IoT based Emergency Handling Communication System for Medical and Traffic Rescue Teams

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Abstract. Cloud Computing is a thriving technology, capable of revolutionizing the planet. On the Internet of Things (IoT), all objects across the universe have the potential to connect, which in turn provides the citizens with an understanding of everything. Many programs hire IoT to help people make their everyday life better, faster and healthier. In this article, we are suggesting an IoT-controlled emergency response system for Medical and Traffic emergency handling teams, which could be very useful when a vehicle is experiencing a catastrophic accident. A quick and accurate assessment of the extent of the incident is critical to improve the overall recovery method and enable emergency responders to properly determine the resources needed. The proposed device immediately starts to work when an emergency condition is observed. The program would initiate communication with the authority involved and sends critical and relevant details, such as the position of the incident, monitored health condition and photographs taken while the accident happened, using the camera. The device implementation uses Raspberry Pi 3 and required specific sensors.

Keywords: IoT, Accident Alert, Emergency Handling System, Raspberry Pi, Driver’s condition.

1. Introduction
In the past few decades, the total number of vehicles on roads has increased exponentially, which increases vehicle traffic. The immediate consequence of this situation is the drastic rise in road traffic fatalities, which is a serious issue in most countries [1]. Drivers are not the only reason always for vehicle accidents. One of the main factors of vehicle crashes is the abrupt stalling of traffic, particularly on fast roads and highways with limited visibility. It could be due to other reasons like work-in-progress roads, traffic levels, etc. Driver visibility can be inadequate due to numerous reasons, like tight corners, fog, scarce light tunnels and so on [2].

As a result of road traffic accidents, millions of people are losing their lives every year. According to the road safety statistics of the World Health Organization (WHO) [3], 1.35 million deaths occur every year all over the world due to road traffic accident injuries. It is estimated that 74% of traffic accident deaths occur in the middle-income countries. Improvements in road safety and the development of effective strategies and systems are vitally important, particularly in the underdeveloped countries [4].

Developing nations’ key goal is to plan and develop many innovative IoT-based initiatives to render their communities a smart city. Connecting all gadgets within a modern city to the universal system is common. The IoT is very much helpful in developing new low-cost intelligent traffic management systems to solve these problems [5].
Various safety equipments are available in cars to protect drivers and passengers during accidents. Airbags are mounted in every car and used for travel protection and security. Since 1968, airbag device is in operation [6]. The Tire Pressure Monitoring System (TPMS) is a device meant to monitor and control the pressure on tires of cars and trucks and provides various driving conditions, such as lesser tire pressure required to increase traction, maneuver through difficult terrain, drag a massive load out of the steep slope at low speeds and crawl out of soft sand. The pressure is variable between 15 and 45 PSI [7].

Reckless driving is one of the major reasons for vehicle accidents. In [8], a defensive system is designed for the safety of people by automatically detecting and alerting reckless driving. Cloud server and machine learning algorithms are used in this defensive system. Driver’s drowsiness is also a reason for vehicle accidents, and various devices are available to detect the drowsiness and alert the driver to avoid road accidents [9].

Nearly, all modern-day vehicles are equipped with multiple sensors that are mounted on the hardware and used to anticipate the crash and have taken precautionary steps to prevent it [10]. All such digital systems are used to prevent the vehicle from accidents, even though accidents occur in some unexpected cases. In most cases, the passengers are losing their lives due to the delayed arrival of emergency services to the crash site [11]. It is apparent that if the relevant teams would collect the crash details, including a photo of the driver’s condition directly from the accident spot, they will reach with lifesaving equipments without delay to save the victims’ life.

1.1 Research Objectives:

a) To create a coordinating network to monitor the driver’s health condition from an accident spot, and which also functions as a lifesaving mechanism by transmitting alert notifications regarding the victims’ whereabouts directly to the rescue teams at the time of accident.

b) To create a system that transfers essential medical information, such as a driver’s body temperature, pulse rate and inside car photos from the accident spot to the server [12].

1.2 Social Benefits:

a) The emergency rescue teams would easily reach the accident spot since the system shares the location information with the server.

b) The picture messages shared by the system help the medical team to analyze the condition of the passenger and driver and make appropriate preparations.

1.3 Proposed Methodology:

An efficient communication framework is implemented in this research work to identify the position of the vehicle when an accident occurs and relays the information to the rescue team along with photos and health information about the driver. This work primarily aims to minimize the time required for the rescue team to reach the accident spot and to start the rescue operations very quickly [13]. The device will be mounted on the vehicle, start functioning immediately after the crash and transfer relevant information to the rescue team via mail and message.

The received data contains the following key information, which helps the emergency team to take immediate action:

a) driver’s body temperature
b) heart rate
c) inside car photos
d) accident location

2. System Architecture

The proposed system consists of two units and they are Accident Sensing Unit (ASU) and Camera Unit (CU). Figure 1 and Figure 2 shows the block diagram of the two units. When an accident situation is
detected by the ASU, it sends an activation signal to CU and starts capturing the health parameters of the driver and geographic location of the accident spot. The health parameters are body temperature and heart rate. The geographic location information includes latitude, longitude along with the date and time of the accident.

**Figure 1:** Accident sensing unit

As shown in figure 1, the ASU is a collection of different components, and each one is doing a unique task. The vibration sensor measures the vibration and gives the signal to the Arduino microcontroller [14]. Based on the trained values, the microcontroller decides that the accident has happened. During this time, it rises and gives an activation signal to the CU to capture inside the car photos. The heartbeat and temperature sensors are used to detect the heart rate and body temperature.

**Figure 2:** Camera Unit
of the driver. The Global Positioning System (GPS) receiver is used to find the geographic location and the GSM modem is used to send SMS to the rescue team during an accident.

The CU consists of a Raspberry Pi processor and a camera as shown in figure 2. When it receives an activation signal from the ASU, it captures a few photos and sends via email to the rescue team. It receives the internet connection from the driver's mobile through Wi-Fi.

**Raspberry Pi 3**: Raspberry Pi is a small size computer. It operates in the open-source ecosystem. It runs with open-source software.

- a) 1.2GHz 64-bit quad-core processor
- b) Wi-Fi, Bluetooth and USB boot capabilities
- c) 1.4GHz processor and a three-time faster gigabit Ethernet.

2.1. **GSM Modem**: GSM stands for Global System for Mobile Communication. A GSM modem is a device used to make the processor communicate over a mobile network. When the car meets with an accident, the alert message with location information [15] will be sent to the emergency handling teams as SMS, using the GSM communication modem.

2.2. **Temperature Sensor**: LM35 is used to measure the body temperature. It produces a proportional analog dc output voltage corresponding to the body temperature. For every 1°C rise in temperature, the sensor output voltage will increase by 10mV. The analog-to-digital converter peripheral of the Arduino microcontroller reads the analog voltage, converts into a digital signal and manipulates the temperature.

2.3. **Camera**: A normal USB protocol supported web camera is used in this system to capture inside the car photos when an accident is detected. Raspberry Pi reads the camera and sends the images to the rescue team via email. The images are used to analyze the health conditions of the passengers and driver and to take the necessary action and precautions accordingly.

2.4. **Heart Rate Sensor**: It consists of two parts, one is LED and another one is a Detector. LED emits and reflects light. The detector receives the reflected light. The bursts of heart rhythm induce a difference in blood supply in different areas of the body. When the incident occurs, the blood loss will result in any light being consumed by the body. The amount of light consumed by the tissue depends on the quantity of blood in it. The sensor performance is in the form of an electrical pulse and is equivalent to the pulse rate. The number of higher peaks in a minute is considered a pulse rate.

2.5. **GPS Receiver**: It receives signals from GPS satellites’ constellations that are placed around the earth. The signal gives information about the geographic location, such as latitude, longitude, altitude and time. This information is useful to the rescue team to reach the accident spot in the shortest possible time. This may help save human lives due to severe blood loss or delayed rescue operations.

2.6. **Vibration Sensor**: The transducer in the sensor converts the physical vibration into an electrical signal, and it is read by the microcontroller. By analyzing the signals, the controller finds the accident situation.

3. **Results and Discussions**

Figure 3 shows the interconnection of devices in the proposed system. It has been tested by means of vibration on the system manually. Immediately after observing vibration from the vibration sensor, the Arduino microcontroller starts reading the GPS receiver, body temperature sensor and heart rate sensor. After reading the information, the microcontroller constructs a message using this information.
regarding the accident and sends it to the rescue team. Also, it sends a triggering signal to Raspberry Pi to capture photos. The Raspberry Pi captures inside the car photos and sends it to the rescue team via email. Figure 4 and Figure 5 shows the screenshots of the output received from the device via SMS and email.

As shown in Figure 4, the received SMS consists of information such as a warning message, date and time of the accident, body temperature, heart rate of the driver and the accident spot’s geographical location.
Figure 5: Screenshot of email message

As shown in Figure 5, the email received by the rescue team consists of photos that will explain the condition of people inside the car. It will help the rescue team with their necessary medical preparedness. Due to the development of the telecommunication system, the speed of both SMS and email delivery is quite fast. Therefore, within a couple of seconds, the message will reach the rescue team, and they can immediately start the rescue mission.

4. Conclusion
The communication system for handling emergencies is developed and tested. The system gives an effective solution to the problems of unexpected deaths due to road traffic accidents. When an accident occurs, the system establishes communication among the accident vehicle, the medical staff and the traffic accident rescue team. It gathers and sends information to the rescue teams immediately regarding the geographic location, the time of the accident, the body temperature and the heart rate of the driver, and also captures inside the car photos. The digital map facilities that are available nowadays can help access the accident spot easily and quickly. The health parameters and photos are useful to the medical team to analyze the health condition of the driver and the passengers. In short, the system can reduce the time taken by the rescue teams to reach the accident spot, and will reduce the death rates due to the treatment delay. In the future, the system could have an in-built feature of sending live videos to the rescue teams instead of sending the photos.
References

1. Mohan, D. (2009). Road accidents in India. *IATSS research*, 33(1), 75.
2. Ruikar, M. (2013). National statistics of road traffic accidents in India. *Journal of Orthopedics, Traumatology and Rehabilitation*, 6(1), 1.
3. Jain, A., Ahuja, G., & Mehrotra, D. (2016, September). Data mining approach to analyze the road accidents in India. In *2016 5th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)* (pp. 175-179). IEEE.
4. World Health Organization Road Traffic Injuries Fact Sheet No 358, March 2013, Available from http://www.who.int/mediacentre/factsheets/fs358/en/
5. Chen, S., Xu, H., Liu, D., Hu, B., & Wang, H. (2014). A vision of IoT: Applications, challenges, and opportunities with China perspective. *IEEE Internet of Things journal*, 1(4), 349-359.
6. Yu, M., Zhang, D., Cheng, Y., & Wang, M. (2011, May). An RFID electronic tag based automatic vehicle identification system for traffic IOT applications. In *2011 Chinese Control and Decision Conference (CCDC)* (pp. 4192-4197). IEEE.
7. Kalyani, T., Monika, S., Naresh, B., & Vucha, M. (2019, March). Accident detection and alert system. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 8(4S2), 227-229.
8. Zhang, L., Yan, L., Fang, Y., Fang, X., & Huang, X. (2019). A machine learning-based defensive alerting system against reckless driving in vehicular networks. *IEEE Transactions on Vehicular Technology*, 68(12), 12227-12238.
9. Chowdhury, A., Shankaran, R., Kavakli, M., & Haque, M. M. (2018). Sensor applications and physiological features in drivers’ drowsiness detection: A review. *IEEE Sensors Journal*, 18(8), 3055-3067.
10. He, W., Yan, G., & Da Xu, L. (2014). Developing vehicular data cloud services in the IoT environment. *IEEE transactions on industrial informatics*, 10(2), 1587-1595.
11. Vatti, N. R., Vatti, P. L., Vatti, R., & Garde, C. (2018, March). Smart road accident detection and communication system. In *2018 International Conference on Current Trends towards Converging Technologies (ICCTCT)* (pp. 1-4). IEEE.
12. Amin, M. S., Jalil, J., & Reaz, M. B. I. (2012, May). Accident detection and reporting system using GPS, GPRS and GSM technology. In *2012 International Conference on Informatics, Electronics & Vision (ICI EV)* (pp. 640-643). IEEE.
13. Ijjina, E. P., & Sharma, S. K. (2019, July). Accident detection from dashboard camera video. In *2019 10th International Conference on Computing, Communication and Networking Technologies (ICCCNT)* (pp. 1-4). IEEE.
14. Khalil, U., Nasir, A., Khan, S. M., Javid, T., Raza, S. A., & Siddiqui, A. (2018, November). Automatic road accident detection using ultrasonic sensor. In *2018 IEEE 21st International Multi-Topic Conference (INMIC)* (pp. 206-212). IEEE.
15. White, J., Thompson, C., Turner, H., Dougherty, B., & Schmidt, D. C. (2011). Wreckwatch: Automatic traffic accident detection and notification with smartphones. *Mobile Networks and Applications*, 16(3), 285-303.