Design of Application an Intelligent Transportation System for Monitoring Traffic Accidents

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ABSTRACT

The purpose of this study is to develop a traffic accident monitoring system employing a variety of sensors (accelerometer sensors, picture and sound sensors, GPS) in connection with Intelligent Transportation System applications on the Android platform. The system can automatically detect traffic accidents early by notifying the emergency messaging server after the accident and providing the driver's situation with photos, position coordinates, video communication channels, and accident data recording. This smartphone application is designed to determine the position and condition of camera-captured images taken during an accident and connects users immediately to the police and nearby hospital. This system is expected to minimize the time between an accident and information transmitted via autonomous accident detection. This accident application may provide information to aid in handling accidents more quickly and precisely.

Keywords: *intelligent transport system, traffic accidents, public transportation, telemonitoring*

1. INTRODUCTION

Today's public transportation system is essential to mobility; public transportation inside a town often operates over shorter distances than public transit between cities. In the metropolis, public transportation options include buses, microbuses, public transportation or commuter lines, express trains and taxis, and online motorbike taxis.

According to the WHO's 2015 Global Status Report on Road Safety, more than 1.25 million people die each year in traffic accidents, and 50 million are seriously injured. 90% of these accidents occur in developing countries, although the total number of registered vehicles is only 54% of the world average.

Considering Indonesia's high number of public vehicles, road safety is a significant issue that requires attention. Traffic crimes reached roughly 249 in 2017, accounting for 15.9 percent of public transit violations, according to www.data.go.id. Three types of traffic violations contribute to accidents, one of which is human mistakes. Human error occurs due to public transportation drivers' lack of external control.

Annually, approximately one million people die in car accidents globally. The World Health Organization/WHO anticipates that traffic fatalities will surpass all other causes of mortality by 2030 [1]. According to research conducted in several significant countries, over half of all accidents are caused by driver mistakes [2]. While numerous factors contribute to traffic accidents, driver irresponsibility is a critical preventable factor.

Traffic collisions are a primary cause of road accidents. The time between the event and the arrival of emergency medical personnel is a critical indicator of the survival rate following the accident. Eliminating the time between an accident and the appearance of first responders reduces the fatality rate [3]. One approach to eliminate the delay between an accident and the dispatch of first responders is automatic in-vehicle accident detection. However, this in-vehicle system is not available in all cars.

Various vehicle manufacturers and other companies have created systems for monitoring vehicle and driver behavior throughout the previous decade. However, vehicles equipped with these features are prohibitively expensive, and there are only a few manufacturers. Similar capabilities are possessed mainly by current smartphones. Smartphones with inbuilt sensors such as accelerometers, gyroscopes, light sensors, distance sensors, magnetometers, and the Global Positioning System can monitor (GPS). This sensor is capable of processing audio and video data from the camera and microphone. This sensor has a long history of use in surveillance applications.

Vehicle monitoring apps utilizing smartphone technology can monitor potentially harmful driver behaviour—extensive smartphone connectivity enables traffic monitoring, routing, and accident reporting. Crash detection is only possible with the use of sensors included in current smartphone [3].

Previous research has explored the usage of cell phones as a telemonitoring system. Research has been conducted on telemonitoring systems for transportation using smartphone [4][5][6][7][8]. But this research focuses exclusively on routes and the number of stops/stations/terminals, mode detection, and stop detection.

This study will develop a telemonitoring accident system for public cars that will utilize an Android-based smartphone application. The method may identify road accidents automatically using accelerometer and auditory data, notify the emergency message server immediately following an accident, and provide driver situational information via photographs, GPS coordinates, video communication channels, and accident data recording.

2. LITERATURE REVIEW

2.1. Monitoring Transportation Using a Smartphone

Ubiquitous smartphone connectivity enables various car monitoring application capabilities such as traffic monitoring, traffic rerouting, and accident reporting. As White et al. [3] point out, it is possible to identify accidents using simply the sensors on current smartphones. Other drivers can be diverted away from the accident by utilizing a machine-to-machine (M2M) communication infrastructure. They are notifying drivers that they are approaching a crash site to raise their attention and urge them to slow down, ultimately reducing additional accidents.

Most modern smartphones have a variety of sensors embedded in them, such as accelerometer, gyroscope, light sensor, proximity, and Global Positioning System (GPS). This sensor can then be added by processing the camera and microphone data. The advantage of this sensor enables support for many sensing applications.

The use of smartphones as traffic signal detectors has been carried out in [9]. In the study, smartphones could detect traffic signals opportunistically with their cameras and collaboratively share and study traffic signal schedules. In [10] used smartphone cameras and wi-fi to detect nearby vehicles in traffic jams. This system collaboratively calculates the length of the traffic queue.

2.2. Applications of Intelligent Transport System (ITS)

ITS is a term used in [11] to apply information and communication technologies to traditional transportation problems. Innovative technology in this industry improves the safety, effectiveness, efficiency, accessibility, and sustainability of transportation networks without increasing their capacity.

In research [12], numerous factors must be considered when it comes to ITS smart mobility, including the following:

a. Electronic toll collection is part of Smart Transport. A mechanism that collects tolls perpetually. Electronic toll collection via contemporary communication trucks. It avoids delays and improves toll station performance.
b. Road data collection allows traffic control centers to collect traffic data using georeferenced systems (GPS, GSM, and GPRS).
c. Transportation management system: This is essential for transportation management. It collects and analyzes real-time data from devices like cameras.
d. Vehicle data collection: This collects vehicle data from the road network.
e. In congestion, this technology allows emergency vehicles to travel freely on the road network without adding to the bottleneck.
b) Monitoring road conditions: a monitoring system with many sensors are required to monitor road conditions. In a disaster, it helps with vehicle communication and online apps.

2.2.1. Intelligent Transport System For Monitoring Traffic

The intelligent transportation system, which monitors traffic and event information, strives to offer useful information to users in real-time to make optimal mobility decisions in an urban setting. In [13], the technology provided may recommend alternate routes to the driver to avoid a location where an event is taking place. This system will give information on road events, advise alternate routes, and provide urban mobility monitoring, allowing users to identify potentially congested points.

3. RESEARCH METHODOLOGY

3.1. Design of a Traffic Accident Monitoring System

The hardware diagram for this research is shown in Figure 1. The appearance of the accident monitoring hardware is depicted in Figure 1, which is equipped with an FC04 sensor that doubles as an ambient sound meter. The MPU 6050 sensor is used as a tilt detector. The camera serves as a recorder of the surrounding environment, while the panic button serves as a signal to declare an emergency. Additionally, this accident monitoring module contains a 13-cell 12-volt lithium battery, an Arduino Mega 2560 module for connecting these sensors, a Raspberry Pi 3 module for microprocessor and communication between the hardware and a server operating as a database, and a GPS module for determining the location of the accident. on the hardware's coordinates.

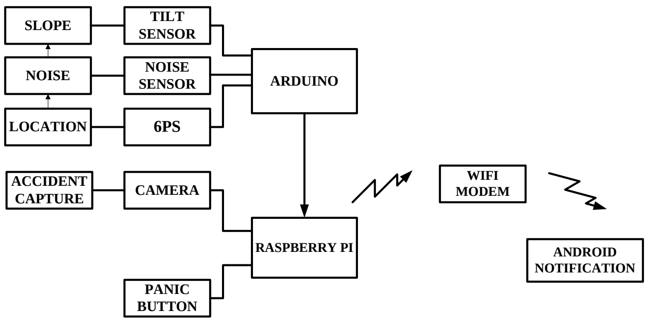

Figure 1. Traffic Accident Monitoring System Hardware Design

The monitoring system in ITS technology is designed to monitor traffic accidents and emergencies data that the sensors have collected. The monitoring system is designed to detect the driver's and passengers' status during an accident and the incident's location by transmitting the location and environmental conditions in real-time. The server receives data from the incident's location and accident data recording. The server will send information to police and hospitals. The monitoring system software diagram using the Intelligent Transportation System is shown in Figure 2.

The traffic accident monitoring system uses the accelerometer, sound, and wifi modems as service providers. In Figure 2, the system performance will be automatically activated if the sensor node detects a traffic collision and presses the panic button, indicating an emergency. The system in this experiment is meant to detect traffic accidents automatically. This system will immediately transmit notifications to the server following an accident in emergency messages, coordinate points on a map, video communication channels, and record accident data.

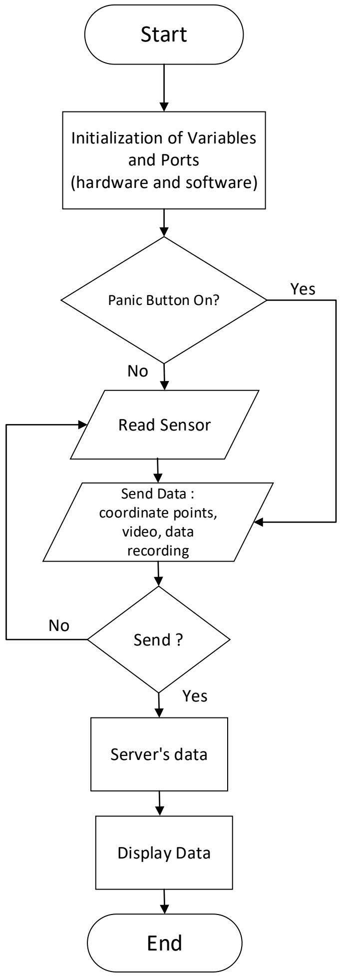

Figure 2. Application Design Flowchart

3.2. Design Accident information on Android-based applications

The monitoring results will be displayed in an application using sensor reading data, specifically slope and noise. During an accident or emergency, the location and recording of the situation will be recorded. Accident information is displayed on android-based applications. In this research, designing an android-based application will display accident information in emergency messages, map coordinates, and accident data recording in real-time.

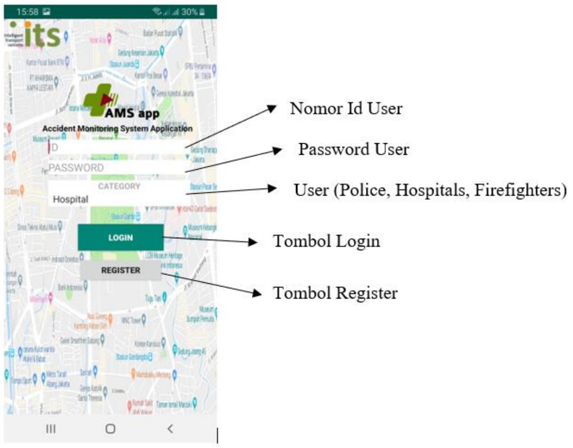

Figure 3. Display Layout Login

Figure 3 depicts the android application's login layout, which displays the user's Id, Password, and Category for performing the login process entering the application. Figure 4 depicts the application's register layout for users that do not have an account by filling out the form.

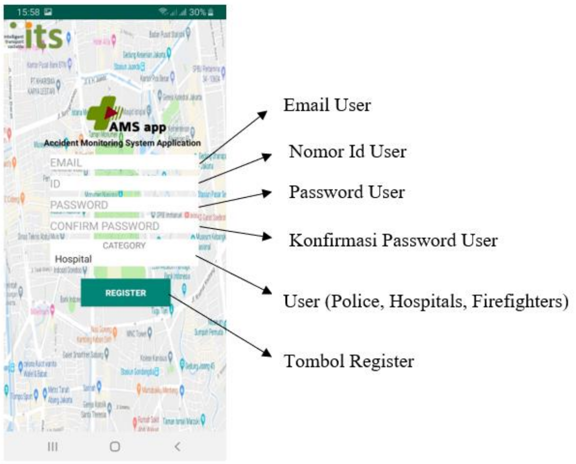

Figure 4. Display Layout Register

4. RESULT AND DISCUSSION

The traffic accident monitoring system monitors traffic accidents and emergencies. This system has been demonstrated on remote control cars. The overall system performance in this test operates automatically when the sensor detects a traffic accident and pushes the panic button. The technology in this study automatically identifies traffic accidents by sending emergency signals to the server, providing GPS coordinates, and recording data.

The notification received on applying the traffic accident monitoring system at the community service consisting of the police, hospital, and fire department. The operator of the community service will carry out an analysis of the accident to take further action.

The results of this experiment are used to design a hardware-integrated monitoring system application using Android Studio. The experimental data consist of three emergency accidents if the slope conditions are too high. Accidents are expected if the slope is not too steep and the noise is not too loud. When the panic button is pressed, the tilt and sound are dismissed. The Accident Monitoring System program can monitor accidents in real-time using a smartphone. The Accident Monitoring System application displays monitoring data in accident images, sensor measurements, accident location points, and accident conditions. The physical components monitoring results are data read and transmitted by the sensor nodes to be effectively integrated into the application.

Figures 5-6 illustrate the application of the monitoring on accident monitoring system is used in normal, medium, and fatal accident situations. The application's display shows the accident time, location, accelerometer, vibration, sound values, and the application's state. The display is received data from the system's sensors, mainly the GPS, which displays the coordinates in the form of latitude and longitude. The accelerometer gets data from the MPU 6050 sensor; this sensor measures the tilt angle based on the accelerometer and gyroscope data.

With the MPU 6050 sensor and a sound sensor, the traffic accident monitoring system will automatically detect traffic accidents based on the experimental results. A damaged road and holes cause a vehicle to have a slight slope at the time of an accident. The noise levels depicted represent the result of impacts with hard things such as trees and concrete and accidents with other vehicles. The sensor will read the slope and noise values in the event of an accident. Concurrently, the camera will capture traffic accident conditions and location points transmitted directly to the community service in real-time, without time-lapse. The application captures data on the time and date of the accident, the vehicle's slope, noise level, position, and the passengers' condition.

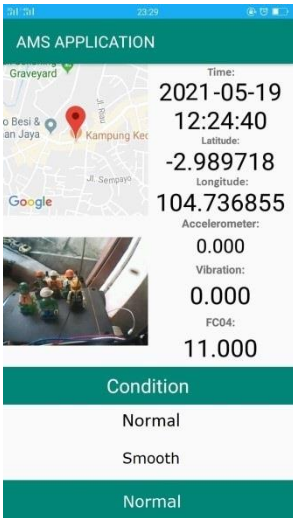

Figure 5. Result of Monitoring on Normal Condition

The research was held at a 0 until 20^0 slope with multiple test (Figure 6). The system reads an average sound level of 10-14 dB with a slight tilt. The greatest decibel read in experiments with a constant tilt angle is 96. The monitoring device can also read noise up to 76 decibels at a 7-degree slope. The system reads 91-114 decibels when a loud noise is given. The maximum reading is recorded at 19 degrees slope and 120 dB noise.

Figure 6. Result of Monitoring on Medium Condition

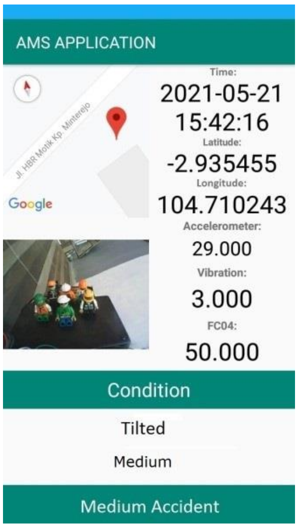

Figure 6 shows the test at a 21–60 degree slope. With a 21–30-degree slope, the device can read noise at 120 dB. Under smooth noise testing, the system reads 15-18 decibels. The second test accurately detects a 36–60-degree slope with 10 dB of noise. The experimental average is 60-110 dB. The maximum noise level in the 22-degree experiment is 120 dB.

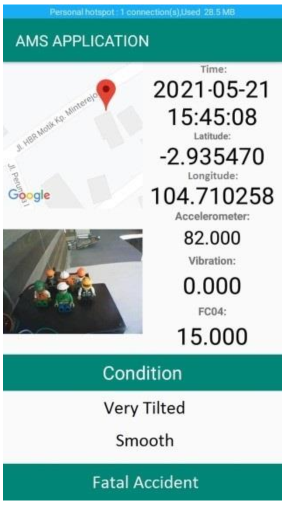

Figure 7. Result of Monitoring on Fatal Accident

Experiments on the traffic accident monitoring system were conducted on a slope ranging from 61 to 90 degrees. Figure 7 shows a fatal accident where the vehicle slid down a slope due to a broken road and hit hard objects such as trees and sidewalks. The system can still read normal, medium, and loud sound levels in this range. The average acceptable noise is 14-16 decibels, whereas moderate noise is 65-69 dB. The maximum noise level is 100 decibels at an angle of 80 degrees.

The experiments indicate that the results of monitoring traffic accidents perform reasonably well to increase the accuracy, timing, location, slope, and noise. This is shown at the time stated, based on the accident's time, delayed by a few seconds. The location data provided is accurate, including latitude and longitude coordinates, allowing for the actual location of the accident and prompt response by the community. The slope data is derived from the slope of the vehicle at the time of the accident. The noise data is derived from the sound of collisions and vehicle collisions occurring during an accident and is used to predict the accident rate.

5. CONCLUSION

The data on vehicle accident conditions is collected using multi-sensor devices integrated with intelligent transport system hardware and connected to the internet via Smartphone technology. The server's data can be linked to the input hardware components and connected to the emergency center. This application is evaluated in terms of network performance under various scenarios, indicating that it can satisfy the demands of normal, medium, and fatal accident conditions.

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