

**POSSIBILITY OF A LOW-COST ARDUINO-BASED CRASH DETECTION AND ALERT SYSTEM****Rakean Shidqii Hasan Ali Wisesa , Nuriya Parsa , Pahala Marzuki Pakpahan , Loviera Azahra , Nurhidayatulloh**

Nama kampus: Universitas Pendidikan Indonesia

Email: [lovieratrading@gmail.com](mailto:lovieratrading@gmail.com)**ABSTRACT**

This paper introduced a possible concept for a crash detection system, designed to enhance road safety for both cars and motorcycles. The system is built on the Arduino platform, it aims to be a cost-effective crash detection system, that can detect crashes immediately and warn the emergency contacts, as soon as the crash happens, using its emergency protocol, upon detecting a crash, the Arduino will fetch the location data from the GPS module, which it will send to the emergency contacts using text message, utilizing its GSM module. Enabling faster response time and increased survival rate for the crash victims. Our tests which focus on the accuracy of the accelerometer module have found that it has promising results, but still needs more research into increasing its accuracy to avoid false positives and undetected crashes

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Road accidents are a major source of concern that we need to deal with in our everyday lives, every day a great number of lives are lost as a result of accidents, due to the high frequency of fatalities, it's a critical field that requires extensive research[1]. according to the World Health Organization (WHO), the severity of road accidents is a key factor in accounting and resolving welfare losses[2]. some of the main causes of road accidents are insufficient sleep, improper distance between two vehicles, and insufficient sleep[3]. In addition, Road types, light conditions, weather conditions, etc. These are all factors in an accident as well. Lots of injuries take place and reporting the accident as quickly as possible is necessary[4] This paper introduces an innovative crash detection system that is designed for both motorcycles and cars. utilizing sensor and communication modules that are integrated into the Arduino platform. This concept proposes vehicle or helmet-mounted sensors[5][6], to detect potential road accidents, which will promptly notify the relevant individuals to facilitate immediate actions without unnecessary delays [7]. Currently, when a crash happens and the victim is passed out, they are solely relying on the people around them to call for help, which could be an issue if they're in a remote place, delaying the life-saving first aid that they require[8] even if there are people, some might not even be too keen in helping, a 2013 study in India found that 74% of people would not help an accident victim[9] The proposed solution is a system that employs an accelerometer and gyro sensor for accurate crash detection, a GSM module for seamless communication, and a GPS module for precise location

data retrieval. The integration of these components aims to create a comprehensive solution that not only identifies crashes but also expeditiously communicates critical information to emergency contacts. Since predicting the occurrence of accidents is often challenging, our Accident Detection system, featuring GPS technology, seeks to address these uncertainties [10]. This system aims to garner quick attention which will be potentially life-saving. In the event of an accident, the accelerometer within the system, relays signals to the Arduino controller, which then The GPS captures latitude and longitude data, transmitting the information as a text message to individuals on the emergency contact list. Obtaining precise location details helps the ambulance's quick arrival, using the shortest route. This cost-effective alert system could be seamlessly integrated into all vehicles in the foreseeable future, contributing to a reduction in the loss of lives [11]. We aim to explore the possibility of a low-cost and effective crash detection system, creating a prototype to research the effectiveness of our approach.

## 1. 1. RELATED WORKS

There have been many technologies that are developed in the field of crash detection, with many different approaches to the issue, Some examples include a video-based detection system, using a tracking algorithm[12], or an even more state-of-the-art system using convolutional networks to detects the crashes [13]. Though a great system with promising results, it requires a network of cameras and computers to process the data, a system that needs support and funding from the government, or a big company with substantial funding. With our research we hope to have an economical system, creating a stand-alone device that anyone could purchase or make for their vehicle. Another approach to the issue, proposed, is using the accelerometer sensor and GPS within a smartphone, detecting the crash with an Android application[14], though the results look promising, it still relies on someone in the vehicle having the app in the first place, with our approach, we aim to have a system that is set up permanently within the vehicle, ensuring that the device will always detect a crash.

## 2. METHOD

The development and implementation of the crash detection system involve a systematic approach, encompassing the hardware setup, sensor integration, software design, and testing procedures. The following sections detail the step-by-step methodology employed in creating a robust and effective crash detection system.

### 2. 1. Hardware Configuration

**Arduino Platform:** The system is built on the Arduino platform, chosen for its versatility and ease of use in integrating various components. In this particular test, we're using the ESP8266, due to its low cost and small size, the small size is particularly useful for our testing methodology, using a small car to simulate the crash. ESP8266 is not an official Arduino microcontroller, but it still uses the Arduino coding platform. An onboard reset button is used to reset the code every time a crash is detected.

MPU6050 Accelerometer and Gyro Sensor: Configured to continuously monitor acceleration and angular velocity changes, enabling the identification of abrupt motions characteristic of a crash event. This mode is what we will focus on in the testing, seeing its reliability in detecting crashes.

Active Piezo Buzzer: This module is used for making a sound, at the moment that the crash test car hits the wall, giving a clear sign that an impact has been detected, this ensures that we can accurately test, knowing when a crash has been detected, both true and false ones.

LED: Other than the buzzer giving a sound, the LED will also blink when a test has been detected, ensuring both visual and auditory cues

16x2 LCD: As another redundancy and to display the testing device's state, we used an LCD, it has two states, one displaying the text siap mendeteksi tabrakan (Ready to detect a crash), and when the crash happens, it will display tabrakan terdeteksi (Crash Detected).

GSM Module (SIM 800L): This is used to facilitate SMS communication, transmitting crash alerts and GPS data to predefined emergency contacts. This module is omitted in our testing, due to our focus on the MPU6050 Accelerometer and Gyro Sensor

GPS Module (GY-NEOMv2): Employed for accurate location data retrieval, triggered upon crash detection for precise incident location information. Due to our focus on testing the MPU6050 module, the GPS module is omitted and replaced with a buzzer and an LED, so signal a crash

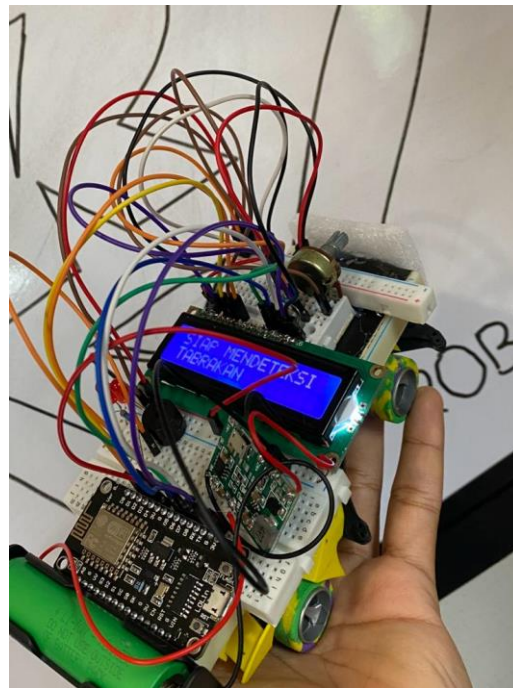


Figure 1. System prototype

## 2. 2. Sensor Calibration

MPU6050: Calibration codes were implemented to ensure accurate sensor readings by compensating for any biases or offsets when the sensor is at a known stationary position, zeroing out its acceleration and orientation while also filtering out its signal noise. GPS Module Initialization: Configured to acquire and transmit accurate GPS coordinates by accounting for satellite acquisition delays and signal accuracy.

### 2. 3. Data Processing and Decision-Making

Arduino Code: Developed to continuously monitor sensor data, checking the accelerometer status and triggering the emergency protocols, when it detected a crash, based on the accelerometer data.

### 2. 4. Emergency Response Protocol

Programmed to initiate the GSM module for SMS transmission and request GPS data when a crash is detected, sending the data to the pre-assigned emergency contacts.

### 2. 5. Communication Protocol

GSM Module Configuration: Set up to establish communication with mobile networks, enabling the transmission of SMS alerts when needed.

SMS Content Formatting: Defined the structure of the text message to include crash alert information, such as timestamps and GPS coordinates.

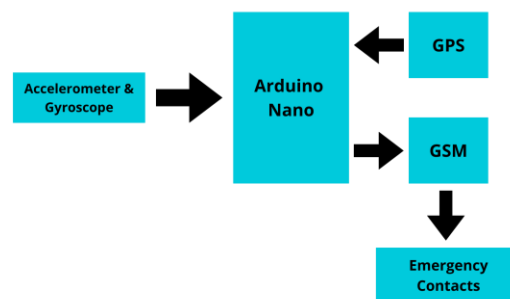


Figure 2. System Architecture

### 2. 6. Side note

Due to our testing mainly focusing on the reliability of the MPU6050 sensor, we have disabled both the emergency protocol and the communication protocol, replacing them with a buzzer, LED and screen.

### 2. 7. Testing and Validation

A Simulated Crash is created with an electric motor-powered toy car, turning it on and crashing it into the wall, the ideal result will be that the crash is detected at the moment that the wall is hit by the car, but unfortunately, we have found some flaws that we could not solve in a reliable manner, in the data we could see that in a test of 20 crashes, 10 were true positives, this is when the system managed to detect the crash as soon as it happens. 6 crashes were false positives,

where the crash was detected while the vehicle is stationary or when it was only accelerating. The 4 failed to detect were when the car crashed into the wall but no crash was detected

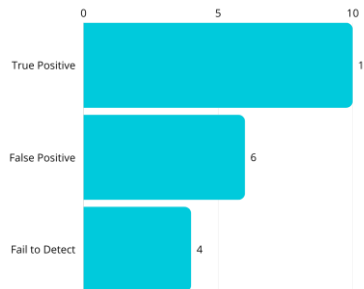


Figure 3. Prototype test results

### 3. RESULTS AND DISCUSSION

The prototype of our crash detection system demonstrated promising results for our concept of a low-cost crash detection system, the accelerometer showed its capabilities in detecting crashes as soon as they happen. Unfortunately we have also come to the issues of false positives and undetected crashes, which would need more research into the sensor's calibration.

#### 3.1 Future Directions

Future research will need to be done, focusing on refining the calibration algorithm, with more advanced techniques and maybe even incorporating machine learning technology, for improved crash detection and filtering out the false detections that are still prevalent in our iteration. We are also looking into integrating our system into the cloud, making our device into an IOT device. Mochammad Taufiq Ardiansyah Amir and Yusrila Yeka Kerlooza in their paper [15] made a crash detection system that uses the sensors that is inside of a smartphone, when a crash is detected, the application that they made, will upload the incident data to a server database. The approach of combining the simplicity of an SMS notification, and the more complex cloud-based approach might be a direction that is worth looking into.

### 4. CONCLUSION

In this research we have proven that the budget-friendly crash detection system we're proposing, has promising results, utilizing the MPU6050 and the Arduino platform's versatility and cost-effectiveness. Our prototype has demonstrated a 50% accuracy in detecting crashes, despite the challenges that we face, we hope that our system will be a valuable step forward for a cost-effective solution in the fields of crash detection and timely emergency response.

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