QuanserShield2

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Contents

Chapter 1

Quanser Shield v.2

Intel Galileo Gen 2 shield for use with the Quanser 2DSFJE robot. Documentation can be found in the `docs/` folder or by accessing the link https://franciscoknebel.github.io/quansershield2/.

Prerequisites

- Doxygen

```
$ sudo apt install doxygen
```

- GCC
- Make

File Hierarchy

- bin
  - Temporary folder for built program binaries.
- Boards & Schematics
  - Folder containing project Gerbers, Netlist, Bill of Materials and schematics.
- docs
  - Project documentation, built with Doxygen.
- ext
  - External files, used in documentation.
- include
  - Header Files.
- init
  - Intel Galileo `/etc/init.d` files to setup pins.
- lib
  - Folder for storage of built library files.
- scripts
  - Scripts used to automate project tasks.
- src
  - Project source files.

Makefile

Project

- Compile the full project with `make`.
- Clean built files with `make clean`.

Don't forget to setup environment variables from `iss_setup.sh`;

Documentation

Compile the project documentation to `docs/` folder.

```
$ doxygen
```

Then you can open the `docs/index.html` file and search the `Files` section for code documentation. To change the docs generation configuration, you need to install the `doxygen-gui` config and run:

```
$ doxywizard Doxyfile
```

Versioning

We use SemVer for versioning. For the versions available, see the tags on this repository.

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Chapter 2

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Version 3, 29 June 2007

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```
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```
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```

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Chapter 3

File Index

3.1 File List

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

Chapter 4

File Documentation

4.1 include/arm.h File Reference

Header for the arm module, containing arm function helpers and manipulators.

```
#include <galileo2io.h>
#include <stdio.h>
#include <stdlib.h>
#include <fcntl.h>
#include <poll.h>
#include <pthread.h>
#include <unistd.h>
#include <pwm.h>
#include <h_bridge.h>
```

Functions

- int detect_endoftrajectory_elbow (int index)

  Detect if reached end of trajectory in 'index' elbow.
- int detect_endoftrajectory_shoulder (int index)

  Detect if reached end of trajectory in 'index' shoulder.
- void read_arm (int i)

  Creates threads to detect end of trajectory for elbow or shoulder.
- int read_file_end_of_trajectory (int gpio)

  Read GPIO file and waits for interrupt, for use with end of trajectory. Disables PWM and H_bridge when reached.
- void detect_endoftrajectory ()

  Set all threads to detect end of trajectory in both shoulder and elbow.

4.1.1 Detailed Description

Header for the arm module, containing arm function helpers and manipulators.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.2 include/decoder.h File Reference

Header for the decoder module, containing functions to read the arm decoder and cnvert to radians.

```
#include <galileo2io.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
```

Functions

- int read_decoder ()
  Returns decoded counter from motor.
- int counted_to_radians (int counted)
  Converts counted value from decoder to radians.

4.2.1 Detailed Description

Header for the decoder module, containing functions to read the arm decoder and cnvert to radians.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.3 include/h_bridge.h File Reference

Header for the H-bridge module, containing H-bridge function helpers and manipulators.

```
#include <galileo2io.h>
#include <stdio.h>
```

Functions

- int h_bridge_disable_left ()
  Disable the H-bridge (left and right).
- int h_bridge_disable_right ()
  Disable the H-bridge right signal, on GPIO.
- int h_bridge_enable_left ()
  Enable the H-bridge (left and right).
- int h_bridge_enable_right ()
  Enable the H-bridge right signal, on GPIO, and disables left.
- int h_bridge_enable ()
  Enable the H-bridge.
- int h_bridge_disable ()
  Disable the H-bridge.

4.3.1 Detailed Description

Header for the H-bridge module, containing H-bridge function helpers and manipulators.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.3.2 Function Documentation

4.3.2.1 h_bridge_disable()

```
int h_bridge_disable ( )
```

Disable the H-bridge.

Disable the H-bridge.

Definition at line 64 of file h_bridge.c.

```
64                      {
65   printf("Disabling both sides of h_bridge.\n");
66   pputs("/sys/class/gpio/gpio11/value", "0");
67   pputs("/sys/class/gpio/gpio12/value", "0");
68
69   return 0;
70 }
```

4.3.2.2 h_bridge_disable_left()

```
int h_bridge_disable_left ( )
```

Disable the H-bridge (left and right).

Disable the H-bridge (left and right).

Definition at line 29 of file h_bridge.c.

```
29                           {
30   printf("Disabling left side of h_bridge.\n");
31   return pputs("/sys/class/gpio/gpio11/value", "0");
32 }
```

4.3.2.3 h_bridge_enable()

```
int h_bridge_enable ( )
```

Enable the H-bridge.

Enable the H-bridge.

Definition at line 75 of file h_bridge.c.

```
75                      {
76   printf("Enabling both sides of h_bridge.\n");
77   pputs("/sys/class/gpio/gpio11/value", "1");
78   pputs("/sys/class/gpio/gpio12/value", "1");
79
80   return 0;
81 }
```

4.3.2.4 h_bridge_enable_left()

```
int h_bridge_enable_left ( )
```

Enable the H-bridge (left and right).

Enable the H-bridge (left and right).

Definition at line 46 of file h_bridge.c.

```
46                          {
47   h_bridge_disable_right();
48   printf("Enabling left side of h_bridge.\n");
49   return pputs("/sys/class/gpio/gpio11/value", "1");
50 }
```

4.4 include/pwm.h File Reference

Header for the PWM module, containing PWM function helpers and manipulators.

```
#include <galileo2io.h>
#include <stdio.h>
#include <math.h>
```

Macros

- #define TIME_STEP 10000

  Time step used in sleep functions.
- #define FREQ_MAX 1500

  Frequency used for duty cycle calculation.
- #define VOLT_MAX 27

  Max voltage defineable in user programs.

Functions

- int pwm_enable ()

  Enable PWM1.
- int pwm_disable ()

  Disable PWM1.
- int pwm_set_period (int period)

  Set the period on the PWM device.
- int pwm_set_duty_cycle (int pwm_set_duty_cycle)

  Set the duty cycle for PWM1.
- int set_pwm (int period, int duty_cycle)

  Set PWM values of period and duty cycle, enabling it and the h_bridge.
- int calculate_period ()

  Calculate period from FREQ_MAX.
- int calculate_duty_cycle (float voltage, int period)

  Calculate duty cycle, according to voltage, period and VOLT_MAX. If absolute value of voltage is above VOLT_MAX, voltage will be set to VOLT_MAX.

4.4.1 Detailed Description

Header for the PWM module, containing PWM function helpers and manipulators.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.5 include/quanser_pid.h File Reference

Module containing PID helper functions.

```
#include <quanser_pwm.h>
#include <decoder.h>
#include <time.h>
```

4.5.1 Detailed Description

Module containing PID helper functions.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.6 include/quanser_pwm.h File Reference

Module containing functions with use for PWM program.

```
#include <pwm.h>
#include <h_bridge.h>
#include <signal_module.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
```

4.6.1 Detailed Description

Module containing functions with use for PWM program.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.7 include/quanser_trajectory.h File Reference

Module for end of trajectory programs.

```
#include <arm.h>
#include <pwm.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
```

4.7.1 Detailed Description

Module for end of trajectory programs.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.8 include/signal_module.h File Reference

Module containing signal handling functions.

```
#include <signal.h>
#include <stdio.h>
#include <stdlib.h>
```

Functions

- void handle_termination (int(∗callback)())

  Define functions to use if program detects termination signals.

4.8.1 Detailed Description

Module containing signal handling functions.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

06 Jul 2019

4.9 src/modules/arm.c File Reference

Module containing arm helper functions.

```
#include <arm.h>
```

Functions

- int detect_endoftrajectory_elbow (int index)

  Detect if reached end of trajectory in 'index' elbow.
- int detect_endoftrajectory_shoulder (int index)

  Detect if reached end of trajectory in 'index' shoulder.
- void read_arm (int i)

  Creates threads to detect end of trajectory for elbow or shoulder.
- int read_file_end_of_trajectory (int gpio)

  Read GPIO file and waits for interrupt, for use with end of trajectory. Disables PWM and H_bridge when reached.
- void detect_endoftrajectory ()

  Set all threads to detect end of trajectory in both shoulder and elbow.

4.9.1 Detailed Description

Module containing arm helper functions.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.10 src/modules/decoder.c File Reference

Module containing dec helper functions.

```
#include <decoder.h>
```

Macros

- #define PI 3.14159265358979323846
  Constant of PI, used in converting decoded value to radians.

Functions

- int read_decoder_gpio_file (int index, int gpio, char *str)
  Disables both left and right H-bridge signals.
- void reset_decoder ()
  Reset decoder values.
- int read_gpio ()
  Read decoder GPIO files, both high and low bytes.
- void xsleep (int times)
  Sleeps for x 'times' using nanosleep defined by read_decoder().
- int read_decoder ()
  Returns decoded counter from motor.
- int counted_to_radians (int counted)
  Converts counted value from decoder to radians.

Variables

- struct timespec sleep_time end_time
  xsleep() variables where sleep time is defined.

4.10.1 Detailed Description

Module containing dec helper functions.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.11 src/modules/h_bridge.c File Reference

Module containing H-bridge function helpers and manipulators.

```
#include <h_bridge.h>
```

Functions

- int h_bridge_disable_left ()
  Disable the H-bridge left signal, on GPIO.
- int h_bridge_disable_right ()
  Disable the H-bridge right signal, on GPIO.
- int h_bridge_enable_left ()
  Enable the H-bridge left signal, on GPIO, and disables right.
- int h_bridge_enable_right ()
  Enable the H-bridge right signal, on GPIO, and disables left.
- int h_bridge_disable ()
  Disables both left and right H-bridge signals.
- int h_bridge_enable ()
  Enables both left and right H-bridge signals.
- int h_bridge_status ()
  Returns the values of both left and right H-bridge signals.

4.11.1 Detailed Description

Module containing H-bridge function helpers and manipulators.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.11.2 Function Documentation

4.11.2.1 h_bridge_disable()

```
int h_bridge_disable ( )
```

Disables both left and right H-bridge signals.

Disable the H-bridge.

Definition at line 64 of file h_bridge.c.

```
64                      {
65   printf("Disabling both sides of h_bridge.\n");
66   pputs("/sys/class/gpio/gpio11/value", "0");
67   pputs("/sys/class/gpio/gpio12/value", "0");
68
69   return 0;
70 }
```

4.11.2.2 h_bridge_disable_left()

```
int h_bridge_disable_left ( )
```

Disable the H-bridge left signal, on GPIO.

Disable the H-bridge (left and right).

Definition at line 29 of file h_bridge.c.

```
29                           {
30   printf("Disabling left side of h_bridge.\n");
31   return pputs("/sys/class/gpio/gpio11/value", "0");
32 }
```

4.11.2.3 h_bridge_enable()

```
int h_bridge_enable ( )
```

Enables both left and right H-bridge signals.

Enable the H-bridge.

Definition at line 75 of file h_bridge.c.

```
75                      {
76   printf("Enabling both sides of h_bridge.\n");
77   pputs("/sys/class/gpio/gpio11/value", "1");
78   pputs("/sys/class/gpio/gpio12/value", "1");
79
80   return 0;
81 }
```

4.11.2.4 h_bridge_enable_left()

```
int h_bridge_enable_left ( )
```

Enable the H-bridge left signal, on GPIO, and disables right.

Enable the H-bridge (left and right).

Definition at line 46 of file h_bridge.c.

```
46                          {
47   h_bridge_disable_right();
48   printf("Enabling left side of h_bridge.\n");
49   return pputs("/sys/class/gpio/gpio11/value", "1");
50 }
```

4.12 src/modules/pwm.c File Reference

Module containing PWM helper functions.

```
#include <pwm.h>
#include <h_bridge.h>
```

Functions

- int pwm_enable ()

  Enable PWM1.
- int pwm_disable ()

  Disable PWM1.
- int pwm_set_period (int period)

  Set the period on the PWM device.
- int pwm_set_duty_cycle (int duty_cycle)

  Set the duty cycle for PWM1.
- int set_pwm (int period, int duty_cycle)

  Set PWM values of period and duty cycle, enabling it and the h_bridge.
- int calculate_period ()

  Calculate period from FREQ_MAX.
- int calculate_duty_cycle (float voltage, int period)

  Calculate duty cycle, according to voltage, period and VOLT_MAX. If absolute value of voltage is above VOLT_MAX, voltage will be set to VOLT_MAX.

Variables

- char str [100]

  Buffer variable used in PWM module functions.

4.12.1 Detailed Description

Module containing PWM helper functions.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.13 src/modules/signal_module.c File Reference

Module containing H-bridge function helpers and manipulators.

```
#include <signal_module.h>
```

Functions

- void handle_signal (int signal)

  Standard handling for all signals. Will be called on SIGINT, SIGTERM and SIGKILL. Will call callback defined by program, if defined.
- void handle_termination (int(∗callback)())

  Define functions to use if program detects termination signals.

Variables

- int(∗ **cb**)() = NULL

4.13.1 Detailed Description

Module containing H-bridge function helpers and manipulators.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

06 Jul 2019

4.14 src/quanser_decode.c File Reference

Receive a duty cycle for PWM and enable it.

```
#include <quanser_pwm.h>
#include <decoder.h>
#include <time.h>
```

Functions

- int **end** (int sig)
- int **main** (int argc, char const *argv[ ])

4.14.1 Detailed Description

Receive a duty cycle for PWM and enable it.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.15 src/quanser_pid.c File Reference

PID algorithm while reading the encoders and enabling motor. Has end of trajectory detections.

```
#include <quanser_pid.h>
```

Functions

- int **end** (int sig)
- int **main** (int argc, char *argv[ ])

4.15.1 Detailed Description

PID algorithm while reading the encoders and enabling motor. Has end of trajectory detections.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

07 Jul 2019

4.16 src/quanser_pwm.c File Reference

Receive a voltage and enables PWM and bridge. Has end of trajectory detection.

```
#include <quanser_pwm.h>
```

Functions

- int **end** (int sig)
- int **main** (int argc, char const ∗argv[ ])

4.16.1 Detailed Description

Receive a voltage and enables PWM and bridge. Has end of trajectory detection.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.17 src/quanser_pwm_cycle.c File Reference

Program to cycle through PWM.

```
#include <quanser_pwm.h>
```

Functions

- int **end** (int sig)
- int **main** (int argc, char const ∗argv[ ])

4.17.1 Detailed Description

Program to cycle through PWM.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.18 src/quanser_testepin.c File Reference

Receive a gpio pin and tests it.

```
#include <quanser_pwm.h>
```

Functions

- int **main** (int argc, char const *argv[ ])

4.18.1 Detailed Description

Receive a gpio pin and tests it.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.19 src/quanser_trajectory.c File Reference

Detect if end of trajectory of elbows 1 and 2, and shoulders 1 and 2.

```
#include <quanser_trajectory.h>
```

Functions

- int **main** (int argc, char const *argv[ ])

4.19.1 Detailed Description

Detect if end of trajectory of elbows 1 and 2, and shoulders 1 and 2.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.20 src/quanser_volt.c File Reference

Receive a voltage and sets PWM period and duty cycle. Does not detect end of trajectory.

```
#include <quanser_pwm.h>
```

Functions

- int **end** (int sig)
- int **main** (int argc, char const ∗argv[ ])

4.20.1 Detailed Description

Receive a voltage and sets PWM period and duty cycle. Does not detect end of trajectory.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

4.21 src/quanser_volt_trajectory.c File Reference

Receive a voltage and sets PWM period and duty cycle. Has end of trajectory detections.

```
#include <quanser_pwm.h>
#include <arm.h>
```

Functions

- int **end** (int sig)
- int **main** (int argc, char const ∗argv[ ])

4.21.1 Detailed Description

Receive a voltage and sets PWM period and duty cycle. Has end of trajectory detections.

Author

Francisco Knebel, Luciano Zancan Mazzutti, Rodrigo Dal Ri

Date

26 Jun 2019

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