Idea Lab Project ID-Autonomous Car Model

Submitted By

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IC and Mechanical Engineering Department

INSTITUTE OF TECHNOLOGY

NIRMA UNIVERSITY

AHMEDABAD-382481

APRIL - 2018

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Under the mentorship of

Prof. Vishal Vaidya, Dr. Mihir Chauhan

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Declaration

We do hereby declare that the technical project report submitted is original, and is the outcome of the independent investigations/research carried out by us and contains no plagiarism. The research is leading to the discovery of new facts/techniques/correlation of scientific facts already known. This work has not been submitted to or supported by any other University or funding agency.

We do hereby further declare that the text, diagrams or any other material taken from other sources (including but not limited to books, journals and web) have been acknowledged, referred and cited to the best of our knowledge and understanding.

Date:

Place:

Mayank Vanani	Maulik Patel	Prof. Vishal Vaidya	Dr. Mihir Chauhan
(15BIC021)	(15BME070)	(IC dept.)	(Mechanical Dept.)

NIRMA UNIVERSITY

INSTITUTE OF TECHNOLOGY

IDEA LAB

IC and Mechanical Department

Annual/Final Report of the work done on the Idea Lab Project.

(Report to be submitted within 3 weeks after completion of the project)

1. Idea Lab Project ID: IDEA-2017-IC-03

2. Project Title: Autonomous Car Model

3. Period of Project: 27 March 2017 – 27 March 2018

4. (a) Name of Student (Roll No.): Mayank Vanani (15BIC021)

   Department: Instrumentation and Control

   (b) Name of Student (Roll No.): Maulik Patel (15BME070)

   Department: Mechanical

   (c) Name of Mentor: Prof. Vishal Vaidya

   Dr. Mihir Chauhan

5. Project Start Date: Project Start Date

6. (a) Total Amount Approved: Rs. 46,000/

7. (b) Total Expenditure: Rs. 43,794/-

8. (c) Report of the work done:

   I. Brief objective of the project: Real-time navigation and object identification and navigation.

ii. Work done:

- Adaptive Cruise control using IR
- Adaptive Cruise control using Camera
- Steering Control Algorithms using feature extraction on Nirma Campus Road
- Object Identification and Obstacle avoidance

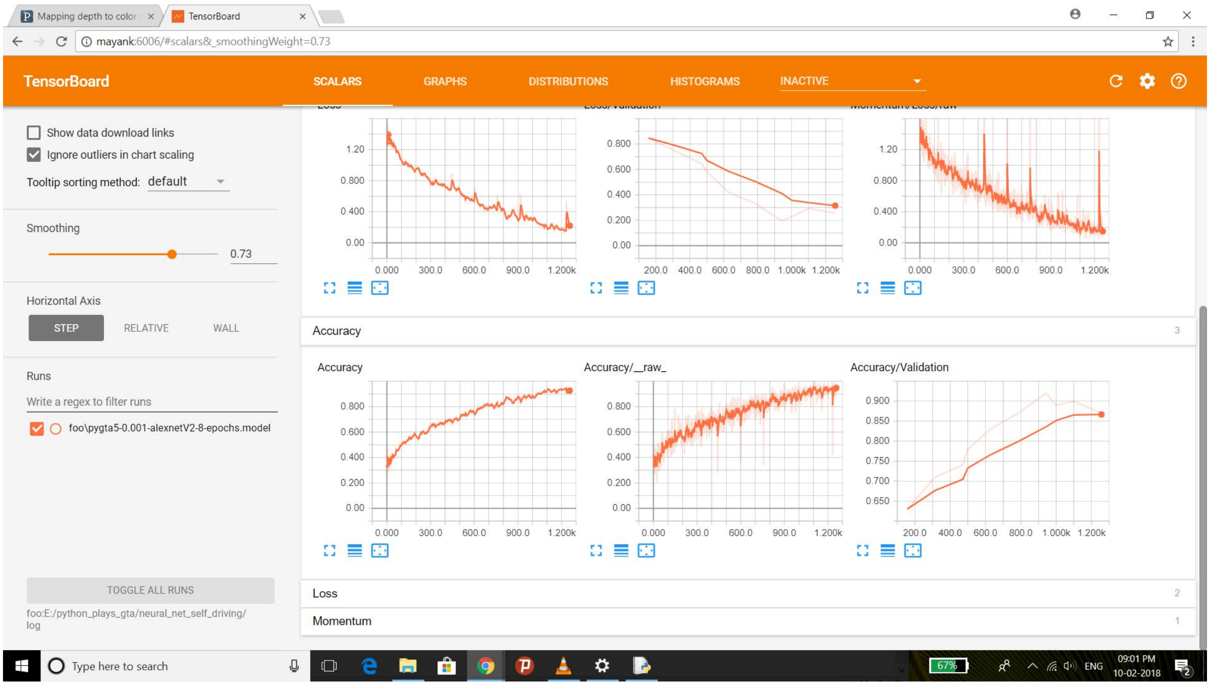

FIG: convolutional neural net achieving 93.9 % accuracy

iii. Results achieved from the work:

- Adaptive Cruise control using IR sensors.
- Adaptive Cruise control using Camera (2D).
- Feature identification for Nirma Campus Road and writing steering algorithm based on the the parameters
- Object Identification using Deep Neural Network
- Object avoidance using relative distance estimation

iv. Has all the objectives been achieved as per plan. If not, state reasons.

Reasons

- Stable and reliable steering could not be achieved as PID algorithm is difficult to implement on python as it was a heavy function which rendered frames to drop.
- Also feature identified were not constant due to different lighting condition and shadows present due to trees were steering algorithm would malfunciton.

v. Please indicate the technical difficulties, if any, experienced in implementing the project

- Sensor data fusion. It was difficult to fuse the IR sensor data and camera feed for drawing out foolproof steering algorithm.
- Camera based steering algorithm was suited to particular lighting condition of road, which was not constant throughout. The algorithm would fail with shadows on path or different lighting condition.

vi. <u>If the project has been completed, please enclose a summary of the findings of the study</u>

- Arduino can be interfaced with any language viz. python, C++, etc. using standard firmata library
- Using 2D camera to find relative distance with respect to camera.
- Deploying deep neural net using Tensorflow to classify objects and used to classified parameters to do adaptive cruise control.

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(15BME070)

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Department Name,
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Nirma University, Ahmedabad.

Signature of Director
Dr. Alka Mahajan
Director,
Institute of Technology,
Nirma University, Ahmedabad

Contents

1.1 Introduction

This project aims at building an autonomous navigable car model used for obstacle detection and safely navigating it maintaining speed accordingly. This project has made the use of IR sensor and camera for adaptive cruise control. That is navigating it using pwm method actuated by Arduino commanded by python. Also the steering in the toy-car modelled used in this project is Akerman steering governed by a high torque DC motor. So actuating signals to DC motor had been issued based on the camera feed input. The 2D camera feed is used to detected the embossed edges that can been seen on the Nirma Campus Path. Based on the cartesian calculation steering decision has been made. The end product is that car is able to navigate avoiding obstacles with steering performance which needs to be improved using modern techniques and more sensor data fusion in order to map the environment exactly as it is.

1.2 Literature Survey

Autonomy is a buzzword going on in today's tech world. Moreover, bringing autonomy to automobiles field is trending thing as car system is a real time system whose parameters keeps constantly changing. Hence drawing out exact model for a car system is nearly impossible in order to control it using procedural parameter modelling. First challenge in achieving autonomy comes in lane identification. On road condition are well defined with lane marking but for off road situation, adaptive vision method is used wherein camera feed and depth data is fused to identify traversable surface. Another things that needs to be done is to classify the object seen by the camera and try to avoid them while staying in the path. Convolutional Neural Network(CNN) provide the best and accurate solution. For car to change its trajectory, stable and reliable steering advice is proposed. For on road, parameters extraction is easy, while for off road condition, pixel manipulation proposes efficient way to steer. Greater the number of sensors used, accurate the environment will be mapped, and more reliable the sensor data would be. On commercial level, Lidar along with other sensors is widely used to perform SLAM(Simultaneous Localization And Mapping).

1.3 Major Objectives Proposed

- Adaptive Cruise Control: It's a method by which linear speed of the car model is varied according to the distance from the obstacle.

- Steering Advice: Steering the vehicle based on the camera feed while avoiding the obstacles in the path.

- Object Classification and Relative Distance Estimating: Using deep learning approach to classify the object in common context. Also with the help of frame size, calculating the relative distance from the camera based on pre-mapped curve-fitting method.

- Failsafe and smooth operation pf DC motors: Due to constant update of actuating signals issued to DC motors, the system becomes oscillatory which may deteriorate the motor health and eventually causes burnout. So, code optimization can be used in order to reduce the high frequency current and voltage fluctuation.

1.4 Objectives Achieved

- Adaptive Cruise Control was the first phase to be achieved that demonstrates speed control by varying the PWM issued to rear DC motors. Various speed zones were preset and accordingly the speed would vary based on the obstacle scenario. Also, while starting the motor, sudden jump in PWM is also harmful, hence code was optimized to start the motor slowly and increasing the speed gradually if no obstacle is in the vicinity. Else it will vary the speed as per situation.
- Steering control was achieved through image processing using pixel manipulation technique. Left and Right line markers were used to get the pixel intensities and monitor and decide the pixel intensities based on which cartesian mean distance was calculated and steering output was given.
- Object Classification was achieved with the help of deep learning classifier – Convolutional neural network. Also getting the frame size and mapping it

with known equation to calculate relative distance. The model took 8 hours for training and fetched 93.83% accuracy in detecting objects.

- Obstacle Avoidance was done by defining the a set ROI in the image and monitoring the coordinates of detected object and raising speed control functions when the coordinates lie inside the ROI.

1.5 Objectives Not Achieved

- Sensor fusion (depth point cloud and image feed) for determining the plain surface to traverse i.e. adaptive vision algorithm was not been able to be achieved.

- Stable and foolproof steering was not achieved as per the mark as feature descriptor used for marking the embossed edges of the campus path could not be detected.

1.6 Technical Difficulties Faced

- IR sensor and camera feed both had their cruise control algorithms but auctioning between the two sensors to give the output based on the situation.
- Steering algorithms was based on the distinct features identified of the campus path but were not constant all the time sue to different lighting condition and shadows.
-

1.7 Experimental Setup and Results

State your Experimental Setup and Results here.

1.8 Budget Analysis

Purchase done for idea lab project "Autonomous Car Model "

Approved Budget: Rs. 46,000/-

Sr. No.	Item Description	Aprox. Price per unit (Rs.)	Quantity	Total in Rs.
1.	Car Model	8201/-	1	8201/-
2.	Xbox one Kinect Sensor bar	6044/-	1	6044/-
3.	Microsoft Xbox Kinect Adapter for Xbox One S and Windows 10 PC	5690/-	1	5690/-
4.	Arduino Mega 2560 R3 with Usb Cable	830/-	1	830/-
5.	Arduino Uno, SMD Version, with USB Cable (Including delivery charges)	455/-	1	455/-
6.	Sharp Distance Measuring Sensor unit 20 to 150 cm GP2Y0A02YK0F	749/-	2	1498/-
7.	Sharp Distance Measuring Sensor unit 100 to 550 cm – GP2Y0A710K0F	1929/-	1	1929/-
8.	APM Neo GPS with Compass	2,482/-	1	2,482/-

9.	APM 2.8 power Module	829/-	1	829/-
10.	ASUS Tinker Board	5,999/-	1	5,999/-
11.	Dual Motor driver Module 30A	2,425/-	2	4,850/-
12.	APM multicopter module	3,279/-	1	3,279/-
13.	15000 MaH lipo power bank with display	1,499/-	1	1,499/-
14.	Jumper wires for arduino	209/-	1	209/-
			Total:	43,794/-

Budget remains: Rs. 2,206/-

1.9 Conclusion and Future Work

Hence with the help of camera and with the use of deep learning approach, we were able to classify 90 COCO objects and were able to develop a steering algorithm for the occurring situation. Level of accuracy achieved was decent enough the model can be further improved in order to get best results. Also we took an aggressive software approach in order to rectify the erroneous sensor data and gradual issuing of actuation signal to motors maintaining its health and preventing the possible burnout.

Future Work:

- Working on improving the Neural Net classifier in order to track the images better and consistently.
- Deploying sensor fusion for adaption vision helping it to maneuver in unmarked roads along with avoiding obstacles in the path.
- Using inertial measurement systems as feedback for vehicular movements.
- Practicing outdoor SLAM for localizing itself.

Bibliography

Appendix A

Name of Appendix

Put your contents here (if any).