Advanced of Accident Monitoring System Application

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Abstract. Smart cities are looking for ways to improve road safety, and intelligent transportation systems (ITS) are receiving a lot of interest from the academic and business community. As the number of automobiles continues to climb, a considerable increase in road accidents has been reported. Vehicles with several sensors allow us to monitor their current state and discover incidents. Therefore, a remote monitoring system is required to operate cars in real-time, utilizing a monitoring tool capable of detecting traffic accidents and emergencies along the route. The design was carried out using accelerometer sensors, vibration sensors, sound sensors, the Neo 6M GPS as a coordinates provider, and PI NoIR cameras to capture images of the surrounding conditions when events occur.

Keywords: intelligent transportation systems · accident monitoring

1 Introduction

The Global Status Report on Road Safety (WHO, 2020) says that more than 3,700 people die daily in traffic accidents worldwide. In certain countries, there is less traffic during a pandemic, but more accidents occur [1]. The significant increase in traffic accidents has caused numerous injuries and fatalities. According to estimates from Korlantas Polri, there will be 101,198 total accidents in 2020 [2]. Meanwhile, traffic accident data from 2015 to 2020 showed 528,058 accidents with 164,091 fatalities and a public transit violation rate of 15.9%. There are three categories of passing offenses: Accidents on the road are caused by human mistakes and the absence of external oversight over public transportation drivers.

Each year, more than one million people die in road accidents worldwide. Traffic accidents will kill the most people by 2030, according to the WHO [3]. Driver factors contribute to about 50% of accidents, according to research in many large countries [4]. Many factors can cause road accidents, but driver irresponsibility is one of the most preventable. Driver irresponsibility is one of the most avoidable causes of road accidents.

Over the past decade, automakers and others have developed intelligent car technologies to track vehicle and driver behavior. Several automakers and other companies have developed intelligent car technologies to monitor vehicle and driver behavior throughout the past decade. However, the price of a vehicle with these amenities is considerable,

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and the number of manufacturers is limited. Smartphones of the present day are the principal owners of comparable features. Besides GPS, smartphone sensors include an accelerometer, gyroscope, light sensor, proximity sensor, and magnet (GPS). This sensor can process camera and microphone data. Utilizing this sensor in monitoring applications has been standard procedure.

Smartphone technology enables vehicle monitoring programs that can track potentially dangerous driving behavior. Widespread smartphone connectivity permits the monitoring of traffic and routes as well as the reporting of accidents. Currently, only smartphone sensors can detect accidents [5]. An earlier study has proven that cell phones can be used as a telemonitoring system. Transportation research has utilized smartphone-based telemonitoring techniques [6–11]. Nonetheless, these studies only address route, stop, station, and terminal data and stop and transit mode detection.

This research will develop a telemonitoring accident system for public vehicles using an Android-based smartphone application. The method may employ accelerometers and auditory data to detect road accidents, quickly inform the emergency message server after a collision, and provide drivers with situational awareness via images, GPS coordinates, video communication channels, and recording accident data.

2 Intelligent Transportation System Using a Smartphone

Developing advanced ITS applications necessitates the use of many sensors and sensing techniques. Many factors, including hardware, software, power supply, and data, exhibit heterogeneity on a broad scale [12]. Applications of ITS require high-quality, integrated, and occasionally real-time data. The problem of data heterogeneity is anticipated to become more complex in future ITS since it would involve data from different sensors on the same item and data with entirely diverse features and generating processes.

Smartphones with many sensors can collect GPS, GSM, accelerometer, and other contextual data for location detection, trajectory tracking, and mode of transportation detection. Smartphones are the most transportable, flexible, and potent gadgets that can function as sensors and machine-to-machine/M2M gateways. In recent years, much research has been conducted on smartphone sensing applications.

Smartphones are used as sensor gateways in automobiles on M2M platforms, providing physical management applications like congestion monitoring and route rerouting [13, 14]. The platform described by Ali et al. serves the same purpose. However, the smartphone user must manually enter the information [15]. In research, [16] is a service that uses smartphones to identify traffic signals using cameras and cooperatively share them opportunistically. Meanwhile, [17] is an application that uses smartphone cameras and wifi to detect nearby vehicles in traffic jams and collectively compute traffic queue durations.

Nericell [18] is a smartphone-based system designed to detect a variety of vehicle-related circumstances, including braking, road imperfections, honking, and stop-and-go traffic. The system employs the smartphone's accelerometer, microphone, GSM, and GPS connections for this aim. The Nericell collects data from several smartphones on a centralized server and aggregates it. Mohan et al. envision a system for annotating existing traffic maps with information such as road surface conditions and traffic chaos levels. Nericell attempts to utilize sensors effectively. Only the accelerometer is sampled constantly when the GSM radio is engaged, which is necessary for communication. The system depends on input from these devices to save energy by activating the microphone or GPS only when necessary. Each smartphone filters and processes data locally before transmitting it to servers for aggregation.

3 Proposed Method

The traffic accident monitoring system is designed using MPU 6050 sensors, FC 04 sound sensors, SW 420 vibration sensors, Pi NoIR cameras, and wifi hotspots as service providers. The system in this study is designed to automatically detect traffic accidents by providing notifications to the server without time lapse in the form of emergency messages after accidents, coordinates on maps, video communication channels, and recording of accident data, block diagram shown in Fig. 1.

The monitoring system process using an intelligent transportation system consists of three stages. The first stage in the monitoring system starts with collecting data, such as data from network traffic and hardware information. Then the data is analyzed in the data analysis process sent through a server connected to the access point then the data will be displayed in the form of information.

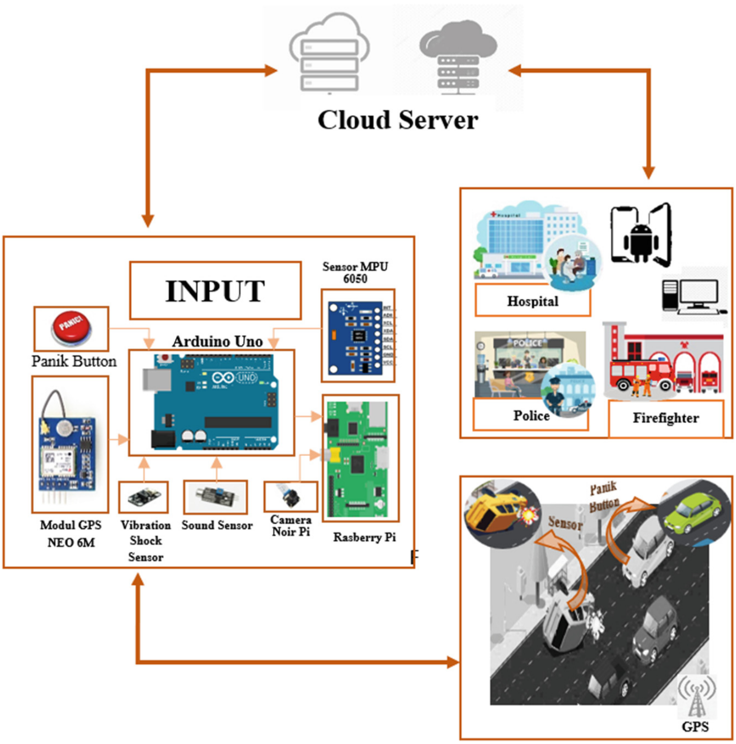

Fig. 1. Block diagram of the accident monitoring system

4 Result and Discussion

The hardware is designed in a compact, portable box to maximize efficiency and minimize storage capacity. Integrating the MPU 6050 sensor with the gyroscope sensor, this device uses the MPU 6050 sensor as a tilt condition detector. The FC 04 sensor acting as a noise detector, can detect a loud bang. The SW 420 sensor detects when the vehicle is subjected to severe shocks. When a collision happens, a Pi NoIR camera records the situation and condition of the driver. Neo 6M GPS works as accident location information on automobiles equipped with this accident monitoring equipment. Utilizing a wifi hotspot network for communication between servers acting as databases and hardware are Raspberry Pi 3 and Arduino Uno devices as microcontrollers.

This research advances earlier studies, with the added benefit of being smaller and more portable [19]. The device can be placed on the vehicle. Figure 2 depicts the results of the design of an accident monitoring device.

In the experiments, the device is mounted on the mobile remote depicted in Fig. 3. Testing the slope, vibration, and sound conditions that result from a crash is done to acquire data.

The traffic accident monitoring system will automatically detect traffic accidents using the MPU-6050 sensor, vibration sensor, and sound sensor. It is shown that the vehicle tilts at the moment of an accident due to a sloping road, giving the car a specific amount of inclination. The displayed noise values are obtained from collisions with complex objects, such as sidewalks or vehicle crashes. Vibration values are illustrated by shaking the tool until it experiences a specific shock limit. When an accident occurs, the sensor will read the slope, noise, and vibration values. At the same time, the camera will automatically take traffic accident conditions and the location of the accident to be sent directly to community services so that further action can be taken quickly.

Table 1 shows the sample data results from the accident rate and slope on the traffic accident monitoring tool. The data shows the results of the information for Latitude (Lat) and Longitude (Long) are coordinate points, X shows the slope of the right and left sides, Y shows the slope of the front and rear sides, and vibration data 1.00, useful data 1.00 indicates that there has been a traffic accident. However, if the vibration and sound data are 0.00, there is no traffic accident.

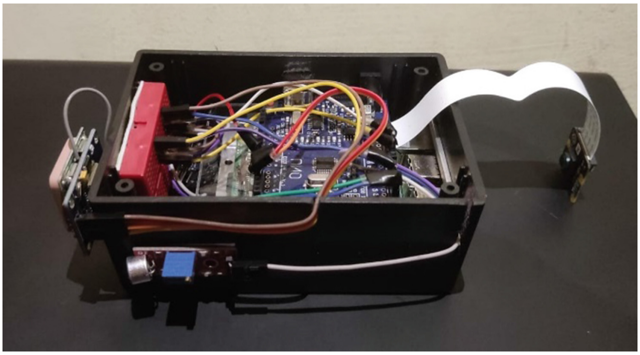

Fig. 2. The design of an accident monitoring device

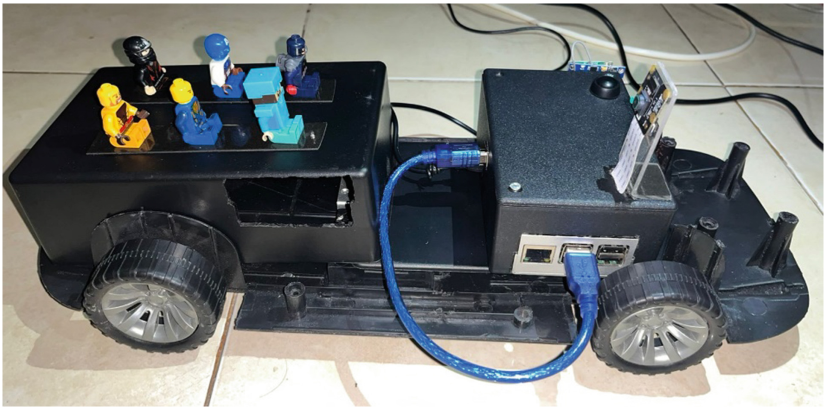

Fig. 3. The device installed on the mobile remote control

Table 1. Intelligent Transportation System Traffic Accident Monitoring Results

Lat	Long	x	y	z	Vib	Sound	Info
-29318378	1047227706	153.00	132.00	0.00	0.00	0.00	Normal
-2.9317669	104.7226638	163.00	133.00	255.00	0.00	0.00	Normal
-2.9318375	104.7226715	168.00	132.00	252.00	0.00	0.00	Normal
-2.9317827	104.7226943	179.00	134.00	251.00	0.00	0.00	Normal
-2.9317626	104.7226562	154.00	77.00	247.00	0.00	1.00	Accident
-2.9317789	104.7226638	154.00	69.00	242.00	0.00	1.00	Accident
-2.9318127	104.7226943	154.00	43.00	224.00	1.00	1.00	Accident
-2.9317317	104.7226943	154.00	45.00	228.00	1.00	0.00	Accident
-2.9317536	104.7226715	254.00	129.00	184.00	1.00	1.00	Emergency
-2.9317693	104.7226715	254.00	129.00	186.00	1.00	1.00	Emergency
-2.9317564	104.7226486	254.00	128.00	176.00	1.00	1.00	Emergency
-2.9317564	104.7226486	255.00	127.00	182.00	1.00	1.00	Emergency

The Android application will display the monitoring system software system in the form of sensor reading data, namely the slope of the MPU-6050 sensor, noise from the sound sensor, and vibration wave data from the vibration sensor (shown in Fig. 4). Additionally, the Neo 6M GPS records position data in latitude and longitude and accident data in photographs when crises or accidents happen. The accident monitoring data will be shown on the server as the original data collected from the sensor, which will generate the result as accident rates under normal conditions, accidents, and emergency accidents. The following is a demonstration of the application for tracking traffic accidents.

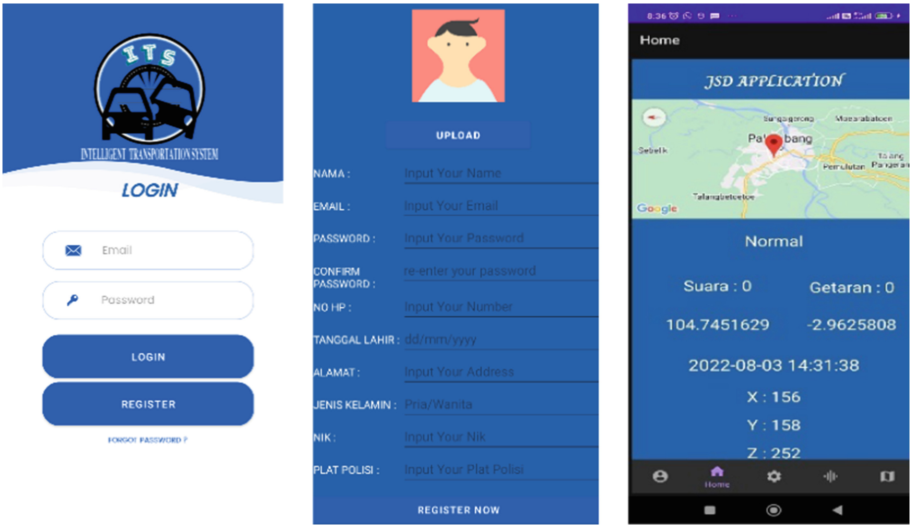

Fig. 4. Integration of an Accident Monitoring Application with an Android-based ITS

5 Conclusion

The performance of the traffic accident monitoring system is correct in terms of timing, accident location, slope, and noise. This research indicates that using a range of sensors can improve the accuracy of road accident detection. The suggested method locates an accident quickly, determines the closest hospital, and notifies the necessary hospital department and firefighter of an emergency call for aid. This system makes decisions based on data obtained from smartphone sensors that monitor vehicle status information.

References

1. R. Abd Rahman, N. Sakim, W. M. Lim, M. I. Mohd Masirin, and M. F. Hassan, "Road Safety and Traffic Injuries Due To Distracted Driving of Smartphone Usage Among University Students," J. Civ. Eng. Sci. Technol., vol. 12, no. 1, pp. 46–55, 2021, https://doi.org/10.33736/jcest.3343.2021.
2. "Berdasarkan catatan data Kementerian Perhubungan yang di dapat dari Karlantas Polri." .
3. T. Toroyan, M. M. Peden, and K. Iaych, "WHO launches second global status report on road safety," Inj. Prev., vol. 19, no. 2, p. 150, 2013, https://doi.org/10.1136/injuryprev-2013-040775.
4. M. S. Young, S. A. Birrell, and N. A. Stanton, "Safe driving in a green world: A review of driver performance benchmarks and technologies to support 'smart' driving," Appl. Ergon., vol. 42, no. 4, pp. 533–539, 2011, https://doi.org/10.1016/j.apergo.2010.08.012.
5. J. White, C. Thompson, H. Turner, B. Dougherty, and D. C. Schmidt, "WreckWatch: Automatic traffic accident detection and notification with smartphones," Mob. Networks Appl., vol. 16, no. 3, pp. 285–303, 2011, https://doi.org/10.1007/s11036-011-0304-8.
6. W. H. Lee and C. Y. Chiu, "Design and implementation of a smart traffic signal control system for smart city applications," Sensors (Switzerland), vol. 20, no. 2, 2020, https://doi.org/10.3390/s20020508.

7. N. Cavus, "Development of an Intellegent Mobile Application for Teaching English Pronunciation," Procedia Comput. Sci., vol. 102, no. August, pp. 365–369, 2016, https://doi.org/10.1016/j.procs.2016.09.413.
8. D. Low et al., "Transportation activity analysis using smartphones," 2012 IEEE Consum. Commun. Netw. Conf., pp. 60–61, 2012, https://doi.org/10.1109/CCNC.2012.6181051.
9. J. Engelbrecht, M. J. Booysen, F. J. Bruwer, and G.-J. van Rooyen, "Survey of smartphone-based sensing in vehicles for intelligent transportation system applications," IET Intell. Transp. Syst., vol. 9, no. 10, pp. 924–935, 2015, https://doi.org/10.1049/iet-its.2014.0248.
10. S. Reddy, M. Mun, J. Burke, D. Estrin, M. Hansen, and M. Srivastava, "Using mobile phones to determine transportation modes," ACM Trans. Sens. Networks, vol. 6, no. 2, pp. 1–27, 2010, https://doi.org/10.1145/1689239.1689243.
11. H. Zhou, B. Liu, and D. Wang, "Design and research of urban intelligent transportation system based on the internet of things," Commun. Comput. Inf. Sci., vol. 312 CCIS, no. 70031010, pp. 572–580, 2012, https://doi.org/10.1007/978-3-642-32427-7_82.
12. X. Zhou, R. Ke, H. Yang, and C. Liu, "When intelligent transportation systems sensing meets edge computing: Vision and challenges," Appl. Sci., vol. 11, no. 20, 2021, https://doi.org/10.3390/app11209680.
13. P. Misra, A. Pal, B. Purushothaman, and C. Bhaumik…, "Computer platform for development and deployment of sensor-driven vehicle telemetry applications and services."
14. D. A. Johnson and M. M. Trivedi, "Driving style recognition using a smartphone as a sensor platform," IEEE Conf. Intell. Transp. Syst. Proceedings, ITSC, pp. 1609–1615, 2011, https://doi.org/10.1109/ITSC.2011.6083078.
15. K. Ali, D. Al-Yaseen, A. Ejaz, T. Javed, and H. S. Hassanein, "CrowdITS: Crowdsourcing in intelligent transportation systems," IEEE Wirel. Commun. Netw. Conf. WCNC, pp. 3307–3311, 2012, https://doi.org/10.1109/WCNC.2012.6214379.
16. E. Koukoumidis, L. Peh, M. Rose, and M. Martonosi, "SignalGuru : Leveraging mobile phones for collaborative traffic signal schedule advisory The MIT Faculty has made this article openly available . Please share Citation Accessed Citable Link Detailed Terms SignalGuru : Leveraging Mobile Phones for Collabor," 2015.
17. J.-C. Herrera, D. Work, X. Ban, R. Herring, Q. Jacobson, and a Bayen., "Evaluation of traffic data obtained via \textsc{GPS}-enabled mobile phones: the Mobile Century field experiment," Transp. Res. Part C, vol. 18, no. August, pp. 568–583, 2010, https://doi.org/10.1016/j.trc.2009.10.006.
18. P. Mohan, V. N. Padmanabhan, and R. Ramjee, "Nericell: Rich Monitoring of Road and Traffic Conditions using Mobile Smartphones," Proceedings of the 6th ACM conference on Embedded network sensor systems - SenSys '08. p. 323, 2008, https://doi.org/10.1145/1460412.1460444.
19. A. S. Handayani, H. Marta Putri, S. Soim, N. L. Husni, Rusmiasih, and C. R. Sitompul, "Intelligent Transportation System for Traffic Accident Monitoring," ICECOS 2019 - 3rd Int. Conf. Electr. Eng. Comput. Sci. Proceeding, no. October, pp. 156–161, 2019, https://doi.org/10.1109/ICECOS47637.2019.8984525.

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