EXOTEC

Gladiator features and API

Contents

1 Version history

1.1 Version v1

- Initial version : Gladiator version 1.9.0
- All functions in different chapters (Game, Maze, Robot, Control, Weapon)
- Remove some functions, and simplify the API
- Add graph representation of the maze
- Correction of the Phase explanation picture
- Add a paragraph that explains the two different modes

1.2 Version v2.0

- Delete message sending and receiving functions
- Add setCalibrationOffset() function in robot category.
- Use pointer for functions returning a MazeSquare struct
- Update Gladiator Features and API for the 2nd edition of Exolegend
- Add new functions to manage rockets

2 System overview

The gladiator robot is used by players to participate to the Exolegend games. it is conceived around the ESP32S3 microcontroller. The GLadiator Library is written in C++ with the aim of being used in conjunction with Platform and Visual Studio Code.

2.1 Definitions

- **Maze** : The field where robots play (playground)
- **World** : Game Arena Struture
- **Arena ControlScreen** : Control screen of the World. It's the small touch screen of the World. It's able to start a new game and identify new players.
- **Game Master** : The software which controls the whole game
- **Gladiator** : The robot used by players.
- **Ghost** : The simulated robot
- **Gladiator Library** : API used to control the robot
- **ID** : Identifier of the robot, it is also the tag ID on the top of the robot. This ID is unique.

2.2 Gladiator Library

Gladiator Library is an API allowing the user to control the Gladiator. This Library provides some functions to control the robot when it is connected to an Arena.

2.2.1 System environment

The Gladiator is built around a ESP32S3 microcontroller.

You need PlatformIO to be able to compile Gladiator Library. There are two ways to compile your code :

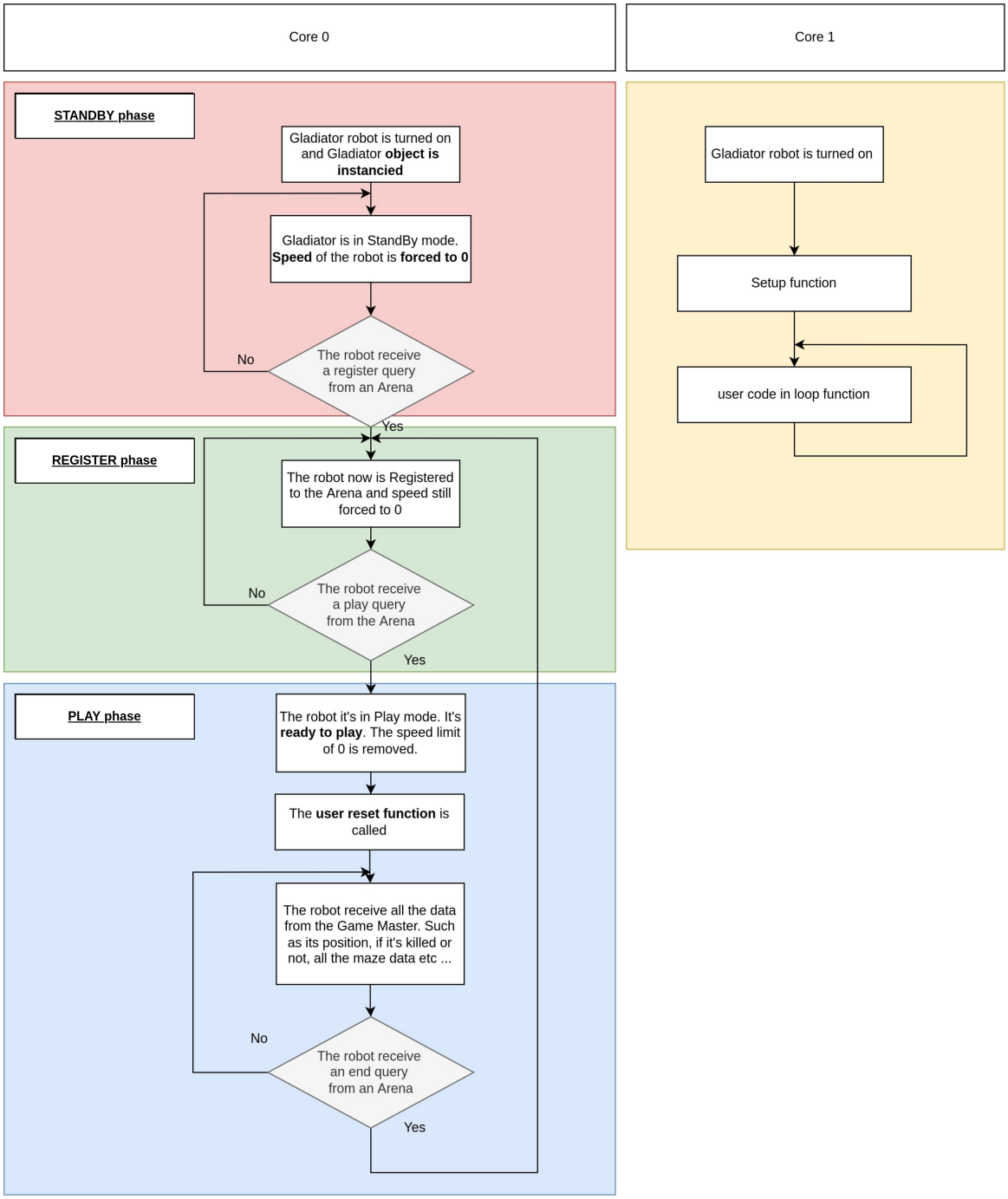
- Compile your code to be run as a Ghost on your computer.
- Compile your code to be flashed in a Gladiator.

Your code is compiled with gnu++17. All the functions needed to control the robot are in the Gladiator library. You can use std functions, but be aware that all dynamic allocation mechanisms can cause memory overflow on esp32 (such as vectors, strings, etc).

2.2.2 Code execution

When you include the Gladiator library and instantiate a gladiator object, a thread runs in the second core of the microcontroller. This thread runs in the background of the user code and communicates with Arena, it also calculates the speed of the robot and filters its position. The user code is executed on the first core.

2.2.3 Gladiator life cycle



2.3 How to start ?

This section provides a basic code template which a user can copy to start using Gladiator:

```
#include <gladiator.h>
void reset();
Gladiator* gladiator;
void setup() {
    gladiator = new Gladiator();
    gladiator->game->onReset(&reset);
    // setup your data after turning on the robot
}
void reset() {
    gladiator->log("Reset function called");
    // reset your data before a game start
}
void loop() {
    if(gladiator->game->isStarted()) {
        // Write your strategy code here
    }
}
```

2.4 The two ways of using Gladiator

There are two modes available by which to control the robot:

- **Arena mode** This is the default mode of Gladiator. The user code is automatically executed after registering and starting a new game.
- **Free mode** The user code is executed even if the robot is not registered to achieve tests without connecting the robot to an Arena.

3 Features

3.1 Control the speed of the robot

The user can control the speed of each wheel. The maximum speed allowed by Gladiator Library is 1m/s. The speed control loop is handled by the Gladiator library. The user can change the settings of the PID of each wheel.

3.2 Get robot data

The user can get the robot's data; its position for example, its ID, life status, etc ... The user is able to see the data of the other robots in the field but with an estimate delay within a range of [20ms, 100ms].

3.3 Get maze data

The user can obtain the data of the maze such as the position of each wall and each remaining rocket coins in the field.

3.4 Tracking data

The robot allows the user to track all the data in a live mode to see it on their computer screen while the robot is playing in the maze. The user can track and see their robot live in the maze and save all the data in a csv file.

3.4.1 The Minotor tool

Minotor is a python tool which allows the user to monitor all the data of the robot remotely from their computer. Minotor shows the position of the robot in the maze and all the data such as the speed of the robot, the robot speed and user's logs. All the data can be saved in a csv file to be examined later. You can access this tool by requesting it from a software coach.

3.5 Control weapon

3.5.1 External weapon

The user can control up to 3 weapons. There are two modes through which to control them. The SERVO which allows the user to control a servo-motor and set a position and PWM mode which allows the user to set a PWM value to an actuator, such as a motor. The pins to which users can connect weapons are located on the back of the robot. The pins are called M1, M2 and M3.

3.5.2 Virtual weapon

The robot can collect rocket coins that are placed in the maze. The rockets can be launched by the robot to kill another robot within a radius of 5 squares. All the robots in the maze know if there is a moving rocket in a square.

4 Gladiator Library - Exolegend API

4.1 Structures and Enumerations

4.1.1 Position

properties :
- **x** *(double)* : x position (m)
- **y** *(double)* : y position (m)
- **a** *(double)* : alpha angle (rad)

The position structure represents the position x, y and alpha of any object.

4.1.2 Coin

properties :
- **value** *(byte)* : Value of the coin
- **p** *(Position)* : position of the coin in the maze

This structure represents a coin in the maze. If the value is 1 it means that there is a rocket coin.

4.1.3 RobotData

properties :
- **position** *(Position)* : position of the robot (filtered)
- **cposition** *(Position)* : position of the robot (non filtered position, received by camera without any processing)
- **speedLimit** *(double)* : speed limit of the robot
- **vl** *(double)* : speed of the left wheel
- **vr** *(double)* : speed of the right wheel
- **score** *(short)* : score of the robot
- **lifes** *(byte)* : lifes of the robot, if the this value is 0, it means that the robot is dead
- **id** *(byte)* : id of the robot
- **teamId** *(byte)* : id of the team (1 or 2)
- **macAddress** *(String)* : MAC address of the robot
- **remote** *(bool)* : If the robot is in remote mode

This structure represents all the data of a robot.

4.1.4 RobotList

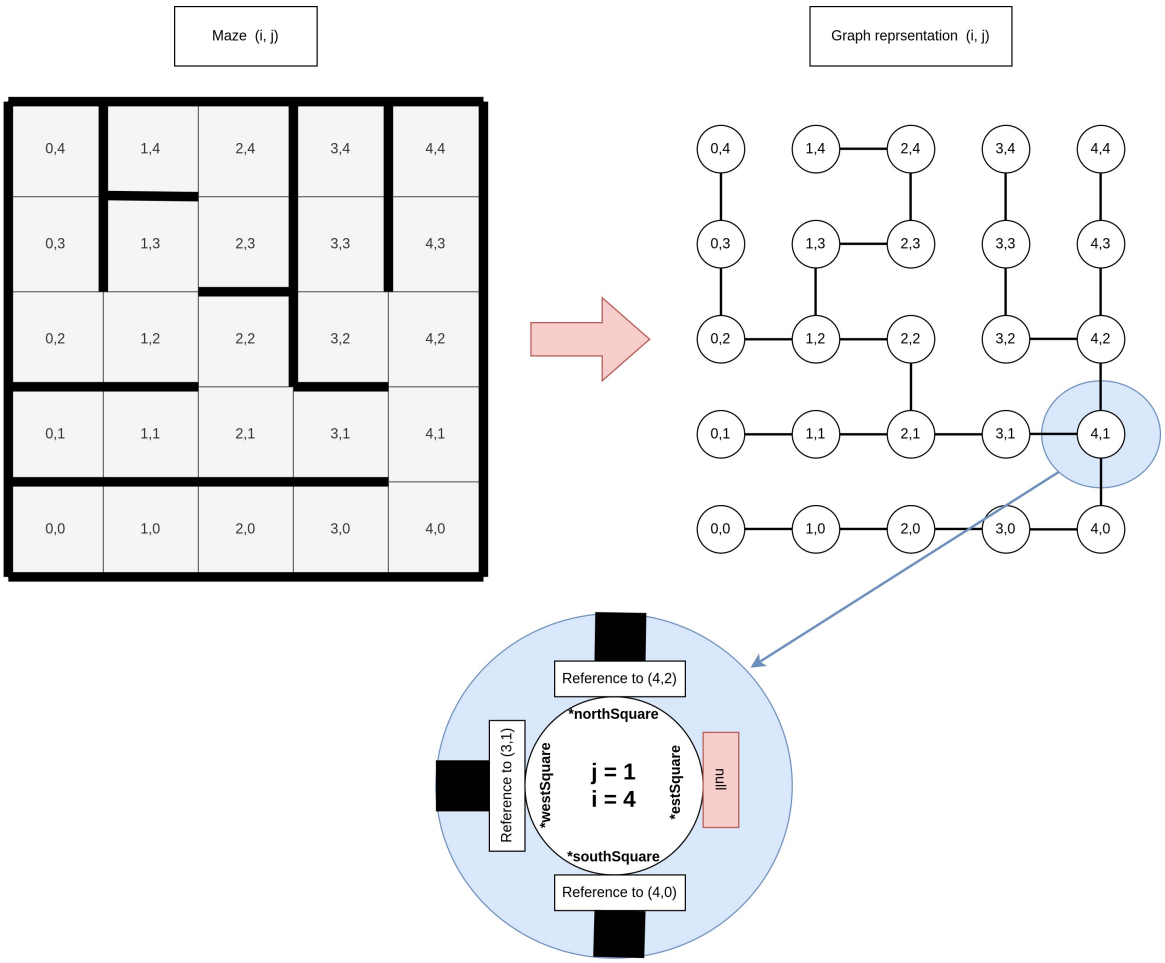
properties :
- **ids** *(byte[4])* : List of robot ids playing currently in the maze.

4.1.5 MazeSquare

properties :

- **i** *(byte)* : i index of the square in the maze (see image below).
- **j** *(byte)* : j index of the square in the maze (see image below).
- **northSquare** *(MazeSquare*)* : Reference to the top square. If the pointer is null, it means that there is a wall.
- **southSquare** *(MazeSquare*)* : Reference to the bottom square. If the pointer is null, it means that there is a wall.
- **westSquare** *(MazeSquare*)* : Reference to the right square. If the pointer is null, it means that there is a wall.
- **eastSquare** *(MazeSquare*)* : Reference to the left square. If the pointer is null, it means that there is a wall.
- **coin** *(Coin)* : The coin of the square. If the value of the coin is 0, there is no coin in the square. If it is 1, it means that there is a rocket.
- **possession** *(byte)* : This value defines which team holds the square. The value 0 means that the square is not held by anyone. 1 means that the square is held by team 1; 2 means that the square is held by team 2.
- **danger** *(bool)* : This boolean lets you know if there's a danger in the square. If a rocket launched by a robot is in the square, then the danger value will be true.

This structure represents a square of the maze. The maze is represented as a graph of 12x12 squares. If the robot can go from one square to another, those two squares will be linked, otherwise there is a wall.


Maze (i, j)
Graph reprsentation (i, j)
0,4
1,4
2,4
3,4
4,4
0,3
1,3
2,3
3,3
4,3
0,2
1,2
2,2
3,2
4,2
0,1
1,1
2,1
3,1
4,1
0,0
1,0
2,0
3,0
4,0
Reference to (4,2)
*northSquare
Reference to (3,1)
*westSquare
j = 1
i = 4
*estSquare
null
*southSquare
Reference to (4,0)

4.1.6 WheelAxis

Values :
- `WheelAxis::LEFT` : left wheel
- `WheelAxis::RIGHT` : right wheel

This enumeration represents a wheel axis (left or right).

4.1.7 WeaponPin

Values :
- `WeaponPin::M1` : pin M1 of the robot
- `WeaponPin::M2` : pin M2 of the robot
- `WeaponPin::M3` : pin M3 of the robot

This enumeration represents the pin of available weapons of the robot.

4.1.8 WeaponMode

Values :
- `WeaponMode::PWM` : pwm output mode
- `WeaponMode::SERVO` : servomotor mode

This enumeration represents the pin mode to use for the weapon.

4.1.9 RemoteMode

Values :
- `RemoteMode::ON` : Control the robot with remote is enabled
- `RemoteMode::OFF` : Control the robot with remote is disabled

Remote mode to ON or OFF

4.2 Robot Control functions

4.2.1 void Gladiator::Control::setWheelSpeed()

Arguments :
- **axis** *(WheelAxis)* : Axis of the wheel for which the speed will be applied. (right or left)
- **speed** *(float)* : speed value to be set to the wheel
- **reset** *(bool) [optional]* : Reset the integrator (default false).

Set the speed of a wheel of the robot in m/s. The speed control loop is handled by the Gladiator library. The value of speed must be in the range $[-1; 1]$. If the game has not started, the speed of the robot is forced to 0.

4.2.2 double Gladiator::Control::getWheelSpeed()

Arguments :
- **axis** *(WheelAxis)* : Axis of the wheel for which speed is measured. (right or left)
- **@return** *(double)* : Speed of a wheel in m/s.

Get the speed of a wheel measured by its encoder, the returned value is in m/s.

4.2.3 void Gladiator::Control::setWheelPidCoefs()

Arguments :
- **axis** *(WheelAxis)* : Axis of the wheel for which the PID coeffcient will be applied. (right or left)
- **kp** *(float)* : proportional coefficient
- **ki** *(float)* : integral coefficient
- **kd** *(float)* : derivative coefficient

Set coefficients of the PID for each wheel (right or left). Default values are set for each coefficient in the initialisation of the Library. Users are free to change those values.
By default $K_p = 1$, $K_i = 5$, $K_d = 0$

4.3 Game functions

4.3.1 bool Gladiator::Game::isStarted()

Arguments :
- **@return** *(bool)* : boolean to know if the game started

If the game has started and the robot can play, this function will return true, otherwise it will return false. This function is supposed to be used before executing the strategy code inside an if statement.
Example :

```
1    void loop () {
2        if(gladiator->game->isStarted()) {
3         //All your strategy code goes here
4        }
5    }
```

4.3.2 bool Gladiator::Game::enableFreeMode()

Arguments :
- **enableRemote** *(RemoteMode)* : enable remote mode during free mode
- **initPosition** *(Position) [optional]* : Position of the robot to be set when free mode is enabled

This function enables the player to use the robot without connecting it to an Arena. The user's code will be executed without any restriction in speed. The user can also measure the speed of each wheel and play with a simulated arena. This function can only be called in the setup function"

For maze simulation, the estimated position of the robot is set to (0,0). Users are free to change this position by setting a new value to *initPosition* argument. The position will be estimated with encoders only. Users can use the Minotor tool to see the position of the robot in the Free mode.

The user has to call this function in the setup function to enable the Free mode, by default the robot is in Arena mode. If the free mode is enabled, it is impossible to change the mode during the execution of the code.

4.3.3 RobotData Gladiator::Game::getOtherRobotData()

Arguments :
- **id** *(byte)* : Id of the robot to get data from
- **@return** *(RobotData)* : Data of the robot

This function returns the data of another robot playing in the maze. If the *id* property is not an id of a robot playing currently in the maze, the function will return an empty robot (with id 0).

4.3.4 RobotList Gladiator::Game::getPlayingRobotsId()

Arguments :
- **@return** *(RobotList)* : List of robot ids

This function returns a list which contains all the Ids of the robots currently playing in the maze.

4.3.5 void Gladiator::Game::setPin()

Arguments :
- **@return** *(int)* : new Pin code

Set a pin code for the Gladiator. This pin code is used when the Minotor attempts to connect to the Gladiator.

4.4 Callback functions

4.4.1 void Gladiator::Game::onReset()

Arguments :
- **resetFunction** *(void*(void))* : Function to be run before a game start

Set a function to be run before a game starts. A reset function is highly recommended to reset all the variables of the user code before each game.

4.5 Debug functions

4.5.1 void Gladiator::log()

Arguments :
- **msg** *(String)* : String message

Logs a message as a string. Logging messages are sent to a Minotor if there is one connected to the current Gladiator.

Warning : A log message is truncated to 150 chars when used with Minotor tool.

4.5.2 void Gladiator::saveUserWaypoint()

Arguments :
- **x** *(float)* : x command value
- **y** *(float)* : y command value

Track the position waypoint of the user. The user can see their command remotely from the Minotor tool (works in Free mode and Arena mode).

4.6 Robot functions

4.6.1 RobotData Gladiator::Robot::getData()

Arguments :
- **@return** *(RobotData)* : Get all the data sent by the gameMaster concerning the current robot

This function returns a struct that contains all the data send by Arena (Game Master) to the current robot, notably its position and the number of lives

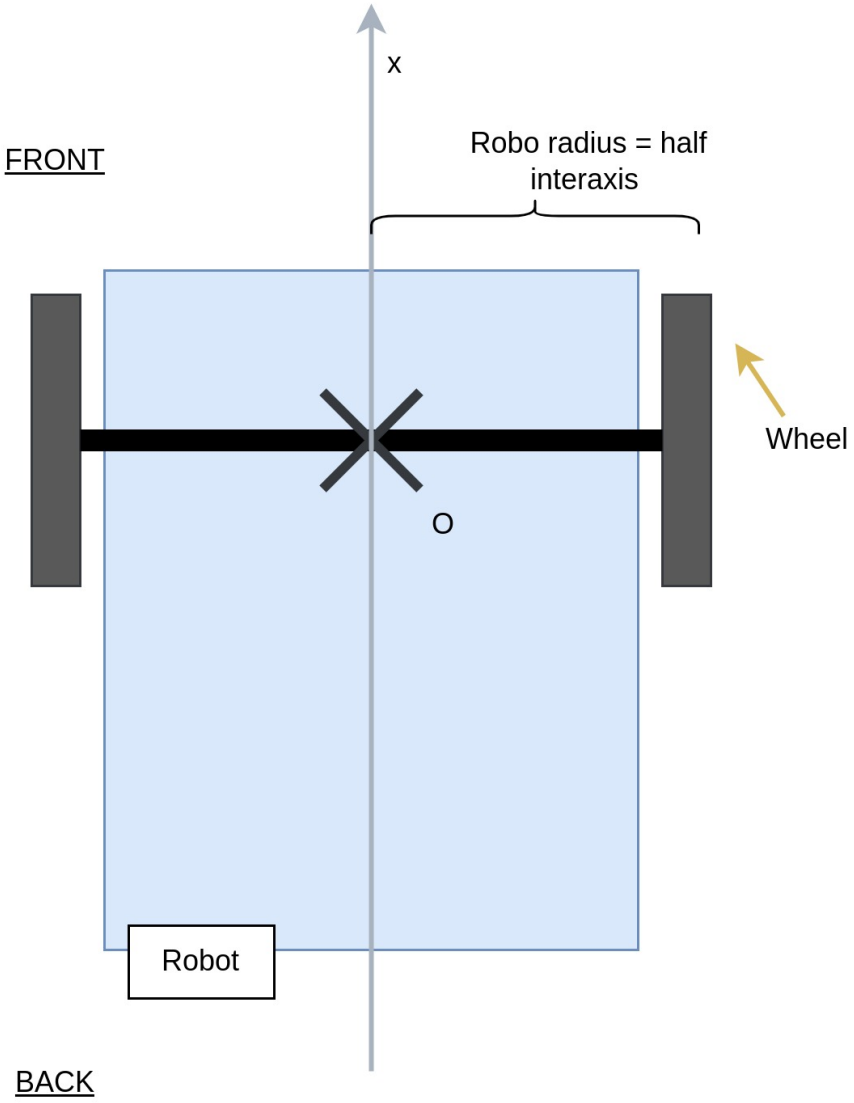
4.6.2 RobotData Gladiator::Robot::setCalibrationOffset()

Arguments :
- **@return** *(dx)* : dx offset between the center of the wheels and the center of the tag
- **@return** *(dy)* : dy offset between the center of the wheels and the center of the tag
- **@return** *(da)* : the angular offset

Set the offset between the position of the tag and the centre of the wheels. The position sent by the camera is the position of the centre of the tag, one must obtain the offsets to get the position of the centre of the robot.
The default of the offset are correct, if you need to change them, you should ask a soft coach.

4.6.3 const float Gladiator::Robot::getRobotRadius()

Arguments :
- **@return** *(float)* : the radius of the robot in metres


x
FRONT
Robo radius = half interaxis
Wheel
O
Robot
BACK

4.6.4 const float Gladiator::Robot::getWheelRadius()

Arguments :

- **@return** *(float)* : the radius of the robot's wheel in meter

4.7 Maze functions

4.7.1 MazeSquare Gladiator::Maze::getSquare()

Arguments :
- **i** *(byte)* : i index
- **j** *(byte)* : j index
- **@return** *(MazeSquare)* : returned Maze Square

This function returns the Maze Square object at the (i, j) index. If i and j are greater than 13 or lower than 0 this function will return an empty MazeSquare object.

4.7.2 MazeSquare Gladiator::Maze::getNearestSquare()

Arguments :
- **@return** *(MazeSquare)* : returned Maze Square

This function returns the maze square where the robot is.

4.7.3 const float Gladiator::Maze::getSize()

Arguments :
- **@return** *(float)* : Size of the maze in metres

4.7.4 const float Gladiator::Maze::getSquareSize()

Arguments :
- **@return** *(float)* : Size of a square of the maze in metres.

4.8 Weapon Control functions

4.8.1 void Gladiator::Weapon::initWeapon()

Arguments :

- **pin** *(WeaponPin)* : Weapon pins available on the back of the robot to be initialized (M1, M2 or M3)
- **mode** *(WeaponMode)* : Mode of the pin (PWM or SERVO)

Initialise a new weapon pin available on the back of the robot, there are 3 pins available (M1, M2 and M3). The 3 pins can be controlled with 2 different modes to control a weapon : SERVO or PWM. This function must be called only once per pin. If it is called several times, only the first mode set will be taken.

4.8.2 void Gladiator::Weapon::setTarget()

Arguments :

- **pin** *(WeaponPin)* : weapon pins available on the back of the robot (M1, M2 or M3)
- **value** *(float)* : value in range [0; 255] to set for the weapon

If the weapon mode is set to SERVO, the value is the position of the servo in degree to set. If the weapon mode is set to PWM. the value is the dutyCycle of the Pwm. **Example :**

```
1
2     void setup () {
3
4         // ... init gladiator
5
6         //set M1 as SERVO
7         gladiator->weapon->initWeapon(WeaponPin::M1, WeaponMode::SERVO);
8         //set M2 as PWM
9         gladiator->weapon->initWeapon(WeaponPin::M2, WeaponMode::PWM);
10    }
11    void loop() {
12        if(gladiator->game->isStarted()) {
13
14          //set the servomotor to 95
15          gladiator->weapon->setTarget(WeaponPin::M1, 95);
16
17          //create a pwm signal with a duty cycle of 0.5 on pin M2 (alpha = 0.5)
18          gladiator->weapon->setTarget(WeaponPin::M1, 128);
19
20          delay(1000);
21
22          //create a pwm signal with a duty cycle of 1 on pin M2 (alpha = 1)
23          gladiator->weapon->setTarget(WeaponPin::M1, 255);
24        }
25
26    }
```

4.8.3 void Gladiator::Weapon::launchRocket()

Arguments :

Launch a virtual rocket. The rocket will be launched only if you pass through a rocket coin. Your rocket inventory is limited to 1 rocket only. The maximum distance of a rocket is limited to five squares.

4.8.4 void Gladiator::Weapon::canLaunchRocket()

Arguments :
- **@return** *(bool)* : return if the robot can launch a rocket

This function returns if the robot can launch a rocket. To be able to launch a rocket the robot should pass across a rocket coin. The robot can only launch one rocket at a time.