Autonomous Car with Collision Avoidance

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Abstract— **Autonomous vehicles are the future brilliant autos foreseen to be driver less, proficient and crash keeping away from perfect urban vehicle of things to come. To achieve this objective automaker have begun working around there to understand the potential and unravel the difficulties as of now here to achieve the normal result. Unmanned ground vehicles are capable of driving itself without on-board operators. A UGV, with sen-sors installed for interacting with environment are now-a-days an interesting area of research. This UGV will be able to sense its environment and take decision according to it. Our proposed design was to implement a prototype of driverless car in controlled environment. The project poses particular challenges in terms of controllability and design considerations.Results are obtained using image processing. The document provides an insight on final year project, autonomous car. The report discusses its objective, its entire working and entire system of autonomous car. It briefs the mechanical design, electronics and electrical design.**

Keywords:

I. INTRODUCTION

What is autonomous car? Autonomous car are the visions of unmanned and autonomous machines. A car which is capable to drive its way to it distention without a driver through uncontrolled environments.All things considered, on going years have seen impressive improvement towards progress of autonomous and unmanned vehicles Car makers, for example, Ford, BMW, Tesla,and different organizations, for example, NVIDIA are putting billions of dollars in self-ruling vehicle driving exploration and make an autonomous car can capable of making its way through uncontrolled environments. Such vehicles are a connected utilization of progressively complex man-made brainpower and mechanical technology abilities.An unmanned ground vehicle (UGV) is a vehicle that works while in contact with the ground and without a locally open human manager. UGVs can be utilized for specific applications where it might be gravely coordinated, unsafe, or difficult to have a human head present. By and large, the UGV have various sensors prepared on it for watching nature, and after that taking activities or settle on choices as indicated by it independently and pass the information to a human director at a substitute region. By design of UGV, we are conserned with number of components: stage, sensors, control frame-works, direction interface, correspondence connections, and frameworks coordination highlights

II. MOTIVATION OF PROJECT

Almost **1.25 million** individuals pass on in street crashes every year, by and large 3,287 passing per day. An extra 20-50 million are harmed or debilitated and the greater part of all street traffic passing happen among youthful grown-ups ages 15-44. More than 85 percent of these accidents are caused by driver negligence. Report by Association for Safe International Road travel (ASIRF).

This motivate us try to manufacture an autonomous car which is capable to sense variable environments prevailing in our world. Try to make it decisions which are safe for human life and make there r ide more comfort by saving their precious time.

III. OBJECTIVES

It spares our time make our ride a lot simpler.With driverless vehicles ready to access regularly updated information to help screen traffic, just as computerized maps and different devices, they will probably decide the quickest, most productive course conceivable. The majority of this will result in less rush hour gridlock, less blockage and less

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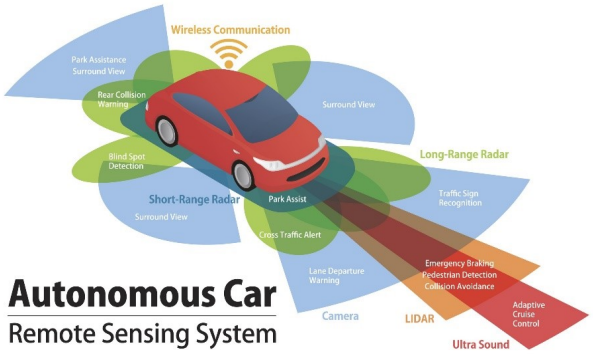

Fig. 1. Autonomous car environment

time and fuel squander. Self-governing vehicles are, to all plans and purposes, programming on wheels.

IV. PROBLEMS ASSOCIATED

The issues with independent frameworks in reality are various. A robot must have some approach to see its condition. A robot must have some approach to balanced out its very own position, yet should be set up to keep up this state regardless of whether any given sensor may not work. A robot must have some technique for changing its position, yet ought to in all likelihood observe unequivocally how its position is truly moving. A completely independent robot must most likely settle on choices to change its position dependent on the world it sees; it ought to be noted, in any case, that this task does exclude CAR PARKING out of extension. Another issue of this generally new eld is the nonattendance of data sharing among vehicles and controller. Independent vehicles are perplexing frameworks that depend intensely on innovations, for example, OPEN CV, GPS, high-denition maps, and articial insight for route and impact shirking. This implies each self-governing vehicle is continually gathering and examining an extremely high volume of information, which as indicated by Intel is about 2.6 terabytes every hour. Which is a great deal for every hour we need to deal with that information which it a ton in itself.

V. DESIGN PROCEDURE

The design procedure of the unmanned ground vehicle required rigorous knowledge on all aspects of road algorithms and scenarios. Mainly the course of action was to try to make the car work autonomously on road and interact with environment. This would be done by 3 modules.

- Input module
- Output module
- Control module

All these modules then have to be placed on the cars body. The body consists of a base with wheels and moving mechanism.
The design process of the project was divided into 2 major phases.

- Mechanical modeling
- Electrical modeling

A. Mechanical Modeling

The challenging task was to select the type of material that would be most suitable in terms of the following aspects:

- Lightweight
- Durability
- Strength
- Machine ability
- Cost and availability

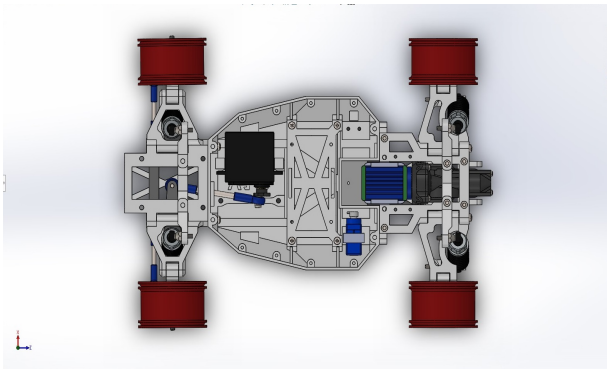

Fig. 2. Autonomous car environment

B. Electrical Modeling

The electrical model was decided and divided into following components:

- Processor
- Motors
- Motor driver
- Battery

1) Processor: A very high-speed microcontroller was required for the programming of the motor control and image processing and making decision according to the environment. The processor used in our project is Raspberry Pi 3 Model B+ which is considered as the brain of the project. It is the control unit by which input unit interacts and the decision making is done in it and output unit is given commands to perform as per decision produced by it. The Raspberry Pi is a progression of little single-board PC. The model we used is Model B+, with processor Broadcom BCM2837B0, with ethernet, USB 2.0 ports and Wi-Fi module installed in it.

Fig. 3. Raspberry Pi

2) Motors: Motors are the part of the output module of the car as mentioned in article 3.1. the design required is to have small sized motors that can produce enough RPM to bear the weight of car. The most appropriate option in the light of above requirement was to use DC motor for movement of chassis and servo motor for steering movement.

3) DC motor: A DC motor is rotating electrical motor which changes over direct stream electrical imperativeness into mechanical essentialness. The most generally perceived sorts rely upon the forces conveyed by alluring fields. Practically a wide extent of DC engine have some inside fragment, either electromechanical or electronic, to unpredictably change the course of current stream in part of the motor. A dc motor speed will be controlled over a wide range, using either a changing supply voltage or by changing the nature of current on the field windings.

We have used **Brushed DC motor**. It produces torque direct from DC control gave to the motor by using internal reward, stationary magnets and turning electromagnets. The brushes reach the commutator. At the point when a DC voltage is connected to the brushes, that voltage is moved into the commutator which, thusly, powers the winding. This electrical info creates an attractive field with armature.

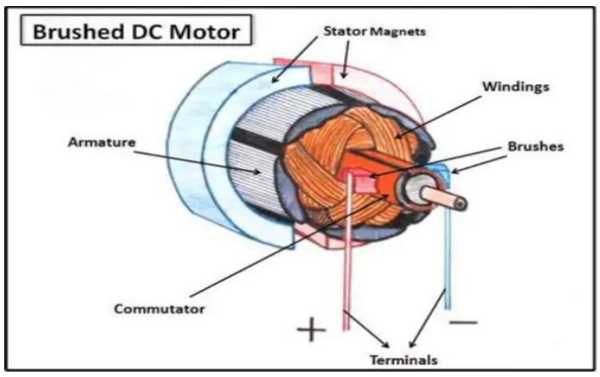

Fig. 4. DC motor

The left-out armature is driven from the left stator magnet, towards the magnet on the right. Moreover, the right half of the armature is driven a long way from the right magnet, towards the left.

By constantly alternating the polarity of the magnetic field around the armature, the motor shaft is made to continuously rotate.

4) Construction of DC motor: Exactly when the circle is powered, an attractive field is made around the armature. The left 50% of the armature is pushed far from the left magnet and drawn toward the right, causing turn. The Armature continues turning. Exactly when the armature ends up being on a dimension plane balanced, the torque ends up zero. Now, the commutator turns around the heading of current through the curl, switching the attractive field. The procedure at that point rehashes, causing ceaseless turn.

5) Rating:

- Name: Gear Motor
- Voltage: 9V
- Output speed: 150 rpm
- No-load current: 200mA
- Rated speed: 100 rpm
- Rated torque: 3 Kg-cm

6) Servo motor: To produce steering movement, an additional motor was attached at the front tires to rotate the car. Servo motor was used

because of its compact size and less weight. Servo motors are mostly 3 wire motors. Two wires used for sending power to the motor and the remaining one wire is used to control the rotation of the motor directed by a control circuit.

The servo used in the chassis is the servo manufactured by **Kyosho Perfex KS-12MG** micro servo motor. The advantage of this motor is light-weight.

Fig. 5. Servo motor

To completely see how the servo functions, you have to investigate the hood. Inside, it comprises of a little DC engine, potentiometer, and a control circuit. The motor is associated by riggings to the control wheel. As the engine turns, the potentiometer's obstruction changes, so the control circuit can decisively supervise how much improvement there is and in which course.

Servos are constrained by sending an electrical pulse, or pulse width adjustment (PWM), through the control wire. There is a base pulse, a most extreme pulse, and impartial pulse. A servo motor can typically just turn 90 in either heading for a sum of 0 - 180 development. The motor's fair position is depicted as the position where the servo has the tantamount extent of potential rotate in the both the clockwise or counter-clockwise course. The PWM sent to the motor chooses position of the motor turns, and subject to the length of the beat sent by methods for the control wire; the rotor will swing to its position. The servo engine sees a heartbeat every 20 ms and this heartbeat will choose how far the engine turns.

For example, a 1.5ms heartbeat will make the engine swing to the 90 position. Shorter than 1.5ms moves it the counter clockwise route toward the 0 position, and any more drawn out than 1.5ms will turn the servo a clockwise path toward the 180.

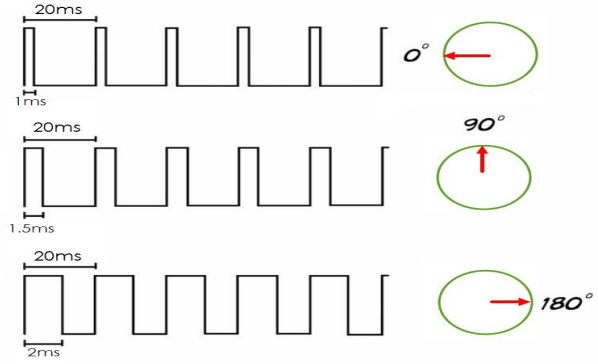

Fig. 6. Servo Duty cycle

7) Rating: Servo Technology: Analogue
Moment of force: 2.60 kg/cm
Servo speed: 0.09 s
Weight: 15 g
Torque: 3.5 Kg.cm
Gear Type: Metal
Servo Duty cycle:
Dc = 0.5/20100 = 2.5% = 0
Dc = 1.5/20100 = 7.5% = 90
Dc = 2.5/20100 = 12.5% = 180

8) Motor driver: The motor driver is utilized for the DC motor. Motor driver utilized in our undertaking is L298N. L298 IC is most normally used to drive motors dynamically or motor controllers. it can be controlled by Arduino, RPi etc. They get input signals from mini-scale controllers and run the motors connected to their yield sticks. L-298 motor driver can control two diverse DC motors in the meantime. Also, it can control a solitary stepper motor too. L298 has two (PWM) pins. When we want to run in PWM mode, these PWM pins are utilized. What's more, the motor can likewise be kept running at full speed by setting jumpers on the PWM pins. PWM is utilized to control the speed of the motor. We can pivot the motor in either clockwise or counter clockwise course by changing the flag's extremity at its information. It has various genuine activities for example mechanical technology, entryways lock

frameworks and so on.

Fig. 7. L298 Motor Driver

9) Ultrasonic Sensor: Ultrasonic sensing is an amongst the most ideal approaches to detect vicinity and distinguish levels with high unwavering quality. A ultrasonic sensor is an instrument that checks the partition to an article utilizing ultrasonic sound waves. A ultrasonic sensor utilizes a transducer to send and get ultrasonic heartbeats that trade back data about a thing's closeness. High-rehash sound waves reflect from limits to pass on verifiable reverberation structures. Ultrasonic sound vibrates at a recurrence over the extent of human hearing.

Transducers are the mouthpieces used to get and send the ultrasonic sound. Our ultrasonic sensors, similarly as different others, use a single transducer to send a heartbeat from trigger stick and to get at the reverberation stick. The sensor chooses the partition to a goal by assessing time between the sending and getting of the ultrasonic heartbeat from trigger to resound by reflecting of wave.

Ultrasound is solid in any lighting condition and can be utilized inside or outside. Ultrasonic sensors can oversee influence keeping away from for a robot, and being moved routinely, as long as it isn't extravagantly quick.

For Distance calculations:

L = x T x Constant (34300 cm/s)

Constant is used as speed of sound for the ultrasonic wave to travel in the air.

Interfacing Ultrasonic with Raspberry Pi:

- Raspberry Pi Input-Output Pins (GPIO) can have voltage up to 3.3Volts.
- So, resistors are installed in the circuit to get 3.3 Volts.

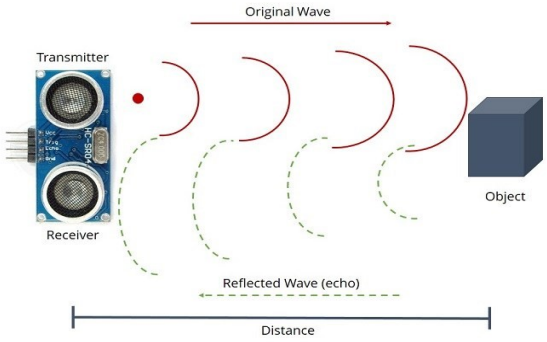

Fig. 8. Sensor working

$$3.3/5=R_2/(R_2+1k)$$
$$0.66(1k+R_2=R_2)$$
$$0.66+0.66R_2=R_2$$
$$0.66=0.34R_2$$
$$R_2=1.94$$

- R1 is fixed for 1k ohms and R2 is calculated by voltage divider to 2k ohm.

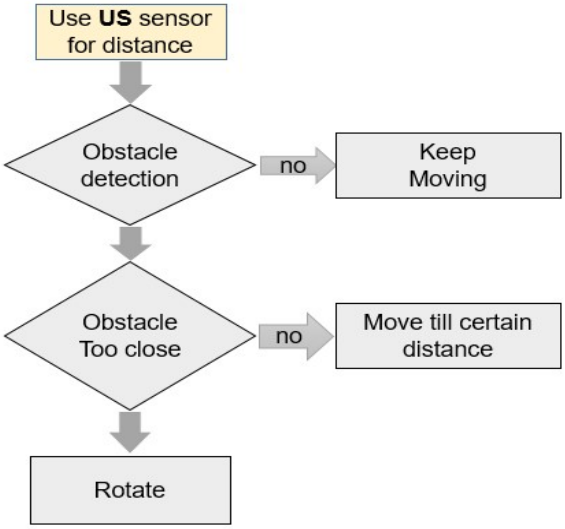

Fig. 9. US Algorithm

10) Pi-Camera: The Raspberry Pi Camera is the camera usually used with the Pi controller. This board is used to feed in HD video stream into the system or pictures.

We have used Pi Camera for image processing input in our project. All the algorithms are run according to the video provided by camera to processor. And decisions are made according to it.

Features:

- On-board lens for imaging.
- 8-MP camera with resolution 3280 x 2464-pixel
- Supports video formats and resolutions
- Weight just over 3g
- Associates with the Raspberry Pi board effectively.
- Camera v2 is supported by Raspberry OS.

VI. IMAGE PROCESSING ALGORITHMS

This output is calculated through the following algorithms:

- **Haar-Cascade Classifier** for stop sign detection.
- **Hough transform** for lane detection.
- **HSV image conversion** for traffic light detection.

A. OpenCV

OpenCV (Open Source Computer Vision Library) is an AI programming library. OpenCV was endeavored to give a normal structure to PC vision applications and to breath life into the utilization of machine recognition in the business things. As an open source stage, OpenCV is make basic associations to use and change the coding. Initially, it was developed by Intel, later it got supported with others. OpenCV was originally in C/C++ but now it contains bindings of different languages i.e. python, JAVA etc.

The library of **Numpy** makes the assignment progressively easier. Numpy is an exceptionally upgraded brary for numerical undertakings. it adds array values to the OpenCV objects. So whatever practices you can do in Numpy, you can consolidate it with OpenCV, which collects number of weapons in your save. Other than that, couple of various libraries like can also be associated with Numpy library to work along with it.

The library has in excess of 2500 person-trained estimations, which fuses a total game plan of both extraordinary and cutting edge PC vision and AI figurings. These estimations can be used to identify and see faces,understand objects, bunch human exercises in accounts, camera tracking improvements, extract 3Ds shapes of articles, solidify pictures to make a high destinations picture of a whole scene, find equivalent pictures from a picture database, expel red eyes from pictures taken utilizing streak, look for after eye headways, see scene and set up markers to overlay it with broadened reality, and so on. OpenCV has in excess of 47 thousand individuals of client organize and assessed number of downloads outflanking 18 million. The library is utilized broadly in affiliations, assess social events and by definitive bodies.

1) Applications: Applications are:

- 2D and 3D highlight Toolkit.
- Sense of self movement estimation.
- Facial acknowledgment System.
- Signal Recognition.

B. Haar-Cascade Classifier

A Haar-Cascade is in a general sense a classifier which is used to distinguish the thing for which it has been prepared for, from the source. The Haar-Cascade is set up by superimposing the positive picture over a great deal of negative pictures. The arrangement is usually done on a server and on various stages. Better results are procured by using superb pictures and extending the proportion of stages for which the classifier is readied.

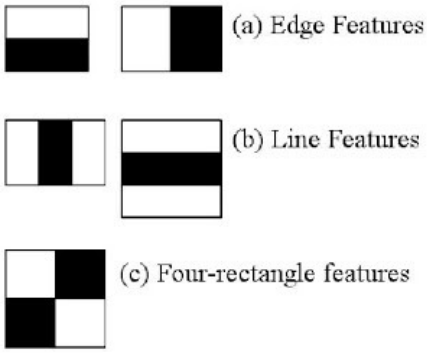

Fig. 10. Haar-cascade working

Article Detection by Haar incorporate based course classifiers is a persuading object acknowledgment methodology proposed by Paul Viola and Michael Jones. It is an AI based methodology where a course work is set up from a great deal of positive and negative pictures. It is then used to see difficulties in different pictures. Now we will work with the **Stop Sign detection**. At first, computation will require incredible arrangement of the Positive pictures and negative pictures to set up the classifier. By then we need to expel features

from it. For this, Haar features showed up in the underneath picture are used. They are much equivalent to our convolutional part. Every component is a single regard procured by subtracting aggregate of pixel under white square shape from entire of pixels under Dark square shape.

For **Stop-sign detection**, first we need to load an XML classifier file of stop-sign classifier. XML is an extension of classifier file. Then image is converted to gray scale. Now we need to find the stop signs in an image. If it is found, it return the position of sign. Once we get the locations of sign, now we need to create ROI (Region of Interest) for signs. Cv2.rectangle function is found for making rectangle on region of interest.

Fig. 11. Stop sign detection

C. Hough Transform

The **Hough transform** is an **object extract mechanism** which is used in image processing, analysis and computer vision. Motivation behind this strategy is to discover defective cases of the articles inside a specific area of shapes by a casting a ballot system. This casting a ballot strategy is done in a parameter space, from which object applicants are gotten as nearby maxima in a purported collector space that is unequivocally built by the calculation for processing the Hough transform.

In robotized examination of advanced pictures, a subproblem routinely rises of recognizing essential shapes, for instance, straight lines, circles or ovals. Generally speaking, an **edge detector** can be used as a pre-getting ready stage to obtain picture centers or picture pixels that are on the perfect curve in the image space. On account of flaws in either the image data or the edge identifier, regardless, there might miss spotlights or pixels on the perfect curves similarly as spatial deviations between the ideal line/circle/oval and the uproarious edge centers as they are gotten from the edge locator. Thusly, it is much of the time non-inconsequential to hoard the isolated edge features to a fitting plan of lines, circles or ovals. The inspiration driving the Hough change is to address this issue by making it possible to perform groupings of edge centers into thing hopefuls by playing out an unequivocal throwing a poll procedure over a ton of parameterized picture objects.

At first, hough trasnform was used for straight lines only which were given by y=mx+c equation, where it can be spoken to as a point (c, m) in the parameter space. Notwithstanding, vertical lines represent an issue. With more study and working on it, people started using another equation with this algorithm for vertical lines.

r=x.cos +y.sin

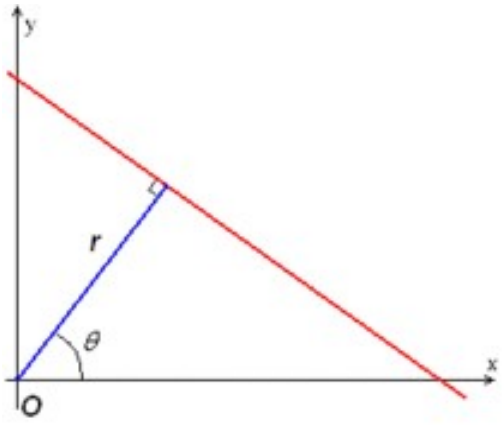

Fig. 12. Vertical lines in Hough space

here, r is the detachment from the commencement on the straight line, and (theta) is the angle between the origin and straight line.

It is along these lines possible to interface with each line of the image. The (r,) plane is on occasion implied as Hough space for the game plan of straight lines in two estimations.

Given a line point in the plane, by then the course of action of every single straight line experiencing that point relates to a sinusoidal bend in the (r,) plane, which is extraordinary to that point. A lot

of something like two that structure a straight line will make sinusoids which cross at the (r,) for that line. In this manner, the issue of recognizing collinear focuses can be changed over to the issue of finding synchronous turns.
The capacity utilized is **cv2.HoughLinesP()**. It has two new contentions.

- **minLineLength**
- **maxLineGap**

1) Canny Edge Detector: The Canny edge marker is an edge affirmation director that utilizes a multi-compose tally to recognize a wide degree of edges in pictures. Canny in like manner conveyed a computational speculation of edge disclosure clearing up why the strategy works.
Vigilant edge discovery is a technique to isolate accommodating fundamental information from different vision objects and altogether decrease the proportion of data to be taken care of. It has been commonly associated in different PC vision frameworks. Watchful has found that the necessities for the use of edge area on grouped vision structures are commonly relative. Thusly, an edge acknowledgment answer for area these requirements can be completed in a wide extent of conditions.

Among the edge revelation systems grew as of not long ago, shrewd edge distinguishing proof figuring is a champion among the most deliberately portrayed methodologies that gives extraordinary and trustworthy acknowledgment. Inferable from its optimality to meet with the three criteria for edge disclosure and the ease of methodology for execution, it wound up a champion among the most unmistakable computations for edge recognizable proof.

A function is used for this called, **cv2.Canny()**.

2) Process of algorithm: The Process of Canny edge recognizable proof figuring can be isolated to 5 special advances:

1) Applying Gaussian blur to even the image in order to clear the noise
2) Apply non-most extraordinary covering to discard misdirecting response to edge acknowledgment.
3) Apply edge point of confinement to pick potential edges.
4) Finalize the discovery of edges by smothering the various edges that are feeble and not associated with solid edges.
5) Discover the force slopes of the picture.

D. HSV Image Conversion

HSV (hue, saturation, value) are elective portrayals of the RGB shading model, structured during the 1970s by computer illustrations specialists to all the more intently line up with the manner in which human vision sees shading making properties. In these models, shades of each tone are masterminded in an outspread cut, around a focal hub of unbiased hues which ranges from dark at the base to white at the top. The HSV portrayal models the route paints of various hues combine, with the immersion measurement looking like different shades of brilliantly hued paint, and the esteem measurement taking after the blend of those paints with fluctuating measures of dark or white paint.

HSV is described in a way that resembles how

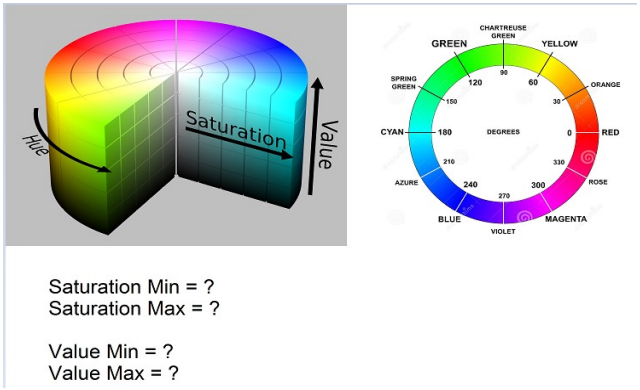

Fig. 13. HSV scheme

individuals see shading. It relies upon three characteristics: tint, immersion, and esteem. This shading space portrays tones (tint) similar to their shade (drenching or proportion of dull) and their brightness regard. **HSV Image Conversion** is used in our project for traffic light detection. We want to detect **red** and **green** light. Red light for signaling that the car needs to stop until the green light appears. So, we have stored the upper and lower ranges of the colors in our algorithm so that when the image is converted from RGB to HSV, inputting from the camera module, when that range of specific color appears, we have to perform the specific tasks which are defied in our code.

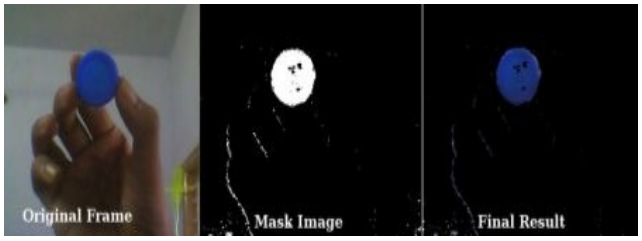

Fig. 14. Result of HSV masking

VII. CONCLUSION

1) We initially started with nothing and have implemented a totally driverless car in a controlled environment which can operate itself and take decision according to the environment.
2) All the decisions are done by processor after working on different algorithms in the code which are executed at the same time. The main aim was to make it a collision free vehicle, which can sense the hurdle in front of it and can overtake it with good precision.
3) Image processing was slow at first because of different algorithms working together at the same time, but we are still working on it to make it faster somehow and produce good GPU. So that this project can get any better in near future.
4) The prototype car is fully autonomous; we just have to give it power and all the algorithms work on their own and car works perfectly fine.

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