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Research paper

Real-Time Monitoring of Driver's Biometrics to Prevent Multi-Vehicle Chain Collisions Caused by Impending Medical Emergencies

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Abstract

Smart healthcare systems are essentially going to become an inevitable part of our day to day activities. Sophisticated health monitoring devices will be used to provide a safer and less accident-prone society. Their use in active accident mitigation and management will extend, in the coming years, to not only our home atmosphere but will also include manufacturing, transportation, work-place and agricultural milieu. As a matter of fact, real time healthcare monitors have been introduced in some high-end, expensive luxury cars such as Mercedes-Benz and Tesla. The design proposed is a low-cost and affordable, continuous healthcare monitoring system which aims to extend the use Internet of Things (IoT) to vehicular systems. It is designed to detect anomalies in the driver's health conditions and take preventive actions to prevent road accidents. These actions include steadily reducing the vehicle's speed and ultimately stopping it. Simultaneously, an alarm or warning is relayed to the nearby vehicles of the impending emergency that has occurred, thus cautioning them of a possible accident. An emergency message is spontaneously relayed to the concerned medical personnel and to the emergency contacts–relatives of the driver.

Keywords: *Sphygmomanometer, Internet of Things (IoT), Motor Driver, Global Positioning System (GPS), Global System of Mobile Communication (GSM).*

1. Introduction

In countries such as India, which experiences a diverse range of climatic conditions and may experience extremes for more than half the year, some road accidents may happen due to driver's poor health condition like heart stroke while driving, over stress due to continuous work, diabetic strokes and blood pressure spikes etc. Hence, if a smart health care monitoring system is available at an affordable cost, it can be used to take both preventive and precautionary measures, and as a consequence may drastically reduce accidents related to medical emergencies and prior conditions to the drivers.

Drivers with prior medical conditions are at risk of causing a chain accident on the traffic-intensive roads of the present transportation system. 84% of the drivers in crashes precipitated by medical emergencies experienced heart related seizures, blackouts, or diabetic reactions prior to the crashes. This engineering endeavour aims at providing prompt precautionary measures to save a chain of accidents from happening in a fast-moving lane of traffic.

Internet of Things (IoT) has revolutionized the standards of living and has helped us achieve a smart society. Here, IoT is extended further to facilitate vehicle to vehicle communication (Internet of Vehicles). An IoT based solution which continuously monitors the driver's health by sensing and recording the heart rate and blood pressure is implemented to overcome the ever-increasing danger of accidents caused by medical emergencies. Anomalies detected prompt the vehicle to gradually slow down and ultimately stop.

The healthcare monitoring system is further extended to provide the detected and recorded abnormal values as well as the location information to both the transport office and the healthcare providers. Healthcare professionals can take the necessary course of action promptly, by using ambulance service and Transport Corporation can ensure driver's safety by conveying the situation to the nearest known relatives. Global Positioning System (GPS) is used to collect the location information of that particular vehicle and the medical anomalies are then relayed to the concerned medical authorities, along with the location information using a Global System of Mobile Communication (GSM) protocol.

2. Literature Survey

Gobhinath, S., Aparna, V., & Azhagunacchiya, R[1] focus on developing a system which will automatically stop the vehicle if the driver is found sleepy or in any abnormal condition and it is achieved by using eye blink sensor which will check whether the driver is sleeping or not whereas heart beat sensor monitors the heart-beat of driver and if found abnormal then it sends a message to the number stored in PIC microcontroller through a GSM module.

Arulananth, T. S., & Shilpa, B. [2] monitor the heart rate of a patient using heart beat sensor which consists of IR LED and a photodiode which will measure the blood flow and the values are sensed and controlled using Arduino Uno microcontroller and the recorded data can be send wirelessly using Radio Frequency Communication which consumes less power.

Chetan, M., & Moldovan, C. [3] tells us how home monitoring of blood pressure can prove useful and how it can be done. The paper points out the fact that the standard cuff does not cover the whole arm which can give error but if we use Intelli Wrap Cuff which is broader, then there will be almost no error as it covers the whole arm, and then this monitored data can be send to a doctor using a smart phone app where you can enter these data and get all the advices regarding your health by being at home.

Pothirasan, N., & Rajasekaran, M. P [4] focus on the vehicle to vehicle communication using micro controller and distance sensor and, the communication between the vehicles is made using NRF24L01 module. The paper focuses on the collision that occurs between vehicles and collision with the infrastructure surroundings. Collision avoidance is accomplished by the motor driver, as it slows down the vehicle when the distance between the obstruction and vehicle reduces below a certain value. They have focused on the man-made errors in driving and have avoided the biomedical aspects of the person which might trigger collisions.

Choudhari, S. D., & Giripunje, V. G. [5] have proposed a wireless healthcare monitoring system to obtain real time physiological health parameters of a driver using an ARM7 processor. This particular microprocessor is specifically used to drive the system at low power supply of up to 3.6V. The recorded data is transmitted to a cloud storage.

Al Rasyid, M. U. H., Lee, B. H., & Sudarsono, A[6] uses the concept of WBAN (Wireless Body Area Network) in which there is a network of sensor devices connected wirelessly to measure the data obtained from and around the body such as body temperature using thermistor and pulse oximeter for measuring hear pulses. The data values are sent wirelessly through ZigBee module to receiver nodes which can be accessed later by a desktop application.

Wang, Y., Hu, J., Zhang, Y., & Xu, C.[7] have used a IEEE 802.11 physical layer and created wireless terminals using Wireless safety units, they have created the wireless medium and used request-and-answer communication scheme, they have calculated the RSSI which means “Received Signal Strength Indicator”, is a measurement that is useful for determining if you have enough signal strength to get a good wireless connection, and their experiments reveals that there is a greater issue with the line of sight communication.

Al Abdulsalam, N., Al Hajri, R., Al Abri, Z., Al Lawati, Z., & Bait-Suwailam, M. M[8] have designed a Li-Fi based vehicle to vehicle communication system. The proposed Li-Fi system uses Light Emitting Diodes (LEDs) to communicate velocity changes in adjacent vehicles, and thus alarming the neighbouring vehicle drivers of the pertinent vehicle slowdown and stoppage. This specific alarm system is designed keeping the alarming vehicular accident rates in Oman.

Segata, M., Bloessl, B., Joerer, S., Sommer, C., Gerla, M., Cigno, R. L., & Dressler, F[9] have proposed a vehicular platooning system to improve efficiency of road traffic flow and as a consequence improve traffic safety. Platooning is the concept of cars implicitly following their leaders to form a road train. A combination of a slotted scheduling mechanism and transmit power control is proposed as an alternative to overcome the challenges in conventional beaconing protocols. The proposed design highlighted possible performance gains as compared to state of art beaconing methodologies.

Gomathi, C., Gandhimathi, D., & Dhivya, K. D. R[10] have designed a Vehicle ad hoc network (VANET) to improve the latency in delivering warning messages. Vehicular Collision Warning Communication (VCWC) protocol has been utilized to improve congestion control measures for emergency alarm messages and thus to improve the road safety. A low delivery delay to expedite the driver's response can be achieved as evident in this proposed design.

Islam, M. M., Rafi, F. H. M., Ahmad, M., Mitul, A. F., Mansur, T. T., & Rashid, M. A.[11] shows that the measurement of BP, heart rate and temperature can be done without using any cuffs and by only using Non-invasive continuous operating mode in which a sensor network consisting of sensor is placed with the body which measures all the data and then these data is send to ATMEGA8L microcontroller. This gives a new way to measure Systolic and Diastolic Pressure which is compared with the normal pressure and necessary action is taken if found a major change in the values.

3. Methodology

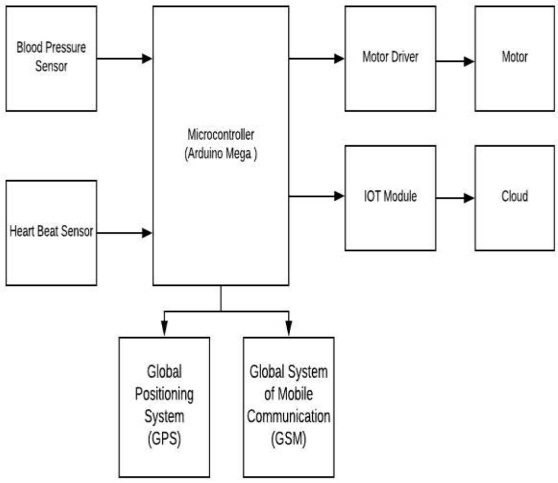

Fig. 1: Block diagram

The project is implemented using biomedical sensors such as Heart-Beat sensor and Blood Pressure sensor to monitor the condition of driver and if any abnormality is detected, then the vehicle will slow down and eventually stop. These sensors as the name suggests measure the heart beat and blood pressure respectively of the driver and the readings will be sent to the Arduino microcontroller which will process these values and take precautionary measures by sending a signal to a relay driver which will stop the vehicle using motor driver circuit.

An Arduino Uno which is widely used and is programmable through Arduino IDE is used to implement this project. The microcontroller uses the values obtained from sensors and helps in interfacing different circuit modules to implement a smart system.

The heart beat sensor uses IR transmitter and receiver system to measure the blood flow. The values are obtained when a finger is placed in front of the IR transmitter and the heart beat is measured by the number of times blood flow is detected by the receiver. Normal heart rate is 65-80 bpm for an adult.

Blood pressure sensor measures two different pressures. The top number refers to the amount of pressure in your arteries during the contraction of your heart muscle. This is called systolic pressure. The bottom number refers to your blood pressure when your heart muscle is between beats. This is called diastolic pressure.The normal blood pressure should show SP between 90 and 120 whereas DP should be between 60 and 80. Therefore normal reading should show pressure below 120/80 mm Hg and above 90/60 mm Hg in an adult.

A motor driver is used to drive the motor connected to the vehicle as Arduino alone cannot control the motor speed and intensity, hence with the use of IC L293D the dc motors are controlled and its speed is varied based on the signal from Arduino.

Once the vehicle gets slowed down, with the use of IOT module all the nearby vehicles will be alerted of the situation of the driver so that a chain of accidents can be prevented.

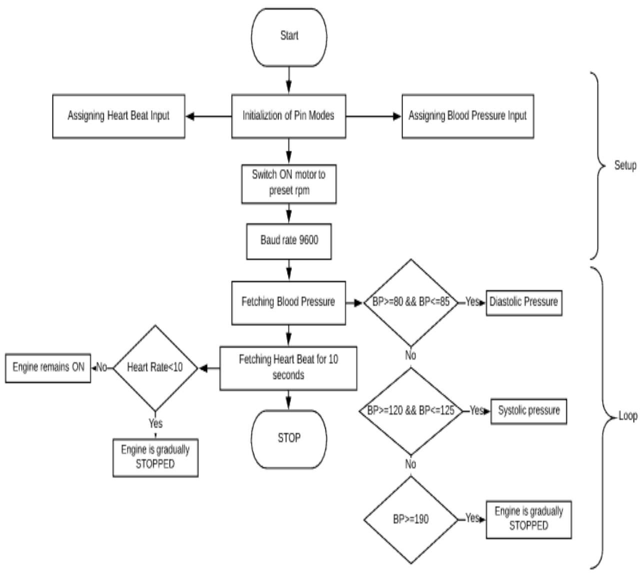

Fig. 2: Flow diagram

Along with this a GPS module is used to send the location of the vehicle to an emergency mobile number with the use of GSM.

4. Results

The Results are recorded from the Arduino Serial Monitor. The tabular columns show the Heart Beat and Blood Pressure readings respectively.

- Table I shows that as the pressure in the Sphygmomanometer is initially increased the diastolic pressure readings are recorded in the range of 80 to 100 mmHg and the systolic pressure readings are above 100 mmHg. As the systolic pressure reaches beyond 180mmHg, an abnormal health condition is conveyed and the motor is gradually slowed down and ultimately stopped.
- In Table II, the 0's and 1's in the Heart Beat values denote that the IR transmitter makes communication with the IR Receiver – when the value is 1, it implies that there is no obstruction. Similarly, when the IR transmitter doesn't make communication with IR Receiver, then the value of the Heart Beat is 0, which implies that there is an obstruction. The obstructions are caused by the increased blood flowing through the finger during the ventricular repolarization (Systole).

Table I: Variation of Status of Motor with change in Blood Pressure

Pressure	Reading	Status
Diastolic	80 mmHg	Motor Running
Diastolic	90 mmHg	Motor Running
Diastolic	100 mmHg	Motor Running
Systolic	110 mmHg	Motor Running
Systolic	120 mmHg	Motor Running
Systolic	130 mmHg	Motor Running
Systolic	140 mmHg	Motor Running
Systolic	150 mmHg	Motor Running
Systolic	160 mmHg	Motor Running
Systolic	170 mmHg	Motor Running
Systolic	180 mmHg	Motor Running
Systolic	190 mmHg	Motor STOPPED
Systolic	200 mmHg	Motor STOPPED

Table II: Variation of Status of Motor with change in Heart Beat

Iteration	Reading
1	Heart_Beat= 0
2	Heart_Beat= 0
3	Heart_Beat= 1
4	Heart_Beat= 1
5	Heart_Beat= 0
6	Heart_Beat= 1
7	Heart_Beat= 1
8	Heart_Beat= 1
9	Heart_Beat= 1
10	Heart_Beat= 0
11	Heart_Beat= 1
12	Heart_Beat= 1
13	Heart_Beat= 0
14	Heart_Beat= 0
15	Heart_Beat= 1
	HEART BEAT = 6
	ABNORMAL HEART RATE

The number of zeros that occur in the time period of roughly 10 seconds is counted which is then multiplied by six to obtain the number of beats per minute.

As soon as either the heart beat or the blood pressure becomes abnormal, the motor is slowed down gradually using the motor driver, and the data is continuously sent to a cloud storage and an alarm signal is sent to the driver driving behind through the wireless communication module. Additionally, a message containing the location of the vehicle is sent to emergency services with the use of GSM and GPS.

5. Conclusion

The implemented design aims to substantially alleviate the standards of road safety. Unavoidable medical emergencies which can consequently reduce the driver's control of the vehicle have, in numerous instances, led to serious road catastrophes and have resulted in multiple driver-passenger deaths. The project makes use of two biomedical sensors in particular – Blood Pressure and Heart Beat – to continuously monitor the health dynamics of the driver. Anomalies recorded prompt the system to gradually slow down the vehicle and simultaneously send crises messages to concerned authorities – medical personnel and close emergency contacts. It also warns the nearby vehicles of the imminent crises with a particular vehicle. On a production scale, highly sophisticated and accurate biomedical sensors can be used instead of the IR based heartbeat sensor and the cuff-pressure sensor used in the design as a consequence of budget constraints. A fully equipped, integrated health monitoring system can additionally include alcohol detectors and breathing pattern recognizers to enhance security and vehicular safety

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