1. Introduction

As a team of first-year students, we are simultaneously adapting to the university learning environment while engaging in our first large-scale engineering project. Through this process, we have been introduced to real-world challenges such as system calibration, parameter tuning, and cross-team coordination. Rather than viewing these as obstacles, we approached them as learning opportunities that helped us develop both technical understanding and project management skills. This early stage of the project has allowed us to establish a structured workflow and a growth-oriented mindset that will guide our progress in the later phases of the competition.

2. Planned activities

Task/Week	Week 1	Week 2	Week 3	Week 4
Study competition rules and regulations				
Review documentation and Github repositories				
Development environment and simulation setup				
Hardware inspection and improvement				
Vehicle calibration and basic tuning				
Initial perception research				

3. Status of planned activities

3.1. Documentation Analysis: Status: 100%.

The team has completed a full review of the competition regulations, technical documentation, and evaluation criteria. To guarantee shared understanding, all members independently reviewed the documentation and compiled notes, which were then discussed collectively. This approach helped clarify ambiguous sections and ensured that all team members were aligned before task assignments were finalized.

3.2. Code base Analysis: Status: 100%.

To understand the provided software framework, the team divided responsibility for reviewing different repositories within the BFMC GitHub ecosystem. Each member summarized key functionalities and module interactions in shared documentation using simplified explanations for team-wide reference. Due to the size and complexity of the codebase, the team supplemented self-study by consulting mentors, previous BFMC participants, and external resources. In addition, running and testing individual modules allowed us to better understand data flow and the role of each subsystem within the overall architecture.

3.3. Tuning the car: Status: 100%.

The hardware inspection and tuning process was completed following the BFMC recommendations. This phase required additional time beyond the estimated duration due to minor mechanical issues and the need for careful adjustments. Despite logistical challenges related to coordinating in-person work sessions, the team established fixed working days to ensure effective collaboration. As a result, the vehicle is now mechanically prepared and suitable for calibration and controlled testing.

3.4. Developing algorithm for lane detection: Status 100%.

Multiple approaches to lane detection were evaluated, including machine learning–based methods. Considering computational constraints and system reliability, the team selected a classical computer vision approach inspired by the methodology described in "*How to Win Bosch Future Mobility Challenge*" by the BFMC 2024 first-place team. To build foundational knowledge in image processing, the team studied additional reference implementations and repositories including Thomas Fermi's. The algorithm was successfully implemented and tested using offline road images. On-vehicle testing and performance validation will be conducted in the next development phase.

3.5. Calibration: 85%

The team successfully accessed the control dashboard and verified basic vehicle behaviors, including straight-line motion, turning, and speed adjustment. These results confirm that the vehicle responds correctly to steering and velocity commands, providing a stable foundation for autonomous control. However, intermittent instability in the USB communication interface has occasionally limited command reliability. The team is currently investigating this issue with mentor support and exploring alternative solutions to improve system robustness before proceeding to full integration.

4. General status of the project

At the current stage, the team has successfully established basic manual control of the vehicle through the dashboard interface, including straight-line motion and directional steering. This confirms that the core hardware, communication, and low-level control interfaces are operational and suitable for further development.

After completing the initial calibration process, a residual steering offset of approximately 5 degrees was observed at the front wheel assembly. Under open-loop control, this offset causes the vehicle to deviate slightly from the intended straight trajectory. This behavior is attributed to a combination of mechanical alignment tolerance and the absence of closed-loop steering correction at this stage. It is expected that closed-loop feedback will significantly improve trajectory accuracy and robustness, even in the presence of minor mechanical imperfections.

5. Upcoming activities

1. As for the aforementioned problem, the team will refine steering and speed calibration using systematic testing and closed-loop control.

2. The team will focus more on the perception part, including lane and object detection, and the car's brain's control part, enabling it to handle multiple tasks properly and effectively.

3. If possible, we will create a custom dashboard to serve the further development process and allow for easier usage.

References:

Papafotiou, T., Tsardoulias, E., Nikolaou, A., Papagiannitsi, A., Christodoulou, D., Gkountras, I., & Symeonidis, A. L. (2025). How to Win Bosch Future Mobility Challenge: Design and Implementation of the VROOM Autonomous Scaled Vehicle. *Machines*, *13*(6), 514. https://doi.org/10.3390/machines13060514

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