Group 3 - Project Proposal

Goals

- Develop a fully functional lane-following robot that is capable of driving autonomously.
- On Jetson Nano, use OpenCV to process camera data in real-time and make decisions about how to navigate the robot.
- Achieve high accuracy in lane detection and tracking.
- Ensure the robot can adapt to different lighting conditions.
- Design the robot to be compact, lightweight, and energy-efficient.

Objectives

- Implement image processing algorithms using OpenCV to detect and track lanes.
- Develop a control system that uses the lane detection data to steer the robot.(optional)
- Use ML techniques to train the robot to recognize different road conditions and make appropriate decisions.(optional)
- Test and optimize the robot's performance under different lighting conditions.

Requirements

- A Jetson Nano board with sufficient processing power to run the image processing and control algorithms.
- A camera module capable of capturing high-quality video in real-time.
- A chassis and drive system that can support the weight of the Jetson Nano board and camera module.
- Motors and controllers capable of providing precise control over the robot's movement.
- Power source with sufficient capacity to support the robot's operation for an extended period.
- The OpenCV library and other necessary software tools and libraries for image processing and control.
- Adequate training data and machine learning models to enable the robot to recognize different road conditions.(optional)
- A user interface (RViz) to monitor and control the robot's operation, including a display and input devices such as a keyboard or joystick.

Task Statements

Hardware setup

- Select and purchase necessary hardware components
- Assemble the robot chassis and drive system
- Connect and power the Jetson Nano board and camera module
- Test hardware components for functionality

Software setup

- Install the required software tools and libraries, including OpenCV and machine learning frameworks if necessary
- Configure the development environment for the Jetson Nano board
- Camera calibration and lane detection

- Calibrate the camera module to correct for distortions and misalignments
- Develop an algorithm to detect and track the lanes in real-time
- Test the lane detection algorithm under various lighting and road conditions

Steering control

- Develop a control algorithm to adjust the robot's steering based on the lane detection data
- Tune the control parameters to optimize the robot's performance
- Test the control algorithm under various scenarios, including curves, intersections, and lane changes

Machine learning integration(Optional)

- Collect and label training data to teach the robot to recognize different road conditions and make appropriate decisions
- Train a machine learning model to recognize various road scenarios and provide feedback to the steering control algorithm
- Test the integrated system and fine-tune the model and control algorithms based on the results

Testing and optimization(Optional)

- Conduct extensive testing of the system under various conditions, including lighting, weather, and road conditions
- Collect feedback from users and incorporate improvements to the system based on their feedback
- Optimize the system's performance to achieve high accuracy and reliability

Documentation and presentation

- Document the project, including hardware and software specifications, algorithms used, and key findings
- Prepare a presentation and demonstrate the project

Technical Approach

- Hardware and software setup
- Lane detection and steering control
- ML integration(Optional)
- Testing and optimization

Organization and Staffing (RACI) (Link)

Schedule (Gantt chart) (Link)

Budget (Link)

Risk Analysis

1. Cost Risk: There is a possibility of unexpected expenses and high costs for hardware components, such as Jetson Nano board, camera module, and motors. Cost risk can be mitigated by thorough research and identifying cost-effective hardware components that

meet the project requirements, checking for refurbished or used hardware components, as they can be a cost-effective alternative to brand new components.

2. Performance Risk: There is a risk of inaccuracies in lane detection and tracking, which can compromise the safety of the robot. To mitigate this risk extensive testing under various conditions and fine-tuning the algorithms and control parameters is necessary.

3. Schedule Risk: Delays in hardware procurement, software setup, or algorithm development can impact the overall schedule. To mitigate this risk, sufficient time should be allocated for each phase of the project. Regular progress reviews should be conducted, and open communication should be maintained with team members to ensure timely completion.