1 Introduction

This report outlines our progress since being accepted into the competition, detailing the research we conducted to gain a deeper understanding of the car's current equipment and identify potential enhancements to improve task performance. It also provides an overview of our team dynamics, the milestones achieved during the first sprint, and the objectives we plan to address in the upcoming phase of the competition.

2 Planned activities

The planned activities for this sprint were the following:

- Documentation, Research and Brainstorming
  - Assignees: Entire team
  - Short description: We familiarized ourselves with the project's documentation and the tasks our car should be able to perform, brainstormed and planned the main tasks we have to do before we start developing.
  - Status: Finished

- Simulation Environment setup & installation
  - Assignees: Luca & Rafa
  - Short description: Gazebo & ROS1-noetic installation on an WSL Ubuntu-20.04.6 LTS instance
  - Status: Finished

- Back-axle, front-axle differential setup and cogwheels adjustment
  - Assignees: Entire team
  - Short description: Cleaning the entire mechanism, making sure that bevel gears are aligned and greased + checking for blockings in the rotational movement
  - Status: Finished

- Wheel Alignment & Suspension adjustment:
  - Assignees: Luca, Adela & Cristian
  - Short description: Getting to understand the key elements of how the wheel alignment(e.g: king pin, camber angle, toe angle, etc), how it can influence the performance of the car and how can we adjust both wheel and suspension in order to optimize the stability and performance
  - Status: Room for improvement

- Raspberry PI & Dashboard setup
  - Assignees:Rafa , Luca & Cristian
  - Short description: Installing the Raspbian OS, debugging the problems caused by improper mounting of the SD card, installing & debugging the dependencies that are used by the Dashboard app, getting the car started and being able to control it through the interface
  - Status: Finished

- Nucleo-STM32 setup
  - Assignees: Luca
  - Short description: Understanding the pinout of the board, how to compile and flash the already provided code on the board + making sure that the board can communicate via UART
  - Status: Finished

- Research on hardware equipment
  - Assignees: Mario, Adela, Rafa
  - Short description: After analyzing various sensors, we selected the best tools for our autonomous vehicle, focusing on depth cameras, lidar, and other sensors. We ultimately chose lidar, along with light and ultrasonic sensors, to create a comprehensive sensing system.We considered factors such as response time, depth accuracy and range. Lidar has limitations in close-range scenarios, so we combined it with ultrasonic sensors, which are effective for close-range detection, improving navigation and parking capabilities. The light sensors will automatically detect reduced light levels, such as when entering the tunnel, and activate the headlights to ensure visibility.
  - Status : Always in progress

- Software Architecture Research + Design
  - Assignees: Rafa
  - Short description : We updated the diagram to align with our team's vision, incorporating the chosen software solution to meet our requirements. The revisions included adding essential inputs, algorithms, actions, outputs, and dependencies for a comprehensive representation.
  - Status: Finished

- Project planning
  - Assignees: Entire team
  - Status: Finished

3. Detailed Description of tasks

Simulation Environment setup & installation

We set up the Gazebo simulation environment with ROS on Ubuntu 20.04.6 LTS after resolving compatibility issues with Ubuntu 24.04. Following package installation, repository cloning, and environment configuration, we successfully launched the simulation.

Back-axle & front-axle differential setup and cogwheels adjustment

We had started this task by disassembling the entire car, literally! Starting from top of the car to the chassis, just to get to this mechanism, break it apart, cleaning the bevel gears, grease them with maybe too much vaseline, and put it right back, exactly how it was. Then we moved to the cogwheels part, where we adjusted the position of the brushless motor, in order to make sure that the gears are permanently jointed.

Wheel Alignment & Suspension adjustment:

When testing the car, we noticed it veered left on straight-line tests. To address this, we adjusted the suspensions, upper and lower screws, and steering arms to align the front wheels perpendicular to the ground. Using a 90-degree ruler, we verified and refined these adjustments. Additionally, we raised the front and lowered the back for better grip and stability, while setting a neutral camber on all wheels to maximize rubber contact with the ground. This required fine-tuning the wheel-to-differential distance by adjusting the arm that connects the wheel to the top of the differential.

Raspberry PI & Dashboard setup

We started by installing the Raspbian OS on the provided SD card, and after a few reboots, kernel panic error occurred and after reviewing the system logs and journal, we noticed some mounting errors that occurred on boot, and the solution was to change the SD card with a new one. After buying a new one and installing the OS on it, the issue was gone and we were able to move forward with the Dashboard setup. We encountered several issues with the provided modules that were in the requirement.txt file, but after renaming them correctly, we were able to install them in the virtual environment and start the dashboard web interface. We also figured out that we had to set the **Camera** and **SerialHandler** variables to **True** in order to be able to see the camera feed in the dashboard and fully control the car.

3 General status of the project

We are happy to inform you that we accomplished all of the things that we proposed to do and had time to further research our ideas and what do we want to further implement so that the car will be able to complete the tasks. From making the car able to be manually controlled from the dashboard, rewiring all the electronics, to making all the necessary hardware adjustments, we optimized its performance, but there is clearly room for improvement.

4 Upcoming activities

Hardware :

- Steering Calibration
- Speed Calibration
- Camera positioning => finding the best position and tilt of the camera so that we will capture as many details as possible
- Researching the best LiDAR, ultrasonic and light sensors to fit our needs

Software:

- Linking the camera feed input to the motors
- Since we chose to research 2 detection algorithms in parallel :
  - Free Space Detection : Research, Development and Testing
  - ROI segmentation: Research, Development and Testing