Semi-Autonomous Vehicle for Pot Hole, Humps with Possible Collision Detection and Avoidance Using Image Processing

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Abstract: The maintenance of the road is one of the significant issues in the developing countries. Identification of potholes and humps not only help drivers to keep away from disaster but it also alerts the concerned authorities about the presence of potholes on which required measures should be taken to eliminate it. Accidents due to pothole and hump and sudden interference of obstructions on the road are a cause of majority of road accidents in India and in many other developing countries. The problems due to potholes increase to a greater extent especially in bad weathers and at night and when driver is new to the road. It is necessity of people to have well maintained roads to be able to avail a safe travel. Our aim is to build a vehicle which is capable of identifying potholes humps and movement of humans or animals on the road at a distance and alerting about those to the driver in order to reduce accidents. An HD camera along with an ultrasonic sensor and IR sensor is used in order to provide necessary data from the real world to the car. The semiautonomous vehicle is capable of reaching the given destination safely and intelligently thus avoiding the risk of accident. Many existing algorithms like potholes, humps, lane, animals, human detection, traffic signal and sign detection are combined together to provide the necessary control to the car.

Key words: Autonomous, ABS, Blurring, CNN.

1. Introduction

In developingcountriesthe presence of potholes and humps and sudden interference are the major problems and these lead to accident and loss of human life. The loss of human life needs to be avoided and well maintained road need to be maintained as roads contribute a major portion of the country's economy. Identification of pavement distress such as potholes and humps helps drivers to avoid accidents by avoiding disaster.

Semiautonomous vehicle reduces human intervention by applying brakes when an event which is pre-defined happens. It is capable of sensing environment without human input.

The potential benefits of semiautonomous cars include reduced mobility and infrastructure costs, increased safety,customer satisfaction and mobility. Autonomous car also helps in reduction of traffic collisions. Semiautonomous cars are predicted to increase traffic flow, provideenhanced mobility for elderly and disabled, review travelers from driving.

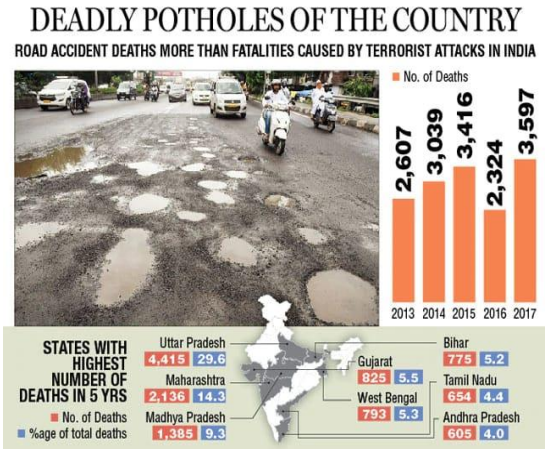


Fig 1: Source Times of India -Sep 19, 2018.

2. Problem statement

Accidents due to pot-hole, hump, road diversion, obstacles, sudden interference of cattle or humans on roads make it difficult to travel safely on roads and if these factors are not noticed while driving it may lead to an accident. Traffic in metropolitan is heavy and there are lot of signals and sign conventions that need to be followed when we are in ametropolitan areas which indicates that driving is not easy in metropolitan cities. A good experienced driver is required to drive in such areas and when we are new to a road, the journey time increases gradually because driver tends to travel slowly as he has no idea about condition of the road. By taking all of these factors into account a system needs to be developed as a solution to address all these problems.

3. Literature survey

There are many ways that have been introduced to reduce the rate of accidents that are caused due to potholes, sudden interference of cattle, humans on the road.[1] Rashmi Deshpande and team have proposed to detect the potholes on the road using Arduino microcontroller along with ultrasonic sensor. Initially they have conducted a survey, pothole is detected and plotted on the maps. Here they have located potholes on the google map. To use the facility the driver has to login on to the google maps. The potholes location is stored in database, when the potholes is removed from the road, user can manually delete it from the database, this helps in reducing accidents and in continuous monitoring of potholes but speed and accuracy is less. [2] S.Jothi and team have used ultrasonic sensor to measure the distance between the vehicle and pothole and same is used to measure the depth and height of the pothole and humps. They have built a mobile application to send information to the government authorities and to the drivers about the presence of potholes on the road which they are travelling. After detection of pothole and humps it alerts drivers by sending message with the help of GSM module but the location consists of latitude and longitude values making it difficult to locate on google maps. [3] Tushar D. Patil and team have proposed framework which catches the geological area directions of the potholes and humps utilizing a Global Positioning System (GPS). The detected information incorporates pothole, hump, and geographic location, which is stored in the Google spread sheet. An Android application is utilized to intimate drivers so that accidents can be prevented. Automatic detection of potholes and humps is done utilizing Raspberry Pi - 3. Liquor sensor, temperature sensor, fuel sensor information is in simple frame. It is changed over into digital value by utilizing MCP 3204 ADC. The main advantage is that it also works in rainy season when potholes are filled with muddy water as warnings are produced utilizing the data put away in the database and disadvantage is the maintenance of the data is crucial as it plays a major role to evade accidents. [4] Bakiya lakshmi.R and team have discussed a method to detect potholes in order to slow down the high rate of accidents that is amplifying every year. The method comprises of a detection and a warning system involving a ATMEGA processor and novel LiDAR sensor that detects the potholes or humps. On the basis of the detected value of distance, it is identified to be a pothole or a hump. Upon the detection of the mentioned irregularities on the road, the simultaneous multi warning system alerts the driver which includes a seven segment LCD display, a red LED, an electronic buzzer and a vibration motor. This system will alert the driver so that he can take necessary measures and prevent accidents due to humps or potholes ahead of the vehicle on the road. The main advantage is less complex architecture And Disadvantages the detection distance is very less and less time to react to the situation. There may be serious issue if we try to prevent a hump or a pothole is very less time. [8] Parag Kadale and team have developed a system which gives prior notice on presence of potholes on the route, this helps driver by allowing to choose the route which has lesser potholes. Once the presence of new pothole is detected it is updated such that users using the database gets notified of the updated location of new pothole using Internet Of Things, since IOT being used and air acts as medium network stability will be poor.

4. Methodology

In our paper we are mainly focusing on self-driven unmanned semi autonomous vehicle to detect potholes, humps, cattle, humans and obstructions on highway and detection of traffic signals and signs along with lane monitoring system. It contains block diagram[Figure 2] and approach to solve the problem.

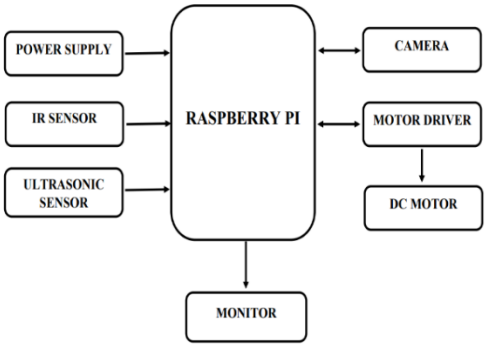


Fig 2 : Block diagram

In our project we are using Raspberry-Pi as a microcontroller to monitor all the sensors input and to control autonomous car according to the data input given by the sensors. A raspberry pi is of 64 bit in size and an upgraded version of ARM cortex version 11. It consists of special features like Bluetooth, wi-fi, Internet connectivity and also it consists of 5 port those are HDMI, USB, Power supply, audio jack and ethernet respectively. It has a ram of 1.2GB and it consists of protocols for communication and data transfer.

The potholes, animals, humans, traffic signs and traffic signals are detected by using a camera, before that we need to train the raspberry pi board with the data of all the parameters mentioned above respectively. After powering the Raspberry-Pi, camera and other sensors mentioned above will continuously monitor road and capture the data and send it to the Raspberry-Pi. The processor will compare the captured data with trained data, if the conditions are satisfied then the Raspberry-Pi gives the output as instructed.

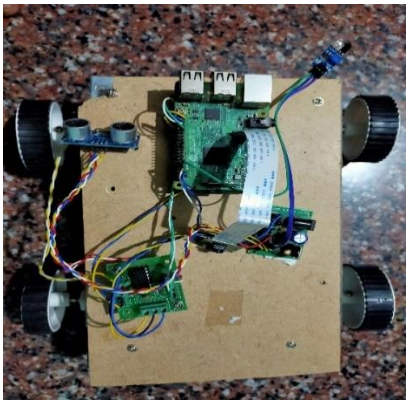


Fig 3: Hardware Implementation

The humps are detected by using ultrasonic sensor, it measures distance by emitting an ultrasonic wave. The sensor consists of two components namely transmitter and receiver, The transmitter emits an ultrasonic wave and receiver receives waves which gets reflected from the object after bouncing back. The sensor measures the distance by using time at which waves are transmitted and received based on this calculation the measurement of distance is achieved, In normal case if there is no hump then waves do not get reflected back, If the hump occurs, then the height with respect to normal road increases, such that the wave gets reflected back. On this basis we can calculate distance between humps and vehicle depending upon the trained data the ABS will work.

IR sensor is an electronic device, that emits the light in order to sense some object in surrounding and is used as obstacle detector in our prototype. It transmits infrared rays, the rays bounces from the surface of an object and are received at infrared receiver. When an object is detected by an IR sensor it sends data to the microcontroller on that basis motor are controlled by motor driver.

Semi-Autonomous car is mainly controlled by Raspberry pi and automatic braking system works with the help of motor driver that is connected to dc motor, it helps in movement of the vehicle. The motor driver consists of two motor terminals along with its control pins. we can operate or control dc motor movement by enabling or disabling a driver pin.

4.1 Animal and human detection

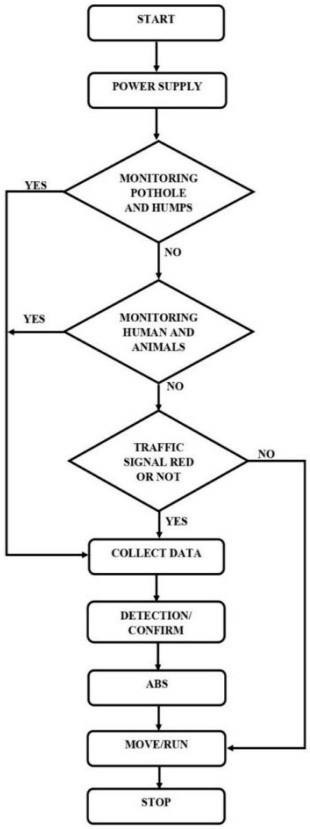
This phase of work is done using a camera as a input device. We are using Convolution neural network (CNN) technology to detect image of animals and humans. To obtain correct predictions from Convolution neural network we need to preprocess the data through following stages

The detection consists of 3 stages:

1) Pre- processing
2) Segmentation
3) Classification

These 3 stages include 5 layers of processing, they are

- Convolution layer
- Relu layer
- Pooling layer
- Padding layer
- Fully connected layer



Flow Chart 1: Program Flow

4.1.1. Capturing phase

To detect, we have to capture live images of the area that needs to be monitored and kept under surveillance. This is done by using camera and the data captured is sent to next stage.

4.1.2. Pre-Processing Stage

Pre – Processing stage is process where images are modified with some features some methods are :

- Denoising: Applying a gaussian or simplex box filter for denoising.
- Contrast enhancement: it is done if Gray level image is too dark or bright.
- Down sampling is done to increase speed.
- Morphological operations are done for a binary image.
- Scaling is done by some factor.

4.1.3. Comparing phase

The data captured in capturing phase is taken and compared with trained data. If both are not same then no actions are taken. Captured data is compared with trained data if they both are similar then actions are taken accordingly as instructed. Comparing the current frames captured with previous frames is used for motion detection.

4.1.4. Image Segmentation Stage

In this process certain part of the image are considered for detection on that basis the CNN algorithm provides certain values, This value is compared with trained values. If the value of both are closer then accordingly results will be displayed. Threshold segmentation has two main steps:

- Determine the threshold T.
- Pixel value which is calculated will be compared with the threshold value T.

On this two condition we can predict the animals.

5 layers of processing ensures that no data is lost once after the image is captured and only the required portion of the image is considered for determining the pixel values in order to compare the values that are already fed in the memory of microprocessor. If whole block of image is considered it increases the processing time and becomes difficult in real time processing.

Algorithm:

Step 1: Image/video acquisition from the camera.

Step 2: Convert video to frames.

Step 3: Store animal images in database, so it can be used like a training kit for program.

Step 4: Compare camera captured frames with the database.

Step 5: Use in read function to read the image and Pre-processing is done on that image. Perform boundary detection on the frame and captured images matched with images from training database images.

Step 6: compare the images if it is matching or not.

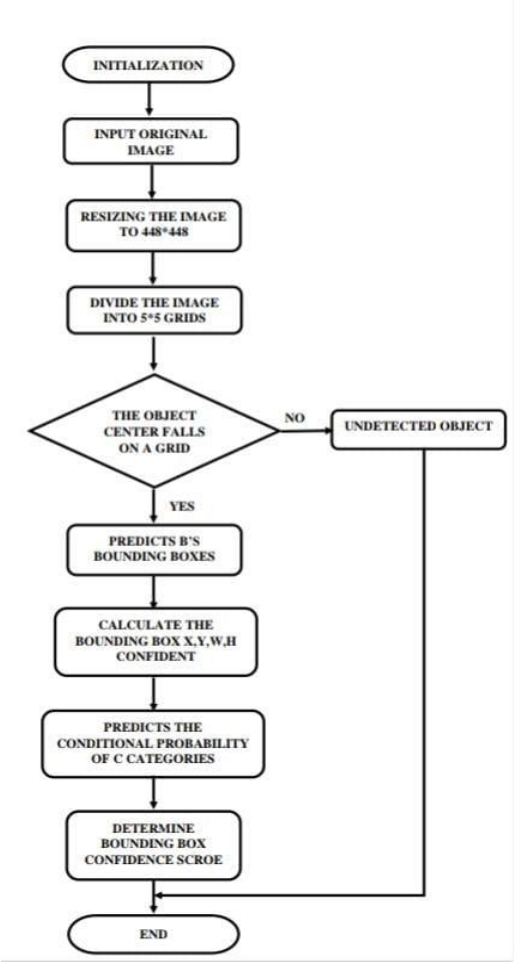
Step 7: An array is created and program is written for each animals to detect animal is desired or not.

Step 8: Intimation or alert.

4.2 Potholes Detection

The camera continuously captures the images, The microcontroller uses image processing concepts to extract frames and detection of potholes. Each frame undergoes all the image processing algorithm in order to detect potholes. OpenCV is used as the shell for the image processing technique.

The proposed methodology is used for detection of potholes by converting extracted road section images into the gray scale image format. After the conversion of image into gray scale image we have to remove the unwanted noise by applying a Gaussian filter to the image to get proper and clean image. To get a proper edge of the captured image an edge detection algorithm that is canny edge detection is performed on the extracted road surfaces.



Flow Chart2: Animal Detection Flow Chart

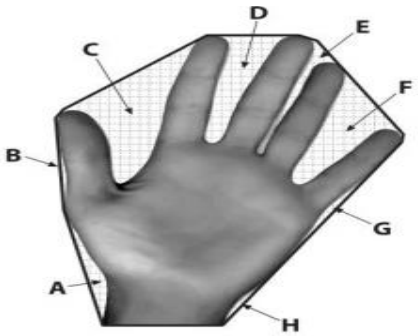
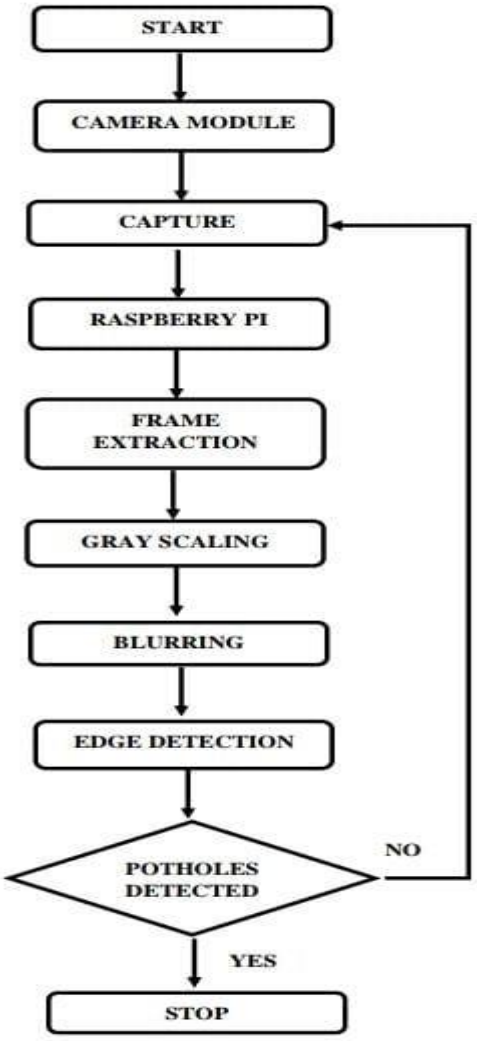


Fig 4: Segmentation of Image



Flow Chart 3: Potholes Detection Flow Chart

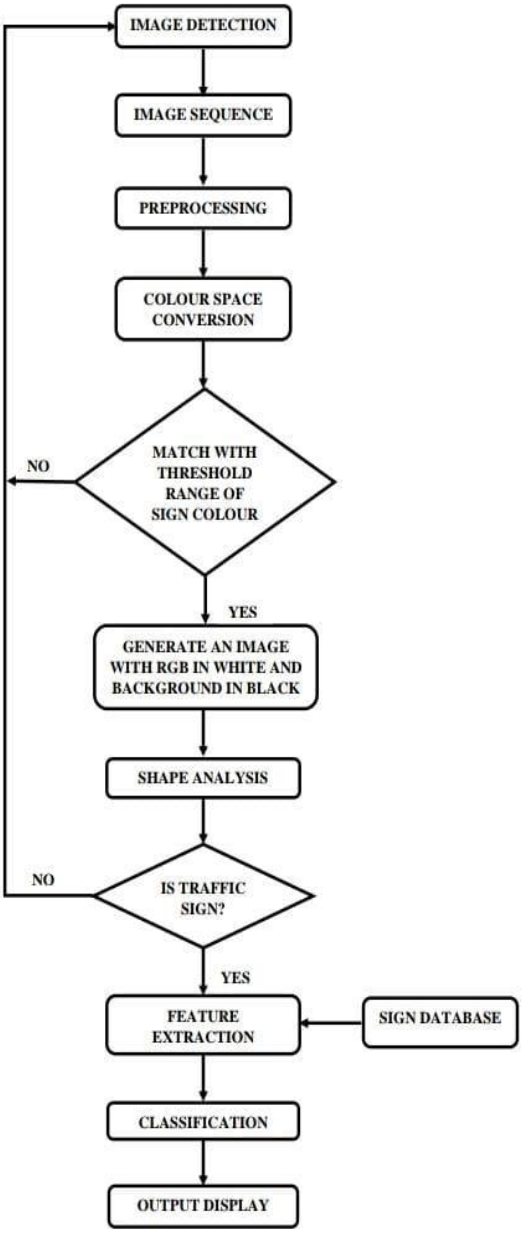
Let us consider an image of hand to explain how the algorithm will work. In hand each cavity is represented or marked by a notation from A to H which indicates gaps in the image with respect to outer points. The outer layer points are connected one by one through set of straight lines, this will continue and covers entire hand by linking points. In road each potholes cannot be extracted by color hence this algorithm is used to extract images and to get outer surface of image. The output of canny edge detection is black and white image. This algorithm used for system then uses Contour detection technique which is a useful tool for object detection and shape analysis, Output of the algorithm removes unwanted edges like boundaries of roads, leaves of trees and shadows etc.

4.3 Traffics Signs and Signal Detection

The system uses few phases to recognize the traffic sign. In that pre-processing is the first step where in case the captured image has low intensity or range it will convert into high resolution by applying colour components. After pre-processing the image will undergo with colour space conversion, for extracting and analyzing colour information we use the HSV(Hue-Saturation-Value) colour space. For matching HSV colour space the formula for conversion of RGB colour into HSV colour space is used as follows V=max(R,G,B)(1) H=H+360. Particular colour threshold values are defined it will compare with them and finds out the specified HSV ranges.

The next step is noise removal by applying morphological function the unwanted noise is removed from the captured image. It gives the perfect high intensity image with good color range. Further it will go for shape classification in this it will eliminate some complex color backgrounds to detect exact traffic sign. And traffic signs have some particular shapes to identify them so the HT(Hough Transform) technique is used to characterize the shapes of the captured sign. HT is one of extraction technique used in digital image processing. This will help in extraction of image and the complete sign detection after the color filtration and shape filtering.

At last the final detected sign is matched with the traffic sign database for this there are several techniques are used in this process but the target is to detect the traffic sign and indicate the driver.



Flow Chart 4: Sign Detection Flow Chart

4.4 Lane Detection

This phase also undergoes with all the layers of processing. The images captured in the intervals are compared and tallied with each other. If the images look alike, that is if the vehicle tends to cross the two lines which are considered as lane, then microcontroller sees that the vehicle is kept intact with the lane by passing instructions motor driver such that vehicle stays in the same lane.

5. Results and discussion

The desired results are obtained by using each algorithm at a time and once the potholes or presence of animals or humans is observed by the camera the prototype would take right such that it avoids potholes, animals or humans and resumes the movement. The moment when prototype encounters humps or obstacles it stops and slows down the vehicle prototype. When the traffic sign right is shown it takes the right turn accordingly and the same follows for all the signs. The moment the red light of traffic is detected the vehicle stops or halts, similarly it makes movement when it encounters the green traffic light.

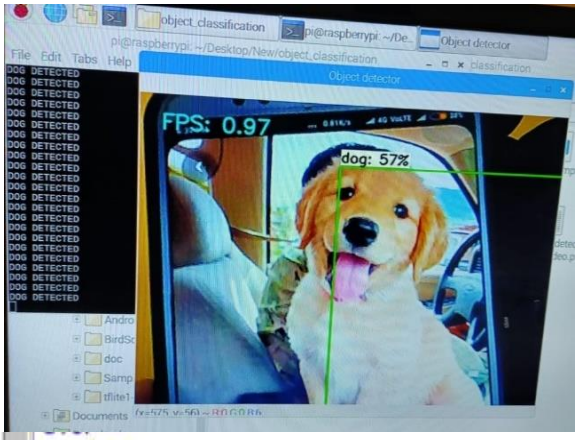


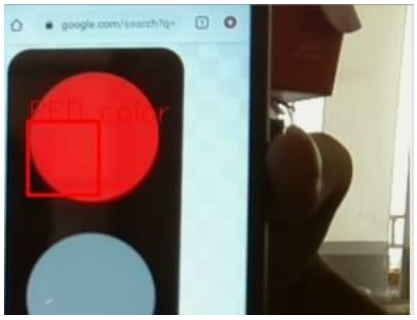
Fig 5: Animal Detection

```
FORWORD
FORWORD
Measured Distance = 73.6 cm
FORWORD
Measured Distance = 6.1 cm
HUMP DETECTED
STOP
FORWORD
object detected
STOP
FORWORD
```

Fig 6: Humps and object Detection


```
-61
right side lane
640 480
-61
right side lane
640 480
-61
right side lane
640 480
-60
right side lane
640 480
-60
right side lane
640 480
```

Fig 7: Lane Detection



```
change to red
STOP
change to red
STOP
change to red
STOP
change to red
STOP
change to red
STOP
change to red
STOP
change to red
STOP
```

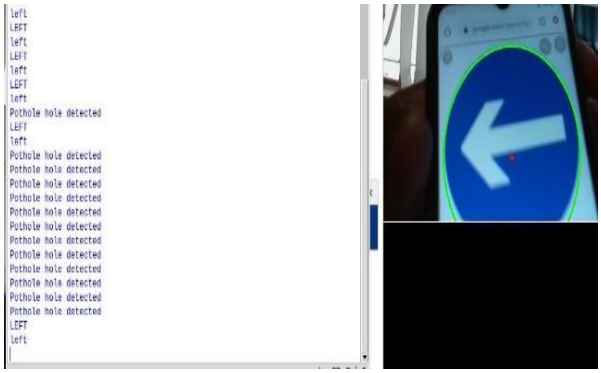


Fig 8: Traffic Red Signal DetectionFig 9: Pothole and traffic Sign Detection

Applications:

- Providing enhanced mobility for children and disabled.
- Shipping and deliveries.
- Public transportation.
- Forest monitoring.
- Industrial Surveillance.

6. Conclusion

Driving on the roads that too in a country like India where there is a sudden interference of cattle or humans on the roads is quite common and due to upgrading the infrastructures of the roads there are sudden changes that are reflected on the road overnight it makes very important to keep a track on the road. This is not possible when you are new to the road and here is where our prototype comes into an act which alerts the driver about the things going on the road and decreases rate of accidents. The prototype developed alerts the driver about presence of potholes by using camera as hardware interface with Raspberry-Pi, which is given with gray scaling algorithms to come to conclusion about presence of potholes. It alerts the driver about presence of humans, animals on the road by using camera and also about traffic signals and signs by using various image processing algorithms. It alerts the driver about the presence of obstacles on the road by using IR sensor. It uses ultra sonic sensor for detection of humps. It uses camera for lane monitoring.

7. Future scope

The prototype can be interfaced with additional hardware like GPS module, GSM module and sensors like force-pressure sensor, accelerometer, temperature sensor to get additional information about state of a engine and send emergency message or SMS in order to ask for help, the SMS contains details like location of the vehicle and parameters already mentioned if any accident occurs. Artificial Intelligence can be implemented to make a semiautonomous vehicle into completely or fully autonomous vehicle.

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