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A Lifesaver: Healthcare System For Road Accident And Emergency Patient

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Abstract: *Healthcare emergency becomes risky when the emergency patients won't get healthcare facility in time and in a proper way. Surveys done by private NGO's, the reports generated by government proves that people/ citizen of India won't get healthcare facility in time because of un-awareness about doctor's list, hospitals services. According to various articles published by newspapers and news shown by electronic media, we observed that people faced issues to get access to these facilities and this is one of the main reason behind the death. To overcome the problem faced by an emergency patient from getting ambulance service till the acceptance of the patient by the hospital, we proposed a solution which helps patient to get the healthcare service in time, using our website, patient or his/her caretaker may contact to the nearest hospital for the service otherwise if road accident happen to car then system is design to sense the accident and contact the nearest ambulance service. Our website contains nearest doctors', hospital's list, phone numbers, mobile numbers, bed available, services provided by the hospital, total expenses required, etc. All events will be recorded by the system and this helps to strengthen the healthcare system and the needy one.*

Keywords: *GPS, Haversine Formula, Node MCU, Gyrosensor, Smart Phone, Blynk, Healthcare.*

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I. Introduction

Each day there are almost 150000 people die in the world [7]. Reasons behinds the deaths are various diseases or road accidents or any other incident. But most of the people die because of diseases and road accidents. The diseases that can cause death are – cancer, cardiovascular diseases, respiratory diseases, dementia, diarrheal diseases, etc. These mention diseases are very fatal in nature. Not only diseases but road accidents are also the major cause of deaths.

In India, out of 1000 people, 7.3 people are dying per day [9]. According to the statistics generated by the Indian government, the national newspaper Times of India done the analysis and according to them, there are top 10 reasons behind this huge number of death rate, out of which heart attack/failure is at 1st position. Likewise lung diseases, stroke, pneumonia, diarrheal diseases, tuberculosis, diabetes, problems regarding kidney, preterm birth, and road accidents [8]. Since 2020, covid-19 is also one of the reason behind deaths. These diseases are categories into types – communicable and non-communicable diseases. In the case of communicable diseases, the patient can express the pain that they are feeling. But this is not possible in the case of non-communicable diseases and this is very risky because the person who suffers is not able to take the help of service or call the service. When such a situation occurs every patient requires immediate help from the healthcare system. Because of inaccessible as well as unavailability of healthcare services people won't get proper medical facilities and they may die before reaching the hospital.

In India, unavailability, as well as the inaccessibility of resources, is a big issue. Technology is enhancing day by day and becoming a part of each and every field. As the government of India adopt the technology and did the changes in the healthcare system too. They make centralized control of ambulance service by connecting all government ambulance to a single system to help the community. But the rate of illiteracy regarding technology in society is high and people won't know how to use it. People involved in the healthcare system won't reply when common people want to reach out to them. When people call for ambulance service they won't reply to their calls. Otherwise, the message delivers late to the authentic person and the ambulance gets late to reach the desired destination. If the ambulance came then the patient is taken to the government hospital for most of the time instead of taking them to the nearest hospital. This can cause an

increase in the chance of death if the patient's situation is critical. For this, automation becomes very important because every life is precious for their family.

II. Literature Review

Road accidents are one of the main contributing factors which cause the death of people across a country. Various researches show that the number of deaths because of road accidents globally is very high. There are a lot of thoughts and ideas behind every technology and innovation which cause new hope for the betterment and advancement of the human being. Currently, there are few technologies for accident detection. Most of these systems need to operate manually and the accident victim depends on others to rush to the hospital. Because of the above factors, the fatality rate of accidental patients is increasing. Some systems are working to make things easier being with some pros and cons.

2.1 Smart Road Accident Detection and Communication System [1]

In [1] authors have developed a hardware system to detect car accidents with the help of sensors. The accident is detected by a vibration sensor and gyroscope sensor and immediately emergency contact numbers are notified with the GSM module. Also, the exact location is recognized by the GPS module. Here, gyroscope sensors are used to measure the tilt and lateral orientation of the car, and vibration sensor**s** are used to measure the amount and frequency of vibration of a given object. When the vehicle gets collided, vibrations are produced. Vibrations are detected when they exceed the maximum threshold value of the vibration sensors. Likewise, if the vehicle doesn't hit but only rotates or tilts by any large angle the system will detect the accident from the gyroscope sensor. A heart rate sensor is also used to detect the variations in the heart rate of the driver only when the accident happens. This helps hospitals to know about the driver's condition and therefore they can proceed to help the driver.

2.2 Automatic Accident Detection and Notification System [2]

This paper presents a system that detects accidents of a car by using an accelerometer, force resistive sensor, gyroscope, Bluetooth module, and GPS module. Here, Android Application is provided with the car driver registration module with personal details such as driver name, photograph, blood group, etc. When the vehicle is met with an accident, values received from the accelerometer and gyroscope sensors are processed. If these values are more than the threshold values of sensors then the accident is detected. And the information is sent to the Smartphone's Bluetooth module to the Bluetooth module of Arduino and the alert is given to the hospital, blood bank, and police station for further help.

2.3 Conformity of Accident Detection Using Drones and Vibration Sensor [3]

In this paper, the author proposes an algorithm for implementing the accident detection and accident reporting system. This system uses vibration sensors, drones, and GPS sensors to detect and report vehicle accidents. Here, vibration sensors are used in a car to detect vibrations produced while in operation. These sensors are attached to the front, back, and sides of the car to detect unexpected vibrations produced by the impact of the accident. GPS is used for obtaining the current location of vehicles and it helps in obtaining the latitudes and longitudes of a particular place. In this system, drones can be used to analyze the accident scene by capturing the images of the driver of the number plate of the vehicles and also taking the pictures of the crashes to send the images to the control room so that the accident is reported and necessary action is taken by the authority based on the details provided by the drones.

2.4 Pre-hospital Emergency Notification System [4]

The author proposes an android application which allows the emergency medical unit to notify hospitals about the arriving of accidental victim's details and medical condition. A web-based system is also provided for hospital staff to keep track of the arriving patients. This project uses the Rapid Application Development model and the prototype is developed using PHP, MYSQL, XAMPP, Apache, and App Inventor 2. The health records of patient's details are recorded in the MYSQL database. The limitations we observed here are there is no search feature to find the nearest hospital in emergency and police stations and ambulance modules are not included in this system.

2.5 Domain-Specific Search Of Nearest Hospital And Healthcare Management System [5]

In this paper, the author proposes Android Tracking System for Healthcare Emergency using cloud computing. This system locates the nearest hospital from the accident location, contacts the hospitals, and maintains the health record of the patient which is used to assist in the future. This system includes the record of the clinics and blood banks which offer the extra services to the patients. The user can also take online health checkups to send their medical condition and get prescriptions from the doctor directly on a smartphone.

2.6 An Android-Based Emergency Alarm and Healthcare Management System [6]

This paper proposes the methodology by using GPS and GSM modules. When the accident occurred the location details of the victim are shared by the system. When the family members receive the emergency alert, they can immediately take the victim to the hospital. The health record of the patient can also be stored and maintained. An emergency button can be pressed manually during an emergency. The emergency message includes the patient's location details. The alert of emergency messages and calls will send to the victim's family members and the hospital. The limitations of this system are:

- The user always needs to install this mobile application to perform the task throughout.
- This emergency alarm system works manually when an emergency occurs.
- Alert is not given to the control center.

III. Proposed System

World Health Organization (WHO) had taken a survey on different root causes of deaths due to accidents. According to this survey report, the leading causes of the increasing mortality rate are road accidents, and every year, more than 1.35 million people lost their lives due to road accidents [10]. In India, a huge number of accidents are reported daily due to road crashes. In some cases, the accidents are much severe that the accident victim could not sustain due to delayed response from the healthcare department. This situation occurs because the details about the accidents could not reach the rescue department immediately. In the case of pregnant women, heart attack patients or any other emergency also have an issue of delay in ambulance or delay in medical assistance. To avoid these problems we proposed a web-based system for accident detection and to provide immediate healthcare to the emergency patient.

This section discusses the functionality and architecture of our proposed system. Fig. 1. Describes the system architecture. The proposed system has divided into two parts which are: 1) Hardware Module, 2) Software Module.

3.1 Hardware Module for Accident Detection

The vehicle Accident detection module is used to prevent unpredicted incidents that result in severe harm or damage and hence minimize death rates from road accidents. The figure demonstrates the main components used in the detection phase. These components help in recognizing the existence of an accident. The detection module utilizes the data from the components: 4 DC Motors, Node MCU, GPS, push-button, and gyroscope sensor to identify the occurrence of a vehicle accident. The following are the details on the hardware components used in the accident detection module. Fig. 1 shows the flow diagram of the accident detection system.

3.1.1 *DC Motor:*

A DC motor is a rotary electrical device/motor that converts electrical power into mechanical power, and then into rotational force. DC motors are powered from direct current.

Specifications:

- Operating Voltage Range: 4.5-9 V
- Rated Voltage: 6 V
- No load speed: 9000 rpm
- Max. No load current: 70 mA
- Loaded current: 250 mA

3.1.2 *Node MCU*:

Node MCU is an open-source development kit used to build IoT Applications.

Specifications:

- Microcontroller: 32-bit Tensilica LX106
- Frequency: 80/160 MHz
- Input-Output: 17*DIO
- ADC Pin: 1*10 bit(1V)
- Operating Voltage: 3.0~3.6V
- Program Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz

3.1.3 *Gyroscope sensor:*

Gyroscope sensors are used to detect the tilt and lateral orientation of an object in degrees per second. When the device is not rotating, the sensor values will be zeroes.

Specifications:

- Operating range: ±100 deg/s
- Noise (RMS): 0.06 deg/s
- Sensitivity: 50 LSB/(deg/s)
- Offset short term instability: < 2 deg/h
- Quantization: 0.05 deg/s
- SPI clock rate: 0.1 — 8 MHz

3.1.4 *GPS Technology:*

Global Positioning System (GPS) is a satellite navigation system that helps to determine the time and location (geographical latitude and longitude) information of any object across the globe with help of signals collected from the satellite in all weather conditions. GPS is mainly used for location, navigation, mapping, tracking, and surveying.

3.1.5 *Push Button:*

A push-button is a simple switch mechanism that allows to power any circuit or makes any particular connection on pressing the button.

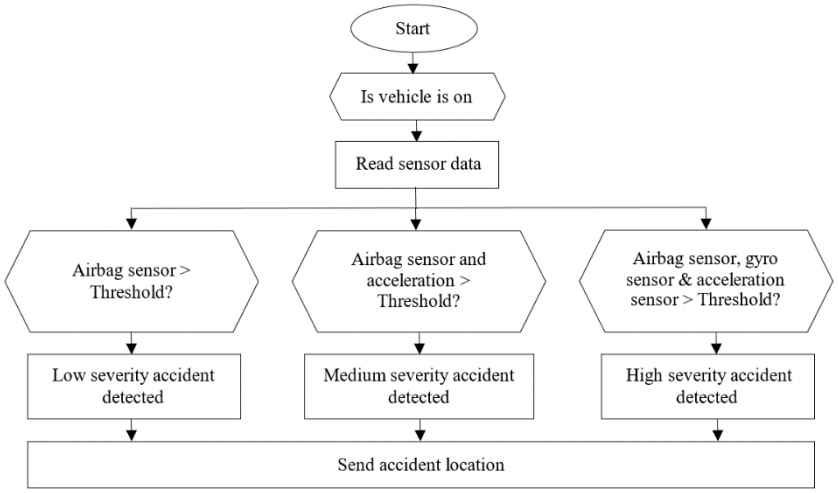

Fig. 1. Flow Diagram of Accident Detection System

3.2 Software Module for emergency patients

In the software module of our system, 3 main actors working as an ambulance driver, a hospital, and the police station. These three actors have a web-based system to connect with each other. As discussed above, vehicle accidents are detected and an alert message is sent to the ambulance driver as well as to the ambulance owner with accident location by using our Accident Detection System. In this system, common users can also search for the nearest hospitals to call for appointments for their routine checkups. An analysis is done on the gathered data which is generated by the cases. The flow of the system is shown in Fig. 2. The software system is further divided into sub-modules according to their working as follows:

3.2.1 Personalized Search:

This module of this system gives the way to the user who wants the ambulance service either from the specific hospital or from the nearest hospital. This module is divided into 2 sub-modules.

- *Hospital Specific Search:*

When a user wants to get the ambulance service from the specific hospital where he/she does the regular checkup or takes advice from that doctor then he/she is supposed to choose this option. After selection of this option, the user can see the list of the nearest hospital according to his location and he is able to choose the specific hospital. After submitting this form, a request is sent to the ambulance driver of the selected hospital.

- *Emergency Ambulance Service:*

When a user wants to get the service of the ambulance regardless of the hospital name or other parameters then he is supposed to choose this option. After selecting this option he is supposed to give the information of the patient and the request is sent to the nearest ambulance driver.

3.2.2 *Doctor's availability status:*

This is the sub-module of the hospital admin where the information of the availability of the doctor is updated. This is implemented by selecting the availability status (yes/no) of the doctor. If the doctor is not available then the hospital is not shown in the list of the nearest hospital list.

3.2.3 Analysis of the Data:

An analysis is done on the data which is generated by the cases. Data analysis is done by classifying it into subcategories. Categorization of the data is done according to the emergency and other parameters like year-wise analysis, overall analysis and also vary from admin to admin.

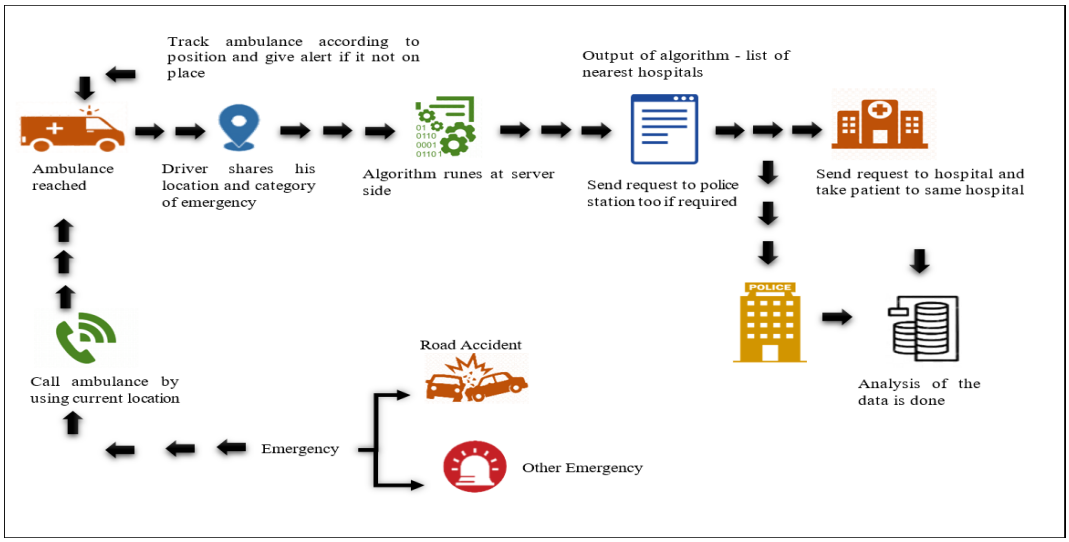

Fig. 2 System Flow

IV. Result and Discussion

The system discussed in the proposed system consists of two modules out of hardware module is implemented in the toy car as shown in Fig. 3 so that at the time of the accident, the hardware part recognizes the intensity and sends signal accordingly.

Fig. 3 Accident Detection Module

Likewise, the website is used by the remaining actors of the system such as ambulance drivers, hospital admin, and police station admin.

When an accident happened with a car, the gyroscope sensor senses the force by which both objects are collapsed on each other. After that sensor sends this data to the Node MCU and it will check the push button is pressed or not. Here push button acts as an airbag sensor. If the push button is pressed and force is greater than the threshold value then an accident is detected and mentioned as severe as shown in Fig 4.

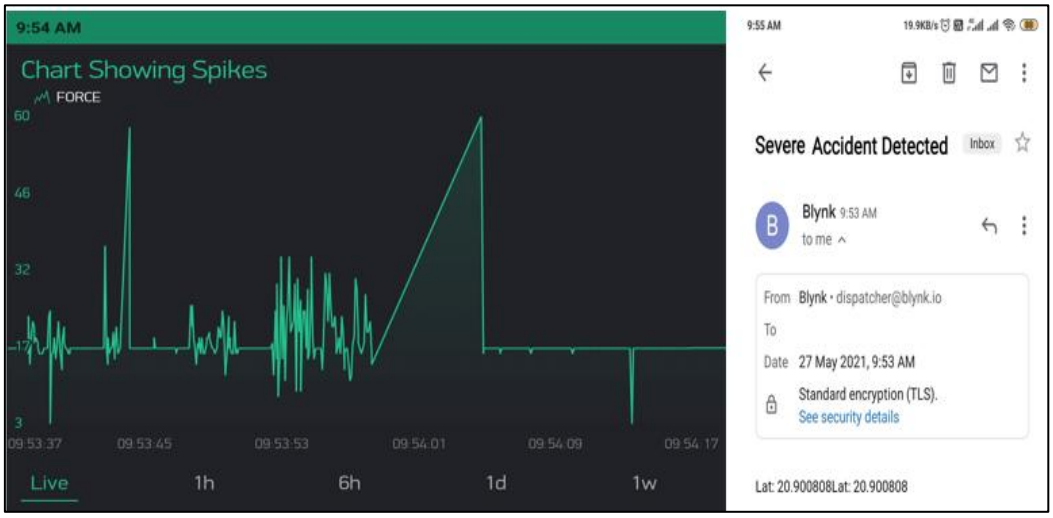

Fig. 4 Notification/Email Alert after Accident Detected

But if the push-button is pushed and the force is lesser than the threshold value then the accident is detected and mentioned as a non-server. This data from the car is then sent to the server. On the server-side, distance is calculated by using Haversine's distance formula by the latitude and longitude of the ambulance available in the system. After calculating distance request is send to the nearest ambulance. Then ambulance reaches to the accident location, then driver shares his current location and get the nearest hospital list and sends a notification to one of the hospital from the list. As soon as a notification is sent to the hospital at the same time police station under which that hospital comes is also notified. All these events are recorded by the system in the database.

System testing is done to check all the functionality of the hardware module as well as the software module. For this, all possible test cases are designed to check the hardware module of accident detection is working correctly or not and the software module of the system. Table I. shows the test table having test cases, input given, expected result, actual/observed result, and status of the test case.

TABLE I. System Test Table

Test Case	Expected Result	Actual Result	Status
Car should be able to detect dash.	Car should detect the dash.	Car detected the dash.	Pass
Severity should be detected by the hardware module.	Serveity should detected	Severity detected successfully and categories into severe and non-severe accident	Pass
Severity detected according to threshold value	Force of the dash should be calculated and check against threshold value	Force > threshold then accident is severe Force < threshold then accident is non-severe	Pass
System should be able to call nearest ambulance service	System should call nearest ambulance	Called nearest ambulance	Pass
Driver should able to see the nearest hospital list	List of nearest hopital should display	List of nearest hospital displayed	Pass
Hsopital should be notified	Hospital should notified	Hospital notified	Pass
Police station should be notified if required	Police station should notified	Police station notified	Pass
Hospital admin should be able to upadate the status of avialability of doctor	Availability status should updated	Availability status updated	Pass
Analysis of data should be done	Data should be analyzed	Data analyzed by using various filters	Pass

V. Conclusion

Healthcare system for road accident and emergency patient has been developed and tested successfully. Hardware module of accident detection has been developed by using IOT and embedded on small car. When there is emergency either accident or other type notification has been sent to the nearest ambulance driver. Ambulance driver able to see hospital list. Hospital has been notified when any emergency case is arriving. Police stations also been notified if required. All the events and their timestamp were recorded in the system.

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