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Accident Detection and Driver Location System Motorcycles with IoT-Based Telegram

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Abstract

In Indonesia, motorcycles are one of the most widely used modes of transportation. Based on data from the Indonesian National Police Traffic Corps (Korlantas Polri), 103,607 traffic accidents occurred throughout 2023, with a total of 23,029 fatalities. This data indicates that vehicle accidents remain one of the leading causes of death in Indonesia. The purpose of this research is to design and build a system that can automatically detect motorcycle accidents using the MPU6050 sensor and the Neo-6M GPS module. This system is designed to send notifications in the form of real-time accident location information via the Telegram application to the closest family members. The research stages include literature review, needs analysis, system design, system testing, and conclusions. Testing was carried out in several scenarios to ensure that the designed accident detection system can function optimally according to its objectives. The results of the research and testing conducted indicate that the motorcycle accident detection system developed using the MPU6050 sensor, the Neo-6M GPS module, and the Telegram API successfully functioned according to its objectives. The system is able to detect accidents automatically through a combination of extreme tilt (with a roll value between -90° to 90°) and a tilt duration of at least 5 seconds.

Keywords: *GPS Neo-6M, Internet of Things (IoT), MPU6050, Motorcycle Accident Detection System, Telegram*

1. Introduction

In everyday life, transportation plays a crucial role as a means of moving from one place to another or transporting goods over a period of time. In Indonesia, motorcycles are one of the most widely used modes of transportation. This is due to their affordability and perceived practicality and efficiency in supporting daily activities, especially in congested urban areas. Due to their effectiveness and convenience, motorcycles are often the primary choice, so it's no surprise that the number of motorcycle users continues to increase annually (Wijayanti, 2018).

According to data from the Indonesian National Police Traffic Corps (Korlantas Polri), 103,607 traffic accidents occurred throughout 2023, with 23,029 fatalities (Wijaya & Giap, 2024). Furthermore, according to BPS data for 2024, the number of vehicle accident victims increased, reaching a total of 139,258, consisting of 28,131 fatalities, 13,364 serious injuries, and the remainder suffering minor injuries (Alfath et al., 2024). These data indicate that vehicle accidents remain one of the leading causes of death in Indonesia. This high number is a serious concern, especially for motorcyclists who are vulnerable to accidents. Therefore, a system capable of automatically detecting accidents and providing real-time location information is needed.

The purpose of this research is to design and build a system that can automatically detect motorcycle accidents by utilizing GPS (Global Positioning System), a navigation system that uses satellite technology to receive signals and determine location accurately (Alfeno & Devi, 2017). This system is built with a Neo-6M GPS sensor, a small GPS signal receiver module with a TTL interface and a high-speed u-blox processor capable of determining location accurately and quickly (Fajardiansyah et al., 2025) and an MPU6050 sensor, a 6-axis motion sensor with a 16-bit ADC that integrates a gyroscope, accelerometer, DMP, and other supporting components to produce position data with high accuracy (Setiawan et al., 2021). This system is designed to send notifications in the form of real-time accident location information through the Telegram application, an open-source platform with end-to-end encryption features, automated messages, and multi-platform support, which allows the use of bots through the API to send notifications automatically (Kusuma et al., 2023). So that family members can immediately know the condition of the driver and take quick steps in providing assistance or contacting the nearest medical service, so that the potential risks due to delayed treatment can be minimized.

2. Research methods

This research uses the Research and Development (R&D) method, a method aimed at developing and producing useful products with proven effectiveness. The R&D method combines the scientific research process to identify problems and the technological development process as a viable solution. In its implementation, the author uses several main stages:

2.1.Literature Study and Needs Analysis

This stage is carried out to understand the problem to be researched and to find a theoretical basis to support system development. Then, a needs analysis is conducted and the objectives of the tool to be developed are formulated. This stage is crucial for determining the direction and focus of system development so that the resulting solution truly aligns with the needs and problems. This stage includes needs analysis, product design, testing, and conclusions.

2.2.System Design

At this stage, researchers begin designing the system's overall workflow based on the problems and needs previously identified. The goal of this design is to ensure that the developed system has a clear, focused structure and working logic, and is capable of meeting the desired objectives.

2.3.System Testing

System testing is conducted to determine the extent to which the designed and developed system can function according to the initial research objectives. This stage includes testing the system's ability to respond to predetermined conditions, as well as the system's accuracy in processing data and producing output according to the scenario.

2.4.Conclusion

The conclusion is the final stage of the research method, aiming to summarize the main results of the entire development process. At this stage, the researcher determines whether the developed system meets its initial objectives and addresses the identified problems.

3. Results and Discussion

3.1. System design

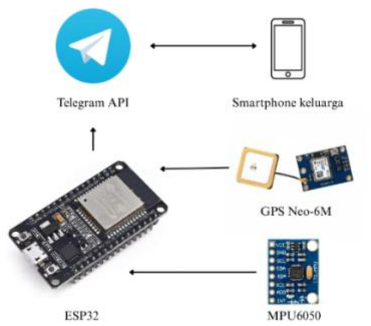

Fig. 1: Wiring system

The system workflow begins with the MPU6050 sensor, which detects extreme changes in tilt, which could indicate an accident. Data from this sensor is then sent to the ESP32 microcontroller for processing. The system uses the roll angle obtained from the MPU6050 sensor to detect potential accidents or falls on motorcycles. Roll is the angle of rotation about the X-axis, which describes the tilt of the vehicle to the left or right. In this context, the system reads roll values in the range of -90° to +90°, where 0° indicates a perpendicular position, a positive value indicates a tilt to the right, and a negative value indicates a tilt to the left, depending on the sensor's installation orientation. To detect falls, the system sets a tilt threshold. A fall to the left is considered if the roll value is less than -50°, while a fall to the right is detected if the roll is greater than 50°. These values deviate significantly from the normal upright position of around 0° and are not common during normal driving conditions such as turning or maneuvering. Therefore, when the roll value falls within this range for at least five seconds, the system retrieves coordinates from the Neo-6M GPS module. This location information is then formatted into an accident alert message along with a Google Maps link, and automatically sent via internet connection to a pre-defined family Telegram account so that the family can immediately locate the vehicle and provide assistance.

3.2. Test Results

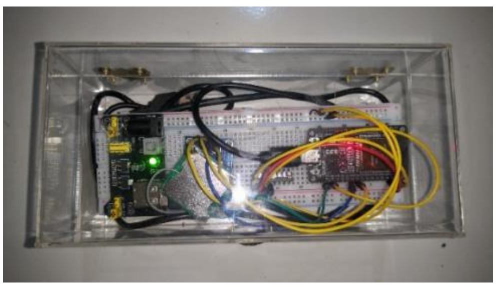

Fig. 2: Tool design

The image above shows the design and assembly of the motorcycle accident detection system hardware developed in this research. The main device consists of an ESP32 microcontroller, an MPU6050 sensor, a Neo-6M GPS sensor, and a connection circuit using a breadboard and jumper cables installed inside the box. The MPU6050 sensor readings were then performed.

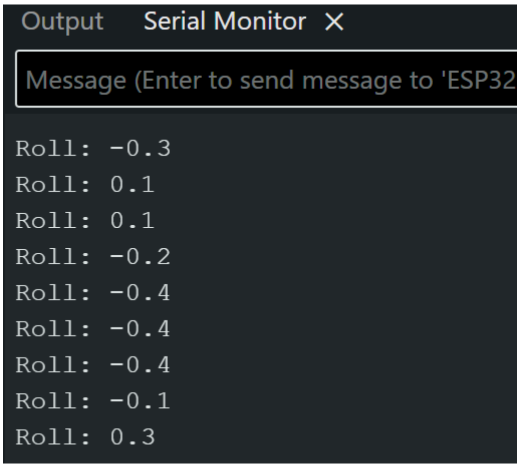

Fig. 3: MPU6050 sensor reading

This system uses roll angle readings to determine the vehicle's position. Figure 3 shows the roll value displayed in real-time via the Arduino IDE serial monitor. Under normal conditions (the motor is upright), the roll value is around 0°, while when the motor is tilted, the roll value will move in a negative direction (if to the left) or positive (if to the right), with a maximum range of ±90°. If the roll shows less than -50° or greater than 50°, the serial monitor will display an accident warning and send a notification to Telegram.

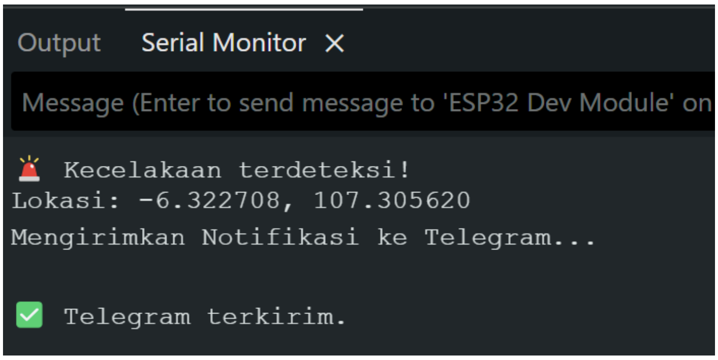

Fig. 4: MPU6050 sensor readings during an accident

Testing was then conducted in several scenarios to ensure that the designed accident detection system could function optimally according to its objectives. Each scenario was designed to represent real-world conditions, both during an accident and under normal circumstances such as a parked motorcycle or a brief, non-threatening accident. This testing aimed to evaluate detection accuracy, notification delivery reliability, and the system's ability to distinguish between emergency and non-emergency conditions. The following is the testing documentation.

Fig. 5: Testing when the motorcycle is in normal position

Figure 5 shows a normal motorcycle position scenario, where the author sits upright on the motorcycle. In this state, the roll value is between 0° and does not trigger the system to detect an accident.

Fig. 6: Testing when the motorcycle is in the side stand position

Figure 6 shows a motorcycle parked using the side stand. The motorcycle will tilt slightly to the left, resulting in a small negative roll value (around -10° to -15°). The system will not consider this condition an accident because it does not fall within the extreme tilt threshold and does not meet the duration requirement.

Fig. 7: Testing when the motorcycle has an accident

Figure 7 shows the motorcycle being allowed to fall to one side (left or right) to observe the system's response. Under these conditions, the roll value will exceed the extreme slope threshold, and if it persists for at least five seconds, the system will automatically detect it as an accident and send a notification to Telegram.

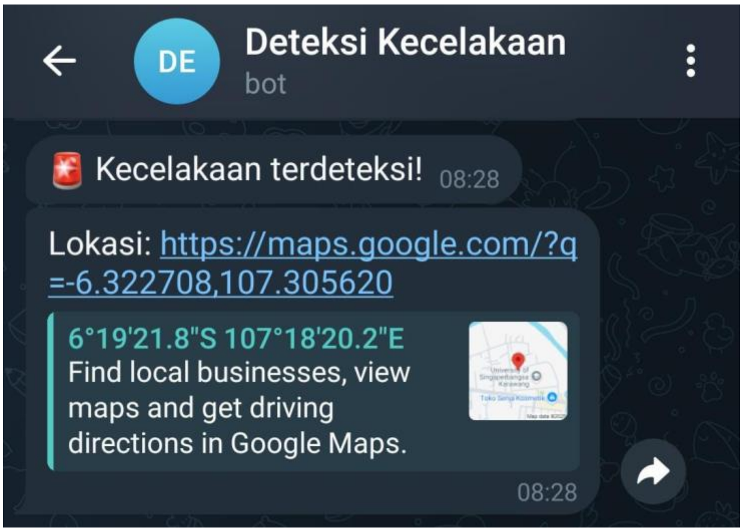

Fig. 8: Telegram notification view

Figure 8 shows the notification results sent by the system to the Telegram app after detecting an accident based on a roll angle exceeding the threshold. Detailed test results can be seen in the following table:

3.3. Section title

There should be no more than three levels of headings. All other headings should be in 9pt font. Only the first word of the heading should be capitalized, and all other words should be lowercase.
Level-1 Headings: Level-1 headings should be left-aligned and numbered with Arabic numerals. Two level-1 headings that should not be numbered are “Acknowledgements” and “References.”
Level-2 Headings: Level-2 headings should be left-aligned and numbered with Arabic numerals followed by a period.
Level-3 Headings: Level-3 headings should be numbered with Arabic numerals.
Sections should be formatted as left, bold, Times New Roman, and 12pt font size. For subsections (left, bold, Times New Roman, and 10pt), the first letter of the first word should be capitalized, and the same applies for other subsections (left, bold, Times New Roman, and 9pt).

Table 1: Test Results

No	Scenario	Desired results	Results	Information
1	Motor in Normal Position	Not Sending Notifications	Notification Not Sent	Roll values range between 0°
2	Motorcycle Falls to the Left	Sending Accident Notifications	Notification Sent	Roll Value < -50°
3	Motorcycle Falls to the Right	Sending Accident Notifications	Notification Sent	Roll Value > 50°
4	Motorcycle Parked Using Side Stand	Not Sending Notifications	Notification Not Sent	Roll Value > -50° and Roll Value Less than 0°
5	Short Duration Slope Accident	Not Sending Notifications	Notification Not Sent	Roll Value < -50° or Roll Value > 50° But With Time Less Than 5 Seconds

4. Conclusion

The results of the research and testing conducted indicate that the motorcycle accident detection system developed using the MPU6050 sensor, Neo-6M GPS module, and Telegram API successfully functioned according to its objectives. The system is able to detect accidents automatically through extreme tilts (with roll values between -90° to 90°), as well as a minimum tilt duration of 5 seconds. By implementing this logic, the system can distinguish between accident conditions and normal situations such as a motorcycle being parked or experiencing a short, non-dangerous accident. The system has also demonstrated good performance in test scenarios designed to represent real conditions in the field. Thus, this system is suitable for use as a safety aid that can increase the speed of information in handling motorcycle accidents.

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