crazyflie-project/simulation

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1 Simulation - ARGoS3

This repository stores the code that defines the drones' behavior in the ARGoS3 simulator.

1.1 Configure a container in a Wayland environment (e.g. argos3 is not installed)

If you want to launch ARGoS separately in a container without using the docker-compose do this :

```
# Create the container
./container.sh build
# Launch a specific arena
./container.sh {1,2,3,4,5}
```

```
# Launch a random arena
./container.sh 0
# Launch the with the last configuration
./container.sh
```

To install Weston use `$ apt-get install -y weston`.

1.2 Launch argos simulation without container (We assume argos3 is installed)

5 arenas are predefined in the simulation. You can specify which one you want to use when launching it :

```
# Launch a specific arena
./launch.sh {1,2,3,4,5}
# Launch a random arena
./launch.sh 0
# Launch the with the last configuration
./launch.sh
```

1.3 [Debug commands]

See https://gitlab.com/polytechnique-montr-al/inf3995/20211/equipe-203/crazyflie-project/-/blob/master/simulation/README.md

```
{"type":"startMission", "data":{"name": "simulation_1"}}
{"type":"startMission", "data":{"name": "simulation_2"}}
{"type":"returnToBase", "data":{"name": "simulation_1"}}
{"type":"returnToBase", "data":{"name": "simulation_2"}}
{"type":"land", "data":{"name": "simulation_1"}}
{"type":"land", "data":{"name": "simulation_2"}}
```

1.4 Documentation

This project comes with an automatically generated documentation from the code's docstrings. An example is located in `doc/latex/refman.pdf`

To generate the project's documentation :

- Install Doxygen
  ```
  git clone https://github.com/doxygen/doxygen.git
  cd doxygen
  mkdir build && cd build
  cmake -G "Unix Makefiles" ..
  make
  make install
  ```
- Install the recommended extension in VSCode (Name: Doxygen Documentation Generator https://marketplace.visualstudio.com/items?itemName=cschlosser.doxdocgen)
- Once in a while, run Doxygen. Make sure you are in the root directory of the project (`/simulation`)
  ```
  doxygen doc/doxygen-config
  ```
  The output can be found in the `latex` folders located in `doc`.

  To generate a PDF :
  ```
  cd doc/latex
  make pdf
  ```

Example of a docstring :

```
 {C++}
/**
 * @brief Updates the status of the drone (battery, position, and speed)
 *
 * @param battery battery percentage
 * @param pos drone position in the simulation
 */
void RTStatus::update(std::float_t battery, const Vec4 &pos);
```

2 Class Documentation

2.1 brain::Brain Class Reference

Brain : the class that decides what the drone should do next depending on where it is, what it sees, and what it receives from the station.

`#include <Brain.hpp>`

Public Member Functions

- **Brain** (uint16_t id)
- std::optional< NextMove > computeNextMove (const CameraData *cd, const SensorData *sd, const double &battery_level)

  Finds and returns the next move the drone should do.
- State getState ()

  Get the state of the brain.
- void setState (State newState)

  Set the State.
- bool isReturningToBase () const

  Checks if the drone is returning to its base.
- void setInitialPosition (Vec4 pos)

  Set the Initial Position.

2.1.1 Detailed Description

Brain : the class that decides what the drone should do next depending on where it is, what it sees, and what it receives from the station.

2.1.2 Member Function Documentation

2.1.2.1 computeNextMove()

```
std::optional< NextMove > brain::Brain::computeNextMove (
        const CameraData * cd,
        const SensorData * sd,
        const double & battery_level )
```

Finds and returns the next move the drone should do.

This function takes in input the different sensors it has (the FlowDeck data, the multiranger data, and the battery level), and decides what the drone should do with these input.

7 states are defined :

- idle : do nothing and stay where you are
- take_off : go up until you reach your cruise altitude, then start exploring by going in auto_pilot
- land : go down until you reach the ground, then go idle.

- auto_pilot : move forward until you see an obstacle too close on your side or front. If you are in front of an obstacle and you are still exploring, go exploration_dodge. If you are in front of an obstacle and you are trying to return to your base, go return_to_base_dodge
- exploration_dodge : rotate until no obstacle is on your side or front, and return to auto_pilot
- stabilize : do nothing until you reached the position you are supposed to be.
- return_to_base : Rotate to the direction of the base. Then go auto_pilot with the flag returning_to_base_ as true
- return_to_base_dodge : rotate and move to the side in order to avoid an obstacle on your way to the base. When nothing is in front of you anymore, go return_to_base.

x,y,z and yaw are the current position and orientation of the drone at the time the function is called

Parameters

cd	current flowdeck data
sd	current multiranger data
battery_level	current battery level

Returns

std::optional<NextMove> struct containing the next instruction. If nullopt, that means the last instruction was not finished.

2.1.2.2 getState() `State brain::Brain::getState ( ) [inline]`

Get the state of the brain.

Returns

state

2.1.2.3 isReturningToBase() `bool brain::Brain::isReturningToBase ( ) const [inline]`

Checks if the drone is returning to its base.

Returns

true if yes

false if no

2.1.2.4 setInitialPosition() `void brain::Brain::setInitialPosition ( Vec4 pos ) [inline]`

Set the Initial Position.

Parameters

pos	initial position

2.1.2.5 setState() `void brain::Brain::setState ( State newState ) [inline]`

Set the State.

Parameters

newState	

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

- include/Brain.hpp
- src/Brain.cpp

2.2 CameraData Struct Reference

CameraData : struct to hold a flowdeck-like outputted data. Inspired from the real flowdeck : https://github.com/bitcraze/crazyflie-firmware/blob/master/src/deck/drivers/src/zranger.c https://github.com/bitcraze/crazyflie-firmware/blob/master/src/deck/drivers/src/flowdeck_v1v2.c.

`#include <CameraData.hpp>`

Public Attributes

- std::float_t **delta_x**
- std::float_t **delta_y**
- std::float_t **z**
- std::float_t **yaw**

2.2.1 Detailed Description

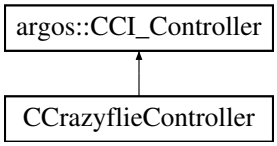
CameraData : struct to hold a flowdeck-like outputted data. Inspired from the real flowdeck : https://github.com/bitcraze/crazyflie-firmware/blob/master/src/deck/drivers/src/zranger.c https://github.com/bitcraze/crazyflie-firmware/blob/master/src/deck/drivers/src/flowdeck_v1v2.c.

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

- include/CameraData.hpp

2.3 CCrazyflieController Class Reference

Inheritance diagram for CCrazyflieController:



Public Member Functions

- CCrazyflieController ()

  Constructor.
- ~CCrazyflieController () override=default

  Destructor.
- void Init (argos::TConfigurationNode &) override

  This function initializes the controller.
- void ControlStep () override

  This function is called once every time step. The length of the time step is set in the XML file.
- void Reset () override

  This function resets the controller to its state right after the Init(). It is called when you press the reset button in the GUI. In this example controller there is no need for resetting anything, so the function could have been omitted. It's here just for completeness.
- void Destroy () override

  Called to cleanup what done by Init() when the experiment finishes. In this example controller there is no need for clean anything up, so the function could have been omitted. It's here just for completeness.

2.3.1 Member Function Documentation

2.3.1.1 Init() `void CCrazyflieController::Init ( argos::TConfigurationNode & ) [inline], [override]`

This function initializes the controller.

Parameters

t_node	points to the <parameters> section in the XML file in the <controllers><crazyflie_sensing_controller> section.

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

- src/main.cpp

2.4 Chn< T > Class Template Reference

Public Member Functions

- void **drain** ()
- bool **is_open** ()
- bool **send** (T &&val)
- std::optional< T > **recv** (bool wait=false)

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

- include/Chn.hpp

2.5 FlowDeck Class Reference

FlowDeck : class that mimicks the behavior of a real crazyflie flowdeck. It saves the initial position and returns a CameraData struct, containing the delta_x and delta_y relative to the initial (takeoff) position.

```
#include <FlowDeck.hpp>
```

Public Member Functions

- void init (const argos::CVector3 &init_position)

  Saves the takeoff position in case the drone does not takeoff at (0,0) in ARGoS. Called only when the simulation is launching.
- CameraData getInitPositionDelta (const argos::CVector3 &position, const argos::CQuaternion &orientation)

  Get the CameraData containing the relative movement done by the drone.

2.5.1 Detailed Description

FlowDeck : class that mimicks the behavior of a real crazyflie flowdeck. It saves the initial position and returns a CameraData struct, containing the delta_x and delta_y relative to the initial (takeoff) position.

2.5.2 Member Function Documentation

2.5.2.1 getInitPositionDelta()

```
CameraData FlowDeck::getInitPositionDelta (
        const argos::CVector3 & position,
        const argos::CQuaternion & orientation )  [inline]
```

Get the CameraData containing the relative movement done by the drone.

Parameters

position	real absolute position gotten from ARGoS directly
orientation	real absolute orientation gotten from ARGoS directly

Returns

CameraData

2.5.2.2 init() `void FlowDeck::init ( const argos::CVector3 & init_position ) [inline]`

Saves the takeoff position in case the drone does not takeoff at (0,0) in ARGoS. Called only when the simulation is launching.

Parameters

init_position	real absolute position gotten from ARGoS directly

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

- include/FlowDeck.hpp

2.6 MathUtils Class Reference

Static Public Member Functions

- static float **computeDirectionToBase** (const Vec4 &pos, const Vec4 &init_pos)
- static void **wrapToPi** (float *val)

Static Public Attributes

- static constexpr float **PI_f** = 3.14159265F

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

- include/MathUtils.hpp
- src/MathUtils.cpp

2.7 brain::NextMove Struct Reference

Public Attributes

- Vec4 **coords**
- bool **relative**
- float_t **yaw**

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

- include/Brain.hpp

2.8 Proxy Class Reference

Public Member Functions

- **Proxy** (std::string name)
- auto **next_cmd** ()
- void **send** (std::string &&msg)

Static Public Member Functions

- static void **recv_cb** (gen_buf_t &&msg)

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

- include/Proxy.hpp
- src/Proxy.cpp

2.9 RTStatus Class Reference

RTStatus (RealTimeStatus): stores the real time state (position, orientation, speed, battery...) of a drone.

`#include <RTStatus.hpp>`

Public Member Functions

- RTStatus (std::string name)

  Construct a new RTStatus::RTStatus object.
- std::string encode ()

  Encodes the current status of the drone as json.
- const std::string & **get_name** () const
- void update (std::float_t battery, const Vec4 &pos, const float_t &yaw, const SensorData &sd, const brain::↩ State &brain_state, const bool &brain_returning_to_base)

  Updates the status of the drone (battery, position, orientation, speed, brain state). Sets the RTStatus::state_↩ appropriety depending on the brain state.
- bool **isFlying** () const
- void **setPosition** (Vec4 pos)
- void **setBattery** (std::float_t battery)
- void enable ()

  Set the drone as flying.
- void disable ()

  Set the drone as not flying.

2.9.1 Detailed Description

RTStatus (RealTimeStatus): stores the real time state (position, orientation, speed, battery...) of a drone.

2.9.2 Constructor & Destructor Documentation

2.9.2.1 RTStatus() `RTStatus::RTStatus ( std::string name ) [explicit]`

Construct a new RTStatus::RTStatus object.

Parameters

name	name to identify the drone

2.9.3 Member Function Documentation

2.9.3.1 encode() `std::string RTStatus::encode ( )`

Encodes the current status of the drone as json.

Returns

std::string serialized pulse object

2.9.3.2 update()

```
void RTStatus::update (
        std::float_t battery,
        const Vec4 & pos,
        const float_t & yaw,
        const SensorData & sd,
        const brain::State & brain_state,
        const bool & brain_returning_to_base )
```

Updates the status of the drone (battery, position, orientation, speed, brain state). Sets the RTStatus::state_↩ appropriety depending on the brain state.

Parameters

battery	battery level
pos	absolute position gotten from the flowdeck
yaw	absolute orientation gotten from the flowdeck
sd	multiranger sensors data
brain_state	current state of the brain class
brain_returning_to_base	boolean to indicate if the drone is currently returning to its base

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

- include/RTStatus.hpp
- src/RTStatus.cpp

2.10 SensorData Struct Reference

SensorData : struct to store the multiranger sensors. The value is between 0-255 if the wall detected is reasonnably close, and 65534 if it's too far away.

`#include <SensorData.hpp>`

Public Attributes

- std::uint16_t **front**
- std::uint16_t **left**
- std::uint16_t **back**
- std::uint16_t **right**
- std::uint16_t **up**

2.10.1 Detailed Description

SensorData : struct to store the multiranger sensors. The value is between 0-255 if the wall detected is reasonnably close, and 65534 if it's too far away.

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

- include/SensorData.hpp

2.11 SharedQueue< T > Class Template Reference

Public Member Functions

- void **push** (T t)
- void **push** (T &&t)
- std::uint_fast32_t **size** ()
- std::optional< T > **pop** ()

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

- include/SharedQueue.hpp

2.12 Vec3 Class Reference

Static Public Member Functions

- static constexpr Vec4 **add** (const Vec4 &a, const Vec4 &b)
- static constexpr void **add** (Vec4 *a, const Vec4 &b)
- static constexpr Vec4 **sub** (const Vec4 &a, const Vec4 &b)
- static constexpr void **sub** (Vec4 *a, const Vec4 &b)
- static constexpr Vec4 **mul** (const Vec4 &a, const Vec4 &b)
- static constexpr void **mul** (Vec4 *a, const Vec4 &b)
- static constexpr Vec4 **div** (const Vec4 &a, const Vec4 &b)
- static constexpr void **div** (Vec4 *a, const Vec4 &b)
- static constexpr Vec4 **neg** (const Vec4 &a)
- static constexpr void **neg** (Vec4 *a)
- static constexpr std::float_t **sum** (const Vec4 &a)
- static constexpr std::float_t **norm_sqr** (const Vec4 &a)
- static constexpr std::float_t **norm** (const Vec4 &a)
- static constexpr Vec4 **normalize** (const Vec4 &a)
- static constexpr void **normalize** (Vec4 *a)
- static constexpr std::float_t **dot** (const Vec4 &a, const Vec4 &b)
- static constexpr Vec4 **cross** (const Vec4 &a, const Vec4 &b)

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

- include/Vec3.hpp

2.13 Vec4 Class Reference

Public Member Functions

- constexpr auto **w** () const
- constexpr auto **x** () const
- constexpr auto **y** () const
- constexpr auto **z** () const
- constexpr **Vec4** (std::float_t r)
- constexpr **Vec4** (std::float_t w, const Vec4 &v)
- constexpr **Vec4** (std::float_t w, std::float_t r)
- constexpr **Vec4** (std::float_t x, std::float_t y, std::float_t z)
- constexpr **Vec4** (std::float_t w, std::float_t x, std::float_t y, std::float_t z)
- constexpr **Vec4** (const Vec4 &v)=default
- constexpr **Vec4** (Vec4 &&v)=default
- constexpr Vec4 & **operator=** (const Vec4 &v)=default
- constexpr Vec4 & **operator=** (Vec4 &&v)=default
- bool **operator==** (const Vec4 &v) const

Public Attributes

- std::float_t **v_** [4]

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

- include/Vec4.hpp

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