Autonomous Driving Car for Cadman Plaza Park

A PROJECT REPORT

Submitted by

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in partial fulfilment for the course

of

ADVANCED MECHATRONICS (ME – GY 6933)

for

MECHATRONICS AND ROBOTICS ENGINEERING

of

TANDON SCHOOL OF ENGINEERING

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ABSTRACT

The aim of the project is to develop an autonomous driving system capable of traversing through the pathway of Cadman Plaza Park. In this term project, we are using Arduino Uno and Raspberry Pi 3. RaspiCam is used for extracting the data from video feedback and OpenCV using Python 2.7 was used for the analyses of the extracted video. The scope of the of the project is to develop a system of capable of differentiating between the black road and grass in the Cadman Plaza Park and communicate the instructions to Arduino for controlling the driving systems.

ACKNOWLEDGEMENT

On our path to completing the project we have received a lot of help and we would like to thank them for helping us despite their busy schedule. First and foremost, we would like to thank Professor Vikram Kapila. He was very instrumental in helping us select a suitable project.

We would also like to thank MakerSpace for allowing us to use the 3D Printers and instruments for manufacturing and testing purpose and for the graduate assistants for staying late with us after working hours. We also like to thank the people in Cadman Plaza Park for being co-operative and patient during our trial runs in their pathway.

INTRODUCTION

An autonomous car is a vehicle that is capable of sensing its environment and navigating without human input. Many such vehicles are being developed, but as of May 2017 automated cars permitted on public roads are not yet fully autonomous. They all require a human driver at the wheel who is ready at a moment's notice to take control of the vehicle. Autonomous cars use a variety of techniques to detect their surroundings, such as radar, laser light, GPS, odometry, and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant road signs.

Initially the team started with autonomous braking system as Arduino mini project and then extended to autonomous driving. The primary reason is to work on autonomous driving system to gain an overall understanding of computer vision using OpenCV, test various concepts learnt in the class in a true dynamic environment.

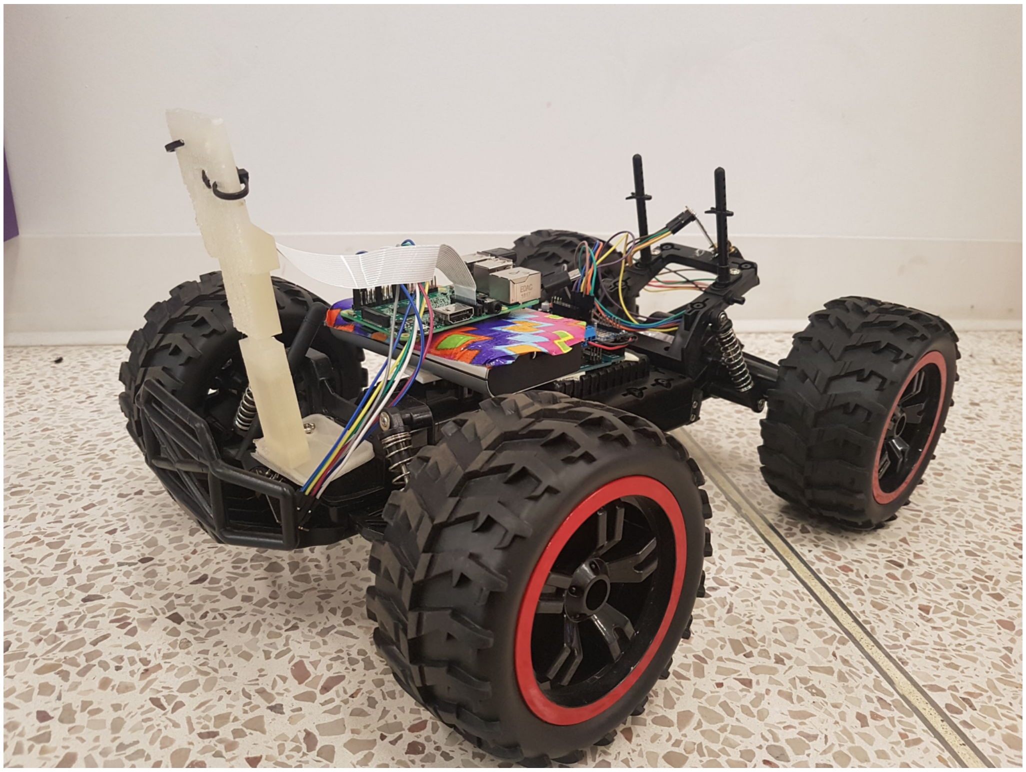
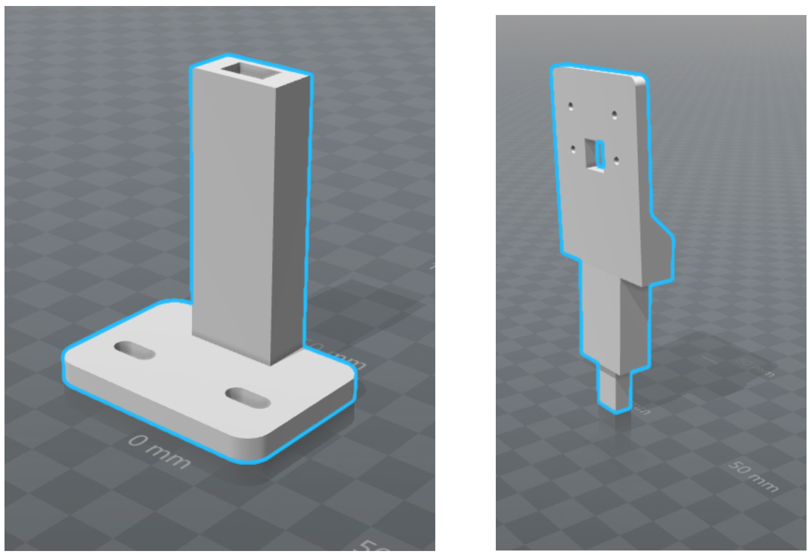


Fig 1: Assembled Autonomous System

MECHANICAL

A commercial RC car, circuity is removed and the wires from the motor are connected to Arduino through Adafruit shield. In the existing mechanical structure, Ping Sensors were attached to attached for autonomous braking. A camera mount was designed to attached the front end of the car to attach the RaspiCam. To get the required field of vision for the effective image processing the end Camera angle from the car must be 20° at a height of 20 cm. So, the camera mount was designed and printed in a 3D printer



(a) Isometric View of Lower part (b) Isometric View of Upper Part

Fig 2: Camera Mount Design

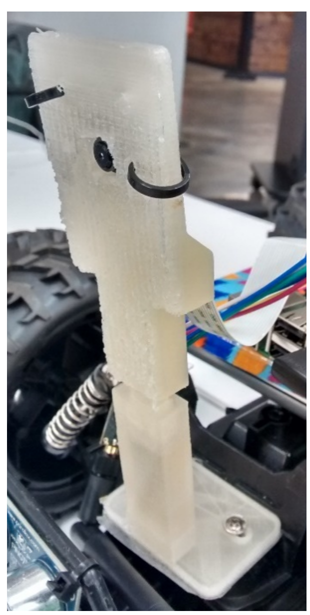


Fig 3: 3D Printed Camera Mount

ELECTRICAL

POWER SOURCE:

1. Inbuilt power source of Car is used to power the steering, drive train motor, Arduino Uno with the shield.
2. External power Bank is used to power the Raspberry pi 3

ELECTRONICS

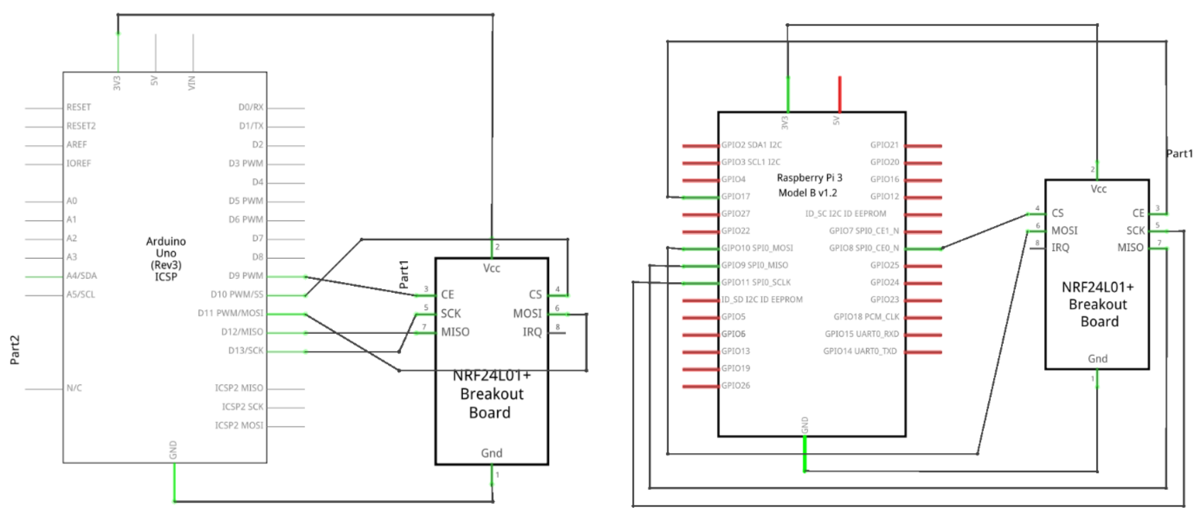
1. nRF24L01 Module is used at Arduino as well as Raspi for communication between them
2. Ping sensors used for autonomous braking and also in parallel parking
3. RaspiCam is used to capture the video feedback from the system

COMMUNICATION

SPI communication is used for data transfer between the devices. 8 Bit data were transferred from Raspi to Arduino. The message is interpreted the following way in the Arduino side

1. Bits 1-3: driving motor speed
2. Bits 4-6: steering motor speed
3. Bit 7 : Driving motor direction
4. Bit 8 : Steering motor direction

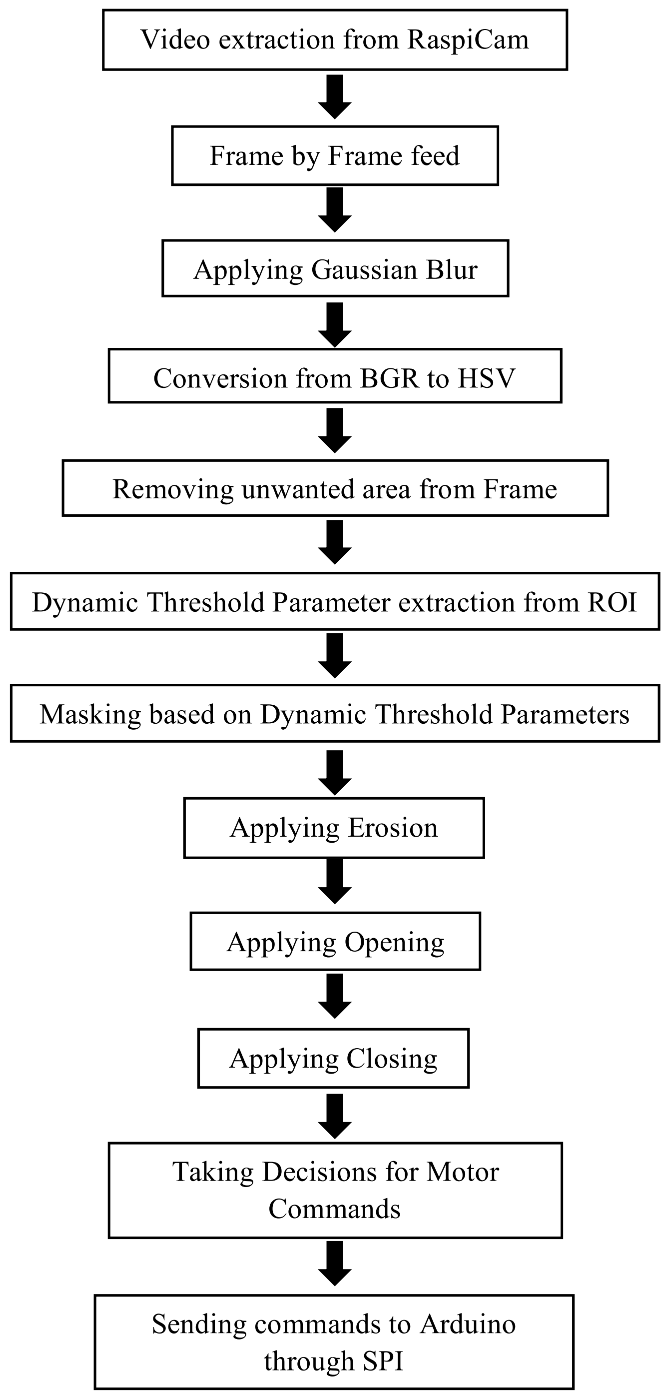
The messages are generated from the Raspi based on the analysis from the video feed. These messages are sent to Arduino as a string for further manipulation to send commands for motor actuation. Since Image processing takes a lot of computing, the motor control happens in Arduino Uno and image processing in Raspberry Pi. This improves the overall efficiency of the entire process.



(a) Arduino and NRF module (b) Raspberry pi and NRF module

Fig 4: Circuit Diagram of nRF module

FLOWCHART: Process Flow for OpenCV Program

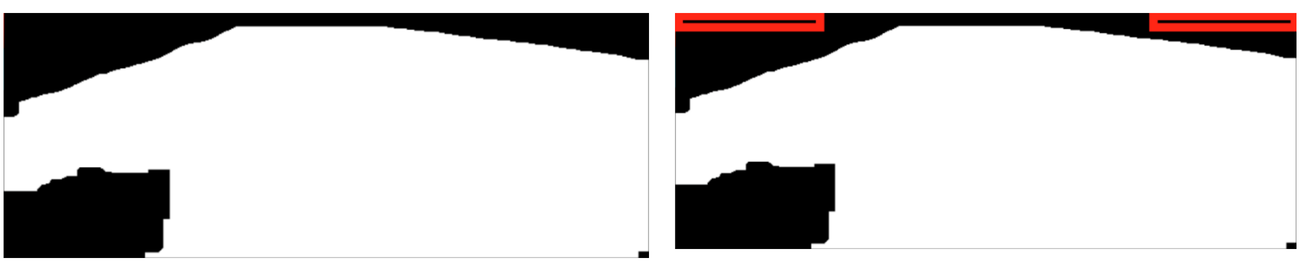


(a) Image before Gaussian Blur

(b) Image after Gaussian Blur

(c) Image after BGR to HSV conversation

(d) Image during Dynamic Threshold & Masking



(e) New region of Interest and deciding on Turning directions

Fig 5: Output Frame from OpenCV

CONCLUSION

As proposed, we could make to system drive autonomously in the Cadman Plaza park. As a future development, we would be redesigning the Camera Mount to get a precise a Field of Vision. Implementing, Wheel Velocities signal scaling based on the voltage feedback from power source. Currently we are planning to look for the processors which would suit our need i.e. high computing performance processor and optimize the code. Now that we are confident to work in real world environment with true noise, we would be trying out similar applications with drones.

Fig 6: A picture of car driving autonomously in Park