HOCHSCHULE
HAMM-LIPPSTADT

**SYSTEMS ENGINEERING AND PROTOTYPING COURSE**

**Prototyping Technical Report: The Design and Construction of Autonomous Vehicle**

# Findings and Analysis:

The following section presents the key findings obtained during the project, along with a detailed analysis. These results are based on the data collected, observations made, and methods applied throughout the project.

## Sensor Behavior and Accuracy

- Ultrasonic Sensors: Successfully detected obstacles within a range of 18cm with an average error margin of ±1cm.
- Infrared Sensors: Accurately detected line paths, but performance was affected by lighting and surface texture.
- Colour Sensor: Could reliably distinguish between Red and Green surfaces under good lighting conditions.

## PID Controller Tuning

- Initial PID values: Kp = 100, Ki = 100, Kd = 100
- Observed that:
  - High Kp caused the robot to oscillate.
  - Ki helped reduce long term drift but too much made it unstable.
  - Kd improved sharp turns and reduced overshoot.
- Final tuned values: Kp = 10, Ki = 5, Kd = 10 – provided smooth line following with minimal overshooting.

## State Machine Performance

- The state transitions worked correctly between:
  - Line following
  - Obstacle avoidance

A pre-requisite report for completion of Prototyping and Systems Engineering Course:

To: Professor Stephen Henkler

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    - Turning logic
- Edge cases (e.g., obstacles, tight corners) were handled with a delay of 200ms on average.

## System Limitations

- Sensor noise occasionally caused false obstacle detection.
- Bright ambient light interfered with IR accuracy.
- Tuning PID required trial and error and was environment dependent.

## Performance Metrics

- Average lap time on test track: 29 seconds
- Success rate for completing track without collision: 90%

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