Middle East Technical University

Department of
Electrical and Electronics Engineering

EE493 ENGINEERING DESIGN I

Car Chasing Robot
Conceptual Design Report

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METU EE / C-112

Project Start: 4/10/2018
Project End: 26/5/2019
Project Budget: $450

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December 26, 2018

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1 VER1

1.1 Systems & Subsystems Requirements

1.1.1 Sensing System Requirements

- The system should detect the sides of the road.
- The system should not be effected from external disturbances.
- The system should detect the opponent vehicle.

1.1.1.1 Lane Detection Subsystem Requirements

- The subsystem should be able to detect only the shades of green color
- The subsystem should be able to detect edges in the camera frame in any light condition
- The subsystem should be able to tell differences between disturbances and lane
- The subsystem should be able to interpret the middle of the lane if both sides are present at the frame

1.1.1.2 Vehicle Detection Subsystem Requirements

- The subsystem should detect the opponent to be caught with in a 5 cm
- The subsystem should detect the chasing opponent if it reaches from back with in a 5 cm

1.1.2 Computation System Requirements

- The system should be able to produce middle line to follow
- The system should be able to control the robot

1.1.2.1 Data Processing Subsystem Requirements

- The subsystem should be able to analyse data produced by sensing system
- The subsystem should be able to produce the angle information required by the controller subsystem
- The subsystem should be able to work on Raspberry Pi
- The subsystem should be able to process one frame at most in 100 milliseconds

1.1.2.2 PID Controller Subsystem Requirements

- The subsystem should be able to control the motors
- The subsystem should be able to react the external disturbances

1.1.3 Communication System Requirements

- The subsystem should ensure safe internal communication
- The subsystem should ensure safe external communication

1.1.3.1 Internal Communication Subsystem Requirements

- The microcontrollers should be able to communicate with each other via serial communication
- The internal communication speed should be compatible with the processing speed of the lane detection subsystem

1.1.3.2 External Communication Subsystem Requirements

- The subsystem should be able to communicate with the opponent via Wi-fi protocol
- The subsystem should be able to execute handshake protocol

1.1.4 Driving System Requirements

- The subsystem should control motion subsystem according to output of the computation system

1.1.4.1 Speed Subsystem Requirements

- The subsystem should decrease the vehicle speed at the narrow lane
- The subsystem should increase the vehicle speed at the wide lane
- The subsystem should decrease the vehicle speed at the extreme disturbance

1.1.4.2 Direction Subsystem Requirements

- The subsystem should drive the motors according to computation system outputs
- The system should ensure that the vehicle follows the lane

1.1.5 Motion System Requirements

- The system should ensure that the vehicle can drive itself with enough power

1.1.5.1 Wheels Subsystem Requirements

- The subsystem should ensure that the wheels can grip lane without slipping in all conditions

1.1.5.2 Motors Subsystem Requirements

- The subsystem should ensure that the motors can supply enough torque to accelerate the vehicle
- The subsystem should ensure that the motors can execute driving system outputs without deviation

1.1.6 Structure System Requirements

- The system should ensure that structure is robust for external effects
- The system should ensure that structure is balanced to increase handling

1.1.6.1 Chasis Subsystem Requirements

- The subsystem should ensure that the chassis is rigid
- The subsystem should ensure that the chassis have enough space for components
- The subsystem should ensure that the chassis can provide low center of mass

1.1.6.2 PCB Subsystem Requirements

- The subsystem should ensure that all the electronic devices are placed on PCB
- The subsystem should ensure that the components are not connected via loose cable

2 VER2

2.1 System Level Requirements

2.1.1 Sensing System Requirements

- The system should detect the sides of the road.
- The system should not be effected from external disturbances.
- The system should detect the opponent vehicle.

2.1.2 Computation System Requirements

- The system should be able to produce middle line to follow
- The system should be able to control the robot

2.1.3 Communication System Requirements

- The subsystem should ensure safe internal communication
- The subsystem should ensure safe external communication

2.1.4 Driving System Requirements

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2.1.5 Motion System Requirements

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2.1.6 Structure System Requirements

- The system should ensure that structure is robust for external effects
- The system should ensure that structure is balanced to increase handling

2.2 Subsystem Level Requirements

2.2.1 Lane Detection Subsystem Requirements

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- The subsystem should detect the opponent to be caught with in a 5 cm
- The subsystem should detect the chasing opponent if it reaches from back with in a 5 cm

2.2.3 Data Processing Subsystem Requirements

- The subsystem should be able to analyse data produced by sensing system
- The subsystem should be able to produce the angle information required by the controller subsystem
- The subsystem should be able to work on Raspberry Pi
- The subsystem should be able to process one frame at most in 100 milliseconds

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- The subsystem should be able to control the motors
- The subsystem should be able to react the external disturbances

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- The microcontrollers should be able to communicate with each other via serial communication
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- The subsystem should be able to execute handshake protocol

2.2.7 Speed Subsystem Requirements

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- The subsystem should increase the vehicle speed at the wide lane
- The subsystem should decrease the vehicle speed at the extreme disturbance

2.2.8 Direction Subsystem Requirements

- The subsystem should drive the motors according to computation system outputs
- The system should ensure that the vehicle follows the lane

2.2.9 Wheels Subsystem Requirements

- The subsystem should ensure that the wheels can grip lane without slipping in all conditions

2.2.10 Motors Subsystem Requirements

- The subsystem should ensure that the motors can supply enough torque to accelerate the vehicle
- The subsystem should ensure that the motors can execute driving system outputs without deviation

2.2.11 Chasis Subsystem Requirements

- The subsystem should ensure that the chassis is rigid
- The subsystem should ensure that the chassis have enough space for components
- The subsystem should ensure that the chassis can provide low center of mass

2.2.12 PCB Subsystem Requirements

- The subsystem should ensure that all the electronic devices are placed on PCB
- The subsystem should ensure that the components are not connected via loose cable

3 TESTVER1

3.1 Systems & Subsystems Tests

3.1.1 Sensing System Tests

3.1.1.1 Lane Detection Subsystem Tests

3.1.1.2 Light Condition Test

3.1.1.3 Visual Disturbance Test

3.1.1.4

3.1.1.5 Vehicle Detection Subsystem Tests

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3.1.2 Computation System Tests

3.1.2.1 Data Processing Subsystem Tests

3.1.2.2 PID Controller Subsystem Tests

3.1.3 Driving System Tests

3.1.3.1 Speed Subsystem Tests

3.1.3.2 Direction Subsystem Tests

3.1.4 Motion System Tests

3.1.4.1 Wheels Subsystem Tests

3.1.4.2 Motors Subsystem Tests

3.1.5 Structure System Tests

3.1.5.1 Chasis Subsystem Tests

3.1.5.2 PCB Subsystem Tests

4 TESTVER2

4.1 Systems Level Tests

4.1.1 Sensing System Tests

4.1.2 Computation System Tests

4.1.3 Driving System Tests

4.1.4 Motion System Tests

4.1.5 Structure System Tests

4.2 Subsystems Level Tests

4.2.1 Lane Detection Subsystem Tests

4.2.1.1 Light Condition Test

4.2.1.2 Visual Disturbance Test

4.2.1.3

4.2.2 Vehicle Detection Subsystem Tests

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4.2.3 Data Processing Subsystem Tests

4.2.4 PID Controller Subsystem Tests

4.2.5 Speed Subsystem Tests

4.2.6 Direction Subsystem Tests

4.2.7 Wheels Subsystem Tests

4.2.8 Motors Subsystem Tests

4.2.9 Chasis Subsystem Tests

4.2.10 PCB Subsystem Tests