish this.

### 5.24.2 Constructor & Destructor Documentation

#### 5.24.2.1 Flywheel()

```
Flywheel::Flywheel (
    vex::motor_group & motors,
    Feedback & feedback,
    FeedForward & helper,
    const double ratio,
    Filter & filt )
```

Create the [Flywheel](#) object using [PID](#) + feedforward for control.

#### Parameters

<i>motors</i>	pointer to the motors on the fly wheel
<i>feedback</i>	a feedback controller
<i>helper</i>	a feedforward config (only kV is used) to help the feedback controller along
<i>ratio</i>	ratio of the gears from the motor to the flywheel just multiplies the velocity
<i>filter</i>	the filter to use to smooth noisy motor readings

### 5.24.3 Member Function Documentation

#### 5.24.3.1 get\_motors()

```
motor_group & Flywheel::get_motors ( ) const
```

Returns the motors

#### Returns

the motors used to run the flywheel

#### 5.24.3.2 get\_target()

```
double Flywheel::get_target ( ) const
```

Return the `target_rpm` that the flywheel is currently trying to achieve

#### Returns

`target_rpm` the target rpm

Return the current value that the `target_rpm` should be set to

### 5.24.3.3 getRPM()

```
double Flywheel::getRPM ( ) const
```

return the velocity of the flywheel

### 5.24.3.4 is\_on\_target()

```
bool Flywheel::is_on_target ( ) [inline]
```

check if the feedback controller thinks the flywheel is on target

#### Returns

true if on target

### 5.24.3.5 Page()

```
screen::Page * Flywheel::Page ( ) const
```

Creates a page displaying info about the flywheel.

#### Returns

the page should be used for `screen::start_screen(screen, {fw.Page()});`

### 5.24.3.6 spin\_manual()

```
void Flywheel::spin_manual (
    double speed,
    directionType dir = fwd )
```

Spin motors using voltage; defaults forward at 12 volts FOR USE BY OPCONTROL AND AUTONOMOUS - this only applies if the `target_rpm` thread is not running

#### Parameters

<i>speed</i>	- speed (between -1 and 1) to set the motor
<i>dir</i>	- direction that the motor moves in; defaults to forward

Spin motors using voltage; defaults forward at 12 volts FOR USE BY OPCONTROL AND AUTONOMOUS - this only applies if the RPM thread is not running

#### Parameters

<i>speed</i>	- speed (between -1 and 1) to set the motor
<i>dir</i>	- direction that the motor moves in; defaults to forward

### 5.24.3.7 spin\_rpm()

```
void Flywheel::spin_rpm (
    double input_rpm )
```

starts or sets the target\_rpm thread at new value what control scheme is dependent on control\_style

#### Parameters

<i>rpm</i>	- the target_rpm we want to spin at
------------	-------------------------------------

starts or sets the RPM thread at new value what control scheme is dependent on control\_style

#### Parameters

<i>input_rpm</i>	- set the current RPM
------------------	-----------------------

### 5.24.3.8 SpinRpmCmd()

```
AutoCommand * Flywheel::SpinRpmCmd (
    int rpm ) [inline]
```

Creates a new auto command to spin the flywheel at the desired velocity.

#### Parameters

<i>rpm</i>	the rpm to spin at
------------	--------------------

#### Returns

an auto command to add to a command controller

### 5.24.3.9 stop()

```
void Flywheel::stop ( )
```

Stops the motors. If manually spinning, this will do nothing just call spin\_mainual(0.0) to send 0 volts

stop the RPM thread and the wheel

### 5.24.3.10 WaitUntilUpToSpeedCmd()

```
AutoCommand * Flywheel::WaitUntilUpToSpeedCmd ( ) [inline]
```

Creates a new auto command that will hold until the flywheel has its target as defined by its feedback controller.

#### Returns

an auto command to add to a command controller



## 5.24.4 Friends And Related Symbol Documentation

### 5.24.4.1 spinRPMTask

```
int spinRPMTask (
    void * wheelPointer ) [friend]
```

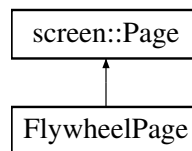
Runs a thread that keeps track of updating flywheel RPM and controlling it accordingly

The documentation for this class was generated from the following files:

- include/subsystems/flywheel.h
- src/subsystems/flywheel.cpp

## 5.25 FlywheelPage Class Reference

Inheritance diagram for FlywheelPage:



### Public Member Functions

- **FlywheelPage** (const [Flywheel](#) &fw)
- void [update](#) (bool, int, int) override
- void [draw](#) (vex::brain::lcd &screen, bool, unsigned int) override

### Static Public Attributes

- static const size\_t **window\_size** = 40

## 5.25.1 Member Function Documentation

### 5.25.1.1 draw()

```
void FlywheelPage::draw (
    vex::brain::lcd & screen,
    bool ,
    unsigned int ) [inline], [override], [virtual]
```

See also

[Page::draw](#)

Reimplemented from [screen::Page](#).

### 5.25.1.2 update()

```
void FlywheelPage::update (
    bool ,
    int ,
    int ) [inline], [override], [virtual]
```

#### See also

Page::update

Reimplemented from [screen::Page](#).

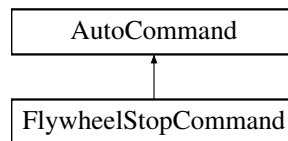
The documentation for this class was generated from the following file:

- src/subsystems/flywheel.cpp

## 5.26 FlywheelStopCommand Class Reference

```
#include <flywheel_commands.h>
```

Inheritance diagram for FlywheelStopCommand:



#### Public Member Functions

- [FlywheelStopCommand](#) ([Flywheel](#) &flywheel)
- bool [run](#) () override

#### Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

#### Additional Inherited Members

#### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

### 5.26.1 Detailed Description

[AutoCommand](#) wrapper class for the stop function in the [Flywheel](#) class

### 5.26.2 Constructor & Destructor Documentation

#### 5.26.2.1 FlywheelStopCommand()

```
FlywheelStopCommand::FlywheelStopCommand (
    Flywheel & flywheel )
```

Construct a [FlywheelStopCommand](#)

##### Parameters

<i>flywheel</i>	the flywheel system we are commanding
-----------------	---------------------------------------

### 5.26.3 Member Function Documentation

#### 5.26.3.1 run()

```
bool FlywheelStopCommand::run ( ) [override], [virtual]
```

Run stop Overrides run from [AutoCommand](#)

##### Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

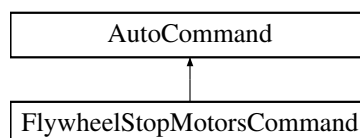
The documentation for this class was generated from the following files:

- include/utlis/command\_structure/flywheel\_commands.h
- src/utlis/command\_structure/flywheel\_commands.cpp

## 5.27 FlywheelStopMotorsCommand Class Reference

```
#include <flywheel_commands.h>
```

Inheritance diagram for FlywheelStopMotorsCommand:



## Public Member Functions

- [FlywheelStopMotorsCommand](#) ([Flywheel](#) &flywheel)
- bool [run](#) () override

## Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.27.1 Detailed Description

[AutoCommand](#) wrapper class for the stopMotors function in the [Flywheel](#) class

### 5.27.2 Constructor & Destructor Documentation

#### 5.27.2.1 FlywheelStopMotorsCommand()

```
FlywheelStopMotorsCommand::FlywheelStopMotorsCommand (
    Flywheel & flywheel )
```

Construct a FlywheelStopMotors Command

#### Parameters

<i>flywheel</i>	the flywheel system we are commanding
-----------------	---------------------------------------

### 5.27.3 Member Function Documentation

#### 5.27.3.1 run()

```
bool FlywheelStopMotorsCommand::run ( ) [override], [virtual]
```

Run stop Overrides run from [AutoCommand](#)

**Returns**

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

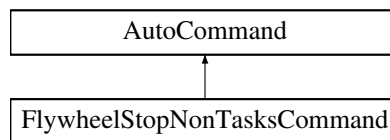
The documentation for this class was generated from the following files:

- include/utils/command\_structure/flywheel\_commands.h
- src/utils/command\_structure/flywheel\_commands.cpp

## 5.28 FlywheelStopNonTasksCommand Class Reference

```
#include <flywheel_commands.h>
```

Inheritance diagram for FlywheelStopNonTasksCommand:

**Additional Inherited Members****Public Member Functions inherited from [AutoCommand](#)**

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

**Public Attributes inherited from [AutoCommand](#)**

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

**Static Public Attributes inherited from [AutoCommand](#)**

- static constexpr double [default\\_timeout](#) = 10.0

### 5.28.1 Detailed Description

[AutoCommand](#) wrapper class for the stopNonTasks function in the [Flywheel](#) class

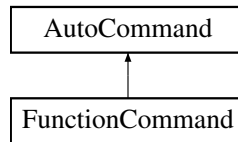
The documentation for this class was generated from the following files:

- include/utils/command\_structure/flywheel\_commands.h
- src/utils/command\_structure/flywheel\_commands.cpp

## 5.29 FunctionCommand Class Reference

```
#include <auto_command.h>
```

Inheritance diagram for FunctionCommand:



### Public Member Functions

- **FunctionCommand** (std::function< bool(void)> f)
- bool [run](#) ()

### Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* **withTimeout** (double t\_seconds)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

#### 5.29.1 Detailed Description

[FunctionCommand](#) is fun and good way to do simple things Printing, launching nukes, and other quick and dirty one time things

## 5.29.2 Member Function Documentation

### 5.29.2.1 run()

```
bool FunctionCommand::run ( ) [inline], [virtual]
```

Executes the command Overridden by child classes

#### Returns

true when the command is finished, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following file:

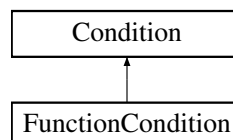
- include/utils/command\_structure/auto\_command.h

## 5.30 FunctionCondition Class Reference

[FunctionCondition](#) is a quick and dirty [Condition](#) to wrap some expression that should be evaluated at runtime.

```
#include <auto_command.h>
```

Inheritance diagram for FunctionCondition:



### Public Member Functions

- **FunctionCondition** (std::function< bool()> cond, std::function< void(void)> timeout=[ ]() {})
- bool [test](#) () override

### Public Member Functions inherited from [Condition](#)

- [Condition](#) \* **Or** ([Condition](#) \*b)
- [Condition](#) \* **And** ([Condition](#) \*b)

### 5.30.1 Detailed Description

[FunctionCondition](#) is a quick and dirty [Condition](#) to wrap some expression that should be evaluated at runtime.

## 5.30.2 Member Function Documentation

### 5.30.2.1 test()

```
bool FunctionCondition::test ( ) [override], [virtual]
```

Implements [Condition](#).

The documentation for this class was generated from the following files:

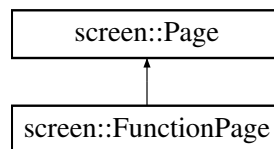
- include/utls/command\_structure/auto\_command.h
- src/utls/command\_structure/auto\_command.cpp

## 5.31 screen::FunctionPage Class Reference

Simple page that stores no internal data. the draw and update functions use only global data rather than storing anything.

```
#include <screen.h>
```

Inheritance diagram for screen::FunctionPage:



### Public Member Functions

- [FunctionPage](#) (update\_func\_t update\_f, draw\_func\_t draw\_t)  
*Creates a function page.*
- void [update](#) (bool was\_pressed, int x, int y) override  
*update uses the supplied update function to update this page*
- void [draw](#) (vex::brain::lcd &, bool first\_draw, unsigned int frame\_number) override  
*draw uses the supplied draw function to draw to the screen*

### 5.31.1 Detailed Description

Simple page that stores no internal data. the draw and update functions use only global data rather than storing anything.

## 5.31.2 Constructor & Destructor Documentation

### 5.31.2.1 FunctionPage()

```
screen::FunctionPage::FunctionPage (
    update_func_t update_f,
    draw_func_t draw_f )
```

Creates a function page.

[FunctionPage](#).



## Parameters

<i>update↔ _f</i>	the function called every tick to respond to user input or do data collection
<i>draw_t</i>	the function called to draw to the screen
<i>update↔ _f</i>	drawing function
<i>draw_f</i>	drawing function

### 5.31.3 Member Function Documentation

#### 5.31.3.1 draw()

```
void screen::FunctionPage::draw (
    vex::brain::lcd & screen,
    bool first_draw,
    unsigned int frame_number ) [override], [virtual]
```

draw uses the supplied draw function to draw to the screen

See also

[Page::draw](#)

Reimplemented from [screen::Page](#).

#### 5.31.3.2 update()

```
void screen::FunctionPage::update (
    bool was_pressed,
    int x,
    int y ) [override], [virtual]
```

update uses the supplied update function to update this page

See also

[Page::update](#)

Reimplemented from [screen::Page](#).

The documentation for this class was generated from the following files:

- include/subsystems/screen.h
- src/subsystems/screen.cpp

## 5.32 GenericAuto Class Reference

```
#include <generic_auto.h>
```

## Public Member Functions

- bool [run](#) (bool blocking)
- void [add](#) (state\_ptr new\_state)
- void [add\\_async](#) (state\_ptr async\_state)
- void [add\\_delay](#) (int ms)

### 5.32.1 Detailed Description

[GenericAuto](#) provides a pleasant interface for organizing an auto path steps of the path can be added with [add\(\)](#) and when ready, calling [run\(\)](#) will begin executing the path

### 5.32.2 Member Function Documentation

#### 5.32.2.1 [add\(\)](#)

```
void GenericAuto::add (
    state_ptr new_state )
```

Add a new state to the autonomous via function point of type "bool (ptr\*)()"

##### Parameters

<i>new_state</i>	the function to run
------------------	---------------------

#### 5.32.2.2 [add\\_async\(\)](#)

```
void GenericAuto::add_async (
    state_ptr async_state )
```

Add a new state to the autonomous via function point of type "bool (ptr\*)()" that will run asynchronously

##### Parameters

<i>async_state</i>	the function to run
--------------------	---------------------

#### 5.32.2.3 [add\\_delay\(\)](#)

```
void GenericAuto::add_delay (
    int ms )
```

[add\\_delay](#) adds a period where the auto system will simply wait for the specified time

##### Parameters

<i>ms</i>	how long to wait in milliseconds
-----------	----------------------------------

#### 5.32.2.4 run()

```
bool GenericAuto::run (
    bool blocking )
```

The method that runs the autonomous. If 'blocking' is true, then this method will run through every state until it finished.

If blocking is false, then assuming every state is also non-blocking, the method will run through the current state in the list and return immediately.

##### Parameters

<i>blocking</i>	Whether or not to block the thread until all states have run
-----------------	--

##### Returns

true after all states have finished.

The documentation for this class was generated from the following files:

- include/utils/generic\_auto.h
- src/utils/generic\_auto.cpp

## 5.33 GraphDrawer Class Reference

### Public Member Functions

- [GraphDrawer](#) (int num\_samples, double lower\_bound, double upper\_bound, std::vector< vex::color > colors, size\_t num\_series=1)  
*Creates a graph drawer with the specified number of series (each series is a separate line)*
- void [add\\_samples](#) (std::vector< [point\\_t](#) > sample)
- void [add\\_samples](#) (std::vector< double > sample)
- void [draw](#) (vex::brain::lcd &screen, int x, int y, int width, int height)

### 5.33.1 Constructor & Destructor Documentation

#### 5.33.1.1 GraphDrawer()

```
GraphDrawer::GraphDrawer (
    int num_samples,
    double lower_bound,
    double upper_bound,
    std::vector< vex::color > colors,
    size_t num_series = 1 )
```

Creates a graph drawer with the specified number of series (each series is a separate line)

## Parameters

<i>num_samples</i>	the number of samples to graph at a time (40 will graph the last 40 data points)
<i>lower_bound</i>	the bottom of the window when displaying (if upper_bound = lower_bound, auto calculate bounds)
<i>upper_bound</i>	the top of the window when displaying (if upper_bound = lower_bound, auto calculate bounds)
<i>colors</i>	the colors of the series. must be of size num_series
<i>num_series</i>	the number of series to graph

## 5.33.2 Member Function Documentation

### 5.33.2.1 add\_samples() [1/2]

```
void GraphDrawer::add_samples (
    std::vector< double > sample )
```

add\_samples adds a point to the graph, removing one from the back

## Parameters

<i>sample</i>	a y coordinate of the next point to graph, the x coordinate is gotten from vex::timer::system(); (time in ms)
---------------	---

### 5.33.2.2 add\_samples() [2/2]

```
void GraphDrawer::add_samples (
    std::vector< point_t > new_samples )
```

add\_samples adds a point to the graph, removing one from the back

## Parameters

<i>sample</i>	an x, y coordinate of the next point to graph
---------------	---

### 5.33.2.3 draw()

```
void GraphDrawer::draw (
    vex::brain::lcd & screen,
    int x,
    int y,
    int width,
    int height )
```

draws the graph to the screen in the constructor

## Parameters

<i>x</i>	x position of the top left of the graphed region
----------	--

## Parameters

<i>y</i>	y position of the top left of the graphed region
<i>width</i>	the width of the graphed region
<i>height</i>	the height of the graphed region

The documentation for this class was generated from the following files:

- include/utils/graph\_drawer.h
- src/utils/graph\_drawer.cpp

## 5.34 PurePursuit::hermite\_point Struct Reference

```
#include <pure_pursuit.h>
```

## Public Member Functions

- [point\\_t](#) **getPoint** () const
- [Vector2D](#) **getTangent** () const

## Public Attributes

- double **x**
- double **y**
- double **dir**
- double **mag**

### 5.34.1 Detailed Description

a position along the hermite path contains a position and orientation information that the robot would be at at this point

The documentation for this struct was generated from the following file:

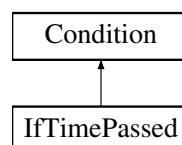
- include/utils/pure\_pursuit.h

## 5.35 IfTimePassed Class Reference

[IfTimePassed](#) tests based on time since the command controller was constructed. Returns true if elapsed time > time\_s.

```
#include <auto_command.h>
```

Inheritance diagram for IfTimePassed:



### Public Member Functions

- **IfTimePassed** (double time\_s)
- bool **test** () override

### Public Member Functions inherited from [Condition](#)

- [Condition](#) \* **Or** ([Condition](#) \*b)
- [Condition](#) \* **And** ([Condition](#) \*b)

#### 5.35.1 Detailed Description

[IfTimePassed](#) tests based on time since the command controller was constructed. Returns true if elapsed time > time\_s.

#### 5.35.2 Member Function Documentation

##### 5.35.2.1 test()

```
bool IfTimePassed::test ( ) [override], [virtual]
```

Implements [Condition](#).

The documentation for this class was generated from the following files:

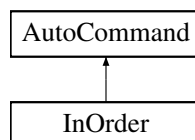
- include/utils/command\_structure/auto\_command.h
- src/utils/command\_structure/auto\_command.cpp

## 5.36 InOrder Class Reference

[InOrder](#) runs its commands sequentially then continues. How to handle timeout in this case. Automatically set it to sum of commands timeouts?

```
#include <auto_command.h>
```

Inheritance diagram for InOrder:



### Public Member Functions

- **InOrder** (const [InOrder](#) &other)=default
- **InOrder** (std::queue< [AutoCommand](#) \* > cmds)
- **InOrder** (std::initializer\_list< [AutoCommand](#) \* > cmds)
- bool **run** () override
- void **on\_timeout** () override

## Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* **withTimeout** (double t\_seconds)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* **true\_to\_end** = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

### 5.36.1 Detailed Description

[InOrder](#) runs its commands sequentially then continues. How to handle timeout in this case. Automatically set it to sum of commands timeouts?

[InOrder](#) runs its commands sequentially then continues. How to handle timeout in this case. Automatically set it to sum of commands timeouts?

### 5.36.2 Member Function Documentation

#### 5.36.2.1 on\_timeout()

```
void InOrder::on_timeout ( ) [override], [virtual]
```

What to do if we timeout instead of finishing. timeout is specified by the timeout seconds in the constructor

Reimplemented from [AutoCommand](#).

#### 5.36.2.2 run()

```
bool InOrder::run ( ) [override], [virtual]
```

Executes the command Overridden by child classes

#### Returns

true when the command is finished, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utils/command\_structure/auto\_command.h
- src/utils/command\_structure/auto\_command.cpp

## 5.37 Lift< T > Class Template Reference

```
#include <lift.h>
```

### Classes

- struct [lift\\_cfg\\_t](#)

### Public Member Functions

- [Lift](#) (motor\_group &lift\_motors, [lift\\_cfg\\_t](#) &lift\_cfg, map< T, double > &setpoint\_map, limit \*homing\_switch=NULL)
- void [control\\_continuous](#) (bool up\_ctrl, bool down\_ctrl)
- void [control\\_manual](#) (bool up\_btn, bool down\_btn, int volt\_up, int volt\_down)
- void [control\\_setpoints](#) (bool up\_step, bool down\_step, vector< T > pos\_list)
- bool [set\\_position](#) (T pos)
- bool [set\\_setpoint](#) (double val)
- double [get\\_setpoint](#) ()
- void [hold](#) ()
- void [home](#) ()
- bool [get\\_async](#) ()
- void [set\\_async](#) (bool val)
- void [set\\_sensor\\_function](#) (double(\*fn\_ptr)(void))
- void [set\\_sensor\\_reset](#) (void(\*fn\_ptr)(void))

### 5.37.1 Detailed Description

```
template<typename T>
```

```
class Lift< T >
```

LIFT A general class for lifts (e.g. 4bar, dr4bar, linear, etc) Uses a [PID](#) to hold the lift at a certain height under load, and to move the lift to different heights

Author

Ryan McGee

### 5.37.2 Constructor & Destructor Documentation

#### 5.37.2.1 Lift()

```
template<typename T >
Lift< T >::Lift (
    motor_group & lift_motors,
    lift_cfg_t & lift_cfg,
    map< T, double > & setpoint_map,
    limit * homing_switch = NULL ) [inline]
```

Construct the [Lift](#) object and begin the background task that controls the lift.

Usage example: `/code{.cpp} enum Positions {UP, MID, DOWN}; map<Positions, double> setpt_map { {DOWN, 0.0}, {MID, 0.5}, {UP, 1.0} }; Lift<Positions> my_lift(motors, lift_cfg, setpt_map); /endcode`



## Parameters

<i>lift_motors</i>	A set of motors, all set that positive rotation correlates with the lift going up
<i>lift_cfg</i>	<a href="#">Lift</a> characterization information; <a href="#">PID</a> tunings and movement speeds
<i>setpoint_map</i>	A map of enum type T, in which each enum entry corresponds to a different lift height

### 5.37.3 Member Function Documentation

#### 5.37.3.1 control\_continuous()

```
template<typename T >
void Lift< T >::control_continuous (
    bool up_ctrl,
    bool down_ctrl ) [inline]
```

Control the lift with an "up" button and a "down" button. Use [PID](#) to hold the lift when letting go.

## Parameters

<i>up_ctrl</i>	Button controlling the "UP" motion
<i>down_ctrl</i>	Button controlling the "DOWN" motion

#### 5.37.3.2 control\_manual()

```
template<typename T >
void Lift< T >::control_manual (
    bool up_btn,
    bool down_btn,
    int volt_up,
    int volt_down ) [inline]
```

Control the lift with manual controls (no holding voltage)

## Parameters

<i>up_btn</i>	Raise the lift when true
<i>down_btn</i>	Lower the lift when true
<i>volt_up</i>	Motor voltage when raising the lift
<i>volt_down</i>	Motor voltage when lowering the lift

#### 5.37.3.3 control\_setpoints()

```
template<typename T >
void Lift< T >::control_setpoints (
    bool up_step,
    bool down_step,
    vector< T > pos_list ) [inline]
```

Control the lift in "steps". When the "up" button is pressed, the lift will go to the next position as defined by `pos_list`. Order matters!

#### Parameters

<i>up_step</i>	A button that increments the position of the lift.
<i>down_step</i>	A button that decrements the position of the lift.
<i>pos_list</i>	A list of positions for the lift to go through. The higher the index, the higher the lift should be (generally).

#### 5.37.3.4 `get_async()`

```
template<typename T >
bool Lift< T >::get_async ( ) [inline]
```

#### Returns

whether or not the background thread is running the lift

#### 5.37.3.5 `get_setpoint()`

```
template<typename T >
double Lift< T >::get_setpoint ( ) [inline]
```

#### Returns

The current setpoint for the lift

#### 5.37.3.6 `hold()`

```
template<typename T >
void Lift< T >::hold ( ) [inline]
```

Target the class's setpoint. Calculate the `PID` output and set the lift motors accordingly.

#### 5.37.3.7 `home()`

```
template<typename T >
void Lift< T >::home ( ) [inline]
```

A blocking function that automatically homes the lift based on a sensor or hard stop, and sets the position to 0. A watchdog times out after 3 seconds, to avoid damage.

#### 5.37.3.8 `set_async()`

```
template<typename T >
void Lift< T >::set_async (
    bool val ) [inline]
```

Enables or disables the background task. Note that running the control functions, or `set_position` functions will immediately re-enable the task for autonomous use.

## Parameters

<i>val</i>	Whether or not the background thread should run the lift
------------	--

## 5.37.3.9 set\_position()

```
template<typename T >
bool Lift< T >::set_position (
    T pos ) [inline]
```

Enable the background task, and send the lift to a position, specified by the setpoint map from the constructor.

## Parameters

<i>pos</i>	A lift position enum type
------------	---------------------------

## Returns

True if the pid has reached the setpoint

## 5.37.3.10 set\_sensor\_function()

```
template<typename T >
void Lift< T >::set_sensor_function (
    double(*) (void) fn_ptr ) [inline]
```

Creates a custom hook for any other type of sensor to be used on the lift. Example: `/code{.cpp} my_lift.set_sensor_function( [](){return my_sensor.position();} );/endcode`

## Parameters

<i>fn_ptr</i>	Pointer to custom sensor function
---------------	-----------------------------------

## 5.37.3.11 set\_sensor\_reset()

```
template<typename T >
void Lift< T >::set_sensor_reset (
    void(*) (void) fn_ptr ) [inline]
```

Creates a custom hook to reset the sensor used in [set\\_sensor\\_function\(\)](#). Example: `/code{.cpp} my_lift.set_sensor_reset( my_sensor.resetPosition );/endcode`

## 5.37.3.12 set\_setpoint()

```
template<typename T >
bool Lift< T >::set_setpoint (
    double val ) [inline]
```

Manually set a setpoint value for the lift [PID](#) to go to.

## Parameters

<i>val</i>	<a href="#">Lift</a> setpoint, in motor revolutions or sensor units defined by <code>get_sensor</code> . Cannot be outside the softstops.
------------	---

## Returns

True if the pid has reached the setpoint

The documentation for this class was generated from the following file:

- `include/subsystems/lift.h`

## 5.38 `Lift< T >::lift_cfg_t` Struct Reference

```
#include <lift.h>
```

## Public Attributes

- double `up_speed`
- double `down_speed`
- double `softstop_up`
- double `softstop_down`
- [PID::pid\\_config\\_t](#) `lift_pid_cfg`

### 5.38.1 Detailed Description

```
template<typename T>
struct Lift< T >::lift_cfg_t
```

[lift\\_cfg\\_t](#) holds the physical parameter specifications of a lify system. includes:

- maximum speeds for the system
- softstops to stop the lift from hitting the hard stops too hard

The documentation for this struct was generated from the following file:

- `include/subsystems/lift.h`

## 5.39 Logger Class Reference

Class to simplify writing to files.

```
#include <logger.h>
```

## Public Member Functions

- [Logger](#) (const std::string &filename)  
*Create a logger that will save to a file.*
- **Logger** (const [Logger](#) &l)=delete  
*copying not allowed*
- **Logger & operator=** (const [Logger](#) &l)=delete  
*copying not allowed*
- void [Log](#) (const std::string &s)  
*Write a string to the log.*
- void [Log](#) (LogLevel level, const std::string &s)  
*Write a string to the log with a loglevel.*
- void [Logln](#) (const std::string &s)  
*Write a string and newline to the log.*
- void [Logln](#) (LogLevel level, const std::string &s)  
*Write a string and a newline to the log with a loglevel.*
- void [Logf](#) (const char \*fmt,...)  
*Write a formatted string to the log.*
- void [Logf](#) (LogLevel level, const char \*fmt,...)  
*Write a formatted string to the log with a loglevel.*

## Static Public Attributes

- static constexpr int **MAX\_FORMAT\_LEN** = 512  
*maximum size for a string to be before it's written*

### 5.39.1 Detailed Description

Class to simplify writing to files.

### 5.39.2 Constructor & Destructor Documentation

#### 5.39.2.1 Logger()

```
Logger::Logger (
    const std::string & filename ) [explicit]
```

Create a logger that will save to a file.

#### Parameters

<i>filename</i>	the file to save to
-----------------	---------------------

### 5.39.3 Member Function Documentation

#### 5.39.3.1 Log() [1/2]

```
void Logger::Log (
    const std::string & s )
```

Write a string to the log.

##### Parameters

<i>s</i>	the string to write
----------	---------------------

#### 5.39.3.2 Log() [2/2]

```
void Logger::Log (
    LogLevel level,
    const std::string & s )
```

Write a string to the log with a loglevel.

##### Parameters

<i>level</i>	the level to write. DEBUG, NOTICE, WARNING, ERROR, CRITICAL, TIME
<i>s</i>	the string to write

#### 5.39.3.3 Logf() [1/2]

```
void Logger::Logf (
    const char * fmt,
    ... )
```

Write a formatted string to the log.

##### Parameters

<i>fmt</i>	the format string (like printf)
<i>...</i>	the args

#### 5.39.3.4 Logf() [2/2]

```
void Logger::Logf (
    LogLevel level,
    const char * fmt,
    ... )
```

Write a formatted string to the log with a loglevel.

## Parameters

<i>level</i>	the level to write. DEBUG, NOTICE, WARNING, ERROR, CRITICAL, TIME
<i>fmt</i>	the format string (like printf)
...	the args

**5.39.3.5 Logln()** [1/2]

```
void Logger::Logln (
    const std::string & s )
```

Write a string and newline to the log.

## Parameters

<i>s</i>	the string to write
----------	---------------------

**5.39.3.6 Logln()** [2/2]

```
void Logger::Logln (
    LogLevel level,
    const std::string & s )
```

Write a string and a newline to the log with a loglevel.

## Parameters

<i>level</i>	the level to write. DEBUG, NOTICE, WARNING, ERROR, CRITICAL, TIME
<i>s</i>	the string to write

The documentation for this class was generated from the following files:

- include/utils/logger.h
- src/utils/logger.cpp

**5.40 MotionController::m\_profile\_cfg\_t Struct Reference**

```
#include <motion_controller.h>
```

**Public Attributes**

- double **max\_v**  
*the maximum velocity the robot can drive*
- double **accel**  
*the most acceleration the robot can do*
- [PID::pid\\_config\\_t](#) **pid\_cfg**  
*configuration parameters for the internal [PID](#) controller*
- [FeedForward::ff\\_config\\_t](#) **ff\_cfg**  
*configuration parameters for the internal*

### 5.40.1 Detailed Description

m\_profile\_config holds all data the motion controller uses to plan paths When motion profile is given a target to drive to, max\_v and accel are used to make the trapezoid profile instructing the controller how to drive pid\_cfg, ff\_cfg are used to find the motor outputs necessary to execute this path

The documentation for this struct was generated from the following file:

- include/utils/controls/motion\_controller.h

## 5.41 Mat2 Struct Reference

### Public Member Functions

- [point\\_t](#) operator\* (const [point\\_t](#) p) const

### Static Public Member Functions

- static [Mat2](#) FromRotationDegrees (double degrees)

### Public Attributes

- double **X11**
- double **X12**
- double **X21**
- double **X22**

The documentation for this struct was generated from the following file:

- include/utils/geometry.h

## 5.42 MecanumDrive Class Reference

```
#include <mecanum_drive.h>
```

### Classes

- struct [mecanumdrive\\_config\\_t](#)

### Public Member Functions

- [MecanumDrive](#) (vex::motor &left\_front, vex::motor &right\_front, vex::motor &left\_rear, vex::motor &right\_rear, vex::rotation \*lateral\_wheel=NULL, vex::inertial \*imu=NULL, [mecanumdrive\\_config\\_t](#) \*config=NULL)
- void [drive\\_raw](#) (double direction\_deg, double magnitude, double rotation)
- void [drive](#) (double left\_y, double left\_x, double right\_x, int power=2)
- bool [auto\\_drive](#) (double inches, double direction, double speed, bool gyro\_correction=true)
- bool [auto\\_turn](#) (double degrees, double speed, bool ignore\_imu=false)



### 5.42.1 Detailed Description

A class representing the Mecanum drivetrain. Contains 4 motors, a possible IMU (intertial), and a possible undriven perpendicular wheel.

### 5.42.2 Constructor & Destructor Documentation

#### 5.42.2.1 MecanumDrive()

```
MecanumDrive::MecanumDrive (
    vex::motor & left_front,
    vex::motor & right_front,
    vex::motor & left_rear,
    vex::motor & right_rear,
    vex::rotation * lateral_wheel = NULL,
    vex::inertial * imu = NULL,
    mecanumdrive_config_t * config = NULL )
```

Create the Mecanum drivetrain object

### 5.42.3 Member Function Documentation

#### 5.42.3.1 auto\_drive()

```
bool MecanumDrive::auto_drive (
    double inches,
    double direction,
    double speed,
    bool gyro_correction = true )
```

Drive the robot in a straight line automatically. If the inertial was declared in the constructor, use it to correct while driving. If the lateral wheel was declared in the constructor, use it for more accurate positioning while strafing.

##### Parameters

<i>inches</i>	How far the robot should drive, in inches
<i>direction</i>	What direction the robot should travel in, in degrees. 0 is forward, +/-180 is reverse, clockwise is positive.
<i>speed</i>	The maximum speed the robot should travel, in percent: -1.0->+1.0
<i>gyro_correction</i>	=true Whether or not to use the gyro to help correct while driving. Will always be false if no gyro was declared in the constructor.

Drive the robot in a straight line automatically. If the inertial was declared in the constructor, use it to correct while driving. If the lateral wheel was declared in the constructor, use it for more accurate positioning while strafing.

##### Parameters

<i>inches</i>	How far the robot should drive, in inches
<i>direction</i>	What direction the robot should travel in, in degrees. 0 is forward, +/-180 is reverse, clockwise is positive.

## Parameters

<i>speed</i>	The maximum speed the robot should travel, in percent: -1.0->+1.0
<i>gyro_correction</i>	= true Whether or not to use the gyro to help correct while driving. Will always be false if no gyro was declared in the constructor.

## Returns

Whether or not the maneuver is complete.

**5.42.3.2 auto\_turn()**

```
bool MecanumDrive::auto_turn (
    double degrees,
    double speed,
    bool ignore_imu = false )
```

Autonomously turn the robot X degrees over it's center point. Uses a closed loop for control.

## Parameters

<i>degrees</i>	How many degrees to rotate the robot. Clockwise postive.
<i>speed</i>	What percentage to run the motors at: 0.0 -> 1.0
<i>ignore_imu</i>	=false Whether or not to use the Inertial for determining angle. Will instead use circumference formula + robot's wheelbase + encoders to determine.

## Returns

whether or not the robot has finished the maneuver

Autonomously turn the robot X degrees over it's center point. Uses a closed loop for control.

## Parameters

<i>degrees</i>	How many degrees to rotate the robot. Clockwise postive.
<i>speed</i>	What percentage to run the motors at: 0.0 -> 1.0
<i>ignore_imu</i>	= false Whether or not to use the Inertial for determining angle. Will instead use circumference formula + robot's wheelbase + encoders to determine.

## Returns

whether or not the robot has finished the maneuver

**5.42.3.3 drive()**

```
void MecanumDrive::drive (
    double left_y,
```

```
double left_x,
double right_x,
int power = 2 )
```

Drive the robot with a mecanum-style / arcade drive. Inputs are in percent (-100.0 -> 100.0) straight from the controller. Controls are mixed, so the robot can drive forward / strafe / rotate all at the same time.

#### Parameters

<i>left_y</i>	left joystick, Y axis (forward / backwards)
<i>left_x</i>	left joystick, X axis (strafe left / right)
<i>right_x</i>	right joystick, X axis (rotation left / right)
<i>power</i>	=2 how much of a "curve" there should be on drive controls; better for low speed maneuvers. Leave blank for a default curve of 2 (higher means more fidelity)

Drive the robot with a mecanum-style / arcade drive. Inputs are in percent (-100.0 -> 100.0) straight from the controller. Controls are mixed, so the robot can drive forward / strafe / rotate all at the same time.

#### Parameters

<i>left_y</i>	left joystick, Y axis (forward / backwards)
<i>left_x</i>	left joystick, X axis (strafe left / right)
<i>right_x</i>	right joystick, X axis (rotation left / right)
<i>power</i>	= 2 how much of a "curve" there should be on drive controls; better for low speed maneuvers. Leave blank for a default curve of 2 (higher means more fidelity)

#### 5.42.3.4 drive\_raw()

```
void MecanumDrive::drive_raw (
    double direction_deg,
    double magnitude,
    double rotation )
```

Drive the robot using vectors. This handles all the math required for mecanum control.

#### Parameters

<i>direction_deg</i>	the direction to drive the robot, in degrees. 0 is forward, 180 is back, clockwise is positive, counterclockwise is negative.
<i>magnitude</i>	How fast the robot should drive, in percent: 0.0->1.0
<i>rotation</i>	How fast the robot should rotate, in percent: -1.0->+1.0

The documentation for this class was generated from the following files:

- include/subsystems/mecanum\_drive.h
- src/subsystems/mecanum\_drive.cpp

## 5.43 MecanumDrive::mecanumdrive\_config\_t Struct Reference

```
#include <mecanum_drive.h>
```

### Public Attributes

- [PID::pid\\_config\\_t](#) **drive\_pid\_conf**
- [PID::pid\\_config\\_t](#) **drive\_gyro\_pid\_conf**
- [PID::pid\\_config\\_t](#) **turn\_pid\_conf**
- double **drive\_wheel\_diam**
- double **lateral\_wheel\_diam**
- double **wheelbase\_width**

### 5.43.1 Detailed Description

Configure the Mecanum drive [PID](#) tunings and robot configurations

The documentation for this struct was generated from the following file:

- include/subsystems/mecanum\_drive.h

## 5.44 motion\_t Struct Reference

```
#include <trapezoid_profile.h>
```

### Public Attributes

- double **pos**  
*1d position at this point in time*
- double **vel**  
*1d velocity at this point in time*
- double **accel**  
*1d acceleration at this point in time*

### 5.44.1 Detailed Description

[motion\\_t](#) is a description of 1 dimensional motion at a point in time.

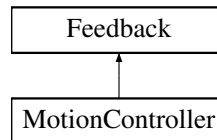
The documentation for this struct was generated from the following file:

- include/utils/controls/trapezoid\_profile.h

## 5.45 MotionController Class Reference

```
#include <motion_controller.h>
```

Inheritance diagram for MotionController:



### Classes

- struct [m\\_profile\\_cfg\\_t](#)

### Public Member Functions

- [MotionController](#) ([m\\_profile\\_cfg\\_t](#) &config)  
*Construct a new Motion Controller object.*
- void [init](#) (double start\_pt, double end\_pt, double start\_vel, double end\_vel) override  
*Initialize the motion profile for a new movement This will also reset the [PID](#) and profile timers.*
- double [update](#) (double sensor\_val) override  
*Update the motion profile with a new sensor value.*
- double [get](#) () override
- void [set\\_limits](#) (double lower, double upper) override
- bool [is\\_on\\_target](#) () override
- [motion\\_t get\\_motion](#) ()

### Static Public Member Functions

- static [FeedForward::ff\\_config\\_t tune\\_feedforward](#) ([TankDrive](#) &drive, [OdometryTank](#) &odometry, double pct=0.6, double duration=2)

### 5.45.1 Detailed Description

Motion Controller class

This class defines a top-level motion profile, which can act as an intermediate between a subsystem class and the motors themselves

This takes the constants kS, kV, kA, kP, kI, kD, max\_v and acceleration and wraps around a feedforward, [PID](#) and trapezoid profile. It does so with the following formula:

```
out = feedforward.calculate(motion_profile.get(time_s)) + pid.get(motion_profile.get(time_s))
```

For [PID](#) and Feedforward specific formulae, see [pid.h](#), [feedforward.h](#), and [trapezoid\\_profile.h](#)

#### Author

Ryan McGee

#### Date

7/13/2022

## 5.45.2 Constructor & Destructor Documentation

### 5.45.2.1 MotionController()

```
MotionController::MotionController (
    m_profile_cfg_t & config )
```

Construct a new Motion Controller object.

#### Parameters

<i>config</i>	The definition of how the robot is able to move max_v Maximum velocity the movement is capable of accel Acceleration / deceleration of the movement pid_cfg Definitions of kP, kI, and kD ff_cfg Definitions of kS, kV, and kA
---------------	--

## 5.45.3 Member Function Documentation

### 5.45.3.1 get()

```
double MotionController::get ( ) [override], [virtual]
```

#### Returns

the last saved result from the feedback controller

Implements [Feedback](#).

### 5.45.3.2 get\_motion()

```
motion_t MotionController::get_motion ( )
```

#### Returns

The current position, velocity and acceleration setpoints

### 5.45.3.3 init()

```
void MotionController::init (
    double start_pt,
    double end_pt,
    double start_vel,
    double end_vel ) [override], [virtual]
```

Initialize the motion profile for a new movement This will also reset the [PID](#) and profile timers.

#### Parameters

<i>start_pt</i>	Movement starting position
<i>end_pt</i>	Movement ending position
<i>start_vel</i>	Movement starting velocity
<i>end_vel</i>	Movement ending velocity

Implements [Feedback](#).

#### 5.45.3.4 is\_on\_target()

```
bool MotionController::is_on_target ( ) [override], [virtual]
```

##### Returns

Whether or not the movement has finished, and the [PID](#) confirms it is on target

Implements [Feedback](#).

#### 5.45.3.5 set\_limits()

```
void MotionController::set_limits (
    double lower,
    double upper ) [override], [virtual]
```

Clamp the upper and lower limits of the output. If both are 0, no limits should be applied. if limits are applied, the controller will not target any value below lower or above upper

##### Parameters

<i>lower</i>	upper limit
<i>upper</i>	lower limit

Clamp the upper and lower limits of the output. If both are 0, no limits should be applied.

##### Parameters

<i>lower</i>	Upper limit
<i>upper</i>	Lower limit

Implements [Feedback](#).

#### 5.45.3.6 tune\_feedforward()

```
FeedForward::ff_config_t MotionController::tune_feedforward (
    TankDrive & drive,
    OdometryTank & odometry,
    double pct = 0.6,
    double duration = 2 ) [static]
```

This method attempts to characterize the robot's drivetrain and automatically tune the feedforward. It does this by first calculating the kS (voltage to overcome static friction) by slowly increasing the voltage until it moves.

Next is kV (voltage to sustain a certain velocity), where the robot will record it's steady-state velocity at 'pct' speed.

Finally, kA (voltage needed to accelerate by a certain rate), where the robot will record the entire movement's velocity and acceleration, record a plot of  $[X=(pct-kV*V-kS), Y=(Acceleration)]$  along the movement, and since  $kA*Accel = pct-kV*V-kS$ , the reciprocal of the linear regression is the kA value.

## Parameters

<i>drive</i>	The tankdrive to operate on
<i>odometry</i>	The robot's odometry subsystem
<i>pct</i>	Maximum velocity in percent (0->1.0)
<i>duration</i>	Amount of time the robot should be moving for the test

## Returns

A tuned feedforward object

**5.45.3.7 update()**

```
double MotionController::update (
    double sensor_val ) [override], [virtual]
```

Update the motion profile with a new sensor value.

## Parameters

<i>sensor_val</i>	Value from the sensor
-------------------	-----------------------

## Returns

the motor input generated from the motion profile

Implements [Feedback](#).

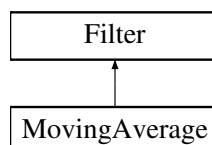
The documentation for this class was generated from the following files:

- include/utls/controls/motion\_controller.h
- src/utls/controls/motion\_controller.cpp

**5.46 MovingAverage Class Reference**

```
#include <moving_average.h>
```

Inheritance diagram for MovingAverage:





## Public Member Functions

- [MovingAverage](#) (int buffer\_size)
- [MovingAverage](#) (int buffer\_size, double starting\_value)
- void [add\\_entry](#) (double n)
- double [get\\_value](#) () const
- int [get\\_size](#) () const

### 5.46.1 Detailed Description

#### [MovingAverage](#)

A moving average is a way of smoothing out noisy data. For many sensor readings, the noise is roughly symmetric around the actual value. This means that if you collect enough samples those that are too high are cancelled out by the samples that are too low leaving the real value.

The [MovingAverage](#) class provides a simple interface to do this smoothing from our noisy sensor values.

WARNING: because we need a lot of samples to get the actual value, the value given by the [MovingAverage](#) will 'lag' behind the actual value that the sensor is reading. Using a [MovingAverage](#) is thus a tradeoff between accuracy and lag time (more samples) vs. less accuracy and faster updating (less samples).

### 5.46.2 Constructor & Destructor Documentation

#### 5.46.2.1 [MovingAverage\(\)](#) [1/2]

```
MovingAverage::MovingAverage (
    int buffer_size )
```

Create a moving average calculator with 0 as the default value

##### Parameters

<i>buffer_size</i>	The size of the buffer. The number of samples that constitute a valid reading
--------------------	---

#### 5.46.2.2 [MovingAverage\(\)](#) [2/2]

```
MovingAverage::MovingAverage (
    int buffer_size,
    double starting_value )
```

Create a moving average calculator with a specified default value

##### Parameters

<i>buffer_size</i>	The size of the buffer. The number of samples that constitute a valid reading
<i>starting_value</i>	The value that the average will be before any data is added

### 5.46.3 Member Function Documentation

#### 5.46.3.1 add\_entry()

```
void MovingAverage::add_entry (
    double n ) [virtual]
```

Add a reading to the buffer Before: [ 1 1 2 2 3 3] => 2 ^ After: [ 2 1 2 2 3 3] => 2.16 ^

##### Parameters

<i>n</i>	the sample that will be added to the moving average.
----------	--

Implements [Filter](#).

#### 5.46.3.2 get\_size()

```
int MovingAverage::get_size ( ) const
```

How many samples the average is made from

##### Returns

the number of samples used to calculate this average

#### 5.46.3.3 get\_value()

```
double MovingAverage::get_value ( ) const [virtual]
```

Returns the average based off of all the samples collected so far

##### Returns

the calculated average. `sum(samples)/numsamples`

How many samples the average is made from

##### Returns

the number of samples used to calculate this average

Implements [Filter](#).

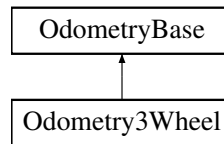
The documentation for this class was generated from the following files:

- include/utls/moving\_average.h
- src/utls/moving\_average.cpp

## 5.47 Odometry3Wheel Class Reference

```
#include <odometry_3wheel.h>
```

Inheritance diagram for Odometry3Wheel:



### Classes

- struct [odometry3wheel\\_cfg\\_t](#)

### Public Member Functions

- [Odometry3Wheel](#) ([CustomEncoder](#) &side\_fwd, [CustomEncoder](#) &side\_rev, [CustomEncoder](#) &off\_axis, [odometry3wheel\\_cfg\\_t](#) &cfg, bool is\_async=true)
- [pose\\_t update](#) () override
- void [tune](#) (vex::controller &con, [TankDrive](#) &drive)

### Public Member Functions inherited from [OdometryBase](#)

- [OdometryBase](#) (bool is\_async)
- [pose\\_t get\\_position](#) (void)
- virtual void [set\\_position](#) (const [pose\\_t](#) &newpos=[zero\\_pos](#))
- void [end\\_async](#) ()
- double [get\\_speed](#) ()
- double [get\\_accel](#) ()
- double [get\\_angular\\_speed\\_deg](#) ()
- double [get\\_angular\\_accel\\_deg](#) ()

### Additional Inherited Members

### Static Public Member Functions inherited from [OdometryBase](#)

- static int [background\\_task](#) (void \*ptr)
- static double [pos\\_diff](#) ([pose\\_t](#) start\_pos, [pose\\_t](#) end\_pos)
- static double [rot\\_diff](#) ([pose\\_t](#) pos1, [pose\\_t](#) pos2)
- static double [smallest\\_angle](#) (double start\_deg, double end\_deg)

### Public Attributes inherited from [OdometryBase](#)

- bool [end\\_task](#) = false  
*end\_task is true if we instruct the odometry thread to shut down*

## Static Public Attributes inherited from [OdometryBase](#)

- static constexpr [pose\\_t](#) [zero\\_pos](#) = {.x=0.0L, .y=0.0L, .rot=90.0L}

## Protected Attributes inherited from [OdometryBase](#)

- vex::task \* [handle](#)
- vex::mutex [mut](#)
- [pose\\_t](#) [current\\_pos](#)
- double [speed](#)
- double [accel](#)
- double [ang\\_speed\\_deg](#)
- double [ang\\_accel\\_deg](#)

### 5.47.1 Detailed Description

#### [Odometry3Wheel](#)

This class handles the code for a standard 3-pod odometry setup, where there are 3 "pods" made up of undriven (dead) wheels connected to encoders in the following configuration:

```
+Y ----- ^ ||||| O ||||| == | | ----- | +-----> + X
```

Where O is the center of rotation. The robot will monitor the changes in rotation of these wheels and calculate the robot's X, Y and rotation on the field.

This is a "set and forget" class, meaning once the object is created, the robot will immediately begin tracking it's movement in the background.

#### Author

Ryan McGee

#### Date

Oct 31 2022

### 5.47.2 Constructor & Destructor Documentation

#### 5.47.2.1 [Odometry3Wheel\(\)](#)

```
Odometry3Wheel::Odometry3Wheel (
    CustomEncoder & lside_fwd,
    CustomEncoder & rside_fwd,
    CustomEncoder & off_axis,
    odometry3wheel_cfg_t & cfg,
    bool is_async = true )
```

Construct a new Odometry 3 Wheel object

## Parameters

<i>lside_fwd</i>	left-side encoder reference
<i>rside_fwd</i>	right-side encoder reference
<i>off_axis</i>	off-axis (perpendicular) encoder reference
<i>cfg</i>	robot odometry configuration
<i>is_async</i>	true to constantly run in the background

### 5.47.3 Member Function Documentation

#### 5.47.3.1 tune()

```
void Odometry3Wheel::tune (
    vex::controller & con,
    TankDrive & drive )
```

A guided tuning process to automatically find tuning parameters. This method is blocking, and returns when tuning has finished. Follow the instructions on the controller to complete the tuning process

## Parameters

<i>con</i>	Controller reference, for screen and button control
<i>drive</i>	Drivetrain reference for robot control

A guided tuning process to automatically find tuning parameters. This method is blocking, and returns when tuning has finished. Follow the instructions on the controller to complete the tuning process

It is assumed the gear ratio and encoder PPR have been set correctly

#### 5.47.3.2 update()

```
pose_t Odometry3Wheel::update ( ) [override], [virtual]
```

Update the current position of the robot once, using the current state of the encoders and the previous known location

## Returns

the robot's updated position

Implements [OdometryBase](#).

The documentation for this class was generated from the following files:

- include/subsystems/odometry/odometry\_3wheel.h
- src/subsystems/odometry/odometry\_3wheel.cpp

## 5.48 Odometry3Wheel::odometry3wheel\_cfg\_t Struct Reference

```
#include <odometry_3wheel.h>
```

### Public Attributes

- double [wheelbase\\_dist](#)
- double [off\\_axis\\_center\\_dist](#)
- double [wheel\\_diam](#)

### 5.48.1 Detailed Description

[odometry3wheel\\_cfg\\_t](#) holds all the specifications for how to calculate position with 3 encoders See the core wiki for what exactly each of these parameters measures

### 5.48.2 Member Data Documentation

#### 5.48.2.1 [off\\_axis\\_center\\_dist](#)

```
double Odometry3Wheel::odometry3wheel_cfg_t::off_axis_center_dist
```

distance from the center of the robot to the center off axis wheel

#### 5.48.2.2 [wheel\\_diam](#)

```
double Odometry3Wheel::odometry3wheel_cfg_t::wheel_diam
```

the diameter of the tracking wheel

#### 5.48.2.3 [wheelbase\\_dist](#)

```
double Odometry3Wheel::odometry3wheel_cfg_t::wheelbase_dist
```

distance from the center of the left wheel to the center of the right wheel

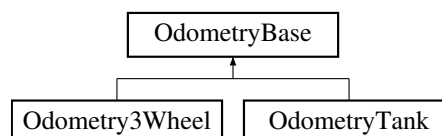
The documentation for this struct was generated from the following file:

- include/subsystems/odometry/odometry\_3wheel.h

## 5.49 OdometryBase Class Reference

```
#include <odometry_base.h>
```

Inheritance diagram for OdometryBase:



### Public Member Functions

- [OdometryBase](#) (bool is\_async)
- [pose\\_t get\\_position](#) (void)
- virtual void [set\\_position](#) (const [pose\\_t](#) &newpos=[zero\\_pos](#))
- virtual [pose\\_t update](#) ()=0
- void [end\\_async](#) ()
- double [get\\_speed](#) ()
- double [get\\_accel](#) ()
- double [get\\_angular\\_speed\\_deg](#) ()
- double [get\\_angular\\_accel\\_deg](#) ()

### Static Public Member Functions

- static int [background\\_task](#) (void \*ptr)
- static double [pos\\_diff](#) ([pose\\_t](#) start\_pos, [pose\\_t](#) end\_pos)
- static double [rot\\_diff](#) ([pose\\_t](#) pos1, [pose\\_t](#) pos2)
- static double [smallest\\_angle](#) (double start\_deg, double end\_deg)

### Public Attributes

- bool [end\\_task](#) = false  
*end\_task is true if we instruct the odometry thread to shut down*

### Static Public Attributes

- static constexpr [pose\\_t zero\\_pos](#) = {.x=0.0L, .y=0.0L, .rot=90.0L}

### Protected Attributes

- vex::task \* [handle](#)
- vex::mutex [mut](#)
- [pose\\_t current\\_pos](#)
- double [speed](#)
- double [accel](#)
- double [ang\\_speed\\_deg](#)
- double [ang\\_accel\\_deg](#)

## 5.49.1 Detailed Description

### [OdometryBase](#)

This base class contains all the shared code between different implementations of odometry. It handles the asynchronous management, position input/output and basic math functions, and holds positional types specific to field orientation.

All future odometry implementations should extend this file and redefine [update\(\)](#) function.

#### Author

Ryan McGee

#### Date

Aug 11 2021

## 5.49.2 Constructor & Destructor Documentation

### 5.49.2.1 OdometryBase()

```
OdometryBase::OdometryBase (
    bool is_async )
```

Construct a new Odometry Base object

#### Parameters

<i>is_async</i>	True to run constantly in the background, false to call <a href="#">update()</a> manually
-----------------	---

## 5.49.3 Member Function Documentation

### 5.49.3.1 background\_task()

```
int OdometryBase::background_task (
    void * ptr ) [static]
```

Function that runs in the background task. This function pointer is passed to the `vex::task` constructor.

#### Parameters

<i>ptr</i>	Pointer to <a href="#">OdometryBase</a> object
------------	--

#### Returns

Required integer return code. Unused.

### 5.49.3.2 end\_async()

```
void OdometryBase::end_async ( )
```

End the background task. Cannot be restarted. If the user wants to end the thread but keep the data up to date, they must run the [update\(\)](#) function manually from then on.

### 5.49.3.3 get\_accel()

```
double OdometryBase::get_accel ( )
```

Get the current acceleration

#### Returns

the acceleration rate of the robot (inch/s<sup>2</sup>)



#### 5.49.3.4 get\_angular\_accel\_deg()

```
double OdometryBase::get_angular_accel_deg ( )
```

Get the current angular acceleration in degrees

##### Returns

the angular acceleration at which we are turning (deg/s<sup>2</sup>)

#### 5.49.3.5 get\_angular\_speed\_deg()

```
double OdometryBase::get_angular_speed_deg ( )
```

Get the current angular speed in degrees

##### Returns

the angular velocity at which we are turning (deg/s)

#### 5.49.3.6 get\_position()

```
pose_t OdometryBase::get_position (
    void )
```

Gets the current position and rotation

##### Returns

the position that the odometry believes the robot is at

Gets the current position and rotation

#### 5.49.3.7 get\_speed()

```
double OdometryBase::get_speed ( )
```

Get the current speed

##### Returns

the speed at which the robot is moving and grooving (inch/s)

#### 5.49.3.8 pos\_diff()

```
double OdometryBase::pos_diff (
    pose_t start_pos,
    pose_t end_pos ) [static]
```

Get the distance between two points

**Parameters**

<i>start_pos</i>	distance from this point
<i>end_pos</i>	to this point

**Returns**

the euclidean distance between start\_pos and end\_pos

**5.49.3.9 rot\_diff()**

```
double OdometryBase::rot_diff (
    pose_t pos1,
    pose_t pos2 ) [static]
```

Get the change in rotation between two points

**Parameters**

<i>pos1</i>	position with initial rotation
<i>pos2</i>	position with final rotation

**Returns**

change in rotation between pos1 and pos2

Get the change in rotation between two points

**5.49.3.10 set\_position()**

```
void OdometryBase::set_position (
    const pose_t & newpos = zero_pos ) [virtual]
```

Sets the current position of the robot

**Parameters**

<i>newpos</i>	the new position that the odometry will believe it is at
---------------	--

Sets the current position of the robot

Reimplemented in [OdometryTank](#).

**5.49.3.11 smallest\_angle()**

```
double OdometryBase::smallest_angle (
    double start_deg,
    double end_deg ) [static]
```

Get the smallest difference in angle between a start heading and end heading. Returns the difference between -180 degrees and +180 degrees, representing the robot turning left or right, respectively.

#### Parameters

<i>start_deg</i>	intitial angle (degrees)
<i>end_deg</i>	final angle (degrees)

#### Returns

the smallest angle from the initial to the final angle. This takes into account the wrapping of rotations around 360 degrees

Get the smallest difference in angle between a start heading and end heading. Returns the difference between -180 degrees and +180 degrees, representing the robot turning left or right, respectively.

#### 5.49.3.12 update()

```
virtual pose_t OdometryBase::update ( ) [pure virtual]
```

Update the current position on the field based on the sensors

#### Returns

the location that the robot is at after the odometry does its calculations

Implemented in [Odometry3Wheel](#), and [OdometryTank](#).

### 5.49.4 Member Data Documentation

#### 5.49.4.1 accel

```
double OdometryBase::accel [protected]
```

the rate at which we are accelerating (inch/s<sup>2</sup>)

#### 5.49.4.2 ang\_accel\_deg

```
double OdometryBase::ang_accel_deg [protected]
```

the rate at which we are accelerating our turn (deg/s<sup>2</sup>)

#### 5.49.4.3 ang\_speed\_deg

```
double OdometryBase::ang_speed_deg [protected]
```

the speed at which we are turning (deg/s)

#### 5.49.4.4 current\_pos

```
pose_t OdometryBase::current_pos [protected]
```

Current position of the robot in terms of x,y,rotation

#### 5.49.4.5 handle

```
vex::task* OdometryBase::handle [protected]
```

handle to the vex task that is running the odometry code

#### 5.49.4.6 mut

```
vex::mutex OdometryBase::mut [protected]
```

Mutex to control multithreading

#### 5.49.4.7 speed

```
double OdometryBase::speed [protected]
```

the speed at which we are travelling (inch/s)

#### 5.49.4.8 zero\_pos

```
constexpr pose_t OdometryBase::zero_pos = {.x=0.0L, .y=0.0L, .rot=90.0L} [inline], [static],  
[constexpr]
```

Zeroed position. X=0, Y=0, Rotation= 90 degrees

The documentation for this class was generated from the following files:

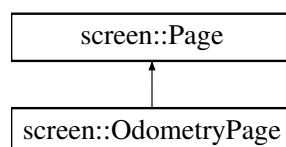
- include/subsystems/odometry/odometry\_base.h
- src/subsystems/odometry/odometry\_base.cpp

## 5.50 screen::OdometryPage Class Reference

a page that shows odometry position and rotation and a map (if an sd card with the file is on)

```
#include <screen.h>
```

Inheritance diagram for screen::OdometryPage:



## Public Member Functions

- [OdometryPage](#) ([OdometryBase](#) &odom, double robot\_width, double robot\_height, bool do\_trail)  
*Create an odometry trail. Make sure odometry is initilized before now.*
- void [update](#) (bool was\_pressed, int x, int y) override
- void [draw](#) (vex::brain::lcd &, bool first\_draw, unsigned int frame\_number) override

### 5.50.1 Detailed Description

a page that shows odometry position and rotation and a map (if an sd card with the file is on)

### 5.50.2 Constructor & Destructor Documentation

#### 5.50.2.1 OdometryPage()

```
screen::OdometryPage::OdometryPage (
    OdometryBase & odom,
    double robot_width,
    double robot_height,
    bool do_trail )
```

Create an odometry trail. Make sure odometry is initilized before now.

#### Parameters

<i>odom</i>	the odometry system to monitor
<i>robot_width</i>	the width (side to side) of the robot in inches. Used for visualization
<i>robot_height</i>	the robot_height (front to back) of the robot in inches. Used for visualization
<i>do_trail</i>	whether or not to calculate and draw the trail. Drawing and storing takes a very <i>slight</i> extra amount of processing power

### 5.50.3 Member Function Documentation

#### 5.50.3.1 draw()

```
void screen::OdometryPage::draw (
    vex::brain::lcd & scr,
    bool first_draw,
    unsigned int frame_number ) [override], [virtual]
```

#### See also

[Page::draw](#)

Reimplemented from [screen::Page](#).

### 5.50.3.2 update()

```
void screen::OdometryPage::update (
    bool was_pressed,
    int x,
    int y ) [override], [virtual]
```

See also

[Page::update](#)

Reimplemented from [screen::Page](#).

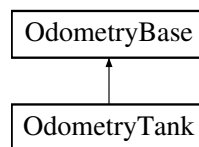
The documentation for this class was generated from the following files:

- include/subsystems/screen.h
- src/subsystems/screen.cpp

## 5.51 OdometryTank Class Reference

```
#include <odometry_tank.h>
```

Inheritance diagram for OdometryTank:



### Public Member Functions

- [OdometryTank](#) (vex::motor\_group &left\_side, vex::motor\_group &right\_side, [robot\\_specs\\_t](#) &config, vex::inertial \*imu=NULL, bool is\_async=true)
- [OdometryTank](#) ([CustomEncoder](#) &left\_custom\_enc, [CustomEncoder](#) &right\_custom\_enc, [robot\\_specs\\_t](#) &config, vex::inertial \*imu=NULL, bool is\_async=true)
- [OdometryTank](#) (vex::encoder &left\_vex\_enc, vex::encoder &right\_vex\_enc, [robot\\_specs\\_t](#) &config, vex::inertial \*imu=NULL, bool is\_async=true)
- [pose\\_t update](#) () override
- void [set\\_position](#) (const [pose\\_t](#) &newpos=[zero\\_pos](#)) override

### Public Member Functions inherited from [OdometryBase](#)

- [OdometryBase](#) (bool is\_async)
- [pose\\_t get\\_position](#) (void)
- void [end\\_async](#) ()
- double [get\\_speed](#) ()
- double [get\\_accel](#) ()
- double [get\\_angular\\_speed\\_deg](#) ()
- double [get\\_angular\\_accel\\_deg](#) ()

## Additional Inherited Members

### Static Public Member Functions inherited from [OdometryBase](#)

- static int [background\\_task](#) (void \*ptr)
- static double [pos\\_diff](#) ([pose\\_t](#) start\_pos, [pose\\_t](#) end\_pos)
- static double [rot\\_diff](#) ([pose\\_t](#) pos1, [pose\\_t](#) pos2)
- static double [smallest\\_angle](#) (double start\_deg, double end\_deg)

### Public Attributes inherited from [OdometryBase](#)

- bool [end\\_task](#) = false  
*end\_task is true if we instruct the odometry thread to shut down*

### Static Public Attributes inherited from [OdometryBase](#)

- static constexpr [pose\\_t](#) [zero\\_pos](#) = {.x=0.0L, .y=0.0L, .rot=90.0L}

### Protected Attributes inherited from [OdometryBase](#)

- vex::task \* [handle](#)
- vex::mutex [mut](#)
- [pose\\_t](#) [current\\_pos](#)
- double [speed](#)
- double [accel](#)
- double [ang\\_speed\\_deg](#)
- double [ang\\_accel\\_deg](#)

## 5.51.1 Detailed Description

[OdometryTank](#) defines an odometry system for a tank drivetrain. This requires encoders in the same orientation as the drive wheels. Odometry is a "start and forget" subsystem, which means once it's created and configured, it will constantly run in the background and track the robot's X, Y and rotation coordinates.

## 5.51.2 Constructor & Destructor Documentation

### 5.51.2.1 [OdometryTank\(\)](#) [1/3]

```
OdometryTank::OdometryTank (
    vex::motor_group & left_side,
    vex::motor_group & right_side,
    robot\_specs\_t & config,
    vex::inertial * imu = NULL,
    bool is_async = true )
```

Initialize the Odometry module, calculating position from the drive motors.

## Parameters

<i>left_side</i>	The left motors
<i>right_side</i>	The right motors
<i>config</i>	the specifications that supply the odometry with descriptions of the robot. See <a href="#">robot_specs_t</a> for what is contained
<i>imu</i>	The robot's inertial sensor. If not included, rotation is calculated from the encoders.
<i>is_async</i>	If true, position will be updated in the background continuously. If false, the programmer will have to manually call <a href="#">update()</a> .

## 5.51.2.2 OdometryTank() [2/3]

```
OdometryTank::OdometryTank (
    CustomEncoder & left_custom_enc,
    CustomEncoder & right_custom_enc,
    robot_specs_t & config,
    vex::inertial * imu = NULL,
    bool is_async = true )
```

Initialize the Odometry module, calculating position from the drive motors.

## Parameters

<i>left_custom_enc</i>	The left custom encoder
<i>right_custom_enc</i>	The right custom encoder
<i>config</i>	the specifications that supply the odometry with descriptions of the robot. See <a href="#">robot_specs_t</a> for what is contained
<i>imu</i>	The robot's inertial sensor. If not included, rotation is calculated from the encoders.
<i>is_async</i>	If true, position will be updated in the background continuously. If false, the programmer will have to manually call <a href="#">update()</a> .

## 5.51.2.3 OdometryTank() [3/3]

```
OdometryTank::OdometryTank (
    vex::encoder & left_vex_enc,
    vex::encoder & right_vex_enc,
    robot_specs_t & config,
    vex::inertial * imu = NULL,
    bool is_async = true )
```

Initialize the Odometry module, calculating position from the drive motors.

## Parameters

<i>left_vex_enc</i>	The left vex encoder
<i>right_vex_enc</i>	The right vex encoder
<i>config</i>	the specifications that supply the odometry with descriptions of the robot. See <a href="#">robot_specs_t</a> for what is contained
<i>imu</i>	The robot's inertial sensor. If not included, rotation is calculated from the encoders.
<i>is_async</i>	If true, position will be updated in the background continuously. If false, the programmer will have to manually call <a href="#">update()</a> .



### 5.51.3 Member Function Documentation

#### 5.51.3.1 set\_position()

```
void OdometryTank::set_position (
    const pose\_t & newpos = zero\_pos ) [override], [virtual]
```

set\_position tells the odometry to place itself at a position

##### Parameters

<a href="#">newpos</a>	the position the odometry will take
------------------------	-------------------------------------

Resets the position and rotational data to the input.

Reimplemented from [OdometryBase](#).

#### 5.51.3.2 update()

```
pose\_t OdometryTank::update ( ) [override], [virtual]
```

Update the current position on the field based on the sensors

##### Returns

the position that odometry has calculated itself to be at

Update, store and return the current position of the robot. Only use if not initializing with a separate thread.

Implements [OdometryBase](#).

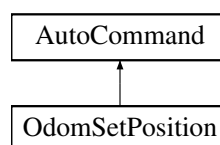
The documentation for this class was generated from the following files:

- include/subsystems/odometry/odometry\_tank.h
- src/subsystems/odometry/odometry\_tank.cpp

## 5.52 OdomSetPosition Class Reference

```
#include <drive_commands.h>
```

Inheritance diagram for OdomSetPosition:



## Public Member Functions

- [OdomSetPosition](#) ([OdometryBase](#) &odom, const [pose\\_t](#) &newpos=[OdometryBase::zero\\_pos](#))
- bool [run](#) () override

## Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.52.1 Detailed Description

[AutoCommand](#) wrapper class for the [set\\_position](#) function in the [Odometry](#) class

### 5.52.2 Constructor & Destructor Documentation

#### 5.52.2.1 [OdomSetPosition\(\)](#)

```
OdomSetPosition::OdomSetPosition (
    OdometryBase & odom,
    const pose\_t & newpos = OdometryBase::zero\_pos )
```

constructs a new [OdomSetPosition](#) command

#### Parameters

<i>odom</i>	the odometry system we are setting
<i>newpos</i>	the position we are telling the odometry to take. defaults to (0, 0), angle = 90

Construct an Odometry set pos

#### Parameters

<i>odom</i>	the odometry system we are setting
<i>newpos</i>	the now position to set the odometry to

### 5.52.3 Member Function Documentation

#### 5.52.3.1 run()

```
bool OdomSetPosition::run ( ) [override], [virtual]
```

Run set\_position Overrides run from [AutoCommand](#)

#### Returns

true when execution is complete, false otherwise

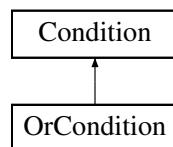
Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utls/command\_structure/drive\_commands.h
- src/utls/command\_structure/drive\_commands.cpp

## 5.53 OrCondition Class Reference

Inheritance diagram for OrCondition:



#### Public Member Functions

- **OrCondition** ([Condition](#) \*A, [Condition](#) \*B)
- bool [test](#) () override

#### Public Member Functions inherited from [Condition](#)

- [Condition](#) \* **Or** ([Condition](#) \*b)
- [Condition](#) \* **And** ([Condition](#) \*b)

### 5.53.1 Member Function Documentation

#### 5.53.1.1 test()

```
bool OrCondition::test ( ) [inline], [override], [virtual]
```

Implements [Condition](#).

The documentation for this class was generated from the following file:

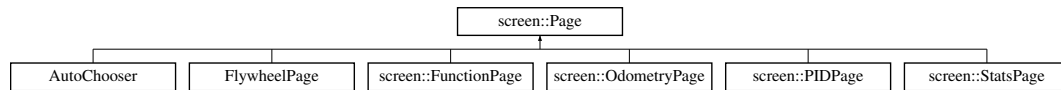
- src/utls/command\_structure/auto\_command.cpp

## 5.54 screen::Page Class Reference

[Page](#) describes one part of the screen slideshow.

```
#include <screen.h>
```

Inheritance diagram for screen::Page:



### Public Member Functions

- virtual void [update](#) (bool was\_pressed, int x, int y)  
*collect data, respond to screen input, do fast things (runs at 50hz even if you're not focused on this [Page](#) (only drawn page gets touch updates))*
- virtual void [draw](#) (vex::brain::lcd &screen, bool first\_draw, unsigned int frame\_number)  
*draw stored data to the screen (runs at 10 hz and only runs if this page is in front)*

### 5.54.1 Detailed Description

[Page](#) describes one part of the screen slideshow.

### 5.54.2 Member Function Documentation

#### 5.54.2.1 draw()

```
virtual void screen::Page::draw (
    vex::brain::lcd & screen,
    bool first_draw,
    unsigned int frame_number ) [virtual]
```

draw stored data to the screen (runs at 10 hz and only runs if this page is in front)

#### Parameters

<i>first_draw</i>	true if we just switched to this page
<i>frame_number</i>	frame of drawing we are on (basically an animation tick)

Reimplemented in [AutoChooser](#), [screen::StatsPage](#), [screen::OdometryPage](#), [screen::FunctionPage](#), [screen::PIDPage](#), and [FlywheelPage](#).

#### 5.54.2.2 update()

```
virtual void screen::Page::update (
    bool was_pressed,
```

```
int x,
int y ) [virtual]
```

collect data, respond to screen input, do fast things (runs at 50hz even if you're not focused on this [Page](#) (only drawn page gets touch updates))

#### Parameters

<i>was_pressed</i>	true if the screen has been pressed
<i>x</i>	x position of screen press (if the screen was pressed)
<i>y</i>	y position of screen press (if the screen was pressed)

Reimplemented in [AutoChooser](#), [screen::StatsPage](#), [screen::OdometryPage](#), [screen::FunctionPage](#), [screen::PIDPage](#), and [FlywheelPage](#).

The documentation for this class was generated from the following file:

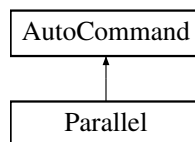
- include/subsystems/screen.h

## 5.55 Parallel Class Reference

[Parallel](#) runs multiple commands in parallel and waits for all to finish before continuing. if none finish before this command's timeout, it will call `on_timeout` on all children continue.

```
#include <auto_command.h>
```

Inheritance diagram for [Parallel](#):



#### Public Member Functions

- **Parallel** (std::initializer\_list< [AutoCommand](#) \* > cmds)
- bool [run](#) () override
- void [on\\_timeout](#) () override

#### Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* **withTimeout** (double t\_seconds)
- [AutoCommand](#) \* **withCancelCondition** ([Condition](#) \*true\_to\_end)

#### Additional Inherited Members

#### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* **true\_to\_end** = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

### 5.55.1 Detailed Description

[Parallel](#) runs multiple commands in parallel and waits for all to finish before continuing. if none finish before this command's timeout, it will call `on_timeout` on all children continue.

### 5.55.2 Member Function Documentation

#### 5.55.2.1 `on_timeout()`

```
void Parallel::on_timeout ( ) [override], [virtual]
```

What to do if we timeout instead of finishing. timeout is specified by the timeout seconds in the constructor

Reimplemented from [AutoCommand](#).

#### 5.55.2.2 `run()`

```
bool Parallel::run ( ) [override], [virtual]
```

Executes the command Overridden by child classes

#### Returns

true when the command is finished, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utls/command\_structure/auto\_command.h
- src/utls/command\_structure/auto\_command.cpp

## 5.56 `parallel_runner_info` Struct Reference

### Public Attributes

- int **index**
- std::vector< vex::task \* > \* **runners**
- [AutoCommand](#) \* **cmd**

The documentation for this struct was generated from the following file:

- src/utls/command\_structure/auto\_command.cpp

## 5.57 PurePursuit::Path Class Reference

```
#include <pure_pursuit.h>
```

### Public Member Functions

- [Path](#) (std::vector< [point\\_t](#) > points, double radius)
- std::vector< [point\\_t](#) > [get\\_points](#) ()
- double [get\\_radius](#) ()
- bool [is\\_valid](#) ()

### 5.57.1 Detailed Description

Wrapper for a vector of points, checking if any of the points are too close for pure pursuit

### 5.57.2 Constructor & Destructor Documentation

#### 5.57.2.1 Path()

```
PurePursuit::Path::Path (
    std::vector< point\_t > points,
    double radius )
```

Create a [Path](#)

#### Parameters

<i>points</i>	the points that make up the path
<i>radius</i>	the lookahead radius for pure pursuit

### 5.57.3 Member Function Documentation

#### 5.57.3.1 get\_points()

```
std::vector< point\_t > PurePursuit::Path::get_points ( )
```

Get the points associated with this [Path](#)

#### 5.57.3.2 get\_radius()

```
double PurePursuit::Path::get_radius ( )
```

Get the radius associated with this [Path](#)

### 5.57.3.3 is\_valid()

```
bool PurePursuit::Path::is_valid ( )
```

Get whether this path will behave as expected

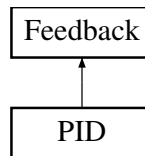
The documentation for this class was generated from the following files:

- include/utls/pure\_pursuit.h
- src/utls/pure\_pursuit.cpp

## 5.58 PID Class Reference

```
#include <pid.h>
```

Inheritance diagram for PID:



### Classes

- struct [pid\\_config\\_t](#)

### Public Types

- enum [ERROR\\_TYPE](#) { **LINEAR** , **ANGULAR** }

### Public Member Functions

- [PID](#) ([pid\\_config\\_t](#) &config)
- void [init](#) (double start\_pt, double set\_pt, double start\_vel=0, double end\_vel=0) override
- double [update](#) (double sensor\_val) override
- double [get\\_sensor\\_val](#) ()  
*gets the sensor value that we were last updated with*
- double [get](#) () override
- void [set\\_limits](#) (double lower, double upper) override
- bool [is\\_on\\_target](#) () override
- void [reset](#) ()
- double [get\\_error](#) ()
- double [get\\_target](#) ()
- void [set\\_target](#) (double target)



## Public Attributes

- [pid\\_config\\_t](#) & **config**

*configuration struct for this controller. see [pid\\_config\\_t](#) for information about what this contains*

## 5.58.1 Detailed Description

### PID Class

Defines a standard feedback loop using the constants kP, kI, kD, deadband, and on\_target\_time. The formula is:

$$\text{out} = kP * \text{error} + kI * \text{integral}(\text{d Error}) + kD * (\text{dError}/\text{dt})$$

The [PID](#) object will determine it is "on target" when the error is within the deadband, for a duration of on\_target\_time

### Author

Ryan McGee

### Date

4/3/2020

## 5.58.2 Member Enumeration Documentation

### 5.58.2.1 ERROR\_TYPE

```
enum PID::ERROR\_TYPE
```

An enum to distinguish between a linear and angular calculation of [PID](#) error.

## 5.58.3 Constructor & Destructor Documentation

### 5.58.3.1 PID()

```
PID::PID (
    pid\_config\_t & config )
```

Create the [PID](#) object

### Parameters

<i>config</i>	the configuration data for this controller
---------------	--

Create the [PID](#) object

## 5.58.4 Member Function Documentation

### 5.58.4.1 `get()`

```
double PID::get ( ) [override], [virtual]
```

Gets the current [PID](#) out value, from when [update\(\)](#) was last run

#### Returns

the Out value of the controller (voltage, RPM, whatever the [PID](#) controller is controlling)

Gets the current [PID](#) out value, from when [update\(\)](#) was last run

Implements [Feedback](#).

### 5.58.4.2 `get_error()`

```
double PID::get_error ( )
```

Get the delta between the current sensor data and the target

#### Returns

the error calculated. how it is calculated depends on `error_method` specified in [pid\\_config\\_t](#)

Get the delta between the current sensor data and the target

### 5.58.4.3 `get_sensor_val()`

```
double PID::get_sensor_val ( )
```

gets the sensor value that we were last updated with

#### Returns

`sensor_val`

### 5.58.4.4 `get_target()`

```
double PID::get_target ( )
```

Get the [PID](#)'s target

#### Returns

the target the [PID](#) controller is trying to achieve

### 5.58.4.5 `init()`

```
void PID::init (
    double start_pt,
    double set_pt,
    double start_vel = 0,
    double end_vel = 0 ) [override], [virtual]
```

Inherited from [Feedback](#) for interoperability. Update the setpoint and reset integral accumulation

`start_pt` can be safely ignored in this feedback controller

## Parameters

<i>start_pt</i>	completely ignored for <a href="#">PID</a> . necessary to satisfy <a href="#">Feedback</a> base
<i>set_pt</i>	sets the target of the <a href="#">PID</a> controller
<i>start_vel</i>	completely ignored for <a href="#">PID</a> . necessary to satisfy <a href="#">Feedback</a> base
<i>end_vel</i>	sets the target end velocity of the <a href="#">PID</a> controller

Implements [Feedback](#).

## 5.58.4.6 is\_on\_target()

```
bool PID::is_on_target ( ) [override], [virtual]
```

Checks if the [PID](#) controller is on target.

## Returns

true if the loop is within [deadband] for [on\_target\_time] seconds

Returns true if the loop is within [deadband] for [on\_target\_time] seconds

Implements [Feedback](#).

## 5.58.4.7 reset()

```
void PID::reset ( )
```

Reset the [PID](#) loop by resetting time since 0 and accumulated error.

## 5.58.4.8 set\_limits()

```
void PID::set_limits (
    double lower,
    double upper ) [override], [virtual]
```

Set the limits on the [PID](#) out. The [PID](#) out will "clip" itself to be between the limits.

## Parameters

<i>lower</i>	the lower limit. the <a href="#">PID</a> controller will never command the output go below <i>lower</i>
<i>upper</i>	the upper limit. the <a href="#">PID</a> controller will never command the output go higher than <i>upper</i>

Set the limits on the [PID](#) out. The [PID](#) out will "clip" itself to be between the limits.

Implements [Feedback](#).

#### 5.58.4.9 set\_target()

```
void PID::set_target (
    double target )
```

Set the target for the [PID](#) loop, where the robot is trying to end up

##### Parameters

<i>target</i>	the sensor reading we would like to achieve
---------------	---

Set the target for the [PID](#) loop, where the robot is trying to end up

#### 5.58.4.10 update()

```
double PID::update (
    double sensor_val ) [override], [virtual]
```

Update the [PID](#) loop by taking the time difference from last update, and running the [PID](#) formula with the new sensor data

##### Parameters

<i>sensor_val</i>	the distance, angle, encoder position or whatever it is we are measuring
-------------------	--

##### Returns

the new output. What would be returned by [PID::get\(\)](#)

Implements [Feedback](#).

The documentation for this class was generated from the following files:

- include/utils/controls/pid.h
- src/utils/controls/pid.cpp

## 5.59 PID::pid\_config\_t Struct Reference

```
#include <pid.h>
```

##### Public Attributes

- double **p**  
*proportional coeffecient p \* error()*
- double **i**  
*integral coeffecient i \* integral(error)*
- double **d**

- derivative coefficient  $d * derivative(error)$*
- double **deadband**  
*at what threshold are we close enough to be finished*
- double **on\_target\_time**  
*the time in seconds that we have to be on target for to say we are officially at the target*
- [ERROR\\_TYPE](#) **error\_method**  
*Linear or angular. wheter to do error as a simple subtraction or to wrap.*

### 5.59.1 Detailed Description

[pid\\_config\\_t](#) holds the configuration parameters for a pid controller In addition to the constant of proportional, integral and derivative, these parameters include:

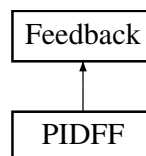
- deadband -
- on\_target\_time - for how long do we have to be at the target to stop As well, [pid\\_config\\_t](#) holds an error type which determines whether errors should be calculated as if the sensor position is a measure of distance or an angle

The documentation for this struct was generated from the following file:

- include/utls/controls/pid.h

## 5.60 PIDFF Class Reference

Inheritance diagram for PIDFF:



### Public Member Functions

- PIDFF** ([PID::pid\\_config\\_t](#) &pid\_cfg, [FeedForward::ff\\_config\\_t](#) &ff\_cfg)
- void **init** (double start\_pt, double set\_pt, double start\_vel, double end\_vel) override
- void **set\_target** (double set\_pt)
- double **update** (double val) override
- double **update** (double val, double vel\_setpt, double a\_setpt=0)
- double **get** () override
- void **set\_limits** (double lower, double upper) override
- bool **is\_on\_target** () override

### Public Attributes

- [PID](#) pid

## 5.60.1 Member Function Documentation

### 5.60.1.1 `get()`

```
double PIDFF::get ( ) [override], [virtual]
```

#### Returns

the last saved result from the feedback controller

Implements [Feedback](#).

### 5.60.1.2 `init()`

```
void PIDFF::init (
    double start_pt,
    double set_pt,
    double start_vel,
    double end_vel ) [override], [virtual]
```

Initialize the feedback controller for a movement

#### Parameters

<i>start_pt</i>	the current sensor value
<i>set_pt</i>	where the sensor value should be
<i>start_vel</i>	the current rate of change of the sensor value
<i>end_vel</i>	the desired ending rate of change of the sensor value

Initialize the feedback controller for a movement

#### Parameters

<i>start_↔ _pt</i>	the current sensor value
<i>set_pt</i>	where the sensor value should be

Implements [Feedback](#).

### 5.60.1.3 `is_on_target()`

```
bool PIDFF::is_on_target ( ) [override], [virtual]
```

#### Returns

true if the feedback controller has reached it's setpoint

Implements [Feedback](#).

#### 5.60.1.4 set\_limits()

```
void PIDFF::set_limits (
    double lower,
    double upper ) [override], [virtual]
```

Clamp the upper and lower limits of the output. If both are 0, no limits should be applied.

##### Parameters

<i>lower</i>	Upper limit
<i>upper</i>	Lower limit

Implements [Feedback](#).

#### 5.60.1.5 set\_target()

```
void PIDFF::set_target (
    double set_pt )
```

Set the target of the [PID](#) loop

##### Parameters

<i>set_pt</i>	Setpoint / target value
---------------	-------------------------

#### 5.60.1.6 update() [1/2]

```
double PIDFF::update (
    double val ) [override], [virtual]
```

Iterate the feedback loop once with an updated sensor value. Only kS for feedforward will be applied.

##### Parameters

<i>val</i>	value from the sensor
------------	-----------------------

##### Returns

feedback loop result

Implements [Feedback](#).

#### 5.60.1.7 update() [2/2]

```
double PIDFF::update (
    double val,
```

```
double vel_setpt,
double a_setpt = 0 )
```

Iterate the feedback loop once with an updated sensor value

#### Parameters

<i>val</i>	value from the sensor
<i>vel_setpt</i>	Velocity for feedforward
<i>a_setpt</i>	Acceleration for feedfoward

#### Returns

feedback loop result

The documentation for this class was generated from the following files:

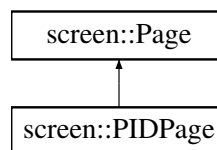
- include/utils/controls/pidff.h
- src/utils/controls/pidff.cpp

## 5.61 screen::PIDPage Class Reference

[PIDPage](#) provides a way to tune a pid controller on the screen.

```
#include <screen.h>
```

Inheritance diagram for screen::PIDPage:



#### Public Member Functions

- [PIDPage](#) ([PID](#) &pid, std::string name, std::function< void(void)> onchange=[])()
- *Create a [PIDPage](#).*
- **PIDPage** ([PIDFF](#) &pidff, std::string name, std::function< void(void)> onchange=[])()
- void [update](#) (bool was\_pressed, int x, int y) override
- void [draw](#) (vex::brain::lcd &, bool first\_draw, unsigned int frame\_number) override

### 5.61.1 Detailed Description

[PIDPage](#) provides a way to tune a pid controller on the screen.

### 5.61.2 Constructor & Destructor Documentation

#### 5.61.2.1 PIDPage()

```
screen::PIDPage::PIDPage (
    PID & pid,
    std::string name,
    std::function< void(void)> onchange = [] () {} )
```

Create a [PIDPage](#).



## Parameters

<i>pid</i>	the pid controller we're changing
<i>name</i>	a name to recognize this pid controller if we've got multiple pid screens
<i>onchange</i>	a function that is called when a tuning parameter is changed. If you need to update stuff on that change register a handler here

### 5.61.3 Member Function Documentation

#### 5.61.3.1 draw()

```
void screen::PIDPage::draw (
    vex::brain::lcd & scr,
    bool first_draw,
    unsigned int frame_number ) [override], [virtual]
```

## See also

[Page::draw](#)

Reimplemented from [screen::Page](#).

#### 5.61.3.2 update()

```
void screen::PIDPage::update (
    bool was_pressed,
    int x,
    int y ) [override], [virtual]
```

## See also

[Page::update](#)

Reimplemented from [screen::Page](#).

The documentation for this class was generated from the following files:

- include/subsystems/screen.h
- src/subsystems/screen.cpp

## 5.62 point\_t Struct Reference

```
#include <geometry.h>
```

## Public Member Functions

- double `dist` (const `point_t` other) const
- `point_t operator+` (const `point_t` &other) const
- `point_t operator-` (const `point_t` &other) const
- `point_t operator*` (double s) const
- `point_t operator/` (double s) const
- `point_t operator-` () const
- `point_t operator+` () const
- bool `operator==` (const `point_t` &rhs)

## Public Attributes

- double `x`  
*the x position in space*
- double `y`  
*the y position in space*

### 5.62.1 Detailed Description

Data structure representing an X,Y coordinate

### 5.62.2 Member Function Documentation

#### 5.62.2.1 `dist()`

```
double point_t::dist (
    const point_t other ) const [inline]
```

`dist` calculates the euclidian distance between this point and another point using the pythagorean theorem

#### Parameters

<i>other</i>	the point to measure the distance from
--------------	--

#### Returns

the euclidian distance between this and other

#### 5.62.2.2 `operator+()`

```
point_t point_t::operator+ (
    const point_t & other ) const [inline]
```

[Vector2D](#) addition operation on points

## Parameters

<i>other</i>	the point to add on to this
--------------	-----------------------------

## Returns

this + other (this.x + other.x, this.y + other.y)

## 5.62.2.3 operator-()

```
point_t point_t::operator- (
    const point_t & other ) const [inline]
```

[Vector2D](#) subtraction operation on points

## Parameters

<i>other</i>	the <a href="#">point_t</a> to subtract from this
--------------	---

## Returns

this - other (this.x - other.x, this.y - other.y)

The documentation for this struct was generated from the following file:

- include/utls/geometry.h

## 5.63 pose\_t Struct Reference

```
#include <geometry.h>
```

## Public Member Functions

- [point\\_t](#) get\_point ()

## Public Attributes

- double **x**  
*x position in the world*
- double **y**  
*y position in the world*
- double **rot**  
*rotation in the world*

### 5.63.1 Detailed Description

Describes a single position and rotation

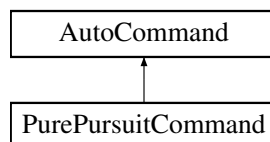
The documentation for this struct was generated from the following file:

- `include/utils/geometry.h`

## 5.64 PurePursuitCommand Class Reference

```
#include <drive_commands.h>
```

Inheritance diagram for PurePursuitCommand:



### Public Member Functions

- [PurePursuitCommand](#) ([TankDrive](#) &drive\_sys, [Feedback](#) &feedback, [PurePursuit::Path](#) path, directionType dir, double max\_speed=1, double end\_speed=0)
- bool [run](#) () override
- void [on\\_timeout](#) () override

### Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.64.1 Detailed Description

Autocommand wrapper class for pure pursuit function in the [TankDrive](#) class

## 5.64.2 Constructor & Destructor Documentation

### 5.64.2.1 PurePursuitCommand()

```
PurePursuitCommand::PurePursuitCommand (
    TankDrive & drive_sys,
    Feedback & feedback,
    PurePursuit::Path path,
    directionType dir,
    double max_speed = 1,
    double end_speed = 0 )
```

Construct a Pure Pursuit [AutoCommand](#)

#### Parameters

<i>path</i>	The list of coordinates to follow, in order
<i>dir</i>	Run the bot forwards or backwards
<i>feedback</i>	The feedback controller determining speed
<i>max_speed</i>	Limit the speed of the robot (for pid / pidff feedbacks)

## 5.64.3 Member Function Documentation

### 5.64.3.1 on\_timeout()

```
void PurePursuitCommand::on_timeout ( ) [override], [virtual]
```

Reset the drive system when it times out

Reimplemented from [AutoCommand](#).

### 5.64.3.2 run()

```
bool PurePursuitCommand::run ( ) [override], [virtual]
```

Direct call to [TankDrive::pure\\_pursuit](#)

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utils/command\_structure/drive\_commands.h
- src/utils/command\_structure/drive\_commands.cpp

## 5.65 Rect Struct Reference

### Public Member Functions

- [point\\_t dimensions](#) () const
- [point\\_t center](#) () const
- double [width](#) () const
- double [height](#) () const
- bool [contains](#) ([point\\_t](#) p) const

### Static Public Member Functions

- static [Rect](#) [from\\_min\\_and\\_size](#) ([point\\_t](#) min, [point\\_t](#) size)

### Public Attributes

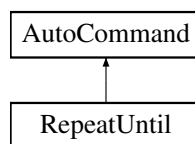
- [point\\_t](#) min
- [point\\_t](#) max

The documentation for this struct was generated from the following file:

- include/utls/geometry.h

## 5.66 RepeatUntil Class Reference

Inheritance diagram for RepeatUntil:



### Public Member Functions

- [RepeatUntil](#) ([InOrder](#) cmds, [size\\_t](#) repeats)  
*RepeatUntil that runs a fixed number of times.*
- [RepeatUntil](#) ([InOrder](#) cmds, [Condition](#) \*true\_to\_end)  
*RepeatUntil the condition.*
- bool [run](#) () override
- void [on\\_timeout](#) () override

### Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

## 5.66.1 Constructor & Destructor Documentation

### 5.66.1.1 RepeatUntil() [1/2]

```
RepeatUntil::RepeatUntil (
    InOrder cmds,
    size_t repeats )
```

[RepeatUntil](#) that runs a fixed number of times.

## Parameters

<i>cmds</i>	the cmds to repeat
<i>repeats</i>	the number of repeats to do

**5.66.1.2 RepeatUntil()** [2/2]

```
RepeatUntil::RepeatUntil (
    InOrder cmds,
    Condition * true_to_end )
```

[RepeatUntil](#) the condition.

## Parameters

<i>cmds</i>	the cmds to run
<i>true_to_end</i>	we will repeat until true_or_end.test() returns true

**5.66.2 Member Function Documentation****5.66.2.1 on\_timeout()**

```
void RepeatUntil::on_timeout ( ) [override], [virtual]
```

What to do if we timeout instead of finishing. timeout is specified by the timeout seconds in the constructor

Reimplemented from [AutoCommand](#).

**5.66.2.2 run()**

```
bool RepeatUntil::run ( ) [override], [virtual]
```

Executes the command Overridden by child classes

## Returns

true when the command is finished, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utls/command\_structure/auto\_command.h
- src/utls/command\_structure/auto\_command.cpp



## 5.67 robot\_specs\_t Struct Reference

```
#include <robot_specs.h>
```

### Public Attributes

- double **robot\_radius**  
*if you were to draw a circle with this radius, the robot would be entirely contained within it*
- double **odom\_wheel\_diam**  
*the diameter of the wheels used for*
- double **odom\_gear\_ratio**  
*the ratio of the odometry wheel to the encoder reading odometry data*
- double **dist\_between\_wheels**  
*the distance between centers of the central drive wheels*
- double **drive\_correction\_cutoff**  
*the distance at which to stop trying to turn towards the target. If we are less than this value, we can continue driving forward to minimize our distance but will not try to spin around to point directly at the target*
- [Feedback](#) \* **drive\_feedback**  
*the default feedback for autonomous driving*
- [Feedback](#) \* **turn\_feedback**  
*the default feedback for autonomous turning*
- [PID::pid\\_config\\_t](#) **correction\_pid**  
*the pid controller to keep the robot driving in as straight a line as possible*

### 5.67.1 Detailed Description

Main robot characterization struct. This will be passed to all the major subsystems that require info about the robot. All distance measurements are in inches.

The documentation for this struct was generated from the following file:

- include/robot\_specs.h

## 5.68 screen::ScreenData Struct Reference

The [ScreenData](#) class holds the data that will be passed to the screen thread you probably shouldnt have to use it.

### Public Member Functions

- **ScreenData** (const std::vector< [Page](#) \* > &m\_pages, int m\_page, vex::brain::lcd &m\_screen)

### Public Attributes

- std::vector< [Page](#) \* > **pages**
- int **page** = 0
- vex::brain::lcd **screen**

### 5.68.1 Detailed Description

The [ScreenData](#) class holds the data that will be passed to the screen thread you probably shouldnt have to use it.

The documentation for this struct was generated from the following file:

- src/subsystems/screen.cpp

## 5.69 Serializer Class Reference

Serializes Arbitrary data to a file on the SD Card.

```
#include <serializer.h>
```

### Public Member Functions

- [~Serializer](#) ()  
*Save and close upon destruction (bc of vex, this doesnt always get called when the program ends. To be sure, call save\_to\_disk)*
- [Serializer](#) (const std::string &filename, bool flush\_always=true)  
*create a [Serializer](#)*
- void [save\\_to\\_disk](#) () const  
*saves current [Serializer](#) state to disk*
- void [set\\_int](#) (const std::string &name, int i)  
*Setters - not saved until save\_to\_disk is called.*
- void [set\\_bool](#) (const std::string &name, bool b)  
*sets a bool by the name of name to b. If flush\_always == true, this will save to the sd card*
- void [set\\_double](#) (const std::string &name, double d)  
*sets a double by the name of name to d. If flush\_always == true, this will save to the sd card*
- void [set\\_string](#) (const std::string &name, std::string str)  
*sets a string by the name of name to s. If flush\_always == true, this will save to the sd card*
- int [int\\_or](#) (const std::string &name, int otherwise)  
*gets a value stored in the serializer. If not found, sets the value to otherwise*
- bool [bool\\_or](#) (const std::string &name, bool otherwise)  
*gets a value stored in the serializer. If not, sets the value to otherwise*
- double [double\\_or](#) (const std::string &name, double otherwise)  
*gets a value stored in the serializer. If not, sets the value to otherwise*
- std::string [string\\_or](#) (const std::string &name, std::string otherwise)  
*gets a value stored in the serializer. If not, sets the value to otherwise*

### 5.69.1 Detailed Description

Serializes Arbitrary data to a file on the SD Card.

### 5.69.2 Constructor & Destructor Documentation

#### 5.69.2.1 Serializer()

```
Serializer::Serializer (
    const std::string & filename,
    bool flush_always = true ) [inline], [explicit]
```

create a [Serializer](#)

## Parameters

<i>filename</i>	the file to read from. If filename does not exist we will create that file
<i>flush_always</i>	If true, after every write flush to a file. If false, you are responsible for calling <code>save_to_disk</code>

## 5.69.3 Member Function Documentation

### 5.69.3.1 `bool_or()`

```
bool Serializer::bool_or (
    const std::string & name,
    bool otherwise )
```

gets a value stored in the serializer. If not, sets the value to otherwise

## Parameters

<i>name</i>	name of value
<i>otherwise</i>	value if the name is not specified

## Returns

the value if found or otherwise

### 5.69.3.2 `double_or()`

```
double Serializer::double_or (
    const std::string & name,
    double otherwise )
```

gets a value stored in the serializer. If not, sets the value to otherwise

## Parameters

<i>name</i>	name of value
<i>otherwise</i>	value if the name is not specified

## Returns

the value if found or otherwise

### 5.69.3.3 `int_or()`

```
int Serializer::int_or (
    const std::string & name,
    int otherwise )
```

gets a value stored in the serializer. If not found, sets the value to otherwise

Getters Return value if it exists in the serializer

**Parameters**

<i>name</i>	name of value
<i>otherwise</i>	value if the name is not specified

**Returns**

the value if found or otherwise

**5.69.3.4 save\_to\_disk()**

```
void Serializer::save_to_disk ( ) const
```

saves current [Serializer](#) state to disk

forms data bytes then saves to filename this was opened with

**5.69.3.5 set\_bool()**

```
void Serializer::set_bool (
    const std::string & name,
    bool b )
```

sets a bool by the name of name to b. If flush\_always == true, this will save to the sd card

**Parameters**

<i>name</i>	name of bool
<i>b</i>	value of bool

**5.69.3.6 set\_double()**

```
void Serializer::set_double (
    const std::string & name,
    double d )
```

sets a double by the name of name to d. If flush\_always == true, this will save to the sd card

**Parameters**

<i>name</i>	name of double
<i>d</i>	value of double

**5.69.3.7 set\_int()**

```
void Serializer::set_int (
```

```
const std::string & name,  
int i )
```

Setters - not saved until `save_to_disk` is called.

sets an integer by the name of `name` to `i`. If `flush_always == true`, this will save to the sd card

#### Parameters

<i>name</i>	name of integer
<i>i</i>	value of integer

### 5.69.3.8 set\_string()

```
void Serializer::set_string (  
    const std::string & name,  
    std::string str )
```

sets a string by the name of `name` to `s`. If `flush_always == true`, this will save to the sd card

#### Parameters

<i>name</i>	name of string
<i>i</i>	value of string

### 5.69.3.9 string\_or()

```
std::string Serializer::string_or (  
    const std::string & name,  
    std::string otherwise )
```

gets a value stored in the serializer. If not, sets the value to `otherwise`

#### Parameters

<i>name</i>	name of value
<i>otherwise</i>	value if the name is not specified

#### Returns

the value if found or `otherwise`

The documentation for this class was generated from the following files:

- `include/utils/serializer.h`
- `src/utils/serializer.cpp`

## 5.70 screen::SliderWidget Class Reference

Widget that updates a double value. Updates by reference so watch out for race conditions cuz the screen stuff lives on another thread.

```
#include <screen.h>
```

### Public Member Functions

- [SliderWidget](#) (double &val, double low, double high, [Rect](#) rect, std::string name)  
*Creates a slider widget.*
- bool [update](#) (bool was\_pressed, int x, int y)  
*responds to user input*
- void **draw** (vex::brain::lcd &, bool first\_draw, unsigned int frame\_number)  
*Page::draws the slide to the screen*

### 5.70.1 Detailed Description

Widget that updates a double value. Updates by reference so watch out for race conditions cuz the screen stuff lives on another thread.

### 5.70.2 Constructor & Destructor Documentation

#### 5.70.2.1 SliderWidget()

```
screen::SliderWidget::SliderWidget (
    double & val,
    double low,
    double high,
    Rect rect,
    std::string name ) [inline]
```

Creates a slider widget.

#### Parameters

<i>val</i>	reference to the value to modify
<i>low</i>	minimum value to go to
<i>high</i>	maximum value to go to
<i>rect</i>	rect to draw it
<i>name</i>	name of the value

### 5.70.3 Member Function Documentation

#### 5.70.3.1 update()

```
bool screen::SliderWidget::update (
```

```

    bool was_pressed,
    int x,
    int y )

```

responds to user input

#### Parameters

<i>was_pressed</i>	if the screen is pressed
<i>x</i>	x position if the screen was pressed
<i>y</i>	y position if the screen was pressed

#### Returns

true if the value updated

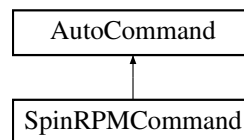
The documentation for this class was generated from the following files:

- include/subsystems/screen.h
- src/subsystems/screen.cpp

## 5.71 SpinRPMCommand Class Reference

```
#include <flywheel_commands.h>
```

Inheritance diagram for SpinRPMCommand:



#### Public Member Functions

- [SpinRPMCommand](#) ([Flywheel](#) &flywheel, int rpm)
- bool [run](#) () override

#### Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

#### Additional Inherited Members

#### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr



## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double **default\_timeout** = 10.0

### 5.71.1 Detailed Description

File: [flywheel\\_commands.h](#) Desc: [insert meaningful desc] [AutoCommand](#) wrapper class for the spin\_rpm function in the [Flywheel](#) class

### 5.71.2 Constructor & Destructor Documentation

#### 5.71.2.1 SpinRPMCommand()

```
SpinRPMCommand::SpinRPMCommand (
    Flywheel & flywheel,
    int rpm )
```

Construct a SpinRPM Command

##### Parameters

<i>flywheel</i>	the flywheel sys to command
<i>rpm</i>	the rpm that we should spin at

File: [flywheel\\_commands.cpp](#) Desc: [insert meaningful desc]

### 5.71.3 Member Function Documentation

#### 5.71.3.1 run()

```
bool SpinRPMCommand::run ( ) [override], [virtual]
```

Run spin\_manual Overrides run from [AutoCommand](#)

##### Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utils/command\_structure/flywheel\_commands.h
- src/utils/command\_structure/flywheel\_commands.cpp

## 5.72 PurePursuit::spline Struct Reference

```
#include <pure_pursuit.h>
```

### Public Member Functions

- double **getY** (double x)

### Public Attributes

- double **a**
- double **b**
- double **c**
- double **d**
- double **x\_start**
- double **x\_end**

### 5.72.1 Detailed Description

Represents a piece of a cubic spline with  $s(x) = a(x-x_i)^3 + b(x-x_i)^2 + c(x-x_i) + d$  The `x_start` and `x_end` shows where the equation is valid.

The documentation for this struct was generated from the following file:

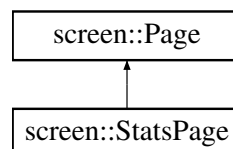
- `include/utls/pure_pursuit.h`

## 5.73 screen::StatsPage Class Reference

Draws motor stats and battery stats to the screen.

```
#include <screen.h>
```

Inheritance diagram for `screen::StatsPage`:



### Public Member Functions

- [StatsPage](#) (std::map< std::string, vex::motor & > motors)  
*Creates a stats page.*
- void [update](#) (bool was\_pressed, int x, int y) override
- void [draw](#) (vex::brain::lcd &, bool first\_draw, unsigned int frame\_number) override

### 5.73.1 Detailed Description

Draws motor stats and battery stats to the screen.

### 5.73.2 Constructor & Destructor Documentation

#### 5.73.2.1 StatsPage()

```
screen::StatsPage::StatsPage (
    std::map< std::string, vex::motor & > motors )
```

Creates a stats page.

Parameters

<i>motors</i>	a map of string to motor that we want to draw on this page
---------------	--

### 5.73.3 Member Function Documentation

#### 5.73.3.1 draw()

```
void screen::StatsPage::draw (
    vex::brain::lcd & scr,
    bool first_draw,
    unsigned int frame_number ) [override], [virtual]
```

See also

[Page::draw](#)

Reimplemented from [screen::Page](#).

#### 5.73.3.2 update()

```
void screen::StatsPage::update (
    bool was_pressed,
    int x,
    int y ) [override], [virtual]
```

See also

[Page::update](#)

Reimplemented from [screen::Page](#).

The documentation for this class was generated from the following files:

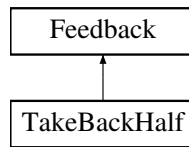
- include/subsystems/screen.h
- src/subsystems/screen.cpp

## 5.74 TakeBackHalf Class Reference

A velocity controller.

```
#include <take_back_half.h>
```

Inheritance diagram for TakeBackHalf:



### Public Member Functions

- **TakeBackHalf** (double [TBH\\_gain](#), double first\_cross\_split, double on\_target\_threshold)
- void [init](#) (double start\_pt, double set\_pt, double, double)
- double [update](#) (double val) override
- double [get](#) () override
- void [set\\_limits](#) (double lower, double upper) override
- bool [is\\_on\\_target](#) () override

### Public Attributes

- double **TBH\_gain**  
*tuned parameter*
- double **first\_cross\_split**

### 5.74.1 Detailed Description

A velocity controller.

#### Warning

If you try to use this as a position controller, it will fail.

### 5.74.2 Member Function Documentation

#### 5.74.2.1 get()

```
double TakeBackHalf::get ( ) [override], [virtual]
```

#### Returns

the last saved result from the feedback controller

Implements [Feedback](#).

#### 5.74.2.2 init()

```
void TakeBackHalf::init (
    double start_pt,
    double set_pt,
    double ,
    double ) [virtual]
```

Initialize the feedback controller for a movement

## Parameters

<i>start_pt</i>	the current sensor value
<i>set_pt</i>	where the sensor value should be
<i>start_vel</i>	Movement starting velocity (IGNORED)
<i>end_vel</i>	Movement ending velocity (IGNORED)

Implements [Feedback](#).

### 5.74.2.3 is\_on\_target()

```
bool TakeBackHalf::is_on_target ( ) [override], [virtual]
```

## Returns

true if the feedback controller has reached it's setpoint

Implements [Feedback](#).

### 5.74.2.4 set\_limits()

```
void TakeBackHalf::set_limits (
    double lower,
    double upper ) [override], [virtual]
```

Clamp the upper and lower limits of the output. If both are 0, no limits should be applied.

## Parameters

<i>lower</i>	Upper limit
<i>upper</i>	Lower limit

Implements [Feedback](#).

### 5.74.2.5 update()

```
double TakeBackHalf::update (
    double val ) [override], [virtual]
```

Iterate the feedback loop once with an updated sensor value

## Parameters

<i>val</i>	value from the sensor
------------	-----------------------

**Returns**

feedback loop result

Implements [Feedback](#).

The documentation for this class was generated from the following files:

- include/utils/controls/take\_back\_half.h
- src/utils/controls/take\_back\_half.cpp

## 5.75 TankDrive Class Reference

```
#include <tank_drive.h>
```

**Public Member Functions**

- [TankDrive](#) (motor\_group &left\_motors, motor\_group &right\_motors, [robot\\_specs\\_t](#) &config, [OdometryBase](#) \*odom=NULL)
- [AutoCommand](#) \* [DriveToPointCmd](#) ([point\\_t](#) pt, vex::directionType dir=vex::forward, double max\_speed=1.0, double end\_speed=0.0)
- [AutoCommand](#) \* [DriveToPointCmd](#) ([Feedback](#) &fb, [point\\_t](#) pt, vex::directionType dir=vex::forward, double max\_speed=1.0, double end\_speed=0.0)
- [AutoCommand](#) \* [DriveForwardCmd](#) (double dist, vex::directionType dir=vex::forward, double max\_speed=1.0, double end\_speed=0.0)
- [AutoCommand](#) \* [DriveForwardCmd](#) ([Feedback](#) &fb, double dist, vex::directionType dir=vex::forward, double max\_speed=1.0, double end\_speed=0.0)
- [AutoCommand](#) \* [TurnToHeadingCmd](#) (double heading, double max\_speed=1.0, double end\_speed=0.0)
- [AutoCommand](#) \* [TurnToHeadingCmd](#) ([Feedback](#) &fb, double heading, double max\_speed=1.0, double end\_speed=0.0)
- [AutoCommand](#) \* [TurnDegreesCmd](#) (double degrees, double max\_speed=1.0, double start\_speed=0.0)
- [AutoCommand](#) \* [TurnDegreesCmd](#) ([Feedback](#) &fb, double degrees, double max\_speed=1.0, double end\_speed=0.0)
- [AutoCommand](#) \* [PurePursuitCmd](#) ([PurePursuit::Path](#) path, directionType dir, double max\_speed=1, double end\_speed=0)
- [AutoCommand](#) \* [PurePursuitCmd](#) ([Feedback](#) &feedback, [PurePursuit::Path](#) path, directionType dir, double max\_speed=1, double end\_speed=0)
- void [stop](#) ()
- void [drive\\_tank](#) (double left, double right, int power=1)
- void [drive\\_arcade](#) (double forward\_back, double left\_right, int power=1)
- bool [drive\\_forward](#) (double inches, directionType dir, [Feedback](#) &feedback, double max\_speed=1, double end\_speed=0)
- bool [drive\\_forward](#) (double inches, directionType dir, double max\_speed=1, double end\_speed=0)
- bool [turn\\_degrees](#) (double degrees, [Feedback](#) &feedback, double max\_speed=1, double end\_speed=0)
- bool [turn\\_degrees](#) (double degrees, double max\_speed=1, double end\_speed=0)
- bool [drive\\_to\\_point](#) (double x, double y, vex::directionType dir, [Feedback](#) &feedback, double max\_speed=1, double end\_speed=0)
- bool [drive\\_to\\_point](#) (double x, double y, vex::directionType dir, double max\_speed=1, double end\_speed=0)
- bool [turn\\_to\\_heading](#) (double heading\_deg, [Feedback](#) &feedback, double max\_speed=1, double end\_speed=0)
- bool [turn\\_to\\_heading](#) (double heading\_deg, double max\_speed=1, double end\_speed=0)
- void [reset\\_auto](#) ()
- bool [pure\\_pursuit](#) ([PurePursuit::Path](#) path, directionType dir, [Feedback](#) &feedback, double max\_speed=1, double end\_speed=0)
- bool [pure\\_pursuit](#) ([PurePursuit::Path](#) path, directionType dir, double max\_speed=1, double end\_speed=0)

## Static Public Member Functions

- static double [modify\\_inputs](#) (double input, int power=2)

### 5.75.1 Detailed Description

[TankDrive](#) is a class to run a tank drive system. A tank drive system, sometimes called differential drive, has a motor (or group of synchronized motors) on the left and right side

### 5.75.2 Constructor & Destructor Documentation

#### 5.75.2.1 TankDrive()

```
TankDrive::TankDrive (
    motor_group & left_motors,
    motor_group & right_motors,
    robot_specs_t & config,
    OdometryBase * odom = NULL )
```

Create the [TankDrive](#) object

#### Parameters

<i>left_motors</i>	left side drive motors
<i>right_motors</i>	right side drive motors
<i>config</i>	the configuration specification defining physical dimensions about the robot. See <a href="#">robot_specs_t</a> for more info
<i>odom</i>	an odometry system to track position and rotation. this is necessary to execute autonomous paths

### 5.75.3 Member Function Documentation

#### 5.75.3.1 drive\_arcade()

```
void TankDrive::drive_arcade (
    double forward_back,
    double left_right,
    int power = 1 )
```

Drive the robot using arcade style controls. *forward\_back* controls the linear motion, *left\_right* controls the turning.

*forward\_back* and *left\_right* are in "percent": -1.0 -> 1.0

#### Parameters

<i>forward_back</i>	the percent to move forward or backward
<i>left_right</i>	the percent to turn left or right
<i>power</i>	modifies the input velocities $\text{left}^{\text{power}}$ , $\text{right}^{\text{power}}$

Drive the robot using arcade style controls. `forward_back` controls the linear motion, `left_right` controls the turning.

`left_motors` and `right_motors` are in "percent": -1.0 -> 1.0

### 5.75.3.2 `drive_forward()` [1/2]

```
bool TankDrive::drive_forward (
    double inches,
    directionType dir,
    double max_speed = 1,
    double end_speed = 0 )
```

Autonomously drive the robot forward a certain distance

#### Parameters

<i>inches</i>	degrees by which we will turn relative to the robot (+) turns ccw, (-) turns cw
<i>dir</i>	the direction we want to travel forward and backward
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

Autonomously drive the robot forward a certain distance

#### Parameters

<i>inches</i>	degrees by which we will turn relative to the robot (+) turns ccw, (-) turns cw
<i>dir</i>	the direction we want to travel forward and backward
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

#### Returns

true if we have finished driving to our point

### 5.75.3.3 `drive_forward()` [2/2]

```
bool TankDrive::drive_forward (
    double inches,
    directionType dir,
    Feedback & feedback,
    double max_speed = 1,
    double end_speed = 0 )
```

Use odometry to drive forward a certain distance using a custom feedback controller

Returns whether or not the robot has reached it's destination.

#### Parameters

<i>inches</i>	the distance to drive forward
---------------	-------------------------------



## Parameters

<i>dir</i>	the direction we want to travel forward and backward
<i>feedback</i>	the custom feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

## Returns

true when we have reached our target distance

Use odometry to drive forward a certain distance using a custom feedback controller

Returns whether or not the robot has reached it's destination.

## Parameters

<i>inches</i>	the distance to drive forward
<i>dir</i>	the direction we want to travel forward and backward
<i>feedback</i>	the custom feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

## 5.75.3.4 drive\_tank()

```
void TankDrive::drive_tank (
    double left,
    double right,
    int power = 1 )
```

Drive the robot using differential style controls. left\_motors controls the left motors, right\_motors controls the right motors.

left\_motors and right\_motors are in "percent": -1.0 -> 1.0

## Parameters

<i>left</i>	the percent to run the left motors
<i>right</i>	the percent to run the right motors
<i>power</i>	modifies the input velocities $\text{left}^{\text{power}}$ , $\text{right}^{\text{power}}$
<i>isdriver</i>	default false. if true uses motor percentage. if false uses plain percentage of maximum voltage

Drive the robot using differential style controls. left\_motors controls the left motors, right\_motors controls the right motors.

left\_motors and right\_motors are in "percent": -1.0 -> 1.0

### 5.75.3.5 drive\_to\_point() [1/2]

```
bool TankDrive::drive_to_point (
    double x,
    double y,
    vex::directionType dir,
    double max_speed = 1,
    double end_speed = 0 )
```

Use odometry to automatically drive the robot to a point on the field. X and Y is the final point we want the robot. Here we use the default feedback controller from the drive\_sys

Returns whether or not the robot has reached it's destination.

#### Parameters

<i>x</i>	the x position of the target
<i>y</i>	the y position of the target
<i>dir</i>	the direction we want to travel forward and backward
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

Use odometry to automatically drive the robot to a point on the field. X and Y is the final point we want the robot. Here we use the default feedback controller from the drive\_sys

Returns whether or not the robot has reached it's destination.

#### Parameters

<i>x</i>	the x position of the target
<i>y</i>	the y position of the target
<i>dir</i>	the direction we want to travel forward and backward
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

#### Returns

true if we have reached our target point

### 5.75.3.6 drive\_to\_point() [2/2]

```
bool TankDrive::drive_to_point (
    double x,
    double y,
    vex::directionType dir,
    Feedback & feedback,
    double max_speed = 1,
    double end_speed = 0 )
```

Use odometry to automatically drive the robot to a point on the field. X and Y is the final point we want the robot.

Returns whether or not the robot has reached it's destination.

## Parameters

<i>x</i>	the x position of the target
<i>y</i>	the y position of the target
<i>dir</i>	the direction we want to travel forward and backward
<i>feedback</i>	the feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

Use odometry to automatically drive the robot to a point on the field. X and Y is the final point we want the robot.

Returns whether or not the robot has reached it's destination.

## Parameters

<i>x</i>	the x position of the target
<i>y</i>	the y position of the target
<i>dir</i>	the direction we want to travel forward and backward
<i>feedback</i>	the feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

## Returns

true if we have reached our target point

## 5.75.3.7 modify\_inputs()

```
double TankDrive::modify_inputs (
    double input,
    int power = 2 ) [static]
```

Create a curve for the inputs, so that drivers have more control at lower speeds. Curves are exponential, with the default being squaring the inputs.

## Parameters

<i>input</i>	the input before modification
<i>power</i>	the power to raise input to

## Returns

$\text{input}^{\text{power}}$  (accounts for negative inputs and odd numbered powers)

Modify the inputs from the controller by squaring / cubing, etc Allows for better control of the robot at slower speeds

## Parameters

<i>input</i>	the input signal -1 -> 1
<i>power</i>	the power to raise the signal to

**Returns**

input<sup>^</sup>power accounting for any sign issues that would arise with this naive solution

**5.75.3.8 pure\_pursuit() [1/2]**

```
bool TankDrive::pure_pursuit (
    PurePursuit::Path path,
    directionType dir,
    double max_speed = 1,
    double end_speed = 0 )
```

Drive the robot autonomously using a pure-pursuit algorithm - Input path with a set of waypoints - the robot will attempt to follow the points while cutting corners (radius) to save time (compared to stop / turn / start)

Use the default drive feedback

**Parameters**

<i>path</i>	The list of coordinates to follow, in order
<i>dir</i>	Run the bot forwards or backwards
<i>max_speed</i>	Limit the speed of the robot (for pid / pidff feedbacks)
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

**Returns**

True when the path is complete

Drive the robot autonomously using a pure-pursuit algorithm - Input path with a set of waypoints - the robot will attempt to follow the points while cutting corners (radius) to save time (compared to stop / turn / start)

Use the default drive feedback

**Parameters**

<i>path</i>	The list of coordinates to follow, in order
<i>dir</i>	Run the bot forwards or backwards
<i>max_speed</i>	Limit the speed of the robot (for pid / pidff feedbacks)

**Returns**

True when the path is complete

**5.75.3.9 pure\_pursuit() [2/2]**

```
bool TankDrive::pure_pursuit (
    PurePursuit::Path path,
    directionType dir,
    Feedback & feedback,
```

```
double max_speed = 1,
double end_speed = 0 )
```

Drive the robot autonomously using a pure-pursuit algorithm - Input path with a set of waypoints - the robot will attempt to follow the points while cutting corners (radius) to save time (compared to stop / turn / start)

#### Parameters

<i>path</i>	The list of coordinates to follow, in order
<i>dir</i>	Run the bot forwards or backwards
<i>feedback</i>	The feedback controller determining speed
<i>max_speed</i>	Limit the speed of the robot (for pid / pidff feedbacks)
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

#### Returns

True when the path is complete

Drive the robot autonomously using a pure-pursuit algorithm - Input path with a set of waypoints - the robot will attempt to follow the points while cutting corners (radius) to save time (compared to stop / turn / start)

#### Parameters

<i>path</i>	The list of coordinates to follow, in order
<i>dir</i>	Run the bot forwards or backwards
<i>feedback</i>	The feedback controller determining speed
<i>max_speed</i>	Limit the speed of the robot (for pid / pidff feedbacks)

#### Returns

True when the path is complete

#### 5.75.3.10 reset\_auto()

```
void TankDrive::reset_auto ( )
```

Reset the initialization for autonomous drive functions

#### 5.75.3.11 stop()

```
void TankDrive::stop ( )
```

Stops rotation of all the motors using their "brake mode"

**5.75.3.12 turn\_degrees() [1/2]**

```
bool TankDrive::turn_degrees (
    double degrees,
    double max_speed = 1,
    double end_speed = 0 )
```

Autonomously turn the robot X degrees to counterclockwise (negative for clockwise), with a maximum motor speed of percent\_speed (-1.0 -> 1.0)

Uses the default turning feedback of the drive system.

## Parameters

<i>degrees</i>	degrees by which we will turn relative to the robot (+) turns ccw, (-) turns cw
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

Autonomously turn the robot X degrees to counterclockwise (negative for clockwise), with a maximum motor speed of percent\_speed (-1.0 -> 1.0)

Uses the default turning feedback of the drive system.

## Parameters

<i>degrees</i>	degrees by which we will turn relative to the robot (+) turns ccw, (-) turns cw
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

## Returns

true if we turned to target number of degrees

## 5.75.3.13 turn\_degrees() [2/2]

```
bool TankDrive::turn_degrees (
    double degrees,
    Feedback & feedback,
    double max_speed = 1,
    double end_speed = 0 )
```

Autonomously turn the robot X degrees counterclockwise (negative for clockwise), with a maximum motor speed of percent\_speed (-1.0 -> 1.0)

Uses PID + Feedforward for it's control.

## Parameters

<i>degrees</i>	degrees by which we will turn relative to the robot (+) turns ccw, (-) turns cw
<i>feedback</i>	the feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power

Autonomously turn the robot X degrees to counterclockwise (negative for clockwise), with a maximum motor speed of percent\_speed (-1.0 -> 1.0)

Uses the specified feedback for it's control.

## Parameters

<i>degrees</i>	degrees by which we will turn relative to the robot (+) turns ccw, (-) turns cw
<i>feedback</i>	the feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

**Returns**

true if we have turned our target number of degrees

**5.75.3.14 turn\_to\_heading() [1/2]**

```
bool TankDrive::turn_to_heading (
    double heading_deg,
    double max_speed = 1,
    double end_speed = 0 )
```

Turn the robot in place to an exact heading relative to the field. 0 is forward. Uses the default turn feedback of the drive system

**Parameters**

<i>heading_deg</i>	the heading to which we will turn
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

Turn the robot in place to an exact heading relative to the field. 0 is forward. Uses the default turn feedback of the drive system

**Parameters**

<i>heading_deg</i>	the heading to which we will turn
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

**Returns**

true if we have reached our target heading

**5.75.3.15 turn\_to\_heading() [2/2]**

```
bool TankDrive::turn_to_heading (
    double heading_deg,
    Feedback & feedback,
    double max_speed = 1,
    double end_speed = 0 )
```

Turn the robot in place to an exact heading relative to the field. 0 is forward.

**Parameters**

<i>heading_deg</i>	the heading to which we will turn
<i>feedback</i>	the feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion



Turn the robot in place to an exact heading relative to the field. 0 is forward.

#### Parameters

<i>heading_deg</i>	the heading to which we will turn
<i>feedback</i>	the feedback controller we will use to travel. controls the rate at which we accelerate and drive.
<i>max_speed</i>	the maximum percentage of robot speed at which the robot will travel. 1 = full power
<i>end_speed</i>	the movement profile will attempt to reach this velocity by its completion

#### Returns

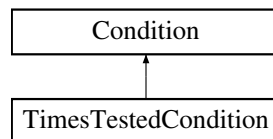
true if we have reached our target heading

The documentation for this class was generated from the following files:

- include/subsystems/tank\_drive.h
- src/subsystems/tank\_drive.cpp

## 5.76 TimesTestedCondition Class Reference

Inheritance diagram for TimesTestedCondition:



#### Public Member Functions

- **TimesTestedCondition** (size\_t N)
- bool [test](#) () override

#### Public Member Functions inherited from [Condition](#)

- [Condition](#) \* **Or** ([Condition](#) \*b)
- [Condition](#) \* **And** ([Condition](#) \*b)

### 5.76.1 Member Function Documentation

#### 5.76.1.1 test()

```
bool TimesTestedCondition::test ( ) [inline], [override], [virtual]
```

Implements [Condition](#).

The documentation for this class was generated from the following file:

- include/utils/command\_structure/auto\_command.h

## 5.77 trapezoid\_profile\_segment\_t Struct Reference

```
#include <trapezoid_profile.h>
```

### Public Attributes

- double **pos\_after**  
*1d position after this segment concludes*
- double **vel\_after**  
*1d velocity after this segment concludes*
- double **accel**  
*1d acceleration during the segment*
- double **duration**  
*duration of the segment*

### 5.77.1 Detailed Description

[trapezoid\\_profile\\_segment\\_t](#) is a description of one constant acceleration segment of a trapezoid motion profile

The documentation for this struct was generated from the following file:

- include/utils/controls/trapezoid\_profile.h

## 5.78 TrapezoidProfile Class Reference

```
#include <trapezoid_profile.h>
```

### Public Member Functions

- [TrapezoidProfile](#) (double max\_v, double accel)  
*Construct a new Trapezoid Profile object.*
- [motion\\_t calculate](#) (double time\_s, double pos\_s)  
*Run the trapezoidal profile based on the time and distance that's elapsed.*
- [motion\\_t calculate\\_time\\_based](#) (double time\_s)  
*Run the trapezoidal profile based on the time that's elapsed.*
- void [set\\_endpts](#) (double start, double end)  
*set\_endpts defines a start and end position*
- void [set\\_vel\\_endpts](#) (double start, double end)  
*set start and end velocities*
- void [set\\_accel](#) (double accel)  
*set\_accel sets the acceleration this profile will use (the left and right legs of the trapezoid)*
- void [set\\_max\\_v](#) (double max\_v)  
*sets the maximum velocity for the profile (the height of the top of the trapezoid)*
- double [get\\_movement\\_time](#) ()  
*uses the kinematic equations to and specified accel and max\_v to figure out how long moving along the profile would take*

## 5.78.1 Detailed Description

### Trapezoid Profile

This is a motion profile defined by:

- maximum acceleration
- maximum velocity
- start position and velocity
- end position and velocity

Using this information, a parametric function is generated, with a period of acceleration, constant velocity, and deceleration. The velocity graph usually looks like a trapezoid, giving it its name.

If the maximum velocity is set high enough, this will become a S-curve profile, with only acceleration and deceleration.

If the initial velocity is in the wrong direction, the profile will first come to a stop, then continue a normal trapezoid profile.

If the initial velocity is higher than the maximum velocity, the profile will first try to achieve the maximum velocity.

If the end velocity is not achievable, the profile will try to get as close as possible. The end velocity must be in the direction of the end point.

This class is designed for use in properly modelling the motion of the robots to create a feedforward and target for [PID](#). Acceleration and Maximum velocity should be measured on the robot and tuned down slightly to account for battery drop.

Here are the equations graphed for ease of understanding: <https://www.desmos.com/calculator/rkm3ivulyk>

#### Author

Ryan McGee

#### Date

7/12/2022

## 5.78.2 Constructor & Destructor Documentation

### 5.78.2.1 TrapezoidProfile()

```
TrapezoidProfile::TrapezoidProfile (
    double max_v,
    double accel )
```

Construct a new Trapezoid Profile object.

## Parameters

<i>max</i> ↔ _v	Maximum velocity the robot can run at
<i>accel</i>	Maximum acceleration of the robot

### 5.78.3 Member Function Documentation

#### 5.78.3.1 calculate()

```
motion_t TrapezoidProfile::calculate (
    double time_s,
    double pos_s )
```

Run the trapezoidal profile based on the time and distance that's elapsed.

## Parameters

<i>time</i> ↔ _s	Time since start of movement
<i>pos</i> ↔ _s	The current position

## Returns

[motion\\_t](#) Position, velocity and acceleration

#### 5.78.3.2 calculate\_time\_based()

```
motion_t TrapezoidProfile::calculate_time_based (
    double time_s )
```

Run the trapezoidal profile based on the time that's elapsed.

## Parameters

<i>time</i> ↔ _s	Time since start of movement
---------------------	------------------------------

## Returns

[motion\\_t](#) Position, velocity and acceleration

#### 5.78.3.3 get\_movement\_time()

```
double TrapezoidProfile::get_movement_time ( )
```

uses the kinematic equations to and specified accel and max\_v to figure out how long moving along the profile would take

**Returns**

the time the path will take to travel

**5.78.3.4 set\_accel()**

```
void TrapezoidProfile::set_accel (
    double accel )
```

set\_accel sets the acceleration this profile will use (the left and right legs of the trapezoid)

**Parameters**

<i>accel</i>	the acceleration amount to use
--------------	--------------------------------

**5.78.3.5 set\_endpts()**

```
void TrapezoidProfile::set_endpts (
    double start,
    double end )
```

set\_endpts defines a start and end position

**Parameters**

<i>start</i>	the starting position of the path
<i>end</i>	the ending position of the path

**5.78.3.6 set\_max\_v()**

```
void TrapezoidProfile::set_max_v (
    double max_v )
```

sets the maximum velocity for the profile (the height of the top of the trapezoid)

**Parameters**

<i>max_v</i>	the maximum velocity the robot can travel at
--------------	--

**5.78.3.7 set\_vel\_endpts()**

```
void TrapezoidProfile::set_vel_endpts (
    double start,
    double end )
```

set start and end velocities

## Parameters

<i>start</i>	the starting velocity of the path
<i>end</i>	the ending velocity of the path

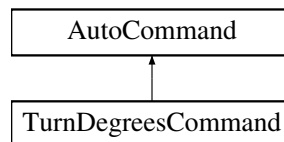
The documentation for this class was generated from the following files:

- include/utils/controls/trapezoid\_profile.h
- src/utils/trapezoid\_profile.cpp

## 5.79 TurnDegreesCommand Class Reference

```
#include <drive_commands.h>
```

Inheritance diagram for TurnDegreesCommand:



### Public Member Functions

- [TurnDegreesCommand](#) ([TankDrive](#) &drive\_sys, [Feedback](#) &feedback, double degrees, double max\_speed=1, double end\_speed=0)
- bool [run](#) () override
- void [on\\_timeout](#) () override

### Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

## 5.79.1 Detailed Description

[AutoCommand](#) wrapper class for the turn\_degrees function in the [TankDrive](#) class

## 5.79.2 Constructor & Destructor Documentation

### 5.79.2.1 TurnDegreesCommand()

```
TurnDegreesCommand::TurnDegreesCommand (
    TankDrive & drive_sys,
    Feedback & feedback,
    double degrees,
    double max_speed = 1,
    double end_speed = 0 )
```

Construct a [TurnDegreesCommand](#) Command

#### Parameters

<i>drive_sys</i>	the drive system we are commanding
<i>feedback</i>	the feedback controller we are using to execute the turn
<i>degrees</i>	how many degrees to rotate
<i>max_speed</i>	0 -> 1 percentage of the drive systems speed to drive at

## 5.79.3 Member Function Documentation

### 5.79.3.1 on\_timeout()

```
void TurnDegreesCommand::on_timeout ( ) [override], [virtual]
```

Cleans up drive system if we time out before finishing

reset the drive system if we timeout

Reimplemented from [AutoCommand](#).

### 5.79.3.2 run()

```
bool TurnDegreesCommand::run ( ) [override], [virtual]
```

Run turn\_degrees Overrides run from [AutoCommand](#)

#### Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

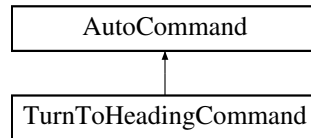
The documentation for this class was generated from the following files:

- include/utls/command\_structure/drive\_commands.h
- src/utls/command\_structure/drive\_commands.cpp

## 5.80 TurnToHeadingCommand Class Reference

```
#include <drive_commands.h>
```

Inheritance diagram for TurnToHeadingCommand:



### Public Member Functions

- [TurnToHeadingCommand](#) ([TankDrive](#) &drive\_sys, [Feedback](#) &feedback, double heading\_deg, double speed=1, double end\_speed=0)
- bool [run](#) () override
- void [on\\_timeout](#) () override

### Public Member Functions inherited from [AutoCommand](#)

- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

### Additional Inherited Members

### Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

### Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

#### 5.80.1 Detailed Description

[AutoCommand](#) wrapper class for the [turn\\_to\\_heading\(\)](#) function in the [TankDrive](#) class

#### 5.80.2 Constructor & Destructor Documentation

##### 5.80.2.1 TurnToHeadingCommand()

```

TurnToHeadingCommand::TurnToHeadingCommand (
    TankDrive & drive_sys,
    Feedback & feedback,
    double heading_deg,
    double max_speed = 1,
    double end_speed = 0 )

```

Construct a [TurnToHeadingCommand](#) Command



## Parameters

<i>drive_sys</i>	the drive system we are commanding
<i>feedback</i>	the feedback controller we are using to execute the drive
<i>heading_deg</i>	the heading to turn to in degrees
<i>max_speed</i>	0 -> 1 percentage of the drive systems speed to drive at

### 5.80.3 Member Function Documentation

#### 5.80.3.1 on\_timeout()

```
void TurnToHeadingCommand::on_timeout ( ) [override], [virtual]
```

Cleans up drive system if we time out before finishing

reset the drive system if we don't hit our target

Reimplemented from [AutoCommand](#).

#### 5.80.3.2 run()

```
bool TurnToHeadingCommand::run ( ) [override], [virtual]
```

Run turn\_to\_heading Overrides run from [AutoCommand](#)

## Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utls/command\_structure/drive\_commands.h
- src/utls/command\_structure/drive\_commands.cpp

## 5.81 Vector2D Class Reference

```
#include <vector2d.h>
```

## Public Member Functions

- [Vector2D](#) (double dir, double mag)
- [Vector2D](#) ([point\\_t](#) p)
- double [get\\_dir](#) () const
- double [get\\_mag](#) () const
- double [get\\_x](#) () const
- double [get\\_y](#) () const
- [Vector2D](#) [normalize](#) ()
- [point\\_t](#) [point](#) ()
- [Vector2D](#) [operator\\*](#) (const double &x)
- [Vector2D](#) [operator+](#) (const [Vector2D](#) &other)
- [Vector2D](#) [operator-](#) (const [Vector2D](#) &other)

### 5.81.1 Detailed Description

[Vector2D](#) is an x,y pair Used to represent 2D locations on the field. It can also be treated as a direction and magnitude

### 5.81.2 Constructor & Destructor Documentation

#### 5.81.2.1 [Vector2D\(\)](#) [1/2]

```
Vector2D::Vector2D (
    double dir,
    double mag )
```

Construct a vector object.

##### Parameters

<i>dir</i>	Direction, in radians. 'foward' is 0, clockwise positive when viewed from the top.
<i>mag</i>	Magnitude.

#### 5.81.2.2 [Vector2D\(\)](#) [2/2]

```
Vector2D::Vector2D (
    point\_t p )
```

Construct a vector object from a cartesian point.

##### Parameters

<i>p</i>	<a href="#">point_t.x</a> , <a href="#">point_t.y</a>
----------	---

### 5.81.3 Member Function Documentation

#### 5.81.3.1 get\_dir()

```
double Vector2D::get_dir ( ) const
```

Get the direction of the vector, in radians. '0' is forward, clockwise positive when viewed from the top.

Use r2d() to convert.

##### Returns

the direction of the vector in radians

Get the direction of the vector, in radians. '0' is forward, clockwise positive when viewed from the top.

Use r2d() to convert.

#### 5.81.3.2 get\_mag()

```
double Vector2D::get_mag ( ) const
```

##### Returns

the magnitude of the vector

Get the magnitude of the vector

#### 5.81.3.3 get\_x()

```
double Vector2D::get_x ( ) const
```

##### Returns

the X component of the vector; positive to the right.

Get the X component of the vector; positive to the right.

#### 5.81.3.4 get\_y()

```
double Vector2D::get_y ( ) const
```

##### Returns

the Y component of the vector, positive forward.

Get the Y component of the vector, positive forward.

### 5.81.3.5 normalize()

```
Vector2D Vector2D::normalize ( )
```

Changes the magnitude of the vector to 1

#### Returns

the normalized vector

Changes the magnetude of the vector to 1

### 5.81.3.6 operator\*()

```
Vector2D Vector2D::operator* (
    const double & x )
```

Scales a [Vector2D](#) by a scalar with the \* operator

#### Parameters

<i>x</i>	the value to scale the vector by
----------	----------------------------------

#### Returns

the this [Vector2D](#) scaled by x

### 5.81.3.7 operator+()

```
Vector2D Vector2D::operator+ (
    const Vector2D & other )
```

Add the components of two vectors together [Vector2D](#) + [Vector2D](#) = (this.x + other.x, this.y + other.y)

#### Parameters

<i>other</i>	the vector to add to this
--------------	---------------------------

#### Returns

the sum of the vectors

### 5.81.3.8 operator-()

```
Vector2D Vector2D::operator- (
    const Vector2D & other )
```

Subtract the components of two vectors together [Vector2D](#) - [Vector2D](#) = (this.x - other.x, this.y - other.y)

## Parameters

<i>other</i>	the vector to subtract from this
--------------	----------------------------------

## Returns

the difference of the vectors

## 5.81.3.9 point()

```
point_t Vector2D::point ( )
```

Returns a point from the vector

## Returns

the point represented by the vector

Convert a direction and magnitude representation to an x, y representation

## Returns

the x, y representation of the vector

The documentation for this class was generated from the following files:

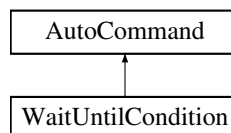
- include/utils/vector2d.h
- src/utils/vector2d.cpp

## 5.82 WaitUntilCondition Class Reference

Waits until the condition is true.

```
#include <auto_command.h>
```

Inheritance diagram for WaitUntilCondition:



## Public Member Functions

- **WaitUntilCondition** ([Condition](#) \*cond)
- bool [run](#) () override

## Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.82.1 Detailed Description

Waits until the condition is true.

### 5.82.2 Member Function Documentation

#### 5.82.2.1 [run\(\)](#)

```
bool WaitUntilCondition::run ( ) [inline], [override], [virtual]
```

Executes the command Overridden by child classes

#### Returns

true when the command is finished, false otherwise

Reimplemented from [AutoCommand](#).

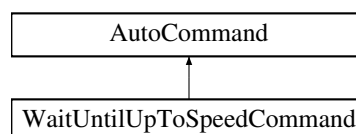
The documentation for this class was generated from the following file:

- include/utlis/command\_structure/auto\_command.h

## 5.83 WaitUntilUpToSpeedCommand Class Reference

```
#include <flywheel_commands.h>
```

Inheritance diagram for WaitUntilUpToSpeedCommand:



## Public Member Functions

- [WaitUntilUpToSpeedCommand](#) ([Flywheel](#) &flywheel, int threshold\_rpm)
- bool [run](#) () override

## Public Member Functions inherited from [AutoCommand](#)

- virtual void [on\\_timeout](#) ()
- [AutoCommand](#) \* [withTimeout](#) (double t\_seconds)
- [AutoCommand](#) \* [withCancelCondition](#) ([Condition](#) \*true\_to\_end)

## Additional Inherited Members

## Public Attributes inherited from [AutoCommand](#)

- double [timeout\\_seconds](#) = default\_timeout
- [Condition](#) \* [true\\_to\\_end](#) = nullptr

## Static Public Attributes inherited from [AutoCommand](#)

- static constexpr double [default\\_timeout](#) = 10.0

### 5.83.1 Detailed Description

[AutoCommand](#) that listens to the [Flywheel](#) and waits until it is at its target speed +/- the specified threshold

### 5.83.2 Constructor & Destructor Documentation

#### 5.83.2.1 WaitUntilUpToSpeedCommand()

```
WaitUntilUpToSpeedCommand::WaitUntilUpToSpeedCommand (
    Flywheel & flywheel,
    int threshold_rpm )
```

Creat a [WaitUntilUpToSpeedCommand](#)

#### Parameters

<i>flywheel</i>	the flywheel system we are commanding
<i>threshold_rpm</i>	the threshold over and under the flywheel target RPM that we define to be acceptable

### 5.83.3 Member Function Documentation

#### 5.83.3.1 run()

```
bool WaitUntilUpToSpeedCommand::run ( ) [override], [virtual]
```

Run spin\_manual Overrides run from [AutoCommand](#)

##### Returns

true when execution is complete, false otherwise

Reimplemented from [AutoCommand](#).

The documentation for this class was generated from the following files:

- include/utils/command\_structure/flywheel\_commands.h
- src/utils/command\_structure/flywheel\_commands.cpp



# Chapter 6

## File Documentation

### 6.1 robot\_specs.h

```
00001 #pragma once
00002 #include "../core/include/utils/controls/pid.h"
00003 #include "../core/include/utils/controls/feedback_base.h"
00004
00011 typedef struct
00012 {
00013     double robot_radius;
00014
00015     double odom_wheel_diam;
00016     double odom_gear_ratio;
00017     double dist_between_wheels;
00018
00019     double drive_correction_cutoff;
00020
00021     Feedback *drive_feedback;
00022     Feedback *turn_feedback;
00023     PID::pid_config_t correction_pid;
00024
00025 } robot_specs_t;
```

### 6.2 custom\_encoder.h

```
00001 #pragma once
00002 #include "vex.h"
00003
00008 class CustomEncoder : public vex::encoder
00009 {
00010     typedef vex::encoder super;
00011
00012     public:
00018     CustomEncoder(vex::triport::port &port, double ticks_per_rev);
00019
00025     void setRotation(double val, vex::rotationUnits units);
00026
00032     void setPosition(double val, vex::rotationUnits units);
00033
00039     double rotation(vex::rotationUnits units);
00040
00046     double position(vex::rotationUnits units);
00047
00053     double velocity(vex::velocityUnits units);
00054
00055     private:
00056     double tick_scalar;
00057 };
00058
```

## 6.3 flywheel.h

```

00001 #pragma once
00002
00003 #include "../core/include/utils/controls/feedforward.h"
00004 #include "vex.h"
00005 #include "../core/include/robot_specs.h"
00006 #include "../core/include/utils/controls/pid.h"
00007 #include "../core/include/utils/command_structure/auto_command.h"
00008 #include "../core/include/subsystems/screen.h"
00009 #include <atomic>
00010
00011 class Flywheel
00012 {
00013 public:
00014     // CONSTRUCTORS, GETTERS, AND SETTERS
00015     Flywheel(vex::motor_group &motors, Feedback &feedback, FeedForward &helper, const double ratio,
00016             Filter &filt);
00017
00018     double get_target() const;
00019
00020     double getRPM() const;
00021
00022     vex::motor_group &get_motors() const;
00023
00024     void spin_manual(double speed, directionType dir = fwd);
00025
00026     void spin_rpm(double rpm);
00027
00028     void stop();
00029
00030     bool is_on_target()
00031     {
00032         return fb.is_on_target();
00033     }
00034
00035     screen::Page *Page() const;
00036
00037     AutoCommand *SpinRpmCmd(int rpm)
00038     {
00039         return new FunctionCommand([this, rpm]()
00040                                     { spin_rpm(rpm); return true; });
00041     }
00042
00043     AutoCommand *WaitUntilUpToSpeedCmd()
00044     {
00045         return new WaitUntilCondition(
00046             new FunctionCondition([this]()
00047                                   { return is_on_target(); }));
00048     }
00049 private:
00050     friend class FlywheelPage;
00051     friend int spinRPMTask(void *wheelPointer);
00052
00053     vex::motor_group &motors;
00054     bool task_running = false;
00055     Feedback &fb;
00056     FeedForward &ff;
00057     vex::mutex fb_mut;
00058     double ratio;
00059     std::atomic<double> target_rpm;
00060     task rpm_task;
00061     Filter &avger;
00062
00063     // Functions for internal use only
00064     void set_target(double value);
00065     double measure_RPM();
00066
00067     void spin_raw(double speed, directionType dir = fwd);
00068 };

```

## 6.4 lift.h

```

00001 #pragma once
00002
00003 #include "vex.h"
00004 #include "../core/include/utils/controls/pid.h"
00005 #include <iostream>
00006 #include <map>
00007 #include <atomic>

```

```

00008 #include <vector>
00009
00010 using namespace vex;
00011 using namespace std;
00012
00020 template <typename T>
00021 class Lift
00022 {
00023     public:
00024
00031     struct lift_cfg_t
00032     {
00033         double up_speed, down_speed;
00034         double softstop_up, softstop_down;
00035
00036         PID::pid_config_t lift_pid_cfg;
00037     };
00038
00060     Lift(motor_group &lift_motors, lift_cfg_t &lift_cfg, map<T, double> &setpoint_map, limit
    *homing_switch=NULL)
00061     : lift_motors(lift_motors), cfg(lift_cfg), lift_pid(cfg.lift_pid_cfg), setpoint_map(setpoint_map),
    homing_switch(homing_switch)
00062     {
00063
00064         is_async = true;
00065         setpoint = 0;
00066
00067         // Create a background task that is constantly updating the lift PID, if requested.
00068         // Set once, and forget.
00069         task t([](void* ptr){
00070             Lift &lift = *((Lift*) ptr);
00071
00072             while(true)
00073             {
00074                 if(lift.get_async())
00075                     lift.hold();
00076
00077                 vexDelay(50);
00078             }
00079
00080             return 0;
00081         }, this);
00082     }
00083
00084
00093     void control_continuous(bool up_ctrl, bool down_ctrl)
00094     {
00095         static timer tmr;
00096
00097         double cur_pos = 0;
00098
00099         // Check if there's a hook for a custom sensor. If not, use the motors.
00100         if(get_sensor == NULL)
00101             cur_pos = lift_motors.position(rev);
00102         else
00103             cur_pos = get_sensor();
00104
00105         if(up_ctrl && cur_pos < cfg.softstop_up)
00106         {
00107             lift_motors.spin(directionType::fwd, cfg.up_speed, volt);
00108             setpoint = cur_pos + .3;
00109
00110             // std::cout << "DEBUG OUT: UP " << setpoint << ", " << tmr.time(sec) << ", " << cfg.down_speed <<
00111             "\n";
00112
00113             // Disable the PID while going UP.
00114             is_async = false;
00115             } else if(down_ctrl && cur_pos > cfg.softstop_down)
00116             {
00117                 // Lower the lift slowly, at a rate defined by down_speed
00118                 if(setpoint > cfg.softstop_down)
00119                     setpoint = setpoint - (tmr.time(sec) * cfg.down_speed);
00120                 // std::cout << "DEBUG OUT: DOWN " << setpoint << ", " << tmr.time(sec) << ", " << cfg.down_speed <<
00121                 "\n";
00122                 is_async = true;
00123             } else
00124             {
00125                 // Hold the lift at the last setpoint
00126                 is_async = true;
00127             }
00128
00129             tmr.reset();
00130         }
00131
00132     void control_manual(bool up_btn, bool down_btn, int volt_up, int volt_down)
00133     {
00134         static bool down_hold = false;

```

```

00141     static bool init = true;
00142
00143     // Allow for setting position while still calling this function
00144     if(init || up_btn || down_btn)
00145     {
00146         init = false;
00147         is_async = false;
00148     }
00149
00150     double rev = lift_motors.position(rotationUnits::rev);
00151
00152     if(rev < cfg.softstop_down && down_btn)
00153         down_hold = true;
00154     else if( !down_btn )
00155         down_hold = false;
00156
00157     if(up_btn && rev < cfg.softstop_up)
00158         lift_motors.spin(directionType::fwd, volt_up, voltageUnits::volt);
00159     else if(down_btn && rev > cfg.softstop_down && !down_hold)
00160         lift_motors.spin(directionType::rev, volt_down, voltageUnits::volt);
00161     else
00162         lift_motors.spin(directionType::fwd, 0, voltageUnits::volt);
00163 }
00164
00165 void control_setpoints(bool up_step, bool down_step, vector<T> pos_list)
00166 {
00167     // Make sure inputs are only processed on the rising edge of the button
00168     static bool up_last = up_step, down_last = down_step;
00169
00170     bool up_rising = up_step && !up_last;
00171     bool down_rising = down_step && !down_last;
00172
00173     up_last = up_step;
00174     down_last = down_step;
00175
00176     static int cur_index = 0;
00177
00178     // Avoid an index overflow. Shouldn't happen unless the user changes pos_list between calls.
00179     if(cur_index >= pos_list.size())
00180         cur_index = pos_list.size() - 1;
00181
00182     // Increment or decrement the index of the list, bringing it up or down.
00183     if(up_rising && cur_index < (pos_list.size() - 1))
00184         cur_index++;
00185     else if(down_rising && cur_index > 0)
00186         cur_index--;
00187
00188     // Set the lift to hold the position in the background with the PID loop
00189     set_position(pos_list[cur_index]);
00190     is_async = true;
00191 }
00192
00193 bool set_position(T pos)
00194 {
00195     this->setpoint = setpoint_map[pos];
00196     is_async = true;
00197
00198     return (lift_pid.get_target() == this->setpoint) && lift_pid.is_on_target();
00199 }
00200
00201 bool set_setpoint(double val)
00202 {
00203     this->setpoint = val;
00204     return (lift_pid.get_target() == this->setpoint) && lift_pid.is_on_target();
00205 }
00206
00207 double get_setpoint()
00208 {
00209     return this->setpoint;
00210 }
00211
00212 void hold()
00213 {
00214     lift_pid.set_target(setpoint);
00215     // std::cout << "DEBUG OUT: SETPOINT " << setpoint << "\n";
00216
00217     if(get_sensor != NULL)
00218         lift_pid.update(get_sensor());
00219     else
00220         lift_pid.update(lift_motors.position(rev));
00221
00222     // std::cout << "DEBUG OUT: ROTATION " << lift_motors.rotation(rev) << "\n\n";
00223
00224     lift_motors.spin(fwd, lift_pid.get(), volt);
00225 }

```

```

00260
00265 void home()
00266 {
00267     static timer tmr;
00268     tmr.reset();
00269
00270     while(tmr.time(sec) < 3)
00271     {
00272         lift_motors.spin(directionType::rev, 6, volt);
00273
00274         if (homing_switch == NULL && lift_motors.current(currentUnits::amp) > 1.5)
00275             break;
00276         else if (homing_switch != NULL && homing_switch->pressing())
00277             break;
00278     }
00279
00280     if(reset_sensor != NULL)
00281         reset_sensor();
00282
00283     lift_motors.resetPosition();
00284     lift_motors.stop();
00285
00286 }
00287
00291 bool get_async()
00292 {
00293     return is_async;
00294 }
00295
00301 void set_async(bool val)
00302 {
00303     this->is_async = val;
00304 }
00305
00315 void set_sensor_function(double (*fn_ptr) (void))
00316 {
00317     this->get_sensor = fn_ptr;
00318 }
00319
00326 void set_sensor_reset(void (*fn_ptr) (void))
00327 {
00328     this->reset_sensor = fn_ptr;
00329 }
00330
00331 private:
00332
00333     motor_group &lift_motors;
00334     lift_cfg_t &cfg;
00335     PID lift_pid;
00336     map<T, double> &setpoint_map;
00337     limit *homing_switch;
00338
00339     atomic<double> setpoint;
00340     atomic<bool> is_async;
00341
00342     double (*get_sensor)(void) = NULL;
00343     void (*reset_sensor)(void) = NULL;
00344
00345
00346 };

```

## 6.5 mecanum\_drive.h

```

00001 #pragma once
00002
00003 #include "vex.h"
00004 #include "../core/include/utils/controls/pid.h"
00005
00006 #ifndef PI
00007 #define PI 3.141592654
00008 #endif
00009
00014 class MecanumDrive
00015 {
00016
00017     public:
00018
00022     struct mecanumdrive_config_t
00023     {
00024         // PID configurations for autonomous driving
00025         PID::pid_config_t drive_pid_conf;
00026         PID::pid_config_t drive_gyro_pid_conf;
00027         PID::pid_config_t turn_pid_conf;

```

```

00028
00029 // Diameter of the mecanum wheels
00030 double drive_wheel_diam;
00031
00032 // Diameter of the perpendicular undriven encoder wheel
00033 double lateral_wheel_diam;
00034
00035 // Width between the center of the left and right wheels
00036 double wheelbase_width;
00037
00038 };
00039
00043 MecanumDrive(vex::motor &left_front, vex::motor &right_front, vex::motor &left_rear, vex::motor
&right_rear,
00044             vex::rotation *lateral_wheel=NULL, vex::inertial *imu=NULL, mecanumdrive_config_t
*config=NULL);
00045
00054 void drive_raw(double direction_deg, double magnitude, double rotation);
00055
00066 void drive(double left_y, double left_x, double right_x, int power=2);
00067
00080 bool auto_drive(double inches, double direction, double speed, bool gyro_correction=true);
00081
00092 bool auto_turn(double degrees, double speed, bool ignore_imu=false);
00093
00094 private:
00095
00096 vex::motor &left_front, &right_front, &left_rear, &right_rear;
00097
00098 mecanumdrive_config_t *config;
00099 vex::rotation *lateral_wheel;
00100 vex::inertial *imu;
00101
00102 PID *drive_pid = NULL;
00103 PID *drive_gyro_pid = NULL;
00104 PID *turn_pid = NULL;
00105
00106 bool init = true;
00107
00108 };

```

## 6.6 odometry\_3wheel.h

```

00001 #pragma once
00002 #include "../core/include/subsystems/odometry/odometry_base.h"
00003 #include "../core/include/subsystems/tank_drive.h"
00004 #include "../core/include/subsystems/custom_encoder.h"
00005
00032 class Odometry3Wheel : public OdometryBase
00033 {
00034     public:
00035
00040     typedef struct
00041     {
00042         double wheelbase_dist;
00043         double off_axis_center_dist;
00044         double wheel_diam;
00046     } odometry3wheel_cfg_t;
00047
00057 Odometry3Wheel(CustomEncoder &lside_fwd, CustomEncoder &rside_fwd, CustomEncoder &off_axis,
odometry3wheel_cfg_t &cfg, bool is_async=true);
00058
00065 pose_t update() override;
00066
00075 void tune(vex::controller &con, TankDrive &drive);
00076
00077 private:
00078
00091 static pose_t calculate_new_pos(double lside_delta_deg, double rside_delta_deg, double
offax_delta_deg, pose_t old_pos, odometry3wheel_cfg_t cfg);
00092
00093 CustomEncoder &lside_fwd, &rside_fwd, &off_axis;
00094 odometry3wheel_cfg_t &cfg;
00095
00096
00097 };

```

## 6.7 odometry\_base.h

```

00001 #pragma once

```

```

00002
00003 #include "vex.h"
00004 #include "../core/include/utils/geometry.h"
00005 #include "../core/include/robot_specs.h"
00006
00007 #ifndef PI
00008 #define PI 3.141592654
00009 #endif
00010
00011
00012
00025 class OdometryBase
00026 {
00027 public:
00028
00034     OdometryBase(bool is_async);
00035
00040     pose_t get_position(void);
00041
00046     virtual void set_position(const pose_t& newpos=zero_pos);
00047
00052     virtual pose_t update() = 0;
00053
00061     static int background_task(void* ptr);
00062
00068     void end_async();
00069
00076     static double pos_diff(pose_t start_pos, pose_t end_pos);
00077
00084     static double rot_diff(pose_t pos1, pose_t pos2);
00085
00094     static double smallest_angle(double start_deg, double end_deg);
00095
00097     bool end_task = false;
00098
00103     double get_speed();
00104
00109     double get_accel();
00110
00115     double get_angular_speed_deg();
00116
00121     double get_angular_accel_deg();
00122
00126     inline static constexpr pose_t zero_pos = {.x=0.0L, .y=0.0L, .rot=90.0L};
00127
00128 protected:
00132     vex::task *handle;
00133
00137     vex::mutex mut;
00138
00142     pose_t current_pos;
00143
00144     double speed;
00145     double accel;
00146     double ang_speed_deg;
00147     double ang_accel_deg;
00148 };

```

## 6.8 odometry\_tank.h

```

00001 #pragma once
00002
00003 #include "../core/include/subsystems/odometry/odometry_base.h"
00004 #include "../core/include/subsystems/custom_encoder.h"
00005 #include "../core/include/utils/geometry.h"
00006 #include "../core/include/utils/vector2d.h"
00007 #include "../core/include/robot_specs.h"
00008
00009 static int background_task(void* odom_obj);
00010
00011
00018 class OdometryTank : public OdometryBase
00019 {
00020 public:
00029     OdometryTank(vex::motor_group &left_side, vex::motor_group &right_side, robot_specs_t &config,
vex::inertial *imu=NULL, bool is_async=true);
00030
00040     OdometryTank(CustomEncoder &left_custom_enc, CustomEncoder &right_custom_enc, robot_specs_t
&config, vex::inertial *imu=NULL, bool is_async=true);
00041
00051     OdometryTank(vex::encoder &left_vex_enc, vex::encoder &right_vex_enc, robot_specs_t &config,
vex::inertial *imu=NULL, bool is_async=true);
00052

```

```

00057     pose_t update() override;
00058
00063     void set_position(const pose_t &newpos=zero_pos) override;
00064
00065
00066
00067 private:
00071     static pose_t calculate_new_pos(robot_specs_t &config, pose_t &stored_info, double lside_diff,
double rside_diff, double angle_deg);
00072
00073     vex::motor_group *left_side, *right_side;
00074     CustomEncoder *left_custom_enc, *right_custom_enc;
00075     vex::encoder *left_vex_enc, *right_vex_enc;
00076     vex::inertial *imu;
00077     robot_specs_t &config;
00078
00079     double rotation_offset = 0;
00080
00081 };

```

## 6.9 screen.h

```

00001 #pragma once
00002 #include "vex.h"
00003 #include <vector>
00004 #include <functional>
00005 #include <map>
00006 #include <cassert>
00007 #include "../core/include/subsystems/odometry/odometry_base.h"
00008 #include "../core/include/utils/graph_drawer.h"
00009 #include "../core/include/utils/controls/pid.h"
00010 #include "../core/include/utils/controls/pidff.h"
00011
00012 namespace screen
00013 {
00015     class Page
00016     {
00017     public:
00026         virtual void update(bool was_pressed, int x, int y);
00034         virtual void draw(vex::brain::lcd &screen, bool first_draw,
00035             unsigned int frame_number);
00036     };
00037
00039     class SliderWidget
00040     {
00041     public:
00048         SliderWidget(double &val, double low, double high, Rect rect, std::string name) : value(val),
low(low), high(high), rect(rect), name(name) {}
00049
00055         bool update(bool was_pressed, int x, int y);
00057         void draw(vex::brain::lcd &, bool first_draw, unsigned int frame_number);
00058
00059     private:
00060         double &value;
00061
00062         double low;
00063         double high;
00064
00065         Rect rect;
00066         std::string name = "";
00067     };
00068
00070     class ButtonWidget
00071     {
00072     public:
00077         ButtonWidget(std::function<void(void)> onpress, Rect rect, std::string name) :
onpress(onpress), rect(rect), name(name) {}
00082         ButtonWidget(void (*onpress)(), Rect rect, std::string name) : onpress(onpress), rect(rect),
name(name) {}
00083
00089         bool update(bool was_pressed, int x, int y);
00091         void draw(vex::brain::lcd &, bool first_draw, unsigned int frame_number);
00092
00093     private:
00094         std::function<void(void)> onpress;
00095         Rect rect;
00096         std::string name = "";
00097         bool was_pressed_last = false;
00098     };
00099
00106     void start_screen(vex::brain::lcd &screen, std::vector<Page *> pages, int first_page = 0);
00107
00109     void stop_screen();

```



```

00110
00112     using update_func_t = std::function<void(bool, int, int)>;
00113
00115     using draw_func_t = std::function<void(vex::brain::lcd &screen, bool, unsigned int)>;
00116
00117
00119     class StatsPage : public Page
00120     {
00121     public:
00124         StatsPage(std::map<std::string, vex::motor &> motors);
00126         void update(bool was_pressed, int x, int y) override;
00128         void draw(vex::brain::lcd &, bool first_draw, unsigned int frame_number) override;
00129
00130     private:
00131         void draw_motor_stats(const std::string &name, vex::motor &mot, unsigned int frame, int x, int
y, vex::brain::lcd &scr);
00132
00133         std::map<std::string, vex::motor &> motors;
00134         static const int y_start = 0;
00135         static const int per_column = 4;
00136         static const int row_height = 20;
00137         static const int row_width = 200;
00138     };
00139
00143     class OdometryPage : public Page
00144     {
00145     public:
00151         OdometryPage(OdometryBase &odom, double robot_width, double robot_height, bool do_trail);
00153         void update(bool was_pressed, int x, int y) override;
00155         void draw(vex::brain::lcd &, bool first_draw, unsigned int frame_number) override;
00156
00157     private:
00158         static const int path_len = 40;
00159         static constexpr char const *field_filename = "vex_field_240p.png";
00160
00161         OdometryBase &odom;
00162         double robot_width;
00163         double robot_height;
00164         uint8_t *buf = nullptr;
00165         int buf_size = 0;
00166         pose_t path[path_len];
00167         int path_index = 0;
00168         bool do_trail;
00169     };
00170
00172     class FunctionPage : public Page
00173     {
00174     public:
00178         FunctionPage(update_func_t update_f, draw_func_t draw_t);
00180         void update(bool was_pressed, int x, int y) override;
00182         void draw(vex::brain::lcd &, bool first_draw, unsigned int frame_number) override;
00183
00184     private:
00185         update_func_t update_f;
00186         draw_func_t draw_f;
00187     };
00188
00190     class PIDPage : public Page
00191     {
00192     public:
00197         PIDPage(PID &pid, std::string name, std::function<void(void)> onchange = [](){});
00198         PIDPage(PIDFF &pidff, std::string name, std::function<void(void)> onchange = [](){});
00199
00201         void update(bool was_pressed, int x, int y) override;
00203         void draw(vex::brain::lcd &, bool first_draw, unsigned int frame_number) override;
00204
00205     private:
00207         void zero_d_f() { cfg.d = 0; }
00209         void zero_i_f() { cfg.i = 0; }
00210
00211         PID::pid_config_t &cfg;
00212         PID &pid;
00213         const std::string name;
00214         std::function<void(void)> onchange;
00215
00216         SliderWidget p_slider;
00217         SliderWidget i_slider;
00218         SliderWidget d_slider;
00219         ButtonWidget zero_i;
00220         ButtonWidget zero_d;
00221
00222         GraphDrawer graph;
00223     };
00224
00225 }

```

## 6.10 tank\_drive.h

```

00001 #pragma once
00002
00003 #ifndef PI
00004 #define PI 3.141592654
00005 #endif
00006
00007 #include "vex.h"
00008 #include "../core/include/subsystems/odometry/odometry_tank.h"
00009 #include "../core/include/utils/controls/pid.h"
00010 #include "../core/include/utils/controls/feedback_base.h"
00011 #include "../core/include/robot_specs.h"
00012 #include "../core/include/utils/pure_pursuit.h"
00013 #include "../core/include/utils/command_structure/auto_command.h"
00014 #include <vector>
00015
00016 using namespace vex;
00017
00022 class TankDrive
00023 {
00024 public:
00032   TankDrive(motor_group &left_motors, motor_group &right_motors, robot_specs_t &config, OdometryBase
    *odom = NULL);
00033
00034   AutoCommand *DriveToPointCmd(point_t pt, vex::directionType dir = vex::forward, double max_speed =
    1.0, double end_speed = 0.0);
00035   AutoCommand *DriveToPointCmd(Feedback &fb, point_t pt, vex::directionType dir = vex::forward, double
    max_speed = 1.0, double end_speed = 0.0);
00036
00037   AutoCommand *DriveForwardCmd(double dist, vex::directionType dir = vex::forward, double max_speed =
    1.0, double end_speed = 0.0);
00038   AutoCommand *DriveForwardCmd(Feedback &fb, double dist, vex::directionType dir = vex::forward,
    double max_speed = 1.0, double end_speed = 0.0);
00039
00040   AutoCommand *TurnToHeadingCmd(double heading, double max_speed = 1.0, double end_speed = 0.0);
00041   AutoCommand *TurnToHeadingCmd(Feedback &fb, double heading, double max_speed = 1.0, double end_speed
    = 0.0);
00042
00043   AutoCommand *TurnDegreesCmd(double degrees, double max_speed = 1.0, double start_speed = 0.0);
00044   AutoCommand *TurnDegreesCmd(Feedback &fb, double degrees, double max_speed = 1.0, double end_speed =
    0.0);
00045
00046   AutoCommand *PurePursuitCmd(PurePursuit::Path path, directionType dir, double max_speed=1, double
    end_speed=0);
00047   AutoCommand *PurePursuitCmd(Feedback &feedback, PurePursuit::Path path, directionType dir, double
    max_speed=1, double end_speed=0);
00048
00052   void stop();
00053
00064   void drive_tank(double left, double right, int power=1);
00065
00076   void drive_arcade(double forward_back, double left_right, int power = 1);
00077
00089   bool drive_forward(double inches, directionType dir, Feedback &feedback, double max_speed = 1,
    double end_speed = 0);
00090
00100   bool drive_forward(double inches, directionType dir, double max_speed = 1, double end_speed = 0);
00101
00112   bool turn_degrees(double degrees, Feedback &feedback, double max_speed = 1, double end_speed = 0);
00113
00124   bool turn_degrees(double degrees, double max_speed = 1, double end_speed = 0);
00125
00138   bool drive_to_point(double x, double y, vex::directionType dir, Feedback &feedback, double max_speed
    = 1, double end_speed = 0);
00139
00152   bool drive_to_point(double x, double y, vex::directionType dir, double max_speed = 1, double
    end_speed = 0);
00153
00163   bool turn_to_heading(double heading_deg, Feedback &feedback, double max_speed = 1, double end_speed
    = 0);
00172   bool turn_to_heading(double heading_deg, double max_speed = 1, double end_speed = 0);
00173
00177   void reset_auto();
00178
00187   static double modify_inputs(double input, int power = 2);
00188
00201   bool pure_pursuit(PurePursuit::Path path, directionType dir, Feedback &feedback, double max_speed=1,
    double end_speed=0);
00202
00216   bool pure_pursuit(PurePursuit::Path path, directionType dir, double max_speed=1, double
    end_speed=0);
00217
00218 private:
00219   motor_group &left_motors;
00220   motor_group &right_motors;
00221

```

```

00222     PID correction_pid;
00223     Feedback *drive_default_feedback = NULL;
00224     Feedback *turn_default_feedback = NULL;
00225
00226     OdometryBase *odometry;
00227
00228     robot_specs_t &config;
00229
00230     bool func_initialized = false;
00231     bool is_pure_pursuit = false;
00232 };

```

## 6.11 auto\_chooser.h

```

00001 #pragma once
00002 #include "vex.h"
00003 #include <string>
00004 #include <vector>
00005 #include "../core/include/subsystems/screen.h"
00006 #include "../core/include/utils/geometry.h"
00007
00016 class AutoChooser : public screen::Page
00017 {
00018 public:
00024     AutoChooser(std::vector<std::string> paths, size_t def = 0);
00025
00026     void update(bool was_pressed, int x, int y);
00027     void draw(vex::brain::lcd &, bool first_draw, unsigned int frame_number);
00028
00033     size_t get_choice();
00034
00035 protected:
00039     struct entry_t
00040     {
00041         Rect rect;
00042         std::string name;
00043     };
00044
00045     static const size_t width = 380;
00046     static const size_t height = 220;
00047
00048     size_t choice;
00049     std::vector<entry_t> list ;
00050 };

```

## 6.12 auto\_command.h

```

00001
00007 #pragma once
00008
00009 #include "vex.h"
00010 #include <functional>
00011 #include <vector>
00012 #include <queue>
00013 #include <atomic>
00014
00015
00025 class Condition
00026 {
00027 public:
00028     Condition *Or(Condition *b);
00029     Condition *And(Condition *b);
00030     virtual bool test() = 0;
00031 };
00032
00033
00034 class AutoCommand
00035 {
00036 public:
00037     static constexpr double default_timeout = 10.0;
00043     virtual bool run() { return true; }
00047     virtual void on_timeout() {}
00048     AutoCommand *withTimeout(double t_seconds)
00049     {
00050         if (this->timeout_seconds < 0)
00051         {
00052             // should never be timed out
00053             return this;
00054         }
00055     }
00056 };

```

```

00055     this->timeout_seconds = t_seconds;
00056     return this;
00057 }
00058 AutoCommand *withCancelCondition(Condition *true_to_end) {
00059     this->true_to_end = true_to_end;
00060     return this;
00061 }
00071 double timeout_seconds = default_timeout;
00072 Condition *true_to_end = nullptr;
00073 };
00074
00079 class FunctionCommand : public AutoCommand
00080 {
00081 public:
00082     FunctionCommand(std::function<bool(void)> f) : f(f) {}
00083     bool run()
00084     {
00085         return f();
00086     }
00087 private:
00088     std::function<bool(void)> f;
00090 };
00091
00092 // Times tested 3
00093 // Test 1 -> false
00094 // Test 2 -> false
00095 // Test 3 -> true
00096 // Returns false until the Nth time that it is called
00097 // This is pretty much only good for implementing RepeatUntil
00098 class TimesTestedCondition : public Condition
00099 {
00100 public:
00101     TimesTestedCondition(size_t N) : max(N) {}
00102     bool test() override
00103     {
00104         count++;
00105         if (count >= max)
00106         {
00107             return true;
00108         }
00109         return false;
00110     }
00111 private:
00112     size_t count = 0;
00113     size_t max;
00115 };
00116
00118 class FunctionCondition : public Condition
00119 {
00120 public:
00121     FunctionCondition(
00122         std::function<bool()> cond, std::function<void(void)> timeout = []() {}) : cond(cond),
00123         timeout(timeout)
00124     {
00125     }
00126     bool test() override;
00127 private:
00128     std::function<bool()> cond;
00129     std::function<void(void)> timeout;
00130 };
00131
00133 class IfTimePassed : public Condition
00134 {
00135 public:
00136     IfTimePassed(double time_s);
00137     bool test() override;
00138 private:
00139     double time_s;
00140     vex::timer tmr;
00142 };
00143
00145 class WaitUntilCondition : public AutoCommand
00146 {
00147 public:
00148     WaitUntilCondition(Condition *cond) : cond(cond) {}
00149     bool run() override
00150     {
00151         return cond->test();
00152     }
00153 private:
00154     Condition *cond;
00156 };

```

```

00157
00160
00163 class InOrder : public AutoCommand
00164 {
00165 public:
00166     InOrder(const InOrder &other) = default;
00167     InOrder(std::queue<AutoCommand *> cmds);
00168     InOrder(std::initializer_list<AutoCommand *> cmds);
00169     bool run() override;
00170     void on_timeout() override;
00171
00172 private:
00173     AutoCommand *current_command = nullptr;
00174     std::queue<AutoCommand *> cmds;
00175     vex::timer tmr;
00176 };
00177
00180 class Parallel : public AutoCommand
00181 {
00182 public:
00183     Parallel(std::initializer_list<AutoCommand *> cmds);
00184     bool run() override;
00185     void on_timeout() override;
00186
00187 private:
00188     std::vector<AutoCommand *> cmds;
00189     std::vector<vex::task *> runners;
00190 };
00191
00195 class Branch : public AutoCommand
00196 {
00197 public:
00198     Branch(Condition *cond, AutoCommand *false_choice, AutoCommand *true_choice);
00199     ~Branch();
00200     bool run() override;
00201     void on_timeout() override;
00202
00203 private:
00204     AutoCommand *false_choice;
00205     AutoCommand *true_choice;
00206     Condition *cond;
00207     bool choice = false;
00208     bool chosen = false;
00209     vex::timer tmr;
00210 };
00211
00215 class Async : public AutoCommand
00216 {
00217 public:
00218     Async(AutoCommand *cmd) : cmd(cmd) {}
00219     bool run() override;
00220
00221 private:
00222     AutoCommand *cmd = nullptr;
00223 };
00224
00225 class RepeatUntil : public AutoCommand
00226 {
00227 public:
00231     RepeatUntil(InOrder cmds, size_t repeats);
00235     RepeatUntil(InOrder cmds, Condition *true_to_end);
00236     bool run() override;
00237     void on_timeout() override;
00238
00239 private:
00240     const InOrder cmds;
00241     InOrder *working_cmds;
00242     Condition *cond;
00243 };

```

## 6.13 basic\_command.h

```

00001
00014 #pragma once
00015
00016 #include "../core/include/utis/command_structure/auto_command.h"
00017
00018 //Basic Motor Classes-----
00019
00024 class BasicSpinCommand : public AutoCommand {
00025     public:
00026
00027         //Enumerator for the type of power setting in the motor

```

```

00028     enum type {percent,voltage,velocity};
00029
00038     BasicSpinCommand(vex::motor &motor, vex::directionType dir, BasicSpinCommand::type setting,
double power);
00039
00046     bool run() override;
00047
00048     private:
00049
00050         vex::motor &motor;
00051
00052         type setting;
00053
00054         vex::directionType dir;
00055
00056         double power;
00057 };
00062 class BasicStopCommand : public AutoCommand{
00063     public:
00064
00071         BasicStopCommand(vex::motor &motor, vex::brakeType setting);
00072
00079         bool run() override;
00080
00081     private:
00082
00083         vex::motor &motor;
00084
00085         vex::brakeType setting;
00086 };
00087
00088 //Basic Solenoid Commands-----
00089
00094 class BasicSolenoidSet : public AutoCommand{
00095     public:
00096
00103         BasicSolenoidSet(vex::pneumatics &solenoid, bool setting);
00104
00111         bool run() override;
00112
00113     private:
00114
00115         vex::pneumatics &solenoid;
00116
00117         bool setting;
00118 };

```

## 6.14 command\_controller.h

```

00001
00010 #pragma once
00011 #include <vector>
00012 #include <queue>
00013 #include "../core/include/utlis/command_structure/auto_command.h"
00014
00015 class CommandController
00016 {
00017     public:
00019         [[deprecated("Use list constructor instead.")]] CommandController() : command_queue({}) {}
00020
00023         CommandController(std::initializer_list<AutoCommand *> cmds) : command_queue(cmds) {}
00029         [[deprecated("Use list constructor instead. If you need to make a decision before adding new
commands, use Branch (https://github.com/RIT-VEX-U/Core/wiki/3-%7C-Utilites#commandcontroller)"])]
void add(std::vector<AutoCommand *> cmds);
00030         void add(AutoCommand *cmd, double timeout_seconds = 10.0);
00031
00042         [[deprecated("Use list constructor instead. If you need to make a decision before adding new
commands, use Branch (https://github.com/RIT-VEX-U/Core/wiki/3-%7C-Utilites#commandcontroller)"])]
void
00043         add(std::vector<AutoCommand *> cmds, double timeout_sec);
00050         void add_delay(int ms);
00051
00054         void add_cancel_func(std::function<bool(void)> true_if_cancel);
00055
00060         void run();
00061
00067         bool last_command_timed_out();
00068
00069     private:
00070         std::queue<AutoCommand *> command_queue;
00071         bool command_timed_out = false;
00072         std::function<bool()> should_cancel = []()
00073         { return false; };
00074 };

```

## 6.15 delay\_command.h

```

00001
00008 #pragma once
00009
00010 #include "../core/include/utils/command_structure/auto_command.h"
00011
00012 class DelayCommand: public AutoCommand {
00013     public:
00018         DelayCommand(int ms): ms(ms) {}
00019
00025         bool run() override {
00026             vexDelay(ms);
00027             return true;
00028         }
00029
00030     private:
00031         // amount of milliseconds to wait
00032         int ms;
00033 };

```

## 6.16 drive\_commands.h

```

00001
00019 #pragma once
00020
00021 #include "vex.h"
00022 #include "../core/include/utils/geometry.h"
00023 #include "../core/include/utils/command_structure/auto_command.h"
00024 #include "../core/include/subsystems/tank_drive.h"
00025
00026 using namespace vex;
00027
00028
00029 // ==== DRIVING ====
00030
00036 class DriveForwardCommand: public AutoCommand
00037 {
00038     public:
00039         DriveForwardCommand(TankDrive &drive_sys, Feedback &feedback, double inches, directionType dir,
00040                             double max_speed=1, double end_speed=0);
00041
00046         bool run() override;
00050         void on_timeout() override;
00051
00052     private:
00053         // drive system to run the function on
00054         TankDrive &drive_sys;
00055
00056         // feedback controller to use
00057         Feedback &feedback;
00058
00059         // parameters for drive_forward
00060         double inches;
00061         directionType dir;
00062         double max_speed;
00063         double end_speed;
00064 };
00065
00070 class TurnDegreesCommand: public AutoCommand
00071 {
00072     public:
00073         TurnDegreesCommand(TankDrive &drive_sys, Feedback &feedback, double degrees, double max_speed = 1,
00074                             double end_speed = 0);
00075
00080         bool run() override;
00084         void on_timeout() override;
00085
00086     private:
00088         // drive system to run the function on
00089         TankDrive &drive_sys;
00090
00091         // feedback controller to use
00092         Feedback &feedback;
00093
00094         // parameters for turn_degrees
00095         double degrees;
00096         double max_speed;
00097         double end_speed;
00098 };
00099
00104 class DriveToPointCommand: public AutoCommand

```

```

00105 {
00106     public:
00107         DriveToPointCommand(TankDrive &drive_sys, Feedback &feedback, double x, double y, directionType
dir, double max_speed = 1, double end_speed = 0);
00108         DriveToPointCommand(TankDrive &drive_sys, Feedback &feedback, point_t point, directionType dir,
double max_speed=1, double end_speed = 0);
00109
00115         bool run() override;
00116
00117     private:
00118         // drive system to run the function on
00119         TankDrive &drive_sys;
00120
00124         void on_timeout() override;
00125
00126
00127         // feedback controller to use
00128         Feedback &feedback;
00129
00130         // parameters for drive_to_point
00131         double x;
00132         double y;
00133         directionType dir;
00134         double max_speed;
00135         double end_speed;
00136
00137 };
00138
00144 class TurnToHeadingCommand: public AutoCommand
00145 {
00146     public:
00147         TurnToHeadingCommand(TankDrive &drive_sys, Feedback &feedback, double heading_deg, double speed =
1, double end_speed = 0);
00148
00154         bool run() override;
00158         void on_timeout() override;
00159
00160
00161     private:
00162         // drive system to run the function on
00163         TankDrive &drive_sys;
00164
00165         // feedback controller to use
00166         Feedback &feedback;
00167
00168         // parameters for turn_to_heading
00169         double heading_deg;
00170         double max_speed;
00171         double end_speed;
00172 };
00173
00177 class PurePursuitCommand: public AutoCommand
00178 {
00179     public:
00188         PurePursuitCommand(TankDrive &drive_sys, Feedback &feedback, PurePursuit::Path path, directionType
dir, double max_speed=1, double end_speed=0);
00189
00193         bool run() override;
00194
00198         void on_timeout() override;
00199
00200     private:
00201         TankDrive &drive_sys;
00202         PurePursuit::Path path;
00203         directionType dir;
00204         Feedback &feedback;
00205         double max_speed;
00206         double end_speed;
00207
00208 };
00209
00214 class DriveStopCommand: public AutoCommand
00215 {
00216     public:
00217         DriveStopCommand(TankDrive &drive_sys);
00218
00224         bool run() override;
00225         void on_timeout() override;
00226
00227     private:
00228         // drive system to run the function on
00229         TankDrive &drive_sys;
00230 };
00231
00232
00233 // ==== ODOMETRY ====
00234

```



```

00239 class OdomSetPosition: public AutoCommand
00240 {
00241     public:
00247         OdomSetPosition(OdometryBase &odom, const pose_t &newpos=OdometryBase::zero_pos);
00248
00254         bool run() override;
00255
00256     private:
00257         // drive system with an odometry config
00258         OdometryBase &odom;
00259         pose_t newpos;
00260 };

```

## 6.17 flywheel\_commands.h

```

00001
00007 #pragma once
00008
00009 #include "../core/include/subsystems/flywheel.h"
00010 #include "../core/include/utils/command_structure/auto_command.h"
00011
00017 class SpinRPMCommand: public AutoCommand {
00018     public:
00024         SpinRPMCommand(Flywheel &flywheel, int rpm);
00025
00031         bool run() override;
00032
00033     private:
00034         // Flywheel instance to run the function on
00035         Flywheel &flywheel;
00036
00037         // parameters for spin_rpm
00038         int rpm;
00039 };
00040
00045 class WaitUntilUpToSpeedCommand: public AutoCommand {
00046     public:
00052         WaitUntilUpToSpeedCommand(Flywheel &flywheel, int threshold_rpm);
00053
00059         bool run() override;
00060
00061     private:
00062         // Flywheel instance to run the function on
00063         Flywheel &flywheel;
00064
00065         // if the actual speed is equal to the desired speed +/- this value, we are ready to fire
00066         int threshold_rpm;
00067 };
00068
00074 class FlywheelStopCommand: public AutoCommand {
00075     public:
00080         FlywheelStopCommand(Flywheel &flywheel);
00081
00087         bool run() override;
00088
00089     private:
00090         // Flywheel instance to run the function on
00091         Flywheel &flywheel;
00092 };
00093
00099 class FlywheelStopMotorsCommand: public AutoCommand {
00100     public:
00105         FlywheelStopMotorsCommand(Flywheel &flywheel);
00106
00112         bool run() override;
00113
00114     private:
00115         // Flywheel instance to run the function on
00116         Flywheel &flywheel;
00117 };
00118
00124 class FlywheelStopNonTasksCommand: public AutoCommand {
00125         FlywheelStopNonTasksCommand(Flywheel &flywheel);
00126
00132         bool run() override;
00133
00134     private:
00135         // Flywheel instance to run the function on
00136         Flywheel &flywheel;
00137 };

```

## 6.18 bang\_bang.h

```

00001 #include "../core/include/utils/controls/feedback_base.h"
00002
00003 class BangBang : public Feedback
00004 {
00005
00006 public:
00007     BangBang(double threshold, double low, double high);
00016     void init(double start_pt, double set_pt, double start_vel [[maybe_unused]] = 0.0, double end_vel
[[maybe_unused]] = 0.0) override;
00017
00024     double update(double val) override;
00025
00029     double get() override;
00030
00037     void set_limits(double lower, double upper) override;
00038
00042     bool is_on_target() override;
00043
00044 private:
00045     double setpt;
00046     double sensor_val;
00047     double lower_bound, upper_bound;
00048     double last_output;
00049     double threshold;
00050 };

```

## 6.19 feedback\_base.h

```

00001 #pragma once
00002
00010 class Feedback
00011 {
00012 public:
00021     virtual void init(double start_pt, double set_pt, double start_vel = 0.0, double end_vel = 0.0) =
0;
00022
00029     virtual double update(double val) = 0;
00030
00034     virtual double get() = 0;
00035
00042     virtual void set_limits(double lower, double upper) = 0;
00043
00047     virtual bool is_on_target() = 0;
00048
00049
00050 };

```

## 6.20 feedforward.h

```

00001 #pragma once
00002
00003 #include <math.h>
00004 #include <vector>
00005 #include "../core/include/utils/math_util.h"
00006 #include "../core/include/utils/moving_average.h"
00007 #include "vex.h"
00008
00029 class FeedForward
00030 {
00031 public:
00032
00041     typedef struct
00042     {
00043         double kS;
00044         double kV;
00045         double kA;
00046         double kG;
00047     } ff_config_t;
00048
00049
00054     FeedForward(ff_config_t &cfg) : cfg(cfg) {}
00055
00066     double calculate(double v, double a, double pid_ref=0.0)
00067     {
00068         double ks_sign = 0;
00069         if(v != 0)
00070             ks_sign = sign(v);

```

```

00071         else if(pid_ref != 0)
00072             ks_sign = sign(pid_ref);
00073
00074         return (cfg.kS * ks_sign) + (cfg.kV * v) + (cfg.kA * a) + cfg.kG;
00075     }
00076
00077     private:
00078
00079     ff_config_t &cfg;
00080
00081 };
00082
00083
00091 FeedForward::ff_config_t tune_feedforward(vex::motor_group &motor, double pct, double duration);

```

## 6.21 motion\_controller.h

```

00001 #pragma once
00002 #include "../core/include/utils/controls/pid.h"
00003 #include "../core/include/utils/controls/feedforward.h"
00004 #include "../core/include/utils/controls/trapezoid_profile.h"
00005 #include "../core/include/utils/controls/feedback_base.h"
00006 #include "../core/include/subsystems/tank_drive.h"
00007 #include "vex.h"
00008
00025 class MotionController : public Feedback
00026 {
00027     public:
00028
00034     typedef struct
00035     {
00036         double max_v;
00037         double accel;
00038         PID::pid_config_t pid_cfg;
00039         FeedForward::ff_config_t ff_cfg;
00040     } m_profile_cfg_t;
00041
00051     MotionController(m_profile_cfg_t &config);
00052
00057     void init(double start_pt, double end_pt, double start_vel, double end_vel) override;
00058
00065     double update(double sensor_val) override;
00066
00070     double get() override;
00071
00079     void set_limits(double lower, double upper) override;
00080
00085     bool is_on_target() override;
00086
00090     motion_t get_motion();
00091
00110     static FeedForward::ff_config_t tune_feedforward(TankDrive &drive, OdometryTank &odometry, double
pct=0.6, double duration=2);
00111
00112     private:
00113
00114     m_profile_cfg_t config;
00115
00116     PID pid;
00117     FeedForward ff;
00118     TrapezoidProfile profile;
00119
00120     double current_pos;
00121     double end_pt;
00122
00123     double lower_limit = 0, upper_limit = 0;
00124     double out = 0;
00125     motion_t cur_motion;
00126
00127     vex::timer tmr;
00128
00129 };

```

## 6.22 pid.h

```

00001 #pragma once
00002
00003 #include <cmath>
00004 #include "vex.h"

```

```

00005 #include "../core/include/utils/controls/feedback_base.h"
00006
00007 using namespace vex;
00008
00023 class PID : public Feedback
00024 {
00025 public:
00029     enum ERROR_TYPE{
00030         LINEAR,
00031         ANGULAR // assumes degrees
00032     };
00040     struct pid_config_t
00041     {
00042         double p;
00043         double i;
00044         double d;
00045         double deadband;
00046         double on_target_time;
00047         ERROR_TYPE error_method;
00048     };
00049
00050
00051
00056     PID(pid_config_t &config);
00057
00058
00069     void init(double start_pt, double set_pt, double start_vel = 0, double end_vel = 0) override;
00070
00077     double update(double sensor_val) override;
00078
00079
00084     double get_sensor_val();
00085
00086
00091     double get() override;
00092
00099     void set_limits(double lower, double upper) override;
00100
00105     bool is_on_target() override;
00106
00110     void reset();
00111
00116     double get_error();
00117
00122     double get_target();
00123
00128     void set_target(double target);
00129
00130
00131     pid_config_t &config;
00132
00133 private:
00134
00135
00136     double last_error = 0;
00137     double accum_error = 0;
00138
00139     double last_time = 0;
00140     double on_target_last_time = 0;
00141
00142     double lower_limit = 0;
00143     double upper_limit = 0;
00144
00145     double target = 0;
00146     double target_vel = 0;
00147     double sensor_val = 0;
00148     double out = 0;
00149
00150     bool is_checking_on_target = false;
00151
00152     timer pid_timer;
00153 };

```

## 6.23 pidff.h

```

00001 #pragma once
00002 #include "../core/include/utils/controls/feedback_base.h"
00003 #include "../core/include/utils/controls/pid.h"
00004 #include "../core/include/utils/controls/feedforward.h"
00005
00006 class PIDFF : public Feedback
00007 {
00008     public:

```

```

00009
00010     PIDFF(PID::pid_config_t &pid_cfg, FeedForward::ff_config_t &ff_cfg);
00011
00020     void init(double start_pt, double set_pt, double start_vel, double end_vel) override;
00021
00026     void set_target(double set_pt);
00027
00035     double update(double val) override;
00036
00045     double update(double val, double vel_setpt, double a_setpt=0);
00046
00050     double get() override;
00051
00058     void set_limits(double lower, double upper) override;
00059
00063     bool is_on_target() override;
00064
00065     PID pid;
00066
00067
00068     private:
00069
00070     FeedForward::ff_config_t &ff_cfg;
00071
00072     FeedForward ff;
00073
00074     double out;
00075     double lower_lim, upper_lim;
00076
00077 };

```

## 6.24 take\_back\_half.h

```

00001 #pragma once
00002 #include "../core/include/utils/controls/feedback_base.h"
00003
00006 class TakeBackHalf : public Feedback
00007 {
00008
00009 public:
00010     TakeBackHalf(double TBH_gain, double first_cross_split, double on_target_threshold);
00019     void init(double start_pt, double set_pt, double, double);
00026     double update(double val) override;
00027
00031     double get() override;
00032
00039     void set_limits(double lower, double upper) override;
00040
00044     bool is_on_target() override;
00045
00046     double TBH_gain;
00047     double first_cross_split;
00048 private:
00049     double on_target_threshold;
00050
00051     double target = 0.0;
00052
00053     bool first_cross = true;
00054     double tbh = 0.0;
00055     double prev_error = 0.0;
00056
00057     double output = 0.0;
00058     double lower = 0.0, upper = 0.0;
00059 };

```

## 6.25 trapezoid\_profile.h

```

00001 #pragma once
00002
00003 const int MAX_TRAPEZOID_PROFILE_SEGMENTS = 4;
00004
00008 typedef struct
00009 {
00010     double pos;
00011     double vel;
00012     double accel;
00013 } motion_t;
00014
00015

```

```

00019 typedef struct
00020 {
00021     double pos_after;
00022     double vel_after;
00023     double accel;
00024     double duration;
00025 } trapezoid_profile_segment_t;
00026
00060 class TrapezoidProfile
00061 {
00062     public:
00063
00070     TrapezoidProfile(double max_v, double accel);
00071
00079     motion_t calculate(double time_s, double pos_s);
00080
00087     motion_t calculate_time_based(double time_s);
00088
00095     void set_endpts(double start, double end);
00096
00103     void set_vel_endpts(double start, double end);
00104
00110     void set_accel(double accel);
00111
00117     void set_max_v(double max_v);
00118
00124     double get_movement_time();
00125
00126     private:
00127     double si, sf;
00128     double vi, vf;
00129     double max_v;
00130     double accel;
00131
00132     trapezoid_profile_segment_t segments[MAX_TRAPEZOID_PROFILE_SEGMENTS];
00133     int num_acceleration_phases;
00134
00135     bool precalculated;
00136
00142     bool precalculate();
00143
00152     trapezoid_profile_segment_t calculate_kinetic_motion(double si, double vi, double v_target);
00153
00161     trapezoid_profile_segment_t calculate_next_segment(double s, double v);
00162 };

```

## 6.26 generic\_auto.h

```

00001 #pragma once
00002
00003 #include <queue>
00004 #include <map>
00005 #include "vex.h"
00006 #include <functional>
00007
00008 typedef std::function<bool(void)> state_ptr;
00009
00014 class GenericAuto
00015 {
00016     public:
00017
00031     [[deprecated("Use CommandController instead.")]]
00032     bool run(bool blocking);
00033
00038     [[deprecated("Use CommandController instead.")]]
00039     void add(state_ptr new_state);
00040
00045     [[deprecated("Use CommandController instead.")]]
00046     void add_async(state_ptr async_state);
00047
00052     [[deprecated("Use CommandController instead.")]]
00053     void add_delay(int ms);
00054
00055     private:
00056
00057     std::queue<state_ptr> state_list;
00058
00059 };

```

## 6.27 geometry.h

```

00001 #pragma once
00002 #include <cmath>
00003
00007 struct point_t
00008 {
00009     double x;
00010     double y;
00011
00017     double dist(const point_t other) const
00018     {
00019         return std::sqrt(std::pow(this->x - other.x, 2) + pow(this->y - other.y, 2));
00020     }
00021
00027     point_t operator+(const point_t &other) const
00028     {
00029         point_t p{
00030             .x = this->x + other.x,
00031             .y = this->y + other.y};
00032         return p;
00033     }
00034
00040     point_t operator-(const point_t &other) const
00041     {
00042         point_t p{
00043             .x = this->x - other.x,
00044             .y = this->y - other.y};
00045         return p;
00046     }
00047
00048     point_t operator*(double s) const
00049     {
00050         return {x * s, y * s};
00051     }
00052     point_t operator/(double s) const
00053     {
00054         return {x / s, y / s};
00055     }
00056
00057     point_t operator-() const
00058     {
00059         return {-x, -y};
00060     }
00061     point_t operator+() const
00062     {
00063         return {x, y};
00064     }
00065
00066     bool operator==(const point_t &rhs)
00067     {
00068         return x == rhs.x && y == rhs.y;
00069     }
00070 };
00071
00075 struct pose_t
00076 {
00077     double x;
00078     double y;
00079     double rot;
00080
00081     point_t get_point()
00082     {
00083         return point_t{.x = x, .y = y};
00084     }
00085
00086 } ;
00087
00088 struct Rect
00089 {
00090     point_t min;
00091     point_t max;
00092     static Rect from_min_and_size(point_t min, point_t size){
00093         return {min, min+size};
00094     }
00095     point_t dimensions() const
00096     {
00097         return max - min;
00098     }
00099     point_t center() const{
00100         return (min + max)/2;
00101     }
00102     double width() const{
00103         return max.x - min.x;
00104     }
00105     double height() const{
00106         return max.y - min.y;

```

```

00107     }
00108     bool contains(point_t p) const
00109     {
00110         bool xin = p.x > min.x && p.x < max.x;
00111         bool yin = p.y > min.y && p.y < max.y;
00112         return xin && yin;
00113     }
00114
00115 };
00116
00117 struct Mat2
00118 {
00119     double X11, X12;
00120     double X21, X22;
00121     point_t operator*(const point_t p) const
00122     {
00123         double outx = p.x * X11 + p.y * X12;
00124         double outy = p.x * X21 + p.y * X22;
00125         return {outx, outy};
00126     }
00127
00128     static Mat2 FromRotationDegrees(double degrees)
00129     {
00130         double rad = degrees * (M_PI / 180.0);
00131         double c = cos(rad);
00132         double s = sin(rad);
00133         return {c, -s, s, c};
00134     }
00135 };

```

## 6.28 graph\_drawer.h

```

00001 #pragma once
00002
00003 #include <string>
00004 #include <stdio.h>
00005 #include <vector>
00006 #include <cmath>
00007 #include "vex.h"
00008 #include "../core/include/utils/geometry.h"
00009 #include "../core/include/utils/vector2d.h"
00010
00011 class GraphDrawer
00012 {
00013 public:
00020     GraphDrawer(int num_samples, double lower_bound, double upper_bound, std::vector<vex::color> colors,
00021                 size_t num_series = 1);
00025     void add_samples(std::vector<point_t> sample);
00026
00031     void add_samples(std::vector<double> sample);
00032
00040     void draw(vex::brain::lcd &screen, int x, int y, int width, int height);
00041
00042 private:
00043     std::vector<std::vector<point_t>> series;
00044     int sample_index = 0;
00045     std::vector<vex::color> cols;
00046     vex::color bgcol = vex::transparent;
00047     bool border;
00048     double upper;
00049     double lower;
00050     bool auto_fit = false;
00051 };

```

## 6.29 logger.h

```

00001 #pragma once
00002
00003 #include <cstdarg>
00004 #include <cstdio>
00005 #include <string>
00006 #include "vex.h"
00007
00009 enum LogLevel
00010 {
00011     DEBUG,
00012     NOTICE,
00013     WARNING,
00014     ERROR,

```



```

00015     CRITICAL,
00016     TIME
00017 };
00018
00020 class Logger
00021 {
00022 private:
00023     const std::string filename;
00024     vex::brain::sdcard sd;
00025     void write_level(LogLevel l);
00026
00027 public:
00029     static constexpr int MAX_FORMAT_LEN = 512;
00032     explicit Logger(const std::string &filename);
00033
00035     Logger(const Logger &l) = delete;
00037     Logger &operator=(const Logger &l) = delete;
00038
00039
00042     void Log(const std::string &s);
00043
00047     void Log(LogLevel level, const std::string &s);
00048
00051     void Logln(const std::string &s);
00052
00056     void Logln(LogLevel level, const std::string &s);
00057
00061     void Logf(const char *fmt, ...);
00062
00067     void Logf(LogLevel level, const char *fmt, ...);
00068 };

```

## 6.30 math\_util.h

```

00001 #pragma once
00002 #include <vector>
00003 #include "math.h"
00004 #include "vex.h"
00005 #include "../core/include/utils/geometry.h"
00006
00007
00015 double clamp(double value, double low, double high);
00016
00023 double lerp(double a, double b, double t);
00030 double sign(double x);
00031
00032 double wrap_angle_deg(double input);
00033 double wrap_angle_rad(double input);
00034
00035 /*
00036 Calculates the variance of a set of numbers (needed for linear regression)
00037 https://en.wikipedia.org/wiki/Variance
00038 @param values the values for which the variance is taken
00039 @param mean the average of values
00040 */
00041 double variance(std::vector<double> const &values, double mean);
00042
00043
00044 /*
00045 Calculates the average of a vector of doubles
00046 @param values the list of values for which the average is taken
00047 */
00048 double mean(std::vector<double> const &values);
00049
00050 /*
00051 Calculates the covariance of a set of points (needed for linear regression)
00052 https://en.wikipedia.org/wiki/Covariance
00053
00054 @param points the points for which the covariance is taken
00055 @param meanx the mean value of all x coordinates in points
00056 @param meany the mean value of all y coordinates in points
00057 */
00058 double covariance(std::vector<std::pair<double, double> const &points, double meanx, double meany);
00059
00060 /*
00061 Calculates the slope and y intercept of the line of best fit for the data
00062 @param points the points for the data
00063 */
00064 std::pair<double, double> calculate_linear_regression(std::vector<std::pair<double, double> const
&points);
00065
00066 double estimate_path_length(const std::vector<point_t> &points);

```

## 6.31 moving\_average.h

```

00001 #pragma once
00002 #include <vector>
00003
00008 class Filter
00009 {
00010 public:
00011     virtual void add_entry(double n) = 0;
00012     virtual double get_value() const = 0;
00013 };
00014
00027 class MovingAverage : public Filter
00028 {
00029 public:
00030     /*
00031      * Create a moving average calculator with 0 as the default value
00032      *
00033      * @param buffer_size    The size of the buffer. The number of samples that constitute a valid
reading
00034      */
00035     MovingAverage(int buffer_size);
00036     /*
00037      * Create a moving average calculator with a specified default value
00038      * @param buffer_size    The size of the buffer. The number of samples that constitute a valid
reading
00039      * @param starting_value The value that the average will be before any data is added
00040      */
00041     MovingAverage(int buffer_size, double starting_value);
00042
00043     /*
00044      * Add a reading to the buffer
00045      * Before:
00046      * [ 1 1 2 2 3 3] => 2
00047      * ^
00048      * After:
00049      * [ 2 1 2 2 3 3] => 2.16
00050      * ^
00051      * @param n    the sample that will be added to the moving average.
00052      */
00053     void add_entry(double n);
00054
00055     double get_value() const;
00060
00065     int get_size() const;
00066
00067 private:
00068     int buffer_index;           // index of the next value to be overridden
00069     std::vector<double> buffer; // all current data readings we've taken
00070     double current_avg;        // the current value of the data
00071 };
00072
00085 class ExponentialMovingAverage : public Filter
00086 {
00087 public:
00088     /*
00089      * Create a moving average calculator with 0 as the default value
00090      *
00091      * @param buffer_size    The size of the buffer. The number of samples that constitute a valid
reading
00092      */
00093     ExponentialMovingAverage(int buffer_size);
00094     /*
00095      * Create a moving average calculator with a specified default value
00096      * @param buffer_size    The size of the buffer. The number of samples that constitute a valid
reading
00097      * @param starting_value The value that the average will be before any data is added
00098      */
00099     ExponentialMovingAverage(int buffer_size, double starting_value);
00100
00101     /*
00102      * Add a reading to the buffer
00103      * Before:
00104      * [ 1 1 2 2 3 3] => 2
00105      * ^
00106      * After:
00107      * [ 2 1 2 2 3 3] => 2.16
00108      * ^
00109      * @param n    the sample that will be added to the moving average.
00110      */
00111     void add_entry(double n);
00112
00117     double get_value();
00118
00123     int get_size();
00124
00125 private:

```

```

00126     int buffer_index;           // index of the next value to be overridden
00127     std::vector<double> buffer; // all current data readings we've taken
00128     double current_avg;        // the current value of the data
00129 };

```

## 6.32 pure\_pursuit.h

```

00001 #pragma once
00002
00003 #include <vector>
00004 #include "../core/include/utils/geometry.h"
00005 #include "../core/include/utils/vector2d.h"
00006 #include "vex.h"
00007
00008 using namespace vex;
00009
00010 namespace PurePursuit {
00011     class Path
00012     {
00013     public:
00022         Path(std::vector<point_t> points, double radius);
00023
00027         std::vector<point_t> get_points();
00028
00032         double get_radius();
00033
00037         bool is_valid();
00038
00039     private:
00040         std::vector<point_t> points;
00041         double radius;
00042         bool valid;
00043     };
00044
00045     struct spline
00046     {
00050         double a, b, c, d, x_start, x_end;
00051
00052         double getY(double x) {
00053             return a * pow((x - x_start), 3) + b * pow((x - x_start), 2) + c * (x - x_start) + d;
00054         }
00055     };
00056
00057     struct hermite_point
00058     {
00062         double x;
00063         double y;
00064         double dir;
00065         double mag;
00066
00067         point_t getPoint() const {
00068             return {x, y};
00069         }
00070
00071         Vector2D getTangent() const {
00072             return Vector2D(dir, mag);
00073         }
00074     };
00075
00076     extern std::vector<point_t> line_circle_intersections(point_t center, double r, point_t point1,
00077 point_t point2);
00078     extern point_t get_lookahead(const std::vector<point_t> &path, pose_t robot_loc, double radius);
00079
00083     extern std::vector<point_t> inject_path(const std::vector<point_t> &path, double spacing);
00084
00088     extern std::vector<point_t> smooth_path(const std::vector<point_t> &path, double weight_data, double
00089 weight_smooth, double tolerance);
00090
00094     extern std::vector<point_t> smooth_path_cubic(const std::vector<point_t> &path, double res);
00095
00099     extern std::vector<point_t> smooth_path_hermite(const std::vector<hermite_point> &path, double
00100 step);
00101
00105     extern double estimate_remaining_dist(const std::vector<point_t> &path, pose_t robot_pose, double
00106 radius);
00107
00108 }

```

## 6.33 serializer.h

```

00001 #pragma once

```

```

00002 #include <algorithm>
00003 #include <map>
00004 #include <string>
00005 #include <vector>
00006 #include <stdio.h>
00007 #include <vex.h>
00008
00010 const char serialization_separator = '$';
00012 const std::size_t MAX_FILE_SIZE = 4096;
00013
00015 class Serializer
00016 {
00017 private:
00018     bool flush_always;
00019     std::string filename;
00020     std::map<std::string, int> ints;
00021     std::map<std::string, bool> bools;
00022     std::map<std::string, double> doubles;
00023     std::map<std::string, std::string> strings;
00024
00026     bool read_from_disk();
00027
00028 public:
00030     ~Serializer()
00031     {
00032         save_to_disk();
00033         printf("Saving %s\n", filename.c_str());
00034         fflush(stdout);
00035     }
00036
00040     explicit Serializer(const std::string &filename, bool flush_always = true) :
flush_always(flush_always), filename(filename), ints({}), bools({}), doubles({}), strings({})
00041
00042     {
00043         read_from_disk();
00044     }
00045
00047     void save_to_disk() const;
00048
00050
00054     void set_int(const std::string &name, int i);
00055
00059     void set_bool(const std::string &name, bool b);
00060
00064     void set_double(const std::string &name, double d);
00065
00069     void set_string(const std::string &name, std::string str);
00070
00073
00078     int int_or(const std::string &name, int otherwise);
00079
00084     bool bool_or(const std::string &name, bool otherwise);
00085
00090     double double_or(const std::string &name, double otherwise);
00091
00096     std::string string_or(const std::string &name, std::string otherwise);
00097 };

```

## 6.34 vector2d.h

```

00001 #pragma once
00002
00003
00004 #include <cmath>
00005 #include "../core/include/utils/geometry.h"
00006
00007 #ifndef PI
00008 #define PI 3.141592654
00009 #endif
00015 class Vector2D
00016 {
00017 public:
00024     Vector2D(double dir, double mag);
00025
00031     Vector2D(point_t p);
00032
00040     double get_dir() const;
00041
00045     double get_mag() const;
00046
00050     double get_x() const;
00051
00055     double get_y() const;

```

```
00056
00061     Vector2D normalize();
00062
00067     point_t point();
00068
00074     Vector2D operator*(const double &x);
00081     Vector2D operator+(const Vector2D &other);
00088     Vector2D operator-(const Vector2D &other);
00089
00090 private:
00091
00092     double dir, mag;
00093
00094 };
00095
00101 double deg2rad(double deg);
00102
00109 double rad2deg(double r);
```



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