VIGIWHEELS

Your autonomous sentinel

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What makes **Vigiwheels** so **Amazing?**

A connected autonomous vehicle that **ensures the security** of an industrial building

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01

Reminder Sprint 1 Objectives

Sprint 1 objectives

Quick reminder

Objectives	Tasks
 Moving the car	• Moving in a straight line **Movement with the console** • Make sure that we can move in a straight line **Autonomous movement** • Velocity control/ Position control
 Dataset manometer	• Build image dataset for labeling • Start image labeling for one class (manometer) • Prepare the data to train an AI model to recognize manometers
 Detecting a basic obstacle	• The car is able to detect fixed obstacles and stop
 Fire detection	• Find the best sensor • Study the sensor's technology and specifications. • Implement a low-level driver for the sensor • Process the sensor data to obtain the temperature of the area.

02

Movement control

Control the car speed

And moving it in a straight line in auto-mode

Terms

- Control System — Commande or regulate the behavior of the systems by using control loop
- Control Loop — Open loop control
Closed loop control
- PID — Type of controller

Movement control

Realization

System Analyzing

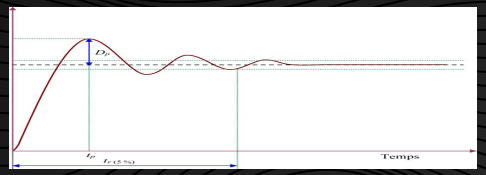
Finding the TF of the system in (open loop control)

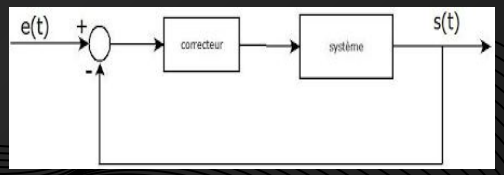
System Control

Set PID parameters to control the motor speed

Realization and Test

Implementation with ROS2 and system responses





ROS

Movement control

Approval Test

Move in a straight line for a specified distance in auto and manual mode

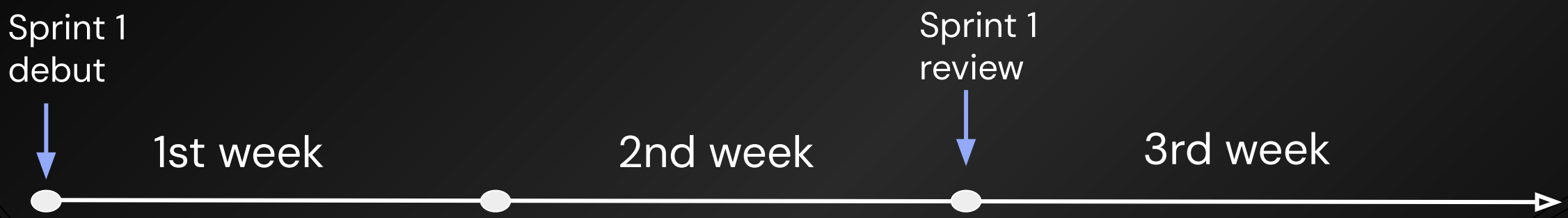
Both motors' RPM sensor values correspond to the speed instruction.
0.5 throttle –> 32 rpm

Suppressing disturbance stopping/accelerating the wheel(s)

No jerk when wheel is moving
or when start/stop

Movement control

Time management



Familiarize with
ROS2
+
System Analysis

System Analysis
+
Control System
+
Coding
+
Approval Test

Review the Control
System and Code
+
Fix bug
+
Approval Test

03 Obstacles detection

Obstacles detection

Fulfilled Functionality

- Detect a fixed obstacle and stop

Obstacles detection

Fulfilled Functionality

- Detect a fixed obstacle and stop
- Move again if the obstacle disappears

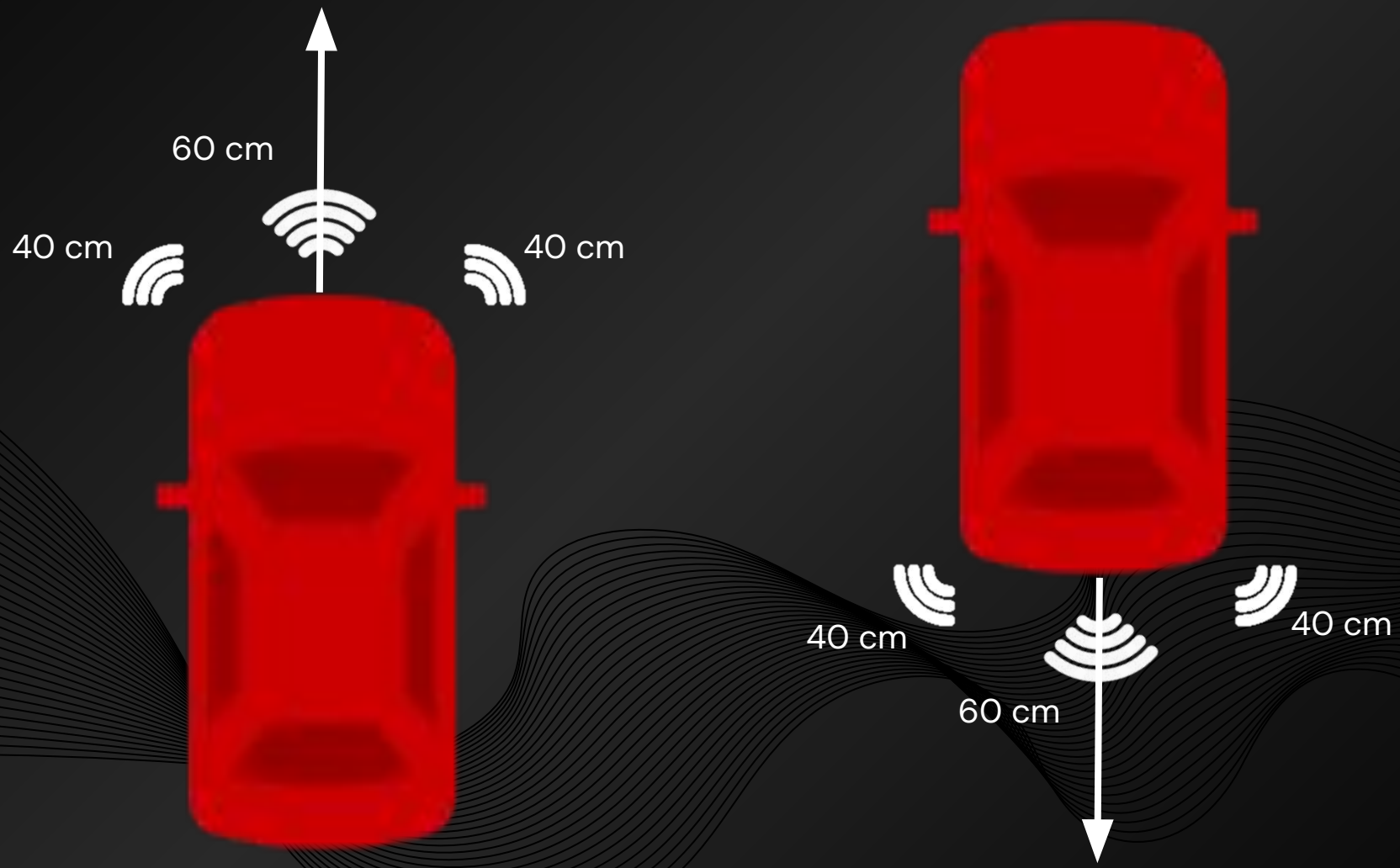
Obstacles detection

Fulfilled Functionality

- Detect a fixed obstacle and stop
- Move again if the obstacle disappears
- Adapt detection to the vehicle orientation

Obstacles detection

Detection System



Detection System

Obstacles detection

Obstacles detection

Acceptance Test

- The car stop 30cm before a fixed obstacle in his trajectory
- The car stop if an obstacle appear in his trajectory
- The car move if the obstacle disappear

Obstacles detection

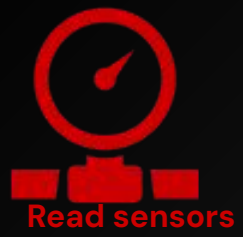
Demonstration

Obstacles detection

Schedule control

- Objectives of sprint 1 & 2 fulfilled in one sprint
- Avoiding obstacles and LiDar detection will be implement with ros2nav (starting sprint 2)

04 Read Sensors



Fulfilled Functionality

- Learn about Jetson implementation
- Create dataset to train the model
- Looking for one state of the art DNN
- Training and deployment on Jetson nano

Getting started with the Jetson nano

Nvidia DLI tutorials

- Use of a nvidia docker
- Pretrained models not suitable

Getting started with the Jetson nano

Nvidia DLI tutorials

- Use of a nvidia docker
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Setting the environment

PyTorch

YOLOv8

PyTorch, YOLO v8, torchvision

Getting started with the Jetson nano

Nvidia DLI tutorials

- Use of a nvidia docker
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Setting the environment

PyTorch

YOLOv8

PyTorch, YOLO v8, torchvision

Datasets in Jetson nano

Need of a docker

Creating the Dataset

2 Options

Creating the Dataset

2 Options

Dataset using Jetson nano and camera

```
Epoch: 0, Step: 150/252, Avg Loss: inf, Avg Regression Loss inf, Avg Classification Loss: 4.2483
Epoch: 0, Step: 160/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 170/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 180/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 190/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 200/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 210/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 220/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 230/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 240/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
Epoch: 0, Step: 250/252, Avg Loss: nan, Avg Regression Loss nan, Avg Classification Loss: nan
```

- Images size 1280 * 720
- Training the model in the nano takes a lot of time

Creating the Dataset

2 Options

Dataset using Jetson nano and camera

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```

- Images size 1280 * 720
- Training the model in the nano takes a lot of time

Image annotation tools

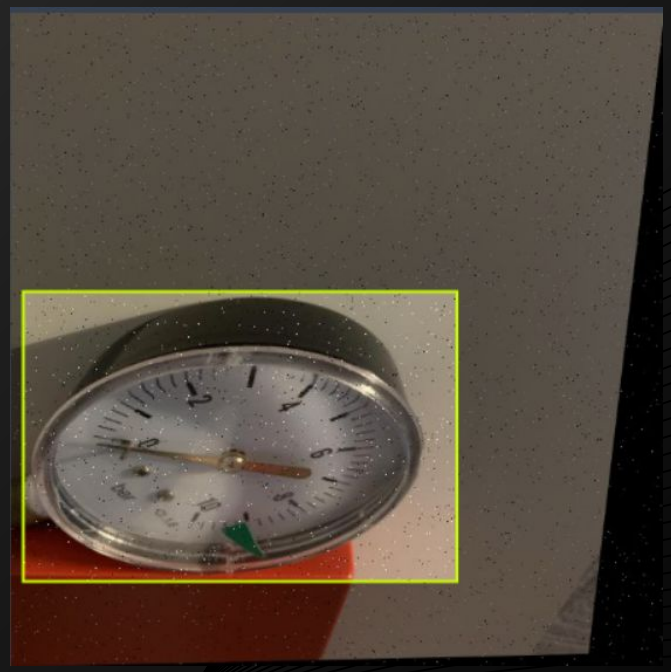
roboflow

- User friendly
- Easy to use
- Use of data augmentation

Read Sensor

Creating the Dataset

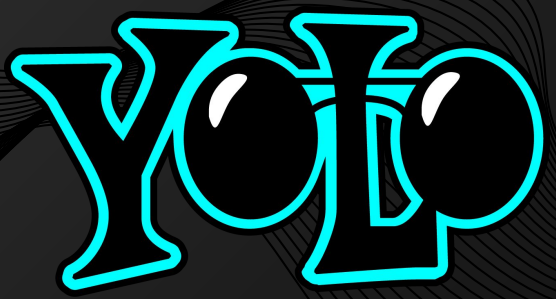
Data augmentation



https://app.roboflow.com/insa-iiy2q/manometerdetectionbase/browse?queryText=&pageSize=50&startingIndex=0&browseQuery=true

Using dataset

- Looking for one state of the art DNN
- Application for object detection
- Versatile training, deployment and scalability

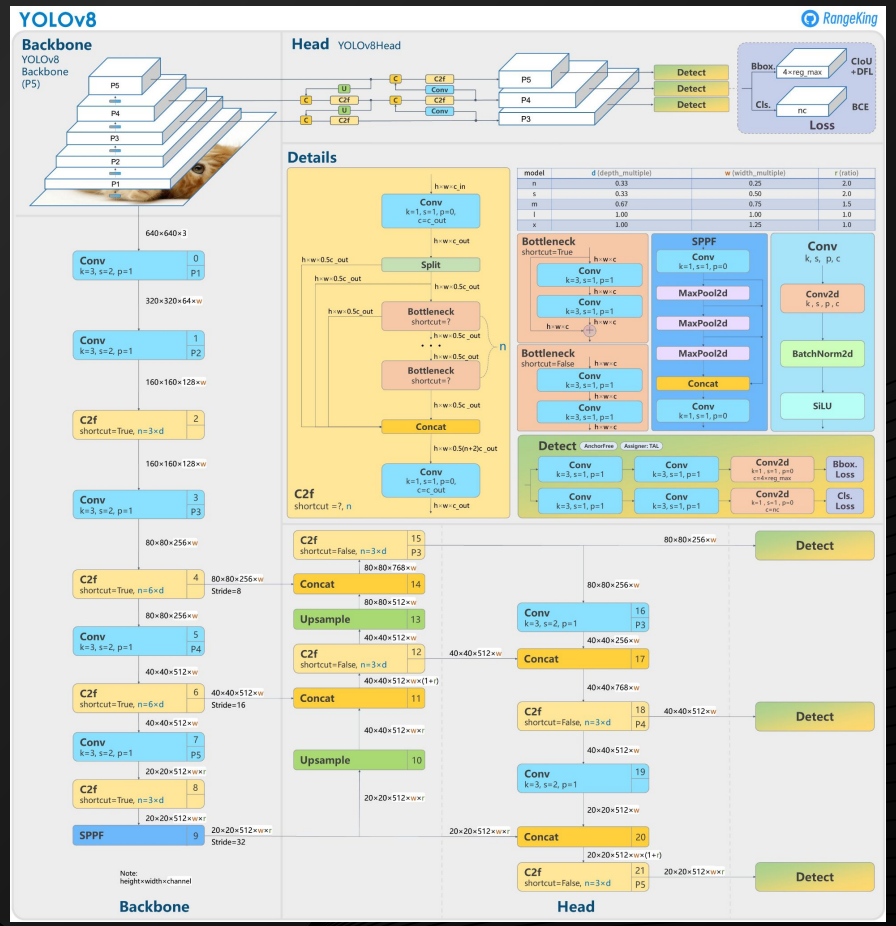


Read Sensor

YOLOv8 architecture

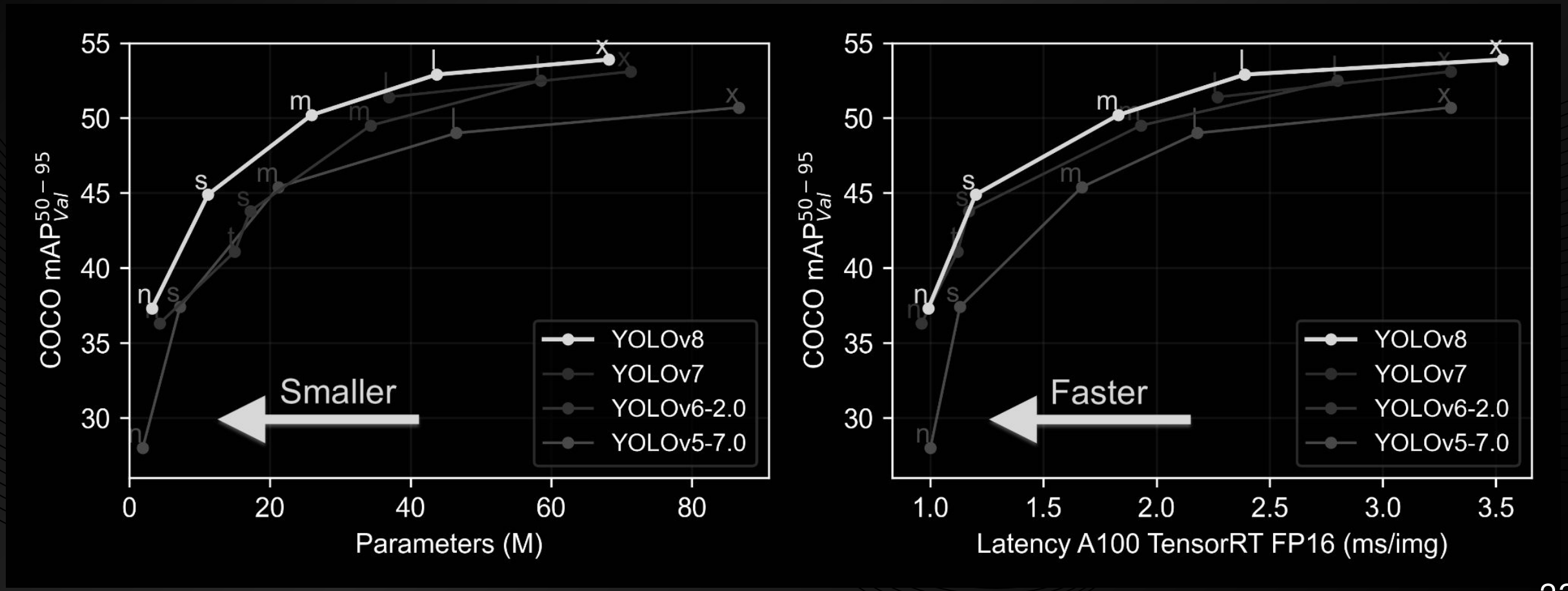
https://deci.ai/blog/sota-dnns-overview/

https://docs.ultralytics.com/models/yolov8/



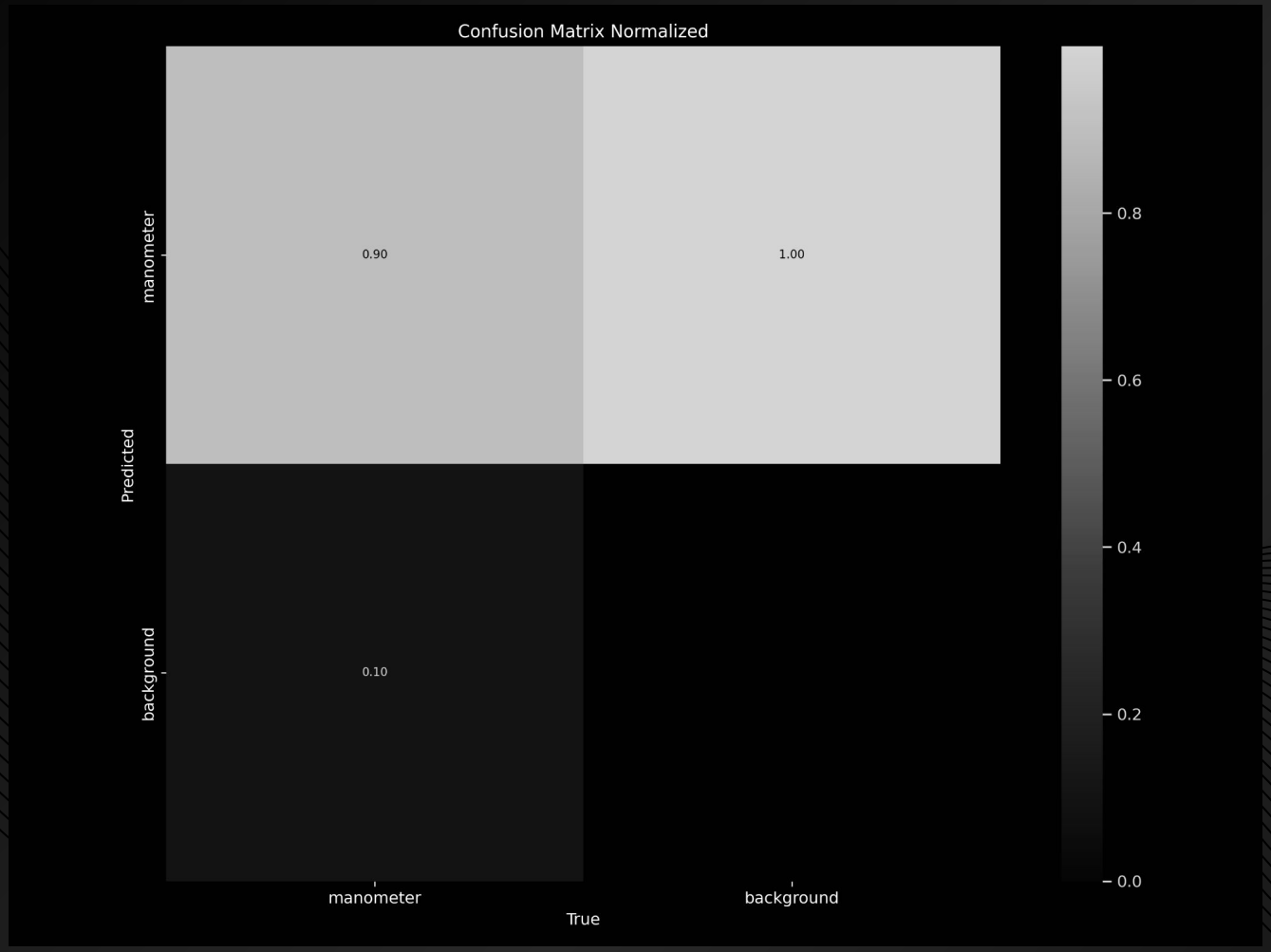
Using dataset

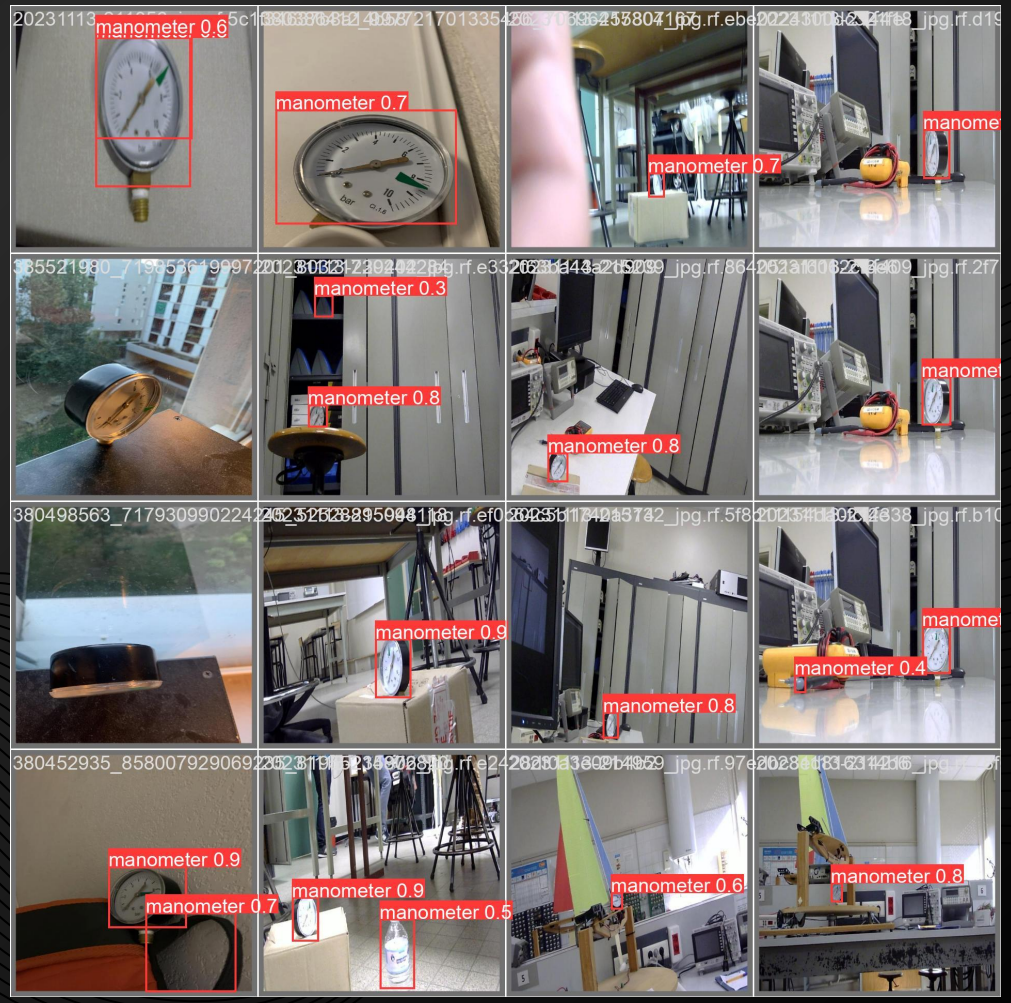
Neural network choice



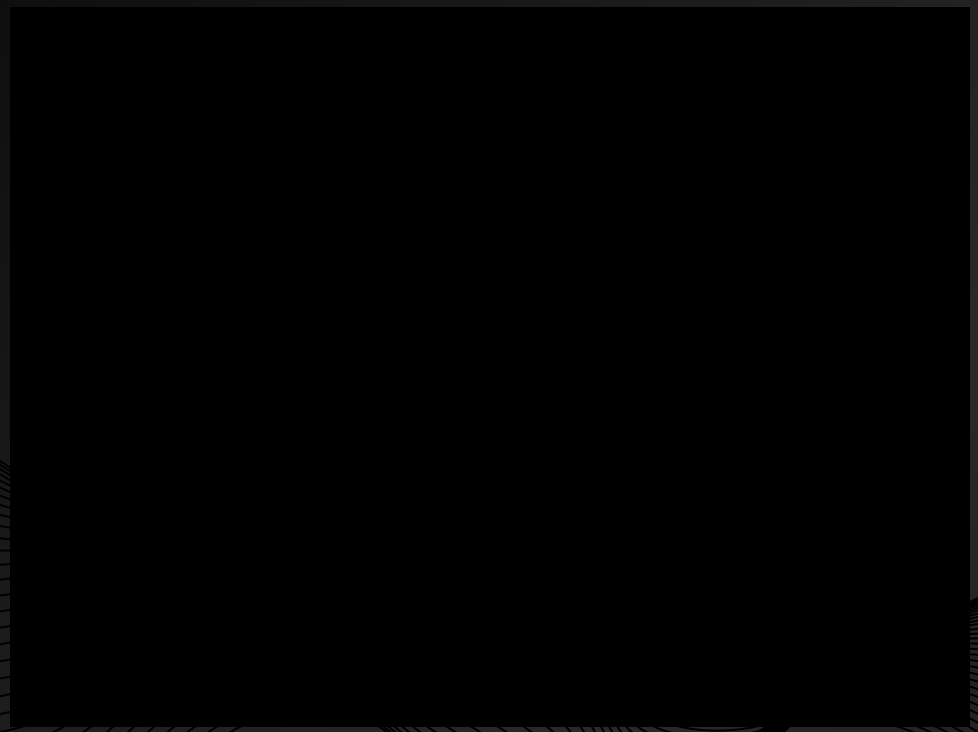
Using dataset

Read Sensor





Model demonstration



Acceptance test

- Object detection at least half a meter away
- Detection of at least 70% confidence on the object
- Over 100 images available for training.

Schedule control

- Sprint 1 and part of Sprint 2 objectives achieved


05
Fire
Detection

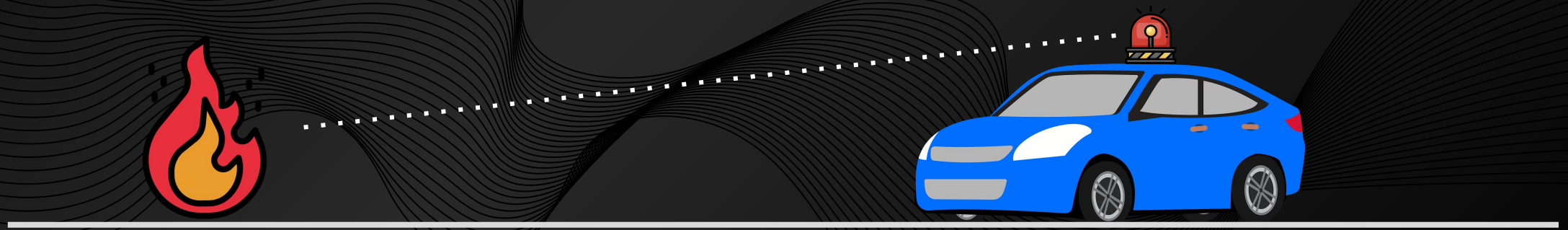
05 Fire Detection

Feature A : Detect a fire in a building throughout its patrol.

05 Fire Detection

Feature A : Detect a fire in a building throughout its patrol.

Feature B : Trigger appropriate security measures (local audible alarm and automatic messaging to firefighters).



Objectives

Fire Detection

1

Exploration of Technical Solutions

Objectives

Fire Detection

1

Exploration of Technical Solutions

2

Selection of the Ideal Solution

Fire Detection

Objectives

1. Exploration of Technical Solutions
2. Selection of the Ideal Solution
3. Comprehensive Testing Phase

Fire Detection

Objectives

1. Exploration of Technical Solutions
2. Selection of the Ideal Solution
3. Comprehensive Testing Phase
4. Compliance Verification

Fire Detection

Sensor Technologies

Technologies		Basic Principle	Advantages	Disadvantages
Infrared Thermal Camera		Receives real-time infrared images	- High performance (Provides precise temperature measurements + distinguishes different heat sources) - Good range (Cover a large surface)	- High price (several thousand euros) - Complex integration (with the architecture of the car)

Fire Detection

Sensor Technologies

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Gas Detector		Measures gases emitted by a fire	- More affordable price (several tens of euros) - Very reliable	- Less effective (Provides gas measurements only, no detection in absence of gas) - Complex installation (The car is close to the ground, and the gases rise)

Fire Detection

Sensor Technologies

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Flame Detector		Measures infrared radiation emitted in its environment	- More affordable price (several tens of euros) - Integration simple	- Less effective (Can be disturbed by other infrared sources) - Shorter range (Depends heavily on the power of infrared radiation)

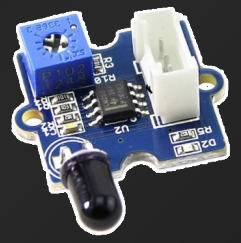
Selected Sensors

Fire Detection

Flame detector ST060 (2,70 €)

Power Supply	5VDC
Output	Analog and Digital output
Range of Spectral Bandwidth	760 to 1100 nanometers
Operating temperature	-40 °C to +85 °C

Grove Flame Detector 101020049 (7,95 €)



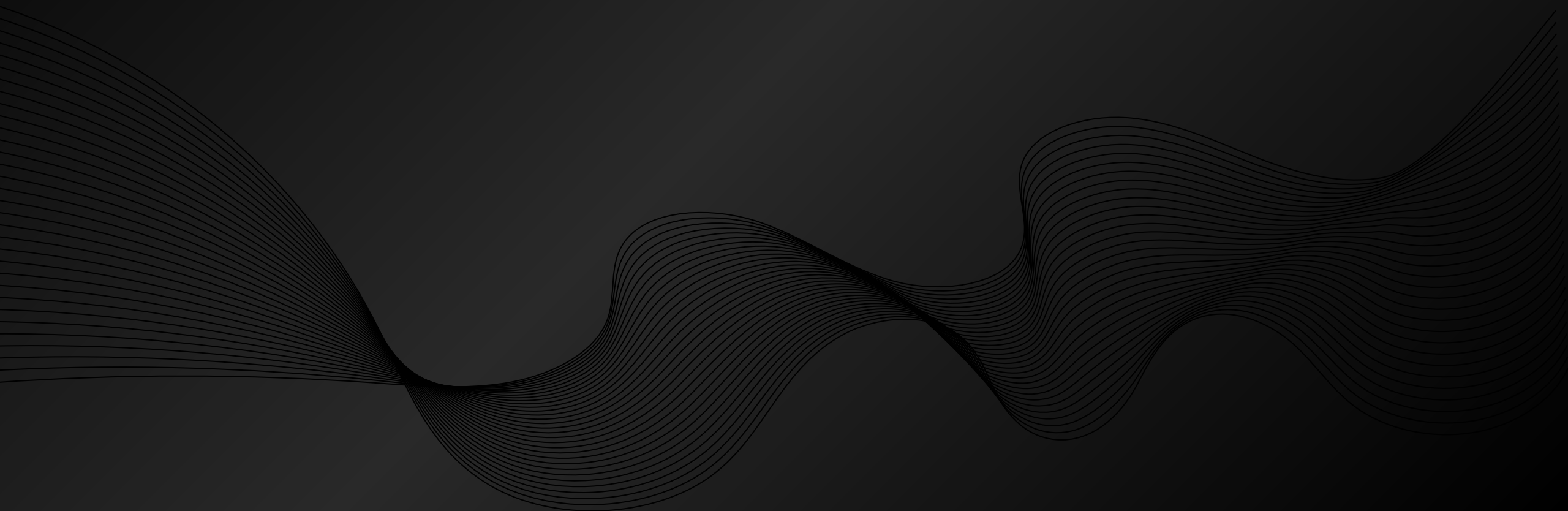
Power Supply	5VDC / 20mA
Output	Digital output
Range of Spectral Bandwidth	760 to 1100 nanometers
Operating temperature	-25 to +85°C

Smoke Detector SEN0570 (5,90 €)

Voltage	3,3 à 5 VDC / < 20mA
Output	Analog output
Detection range	10 to 1000 parts per million
Operating temperature	-10°C to 50°C

For more information: The wavelength can vary considerably depending on what is burned and the temperature of the flame. However, a fire is expected to emit wavelengths in the infrared A range, from 700 nm to 1,400 nm. (Wien's Law: λmax * T = b)

For more information: This sensor can measure 11 different types of gases, and the detected gases depend on the burned material. Carbon monoxide (CO) is one of the measured gases and is present in fires.



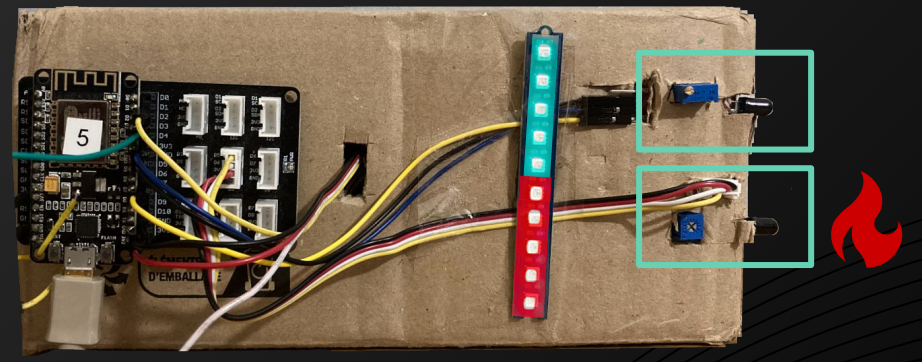
Fire Detection

Testing phase

Detection range depends on :

- Size of fire
- Burning material
- Fire Temperature

Test both sensors together



Fire
(or equivalent)

?

45°

Fire Detection

Test results

	Maximum range of detection			False positive
The outcome of these tests relies significantly on various factors, notably the specific location, prevailing atmosphere, temperature, and other environmental conditions.	Lighter (GEI)	Wood stove (external)	Infrared Lamp (GEI)	
Flame detector ST060 (2,70 €) 	20 cm	> 5 m	35 m	Sometimes
Grove Flame Detector 101020049 (7,95 €) 	10 cm	> 5 m	15 m	None

Demonstration

Fire Detection

Sensor

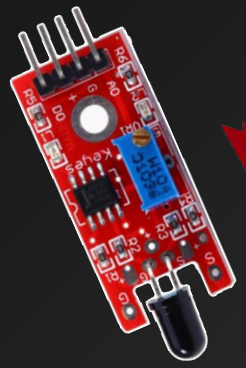
Green Lights
No fire, everything is okay

RedLights
FIRE ! You can panic...

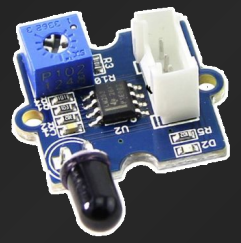
Our choice

Fire Detection

Flame detector
ST060 (2,70 €)



VS



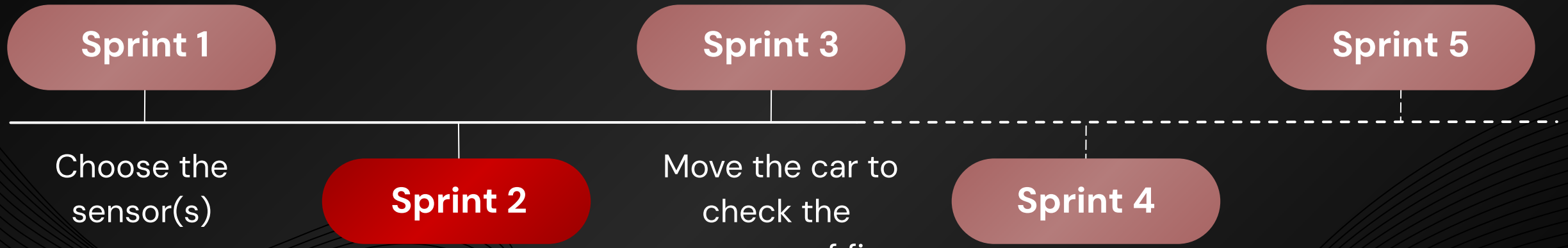
Grove Flame Detector
101020049 (7,95 €)

Best range of detection	Shorter range of detection
Sometimes, false positive	No false positive

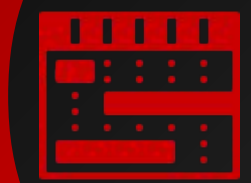
Why not using both ?

Fire Detection

Planning



06



Sprint 2

Next objectives

Team organisation

Organization for sprint 2

Sprint 2

01	**Indoor Car Navigation & Smart patrol**	• Improve RPM control & speed control • Angular control turn • Navigation system (ROS2 Nav)
02	**Instrument reading**	• Camera rotation control • Integration of camera (Jetson) • Integration of AI
03	**Fire Detection**	• Integration of fire sensors




Indoor navigation

Technology

VigiWheels

Sensor

Smart

Communication

Autonomous

IoT

Agile

Team

Safety

Mobility

Actuator

Fire

Intruder

Future

Patrol

Your Thoughts, Please?