Design of a Collision Warning System Using Image Processing and Development of an Android SOS Application

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***Abstract*- In order to avoid the growing number of accidents year after year, we have developed a system to reduce the occurrence of accidents. The system involves maintenance of safe distance from one vehicle to the other and thus avoiding collision. Image processing techniques have been employed to maintain safe distance, between vehicles. A display of distance along with caution notice to the driver of the vehicle is also developed. In case the accident occurs due to the negligence of the driver and also not paying heed to the caution alerts, then an SOS app has been developed to assist the driver both in sending information to the next of kin as well as to provide medical emergency services. Java software is used for the development of SOS app. Open CV is used for the processing of videos captured by web camera.**

***Key Words*- Object detection, SOS app, MS_COCO data set, Mobile net, Open CV**

I. *INTRODUCTION*

India tops the world in the number of road accident related deaths globally as per the records of the World Bank. Almost 11% of the total global deaths related to accidents are accounted by India. On an average, 17 people die in car accidents every hour. The Indian government has been actively trying to tackle this issue for several years.

Despite the fact that precautions such as seat belts, anti-lock brakes, and no drinking and driving have been severely enforced, the patterns show no significant statistical decline over time. Road accidents are multi-causal, resulting from several elements that can be broadly classified as human error, road condition and environment, weather and vehicle condition. Human errors caused by neglect and carelessness account for a large portion of these accidents. Drivers frequently lose sight of the road ahead and end up in a head-on collision.

To avoid such collisions, we devised a collision avoidance system that uses image processing algorithms to detect objects and send alerts when the vehicle comes too close to them. This allows drivers to take the appropriate actions quickly and avoid any fatal catastrophes.

We have also analysed the number of fatalities that occur as a result of a lack of a system that alerts the necessary medical aid team as soon as an accident occurs. The time for an ambulance to reach the destination might not find any significant changes in the future but the time required to inform the ambulance team can surely be reduced. Accidents are also not notified to the next of kin until it is far too late. Our system's SOS feature warns the next of kin and emergency service close to the site of the accident.

II. *RELATED WORK*

With the frequent loss of lives due to negligent driving, it is necessary to find a system which can be used to alert the drivers to avoid any possibility of an accident. In one of such techniques Roopa et al [1], has made use of background subtraction algorithm for vehicle detection and the vehicles are counted in a selected zone of the road but the algorithm accuracy is affected from poor lighting conditions. In [2], Usman et al proposed a system that uses ultrasonic sensors on the car to detect the collision and notify the current location using the GSM-GPS module but the sensors may lead to false alert due to external conditions(temperature, wind, etc). A variation of this prototype has been developed in [3], wherein they use a vibration sensor instead but has less accuracy when compared to the former. A dashboard video accident detection data set has been used in [4] which is used to detect the variation in visual information during an accident using Computer Vision techniques, however, the dataset used is limited.

Nazir et al [5] has proposed a system that makes use of MPU-6050 module which detects the accident and sends notification via the SIM808 module, but its usage is limited only to a mobile network. A 3-part prototype has been developed in [6], which consists of the prevention part, detection and rescue part and the black box part which makes use of various sensors along with Arduino which is coded using C++ software, but the range of the sensors used are limited. A vision-based technique is used in [7], wherein a Convolutional Neural Network is built using accident/non-accident images, however, it provided an accuracy of just around 85%. In [8], Naji et al makes use of an IR sensor along with RF transmitter and receiver modules to send SMS to the users upon the detection of the accident but the IR sensor results are affected by dust, haze or light. The YOLO V2 algorithm is used to detect the vehicles in [9] and estimates the distance using 2 ROS nodes for collision warning but accuracy decreases if object moves away. In [10], Andrew et al developed a warning system that uses YOLO algorithm for accident detection along with ultrasonic sensors for increasing the range of the detection at blind spots, nonetheless the sensors may not work under non-ideal conditions such as heavy winds. The system developed in [11] uses Bluetooth, WIFI and ultrasonic modules along with the processor for collision detection and an android application for distance reminder, alarm etc but the modules used have same communication band which may lead to interference between them. A machine-learning based approach including decision tree, neural net-based classification and support vector machine is implemented to give warning or no-warning signal to the driver in [12] but the processors used in this model makes it expensive. In [13] Abhir et al has chosen the approach which makes use of a LIDAR sensor for the obstacle detection and warns the driver based on the distance and angle of the obstacle, but the working of the sensor is affected during night/cloudy weather. Least Square – Support Vector Machine and Fuzzy logic algorithm is used in [14], which are used to predict danger from camera footage and estimates the appropriate speed respectively, however, it doesn't take other parameters into consideration beside speed of the vehicles. The response system of [15], makes use of MP6050, camera module and ultrasonic sensors for detection of accident and notifies the location fetched using GPS-GSM module via a mobile application but the sensors has limitations owing to it's proper functioning under ideal settings.

III. *METHODOLOGY*

Our work has three distinct modules. The first module caters to Collision Warning. The second module gives information about Collison Detection and Location Tracking. The third module is the development of app for SOS to contact emergency service and inform family.

A. Collision Warning System

Figure 1. Block diagram of Collision Warning System

The Collision Warning System developed by us comprises of a processor and a web camera. The object detection is carried out using Image Processing Techniques.

The camera captures the real time video of the road, where the vehicles are passing through. Then the labelling of the vehicles is carried out using Object Detection Model. The model then calculates the vehicle's approximate distance from each other. If the distance between the vehicles are greater than 10 feet, then no warning is given out. If the approximate distance is greater than 5 ft and less than 10 feet then, a warning sign in Green is displayed.

This mandates the drivers to slow down their vehicles. However, if the distance is less than 5 feet, a warning in RED is issued. This alerts the drivers to keep a safe distance between the vehicles.

B. Collision Detection

A robust Collision Detection has been developed using a microcontroller, accelerometer, GSM and GPS Modules. The Collision Detection Module is embedded in all vehicles. The accelerometer in the vehicles gives out signals to indicate that the vehicle has met with an accident. On collision with another vehicle or an object, the accelerometer senses the change in the acceleration and triggers the GSM and GPS Module. The GSM and GPS module, then broadcasts the vehicle's location to the emergency contact, indicating that the vehicle has met with an accident. This helps the family members and Hospital Emergency aid (such as ambulance) to track the user and reach out to him for help at the earliest.

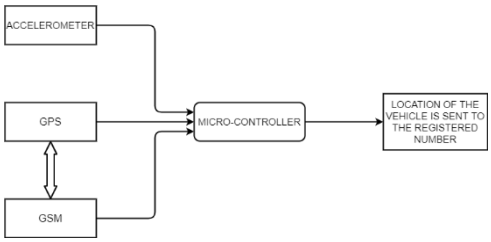

Figure 2. Block diagram of Collision Detection System

C. Development of Android Application for SOS

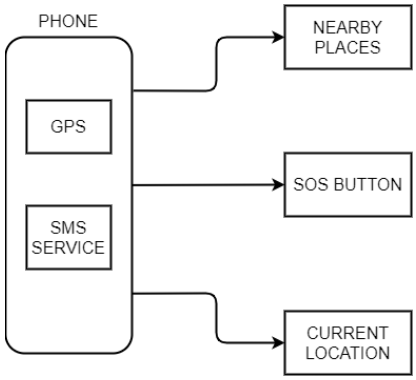

Figure 3. Development of Android Application for SOS

This module makes use of inbuilt Global Positioning System (GPS) and SMS (short message service) services of the phone.

More often than not, the information of any family member meeting with an accident reaches late, which may deprive the victim of good medical aid at the earliest. In order to facilitate a quick medical aid to the victims of accident, an application using android is developed. This android application is designed to facilitate the following:

1. Send an SOS message to the nearest emergency services. It also sends information to the driver's next of kin.
2. Current Location Aid to the driver if he is still alert.
3. Additional Navigational Features are provided to the driver. If he is alert, he can use these navigational features to drive to the nearest hospital. The app additionally gives location to gas stations, restaurants, medical centers, pharmacies, garages etc.

IV. *SOFTWARE DEVELOPMENT:*

PYTHON was used for developing the software required for image processing. The android application was developed using JAVA in Android Studio. The Microcontroller was programmed using embedded C. OpenCV was used to access the webcam as well as perform all the complex mathematical calculations. The MS COCO dataset is used to pre-train Single Shot Detection (SSD) Mobile net V1.

V. *WORKING*

An 8-bit microcontroller is used for controlling and processing the input data. The accelerometer is interfaced to the Microcontroller. If the vehicle collides with any object, the impact causes a sudden decrease in acceleration which activates the accelerometer which in-turn triggers the high signal to be input to the microcontroller. The microcontroller sends out appropriate signals to activate GPS and GSM, which are interfaced through digital IO pins.

The web camera captures the images of the vehicles. These images are processed using SSD mobile net V1. The model is trained using MS COCO data set. The Mobile net labels the data. There are approximately 90 labels in total. After

the object has been spotted, the approximate distance is determined using a probabilistic value in the range of 0 to 1. Each reading indicates a different approximate distance between the driver and the object ahead. A green alert is issued if the value is 0.3. A red alert is displayed if the reading falls below 0.1. This warning informs the driver that he or she must come to a complete stop.

5.1 User Assistance SOS App:

When a user first opens the app, a home screen is presented, which is as shown in figure 4. The app is user friendly. The user can navigate to subsequent displays. The user will be able to view his current location, nearby emergency locations such as hospitals, fuel stations, garages, and an SOS emergency button.

5.1.1 SOS Emergency:

The functioning of the SOS Emergency button is as follows:

1. SOS Emergency button is provided to the user.
2. When the user clicks on the button, the stored emergency number is accessed. (The user is required to register the Emergency contacts on this app prior to its use.)
3. The stored number could be of family members/ Hospital
4. The app sends out the location of the user with SOS message.

Figure 4. Display of Home screen

5.1.2 Nearby Utilities:

When this button is clicked, a list of options is displayed for the user.

Figure 5. Display of nearby services

Some of them are Hospitals, Fuel stations, Pharmacies, Garages, Hotels, etc.
This is presented in figure 5.When the user clicks on, Hospitals, the app locates the coordinates and uses Google maps to access all the hospitals near the user's location. Likewise, for all other services the exact location is marked on the map.

5.1.3 Get Current Location

Get Current Location basically displays the user's location along with Longitude, Latitude, Locality, Postal code, and the complete address. This is an additional feature to help the user get his current location while traveling in an unknown city. The maps API provides more than 20 variables or attributes. The current location service screen is presented in figure 6.

Figure 4. Display of Current Location

VI. *RESULTS*

Our project has been tested in different scenarios. It was broadly classified into three cases based on the distance of the vehicles from each other. The test was carried out for Safe distance, Green Alert Distance and Red Alert Distance. The test outcomes are discussed in the subsequent paragraphs

6.1 Safe Distance:

Safe distance is a distance greater than 10 feet between vehicles. For this distance, the model is successfully recognising the vehicles and is also calculating the proximity. Based on this proximity number, the model will determine the closeness of the object to any vehicle.

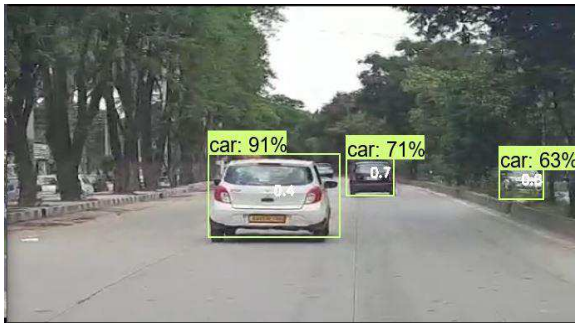

Figure 7. Safe Distance between Vehicles

6.2 GREEN ALERT DISTANCE:

Green Alert distance is a distance less than 10 feet and greater than 5 feet between vehicles. For this distance, the model is successfully recognising the vehicles and is also calculating the proximity. Based on this proximity number, the model will determine the closeness of the object to any vehicle. The model gives a warning in Green suggesting that the driver take heed and keep distance from the object ahead.

Figure 8. Green Distance between Vehicles

6.3 Red Alert Distance:

Red Alert distance is a distance less than 5 feet between vehicles. For this distance, the model is successfully recognising the vehicles and is also calculating the proximity. Based on this proximity number, the model will determine the closeness of the object to any vehicle. The model gives a warning in Red suggesting that the vehicle is too close to each other. And there is a probable chance of collision. The driver must immediately maintain the distance and take heed of the warning.

Figure 9. Red Alert Distance between Vehicles

6.4 Collision Detection

If a collision does occur, the accelerometer is triggered. This would cause the GSM and GPS modules to start working. A message would be sent immediately to the emergency contacts (Next of kin and medical assistance team) giving them the location of the accident.

SOS Message Display to the receiver: The SOS Message received by the next of kin or to Medical

Emergency Services looks as presented in the figure 9. The SOS message clearly indicates the location of accident and gives out the information required for one to reach the accident spot.

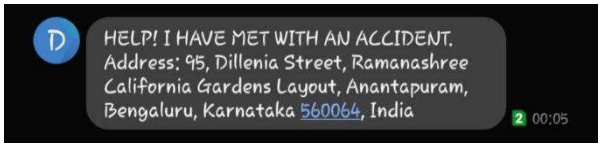

Figure 10. Message received by the user's next of kin and medical assistance team with the user's current location.

VII. *CONCLUSION:*

We have developed a collision warning System with a SOS user application.

The tests were carried out for different distance ranges. First the distance between the vehicles were maintained greater than 10 feet, which we have assumed as a safe distance. No message was displayed for this distance.

The vehicle was brought closer than 10 feet, approximately to a distance of 7 feet, and an alert was displayed to both the vehicle drivers, indicating that it is not a safe distance and a Green alert is displayed.

In the third case the vehicle distances were maintained less than 5 feet, resulting in the display of Red Alert caution to both the drivers.

The last case which is disastrous, when two vehicles collide, was only simulated. The functioning of the SOS application was tested. It sent the message presented in figure 10 to a friend's mobile. The driver was also able to send the medical emergency services message to another phone number. The driver was also able to locate his site of accident. He was also able to view the nearby utilities and services.

VIII. *FUTURE WORK:*

There is a vast scope for any project carried out for further enhancements.

With little modification the same unit can be used for Theft Detection, as the longitudes, latitudes and complete address of the car can be retrieved using the application.

The dataset can also be improved to recognize more vehicles as designs of vehicles are improving over time.

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