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Self-Driving Car using Convolutional Neural Network

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Abstract: The evolution of Artificial intelligence has served as the catalyst in the field of technology. One such creation is the birth of self-driving cars. Days have come where one can do their work or even sleep in the car and without even touching the steering wheel, accelerator you will still be able to reach your target destination safely. This paper proposes a working model of self-driving car which is capable of driving from one location to the other or to say on different types of tracks such as curved tracks, straight tracks and straight followed by curved tracks. Destination is given by setting them on a localised map and using this same map the shortest route is calculated. It will be implemented using a remote-controlled car with a Raspberry Pi and a Raspberry Pi camera module mounted on top. RPI controls the movements of the Vehicle by signalling each motor independently. The camera module captures live feed which is both needed to train the neural network using the data given by the Arduino and in the autonomous mode (when the destination is given) would provide the images to the trained model to predict the movements and direction of the vehicle is controlled by the RPI. The camera mounted on the top of the vehicle will be able to capture the signboards such as school ahead, hospital zone, speed limit signboards etc... and give warning to the driver.
Index Terms: NN, CNN, GSM, Tensorflow, Keras, RPI, Arduino.

I. INTRODUCTION

Globally speaking, nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day. And talking about India the number of people who were killed in road accidents in 2013 alone were 1, 37,000. Automation can help reduce the number of crashes on our roads. Government data identifies driver behaviour or error as a factor in 94 per cent of crashes, and self-driving vehicles can help reduce driver error. Higher levels of autonomy have the potential to reduce risky and dangerous driver behaviours. People with disabilities, like the blind, are capable of self-sufficiency, and highly automated vehicles can help them live the life they want. A working model of self-driving car which is capable of driving from one location to the other or to say on different types of tracks on its own is an ideal solution for all the problems. Automated vehicles maintain a safe and consistent distance between vehicles, helping to reduce the number of stop-and-go waves that produce road congestion. Self-driving car technology like connected cars offers a solution to clogged roads. Connected cars can communicate with each other can help optimize routes for each individual vehicle, creating a network of information that helps distribute traffic flow.

II. RELATED WORK

The work done by Chun-Che Wang, Shih-Shinh Huang, LiChen Fu and Pei-Yung Hsiao [3] aims to improve driving, by creating an assistance system. To enhance driver's safety at nighttime the algorithm includes lane detection along with vehicle recognition system. Lane detection helps to localize the markers so that the lane can be detected while vehicle recognition involves taillight extraction along with taillight paring algorithm. Another research work [4] done by Pro-ceedings of the 2nd International conference on Electronics, Communication and Aerospace Technology (ICECA 2018) IEEE Conference Record 42487; IEEE Xplore ISBN:978-1-5386-0965-1 978-1-5386-0965-1/18/ ©2018 IEEE 1630 Xi-aodong Miao, Shunming Li and Huan Shen models to locate the positions of road lane in real-time. Operation like canny edge extraction is done to extract edge map to which matching technique is applied followed by the selection of potentials edge points. Finally linking is done to localize the lane lines. In [5] Anik Saha, Dipanjan

Das Roy, Tauhidul Alam and Kaushik Deb aims to convert the image from RGB format to gray-scale format. Then flood-filling algorithm was applied to label the connected components. Then the largest connected component is extracted which is nothing but the lane. The model proposed by Gurjashan Singh Panna, Mohammad Dawud Ansari and Pritha Gupta [6] in developing a prototype of autonomous car involves implementation of lane detection algorithm along with obstacle detection. The GPS system steers the robot and is capable of reaching from one point to another without any human intervention. While in the former one with the help of GSM system they promise to report theft in case is there is any. An SMS alert is sent to the vehicle owner reporting about the issue

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and as a result of it, the owner of the car can switch the ignition off and in the latter one the project states that vehicle can only be turned on if the authorized person sends a predefined location to the car. In [9] Dhanasingaraja R, Kalaimagal S, Muralidharan G developed a system that takes the current position and gets the user destination. Then the system finds the shortest path to the destination and also extracts features like latitude, longitude from the graph.

So in a nutshell it helps in navigation as well as monitoring the car. In above mentioned models, the art of taking decision (left, right forward or stop) was merely based on Image Processing techniques while in some of them, it relies on GPS system to take the action. With all the work done before and after analyzing and studying thoroughly, the paper presents a new model which involves Machine Learning as well as Image Processing. Image Processing helps in preparing the input image. The image is resized, converted into grayscale. Once it is completed the image is fed into the Convolutional Neural Network. The output of Neural Network helps in taking the directional decision. Once it is done, the controller simple sends the corresponding signal and the car moves in that particular direction.

III. IMPLEMENTATION

A. Components

1) *Motor driver (L298A Motor driver for Arduino Shield):* The Motor Driver is a module for motors that are used to control the working speed and direction of two motors simultaneously. L298A is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L298A is a 16-pin IC which can simultaneously control a set of two DC motors in any direction that is a single driver(L298A IC) can control two DC motor with a single . It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage flow to be in either of the two directions. As the voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor. In a single L298A chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is frequently used in robotic application preferably for controlling DC motors. Given below is the pin diagram of a L298A motor controller. There are two Enable pins on L298A. Pin 1 and pin 9 are the deciding ones as they both need to be high for being able to drive the motor. For driving the motor with left H-bridge pin-1 should be enabled high. And for right H-Bridge pin-9 should be enabled high. If any of the two pins either pin-1 or pin-9 goes low then the motor in the corresponding section will suspend working just like a switch. There are 4 input pins for L298A, on the left pin 2,7 and on the right pin 15 ,10 as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins a either LOGIC 0 or LOGIC 1.
2) *Camera:* A webcam is a video camera that streams or feeds an image or video in real-time to or through a computer to a computer or a computer network, such as the Internet. Webcam software provides the facility to record a video or stream the video on the Internet. Streams usually use com-pressed formats as video streaming over the Internet requires a lot of bandwidth. The maximum resolution of a webcam is also lower than most commonly used video cameras, thus its perfect for the image recording as higher resolutions would be reduced during transmission. The lower resolution enables webcams to be relatively inexpensive compared to most video cameras

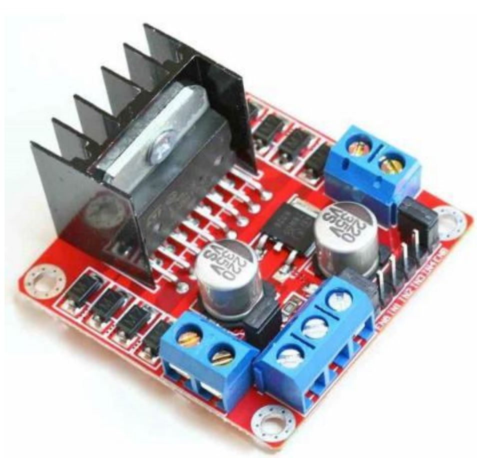

Fig. 1. Motor driver L398A.

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Fig. 2. Web camera.

3) *Raspberry Pi:* This is the most major component due to its dual job as a controller and a communication medium between the car and the HPC. The Raspberry Pi 3 B has a quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz i.e its the Pi 3 is roughly 1.5 times faster than the Pi 2.The RAM of Rpi 3 consists of 1GB of LPDDR2-900 SDRAM, and the graphics capabilities, provided by the Video Core IV GPU. The Pi 3 now includes on-board 802.11n WiFi and Bluetooth 4.0 which was the main reason it was chosen for the project. The presence of on-board wi-fi provides a wireless communication medium between the main processing unit and pi. The Raspbian os which is a free operating system based on Debian optimized for the Raspberry Pi hardware, is installed to the R-pi.The main purpose of pi is to receive commands from the HPC and provide appropriate control signals to the arduino and to stream the images directly to HPC via wifi.
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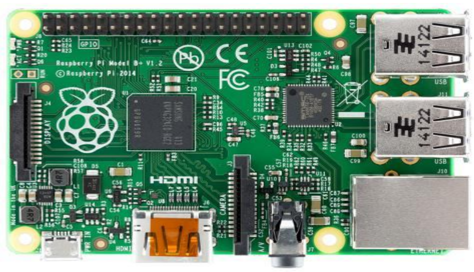

Fig. 3. Raspberry Pi

4) *High Performance Computer:* High-performance computer is a system that has the ability to process data and perform complex and elaborate calculations at high speeds. A normal laptop or desktop with a 3 GHz processor can perform around 3 billion calculations per second which is much faster than any human can achieve but it pales in comparison to HPCs that can perform quadrillions of calculations per second. The best type of HPC solution that can be applied in this project could be supercomputers. A supercomputer contains thousands of compute nodes that work together to complete one or more tasks. This is called parallel processing similar to having thousands of PCs networked together, combining compute power to complete tasks faster. The working of the entire system depends on the speed and efficiency of the neural network, on a normal PC it's impossible to train the NN with more than 2000 images at once. This seriously limits the quality of the NN but using HPC we can train with the optimal sized data set. HPC also improves the processing time of the NN as the system is a real-time system time delay in response affect the performance.

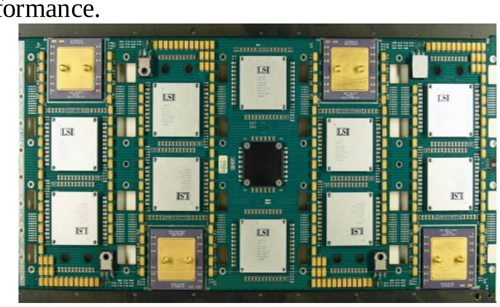

Fig. 4. High Performance processing unit

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5) *Raspberry Pi Interface:* To remotely capture the live feed from the camera to the laptop and to send controls an interface was created. This interface provides us with the live stream of the camera feed. There is an option to record and download images in various resolutions with the corresponding controls. Below is the view the interface.

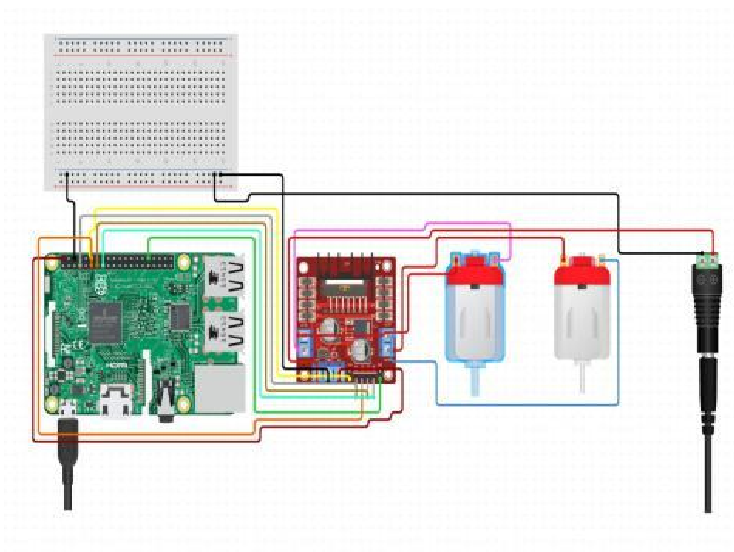

Fig. 5. A general structure of the connection between motors and the controller

6) *Software Utilities:* Tensorflow which is an open source artificial intelligence library used to build models by using data flow graphs. It was used to create the large-scale neural network required for the complexity of the project. TensorFlow is basically a symbolic math library used for machine learning applications such as neural networks.

IV. DATA PROCESSING

A. *Data Preprocessing*

Pre-processing of data refers to the transformations applied to the data objects before feeding it to the algorithm. Data Pre-processing is a technique that is used for converting raw data into a clean one. That means, whenever the data is collected from different sources it is collected in raw form which is not feasible for the analysis. The dependencies among the different features are identified and eliminated. Normalization method is applied to the data during data pre-processing.

$$x_{ij} = \frac{x_{ij} \quad min_j}{max_j \quad min_j} \qquad (1)$$

In image processing, normalization is a process that changes the range of pixel intensity values. Applications including photographs with poor contrast due to glare. This type of normalization is sometimes called contrast stretching or histogram stretching. In more general fields of data processing, such as digital signal processing, it is referred to as dynamic range expansion. The purpose of dynamic range expansion in the various applications is usually to bring the image, or other type of signal, into a range that is more familiar or normal to the senses, hence the term normalization. Often, the motivation is to achieve consistency in dynamic range for a set of data, signals, or images to avoid mental distraction or fatigue. For example, a newspaper will strive to make all of the images in an issue share a similar range of gray scale. Normalization transforms an n-dimensional gray scale image

The intensity range of the image can be in any range but the desired range is 0 to 255 the process entails subtracting starting range value from each of pixel intensity. Then each pixel intensity is multiplied by 255/range duration, making the range 0 to 255.

Normalization might also be non-linear, this happens when there isn't a linear relationship between original value and the normalised value. The non-linear normalization when the normalization follows a sigmoid function, in that case, the normalized image is computed according to the formula.

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B. Learning Phase

For training the model we initially split the dataset obtained into two sections which are 'Training data' and 'Validation data'. The training set is the material through which the computer learns how to process information. A set of data used for learning, that is to fit the parameters of the classifier. Cross-validation is primarily used in applied NN to estimate the accuracy of the machine learning model on the unseen data. A set of unseen data is used from the training data to tune the parameters of a classifier.

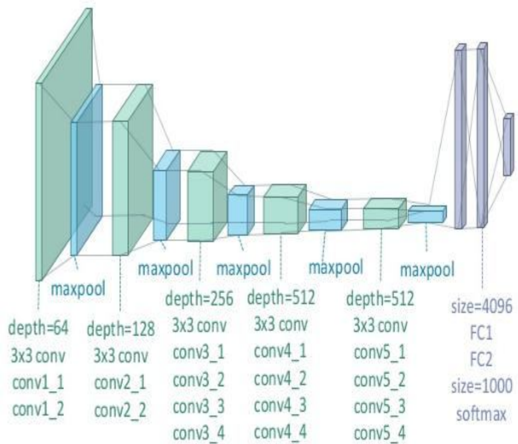

Fig. 6. CNN structure for the model

1) *Training of Convolution Neural Network:* In this phase we feed the NN with image feed downloaded along with the controls. Convolutional neural network are used to find patterns in an image. You do that by convoluting over an image and looking for patterns. In the first few layers of CNNs the network can identify lines and corners, but we can then pass these patterns down through our neural net and start recognizing more complex features as we get deeper. This property is utilized to detect multiple object-pattern. The image is represented using matrix of value. Now you take mxm matrix of value called as kernel and move over the image multiplying the mxm matrix with the window of the image that has been covered to generate a single value. Now the 3x3 matrix is moved to right and down to complete the entire image. At the end we will get a Convolved feature as represented above. The goal of a convolutional layer is filtering. As we move over an image we effective check for patterns in that section of the image. This works because of filters, stacks of weights represented as a vector, which are multiplied by the values outputted by the convolution. When training an image, these weights change, and so when it is time to evaluate an image, these weights return high values if it thinks it is seeing a pattern it has seen before. The combinations of high weights from various filters let the network predict the content of an image. The layer after convolutional layer is mostly pooling layer in CNN architecture. It partitions the input image into a set of non-overlapping rectangles and, for each such sub-region, outputs a value. The intuition is that the exact location of a feature is less important than its rough location relative to other features. Activation layers work exactly as in other neural networks, a value is passed through a function that squashes the value into a range. The data set not only consists of image but also the controls. These controls are considered the class labels i.e left is one label and right is another label etc thus turning the initial prediction problem into a hybrid of prediction and classification. Due to the peculiar nature of the model their is a high possibility that the model may become overfitted. This is avoided by training the car at various locations and lightings or introducing noise to the data set.

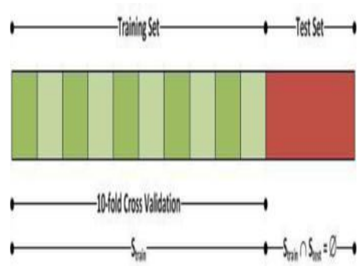

Fig. 7. Distribution of raw data into training set and validation set

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2) *Testing of Neural Network:* In this stage a NN model trained and validated on various types of tracks is obtained but it's not free from errors i.e if exposed to conditions it never encountered in training phase this model could fail to judge it and act accordingly. The key features like curvature, average light intensity, friction of the track, material type, variation in light intensity across the track and even the temperature can affect the decision of the NN , therefore training in variant types of tracks is necessary to create an efficient NN model for the self-driving.
3) *Improvised Learning:* The NN model no matter how efficiently trained will definitely produces some anomalous decisions, like minor inaccuracies in the manoeuvring of the car which wastes time and energy etc. The problems like these can't be corrected by the normal learning process. To overcome this problem our model is designed to improve continuously i.e whenever the model makes mistakes the user can correct the mistake and show the NN the right way to do it.The model is then trained on these corrections. This process which is somewhat like reinforced learning. This allows our car to be in a continuous learning phase where it can learn from its mistakes through the guidance of the user and can evolve further from being a just workable self-driving system to a system with certain driving skills and style matching that of the user.

V. RESULT

The proposed self-driving system was implemented in a RC car with the required hardware including R-pi, motor driver etc. This car was trained under different combinations of the track i.e. straight, curved, combination of straight and curved, coarse, refined and irregular tracks etc. Two cameras one in rear and other in front were used to record videos. Front camera focused on the immediate path while the rear camera focused on distant variations in path like a crossing or obstacles etc. Some 20,000 images were extracted and was categorically placed in different folders like left, right and stop. These images were resized to 320x240 and on which the network was trained on. The Convolutional Neural Network has 128 input nodes, 2 hidden layers of 32 nodes each and finally the output layer consisting of 4 nodes for each of the 4 output. To avoid overfitting of the NN model dropout of 0.1 was provided which is just optimal for the performance of NN. Relu activation was used

between the input and hidden layers for learning and Softmax activation function was used for the output layer. Since the computer even on gpu mode was not capable to handle full training set size. The training set was divided smaller sets and the training was performed one after another. The number of epochs was set to 3 and it took around 3 hours to train. This was all about the NN model and system configuration that was used to train the model. The directions from NN along with the directions from map together makes the system complete. The Map system simply provides direction on when to turn and which turn to make. It simply guides car from its source to the destination. The graph below shows the prediction accuracy of the NN model.

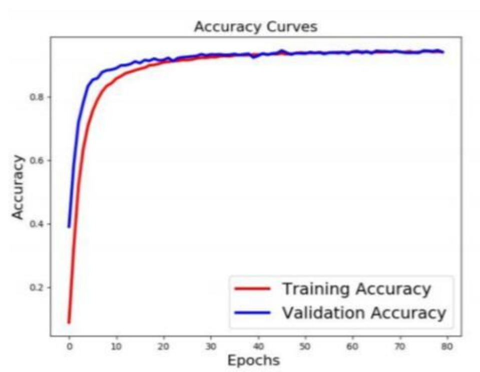


Fig. 8. Accuracy graph of the NN model

VI. CONCLUSION

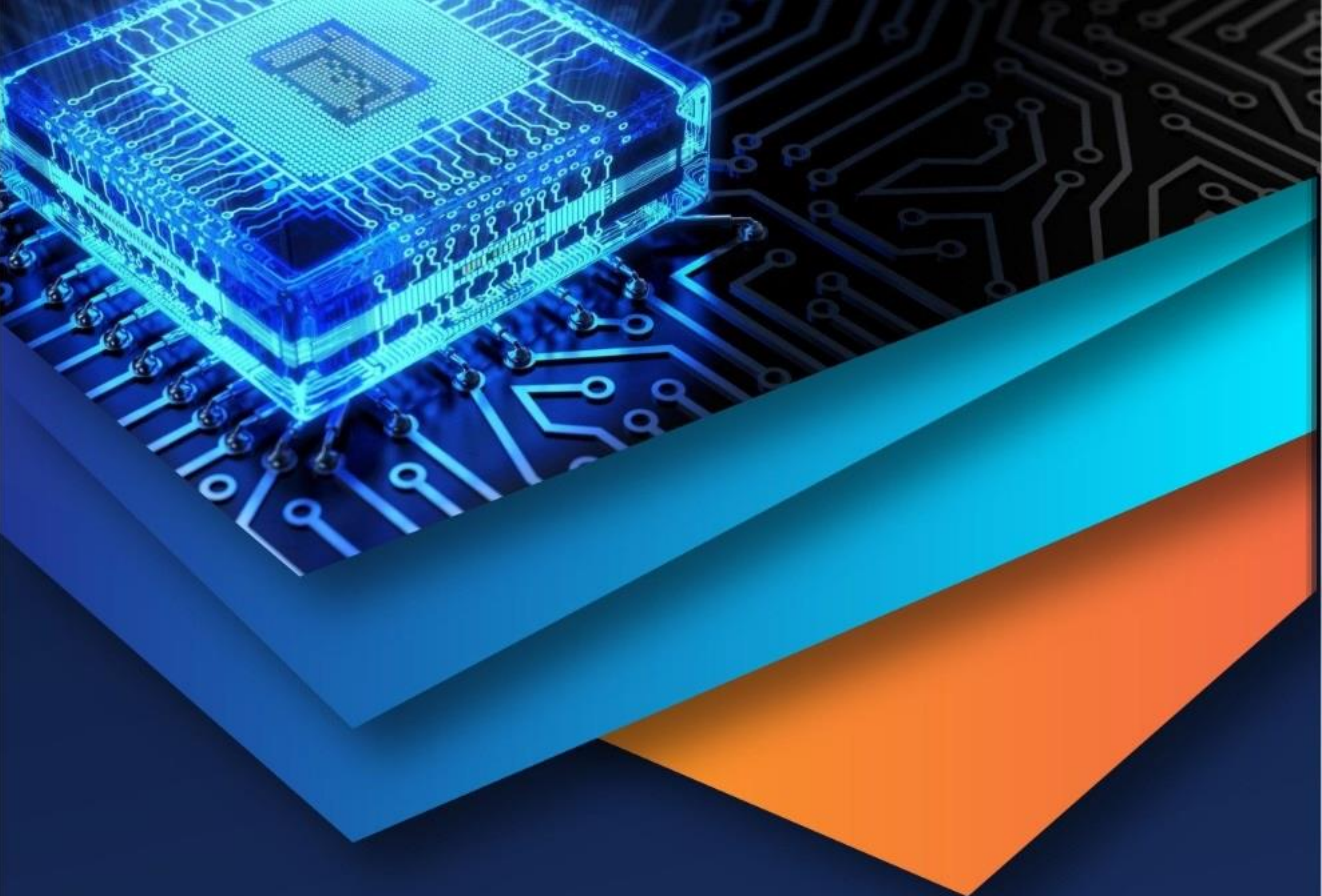
The proposed system is implemented as a way to continuously observe the surrounding for the correct path and obstacles. The existing systems are only partially autonomous which acts as an assistant in certain situations like parking etc. Another major issue is that all these systems require high processing power and is quite expensive. So, our system is designed to overcome these challenges. The proposed system consists of basically a sensory system includes camera and other sensors that surmise the surrounding information, a mapping system that allows the user to decide the destination for the car,a processing unit(HPC) that on the basis of the raw data provided decides directions and controls for the car. A mini-model of self-driving car based on the above concept was successfully designed and tested for performance

VII. ACKNOWLEDGEMENT

This project wouldn't have been possible without the constant support and motivation form our guides Dr. Surekha Mariam Varghese, and Prof. Leya Elizabeth Sunny who took their valuable time to guide us throughout the course of this project. We would also like to thank our Department's Project lab in-charge Prof Neethu Issac, who provided us support with the resources for the project.

REFERENCES

[1] http://asirt.org/initiatives/informing-road-users/road-safety-facts/roadcrash-statistics
[2] http://sites.ndtv.com/roadsafety/important-feature-to-you-in-your-car-5/.
[3] Wang, Chun-Che, Shih-Shinh Huang, and Li-Chen Fu. "Driver assis-tance system for lane detection and vehicle recognition with night vision." Intelligent Robots and Systems, 2005.(IROS 2005). 2005 IEEE/RSJ International Conference on. IEEE, 2005.
[4] Miao, Xiaodong, Shunming Li, and Huan Shen. "ON-BOARD LANE DETECTION SYSTEM FOR INTELLIGENT VEHICLE BASED ON MONOCULAR VISION." International Journal on Smart Sensing In-telligent Systems 5.4 (2012).
[5] Saha, Anik, et al. "Automated road lane detection for intelligent vehi-cles." Global Journal of Computer Science and Technology (2012).
[6] Pannu, Gurjashan Singh, Mohammad Dawud Ansari, and Pritha Gupta. "Design and implementation of autonomous car using Raspberry Pi." International Journal of Computer Applications 113.9 (2015)
[7] Mohanapriya, R., Hema, L. K., Yadav, D., Verma, V. K. (2014). Driverless Intelligent Vehicle for Future Public Transport Based On GPS. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 3.
[8] Ms. D.D Jadhav.,Komal Jadhav,Kajal Shinde,Anjali Sonawane, , , ,."Autonomous Vehicle with Obstacle Avoidance and Tracking", Volume 4, Issue VIII, International Journal for Research in Applied Science and Engineering Technology (IJRASET) Page No: , ISSN : 2321-9653
[9] Dhanasingaraja, R., S. Kalaimagal, and G. Muralidharan. "Autonomous Vehicle Navigation and Mapping System." Division of Mechatronics, 2014 International Conference on Innovations in Engineering and Tech-nology. Vol. 3. No. 3. 2014.
[10] Dhanasingaraja, R., S. Kalaimagal, and G. Muralidharan. "Autonomous Vehicle Navigation and Mapping System." Division of Mechatronics, 2014 International Conference on Innovations in Engineering and Tech-nology. Vol. 3. No. 3. 2014.
[11] P. Jaroszek and M. Trojnacki, "Localization of the Wheeled Mo-bileRobot Based on Multi-Sensor Data Fusion," Journal of Automa-tion,Mobile Robotics Intelligent Systems, vol. 9, no. 3, pp. 73–84, jul2015



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