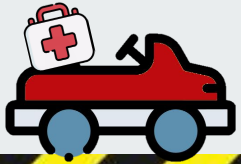
The Good Boy!

Sprint 3 Review

12/07/2021



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SUMMARY

I. Previous sprint

II. Sprint objectives

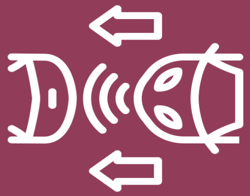
III. Organisation

IV. Stories
- Obstacle detection
- Command law
- LiDAR & Camera analysis

V. Safety

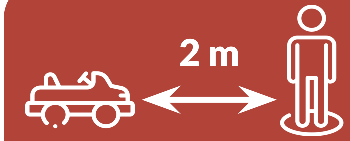
VI. Next sprint & Conclusion

Previous sprint



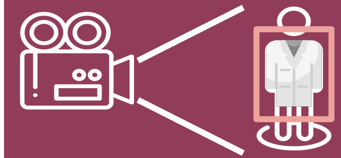
Obstacle detection

Placed in a open area (no objects nearby), **the robot stops** when an **obstacle** is detected at a distance of **50 cm or less**.



One direction follow-up

Placed in an open area, the robot **follows a person in front of it** at a distance of **two meters**, in a **straight line**.

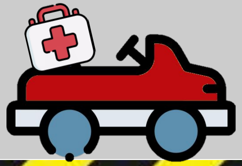


Detection of people dressed in white

The robot is able to detect a person **dressed in white** on the camera, and to **differentiate it** from another white object.

Sprint 3

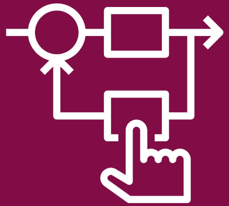
- Sprint objectives
- Organisation



Sprint objectives

Identification and follow-up of a rescuer

Placed in an open area, **identifies and follows** a rescuer using both **camera and LiDAR**, both in a **straight line** and **turns**

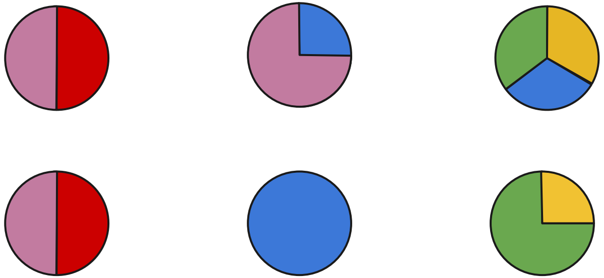


Trajectory control

Establishment of a **control law** using a **Proportional controller** for the **speed** and **trajectory** of the robot

Organisation

- **Group organisation** (each dot represents a team member)

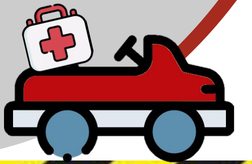


Legend

Ultrasounds
LiDAR
Camera
Server
Motors

Stories

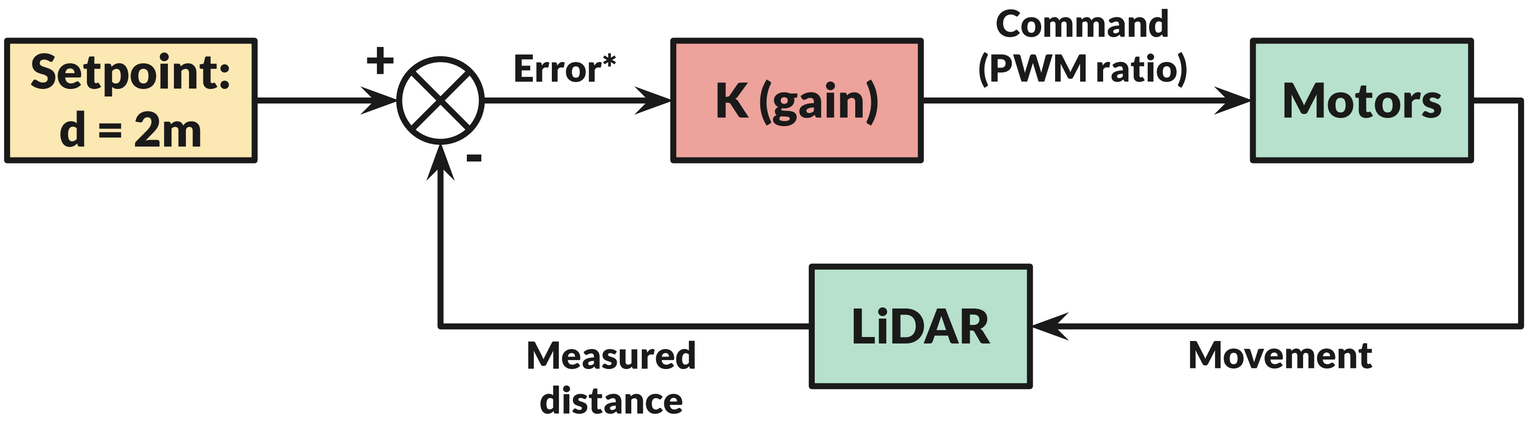
Command Law	XS
LiDAR & Camera analysis	XL
Obstacle detection	L



Command Law

Principle

Proportional command law



In this context, the error is the distance between the setpoint and the measured value

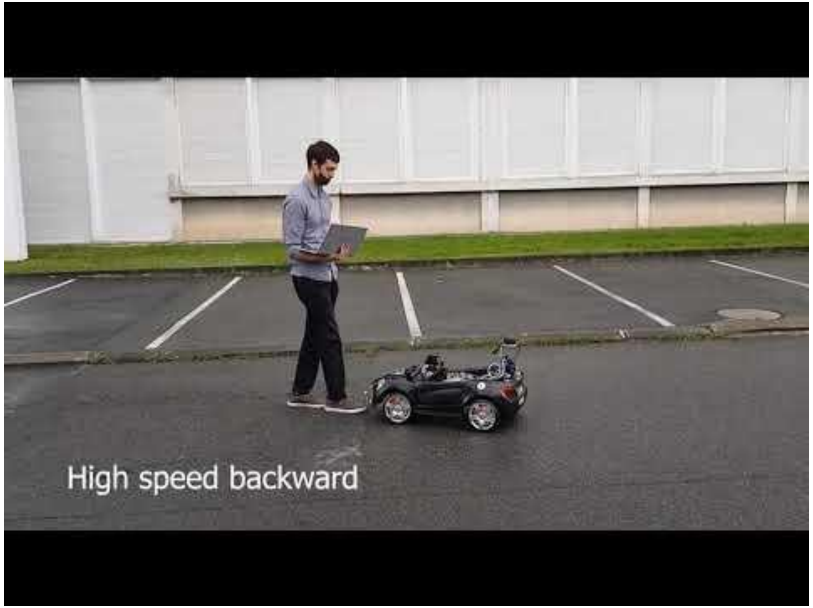
Command Law

Tests

- A person is walking in front of the robot **at variable speed** (<5km/h)

- The robot must go forward or backward at a **speed which depends on the distance** from the target

Demonstration

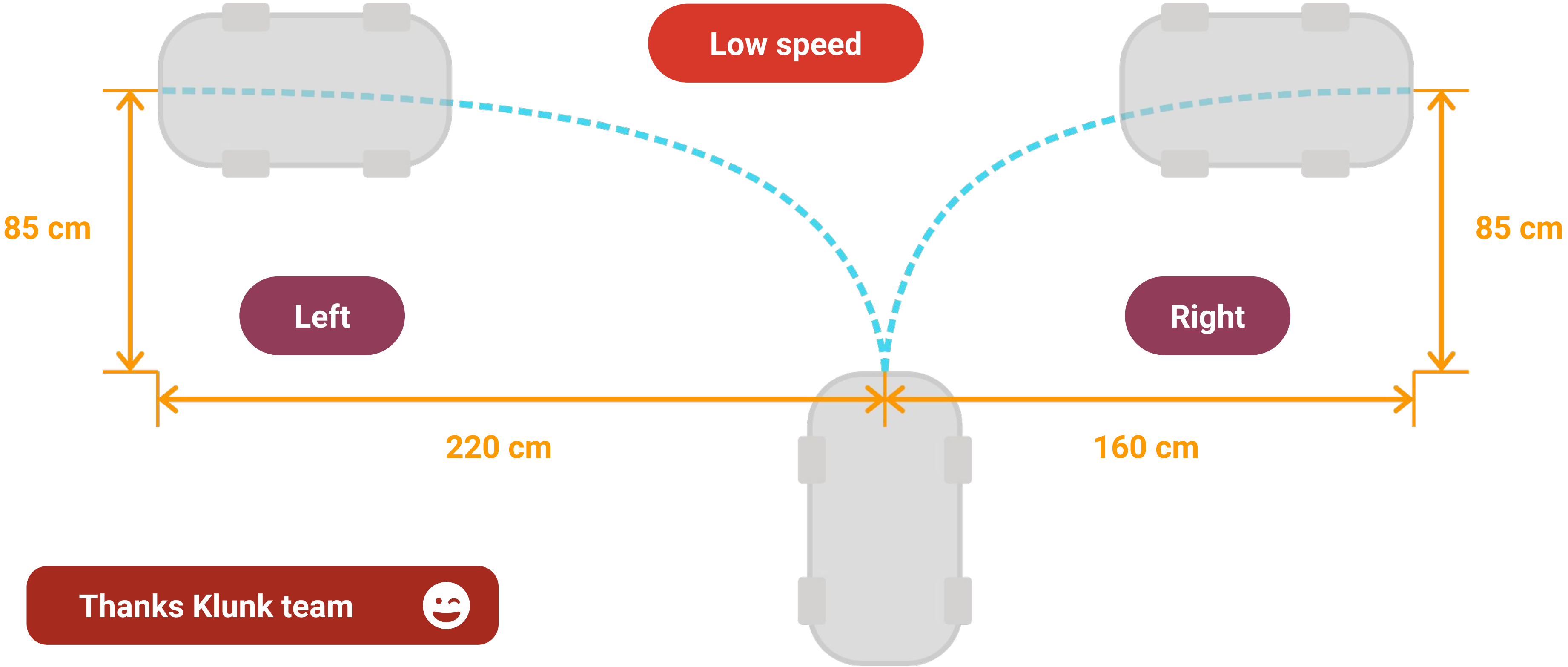


Characterisation

- 90˚ Turn Right & Left

- Static error

90 ° Turn Right & Left



Thanks Klunk team 😉

Static error

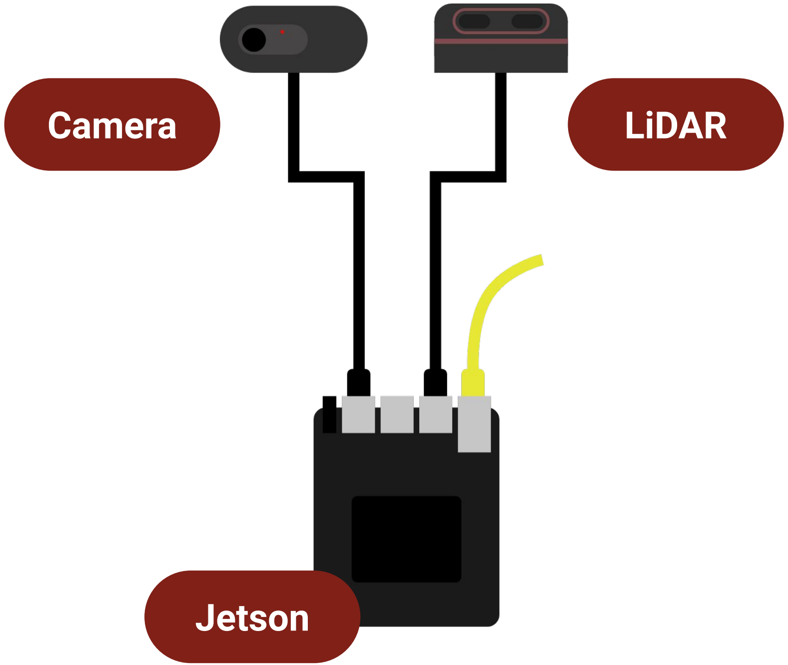
→ **We did 6 measures**

	Expected value (mm)	Measured values (mm)
The robot is moving backward	2300	2150 ; 2080 ; 2060 ; 2050 ; 2110 ; 2130
The robot is moving forward	2300	2500 ; 2490 ; 2490 ; 2480 ; 2500 ; 2510

Means

- **Forward static error = 19,5 cm**
- **Backward static error = 20,33 cm**

LiDAR & Camera analysis



Camera program

- ✓ Detection
- ✗ Distance

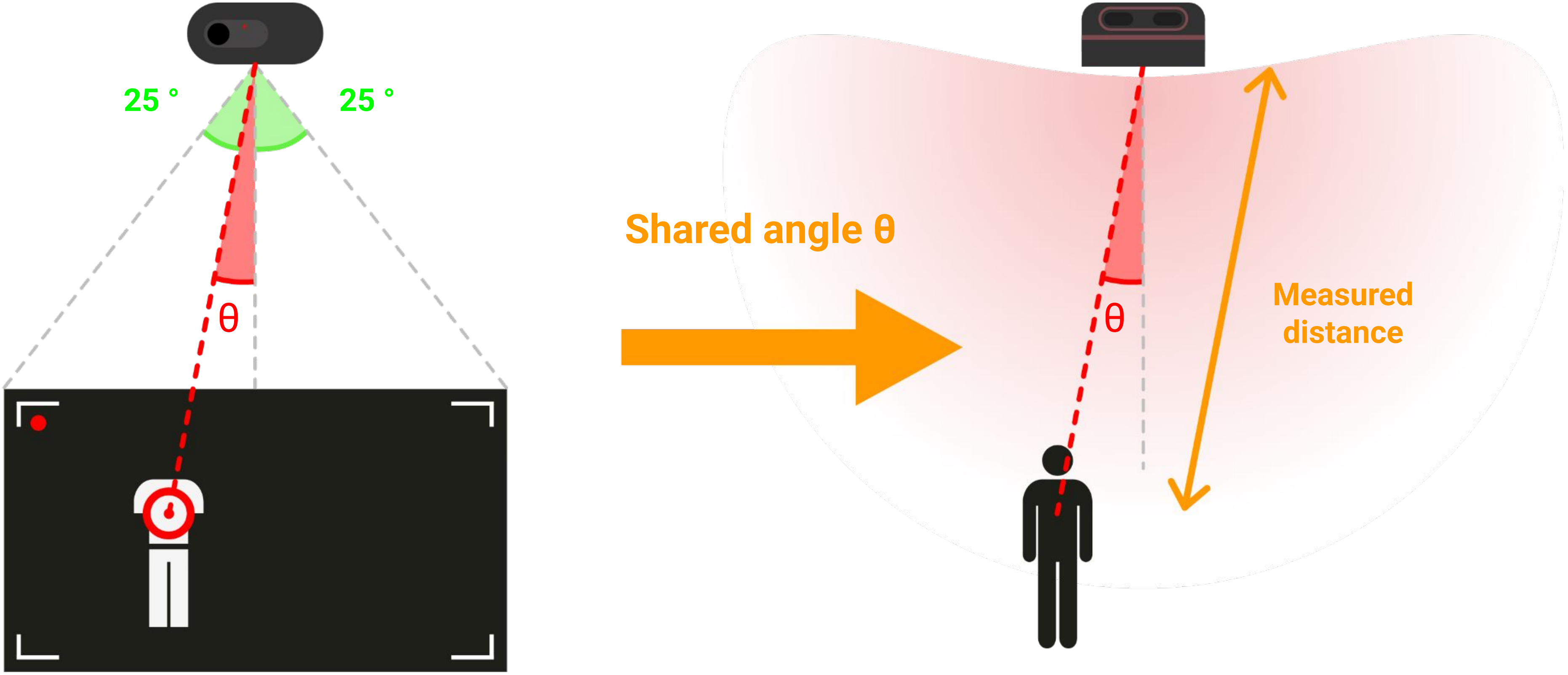
LiDAR program

- ✗ Detection
- ✓ Distance

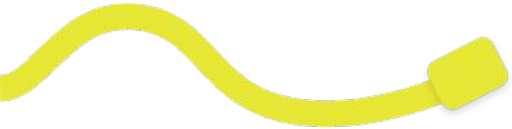
New program

- ✓ Detection
- ✓ Distance

LiDAR & Camera analysis

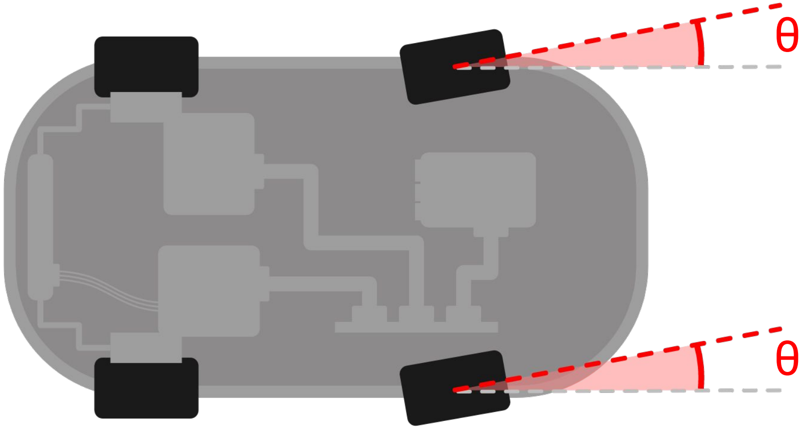


LiDAR & Camera analysis



Get **angle and distance** via ethernet

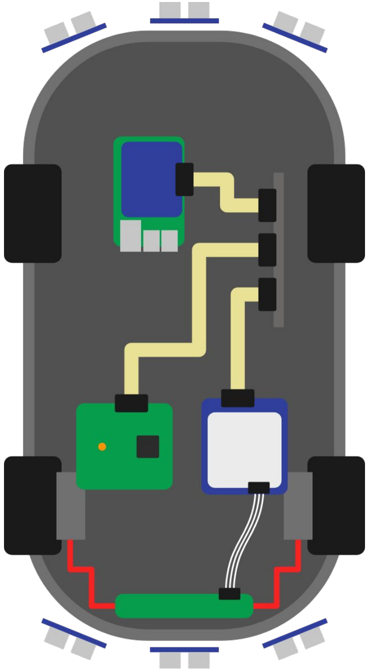
Adjust robot's wheels angle → **Send instruction to motors**



STOP

MOVE FORWARD

MOVE BACKWARD



LiDAR & Camera analysis

Tests

- A person is walking in front of the robot **at slow speed** (<5km.h) and **with small turns** (<45°)

- The robot must go forward or backward to **stay at 2 meters from the target**
- The robot **must turn** left or right to go in the **direction of the target** using its lidar

Demonstration

LiDAR & Camera analysis

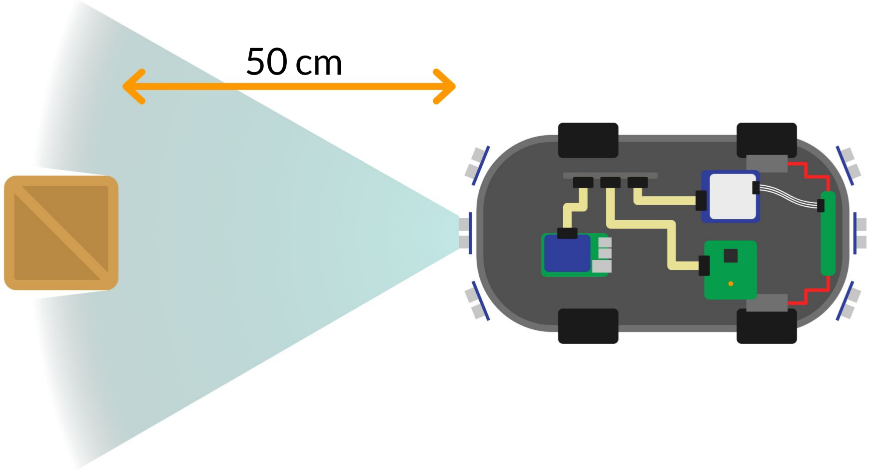
Analysis

- We experience **small stops** that comes from the ultrasons
- The LiDAR alone is not precise enough to follow someone and we need to implement the **camera** to have **a smooth follow** behaviour
- The robot is **able to follow** someone by moving backward or forward
- The robot is **able to turn** to point at the direction of its target

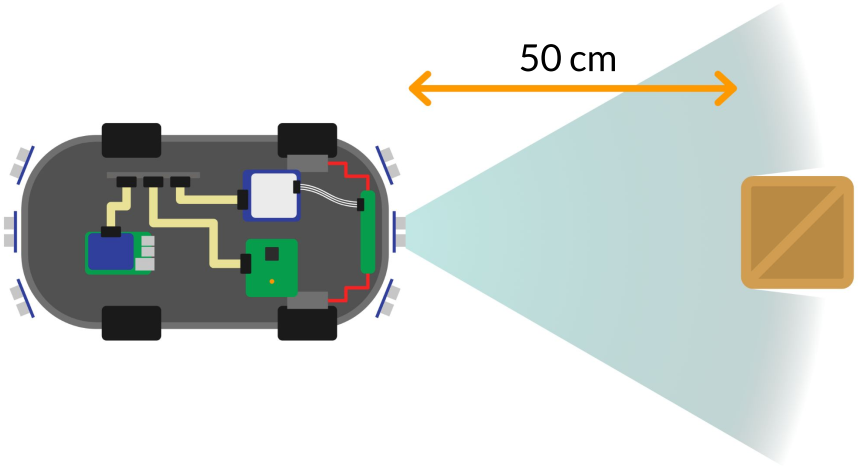
Obstacle detection

Tests

The robot stops if...

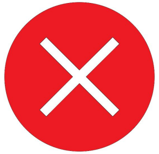


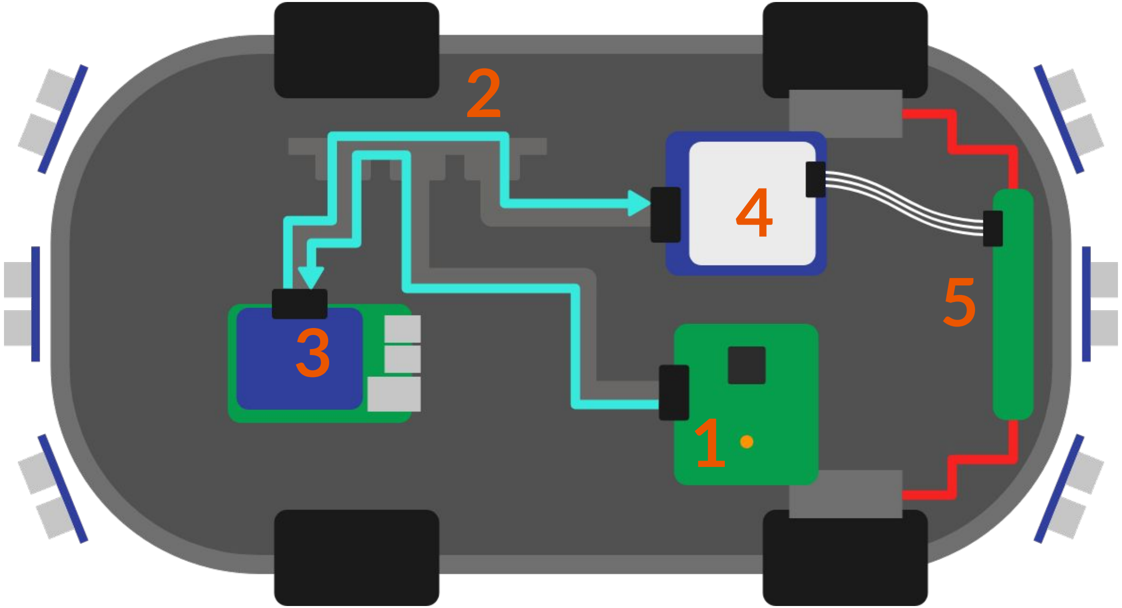
It moves forwards and an obstacle is detected in front



It moves backwards and an obstacle is detected behind

Obstacle detection





Legend

1: Discovery (Ultrasounds detection)

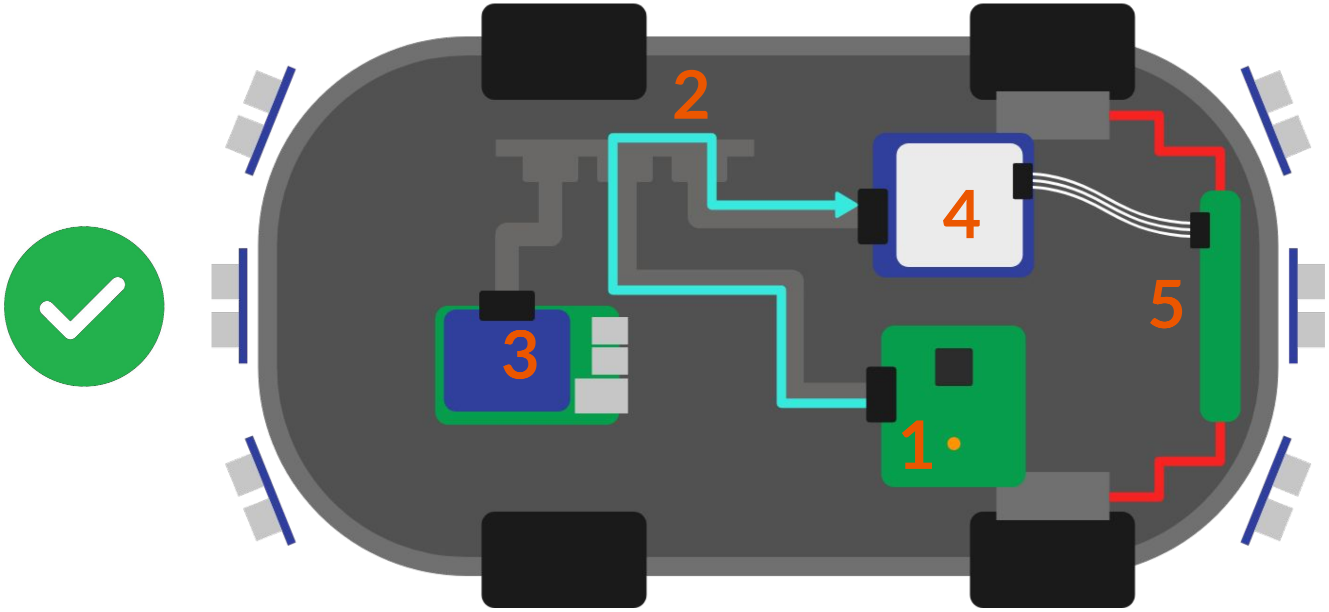
2: CAN bus

3: Raspberry Pi

4: Nucleo (motor direction control)

5: Motor direction

Obstacle detection



Legend

1: Discovery (Ultrasounds detection)

2: CAN bus

3: Raspberry Pi

4: Nucleo (motor direction control)

5: Motor direction

Obstacle detection

Tests

- The robot must stop when an obstacle is detected behind it and it is moving backwards.
- **However**, an obstacle placed behind the robot must not block the robot from moving forward

- The obstacle detection is functional **but** the robot stops **between 15 and 40 cm** from the obstacle
- **Solution** : change the detection from **50 cm to 100 cm**

Demonstration

Objectives completion

Identification and follow-up of a rescuer

Placed in an open area, **identifies and follows** a rescuer using both **camera and LiDAR**, both in a **straight line** and **turns**

80 %

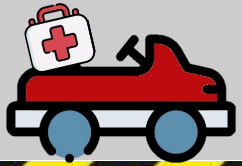
Trajectory control

Establishment of a **control law** using a **Proportional controller** for the **speed** and **trajectory** of the robot

100 %

Safety

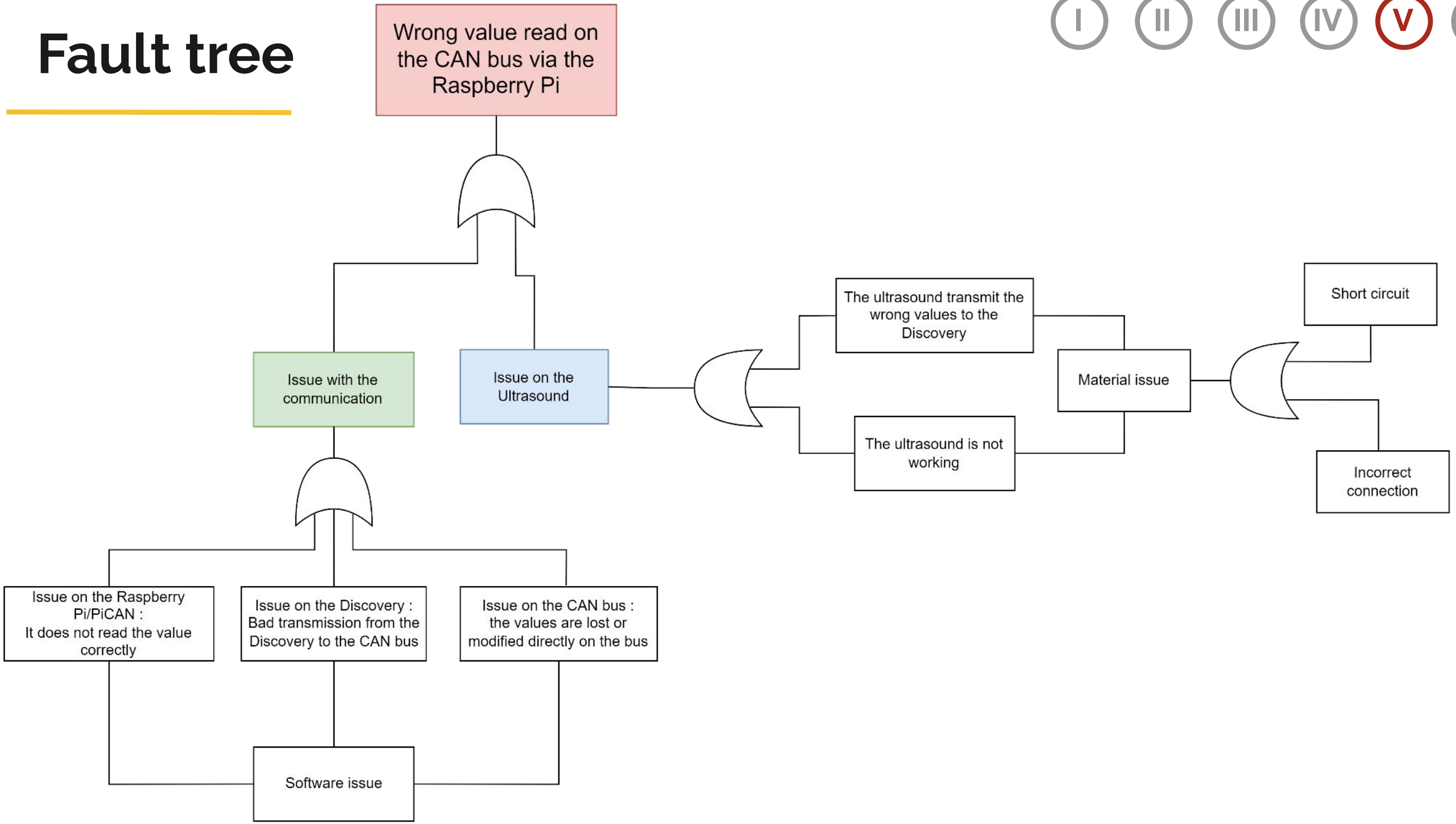
- Fault Modes, Effects and Causes Analysis
- Fault tree



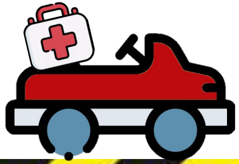
FMECA

Component	Failure modes	Causes	Effects	Detection	Frequency	Severity	Criticality
Ultrasound	• Wrong distance measurement • No emission • No reception	• Broken Ultrasound • Connection (wire) issue • Code mistakes	• Not able to use the ultrasound to detect an obstacle	• Red LED is not working on the ultrasound • CAN messages with the wrong values (hand-measured to check)	4	5	20
Raspberry PI	• Wifi not working • Application crashes • Wrong command interpretation/emission	• Programming errors • Configuration errors	• Distance informations is not relayed to the motors • Robot can go crazy or get lost	• No information is coming from the RPi • Connection Jetson/RPi is lost	6	5	30
GPS	• Measurement error	• Zone poorly covered • Not enough time to locate precisely	• The rescuer is not able to find the robot again	• Loss is detected but not data comes from GPS • GPS information sent do not fit in a pre-defined range which corresponds to approximate location	7	1	7

Fault tree


Wrong value read on the CAN bus via the Raspberry Pi
Issue with the communication
Issue on the Ultrasound
The ultrasound transmit the wrong values to the Discovery
The ultrasound is not working
Material issue
Short circuit
Incorrect connection
Issue on the Raspberry Pi/PiCAN : It does not read the value correctly
Issue on the Discovery : Bad transmission from the Discovery to the CAN bus
Issue on the CAN bus : the values are lost or modified directly on the bus
Software issue

Sprint 3 → Sprint 4

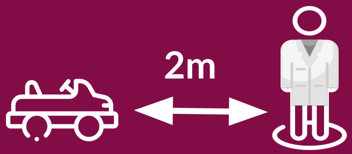


Next Sprint

User-oriented objectives

Postponed from this sprint

Identification and follow-up of a rescuer

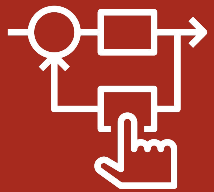


Placed in an open area, **identifies and follows** a rescuer using both **camera and LiDAR**

Next Sprint

User-oriented objectives

New in next sprint



Trajectory control

Improving the control law for the speed: **precise** and **fast response**

Identification of a sign

The robot must be able to **recognize a sign** issued by **a rescuer**

Scrum master time !

Tasks

Exchanging with the clients/tutors

Planning work sessions and meetings

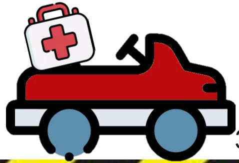
Summarising the progress of the team

Conclusion

- Aggregation of several scattered features
- A more advanced safety analysis of our robot
- A characterisation of the performances of our product

- Continue to implements new features
- Some improvements still needed for merging functionalities together
- More characterisation while implementing new features

Annex → FMECA



FMECA

Component	Failure modes	Causes	Effects	Detection	Frequency	Severity	Criticity
Jetson	• Communication lost with RPi • Wrong LiDAR/Camera management • Wrong communication with RPi	• Programming errors • Configuration errors	• Wrong distance is sent so motor command (speed & direction) is impacted	• No information is coming from the Jetson • Connection Jetson/RPi is lost • Info sent to RPi (distance/angle) is too different from previous ones	6	3	18
Nucleo	• Unwelcome motor command • No motor command • No self-sustain • No/bad communication with RPi • No/bad communication with Discovery	• Programming errors • Hardware errors (pins, cables)	• The robot is unable to self-sustain powered on • The robot can go crazy or stop when not desired	• Robot don't stop when an obstacle is detected • Robot don't behave accordingly to the situation (distance/angle)	2	8	16
Discovery	• Bad US reception • No/bad communication with Nucleo	• Programming errors • Hardware errors (pins, cables)	• The robot do not stop when there is an obstacle and a collision can happen • The robot stops even if there is no obstacle	• Robot don't stop when an obstacle is detected • Robot stops when it should not	2	5	10

FMECA

Component	Failure modes	Causes	Effects	Detection	Frequency	Severity	Criticity
Motors	• Unwelcome working • No response	• Broken motors • Bad communication with the Nucleo (programming errors) • Bad command from Nucleo	• The robot does not move or moves when we do not want it to.	• We cannot see the motors move	3	8	24
Camera	• Measurement error • Loss of the visual contact	• Broken Camera (internal material) • Programming errors • User movements	• The robot miscalculate the position of an object and make a wrong move decision • The robot is not able to follow his target	• Absurd values are received by the Jetson • The angle computed from the image is not coherent with LiDAR information • Values are too different from previous ones	6	3	18
LiDAR	• Measurement error	• The robot will miscalculate the position of an object and make a wrong move decision.	• Unable to follow his target	• Absurd values are received by the Jetson • The angle computed from the image is not coherent with Camera information • Values are too different from previous ones	6	3	18