International Research Journal on Advanced Engineering and Management

https://goldncloudpublications.com

e ISSN: 2584-2854
Volume: 02
Issue: 02 February 2024
Page No: 20-26

IoT-based Collision Detection System

Harshita Patil [1], Sujata Wankhede[2], Monali Raut[3], Ekata Chimote [4], Hansika Thakare[5], Janvi Tote[6], Aman Kundal[7]

[1,2]Assistant Professor in the Department of Computer Science and Engineering, S.B. Jain Institute of Technology, Management and Research, Nagpur, India.

[3, 4, 5, 6, 7]B. Tech (CSE), S.B. Jain Institute of Technology, Management and Research, Nagpur, India.

Email: *wankhede.harshita27@gmail.com[1], sujatawan@gmail.com[2], monalir.cse20@sbjit.edu.in[3], ekatac.cse20@sbjit.edu.in[4], hansikat.cse20@sbjit.edu.in[5], janvit.cse20@sbjit.edu.in[6], amank.cse20@sbjit.edu.in[7]*

Abstract

All around the world, a sizable percentage of traffic deaths take place every day. Two effective methods for reducing traffic fatalities include implementing systems that allow for real-time incident reporting can significantly reduce the time it takes for emergency services to be notified. Providing thorough training for emergency dispatchers, responders, and other personnel involved in the response process is crucial. The incidence of automobile accidents has increased as technology and auto manufacturing have advanced. Due to limited emergency facilities, the survival rate following an accident is quite low. Our strategy would help find an accident and identify it so that the rescue squad and the rider's emergency contact could be informed.

Keywords: *Impact sensor, ADXL335, GPS, GSM, and Arduino Uno.*

1. Introduction

Traffic accidents have become more common as technology and motor manufacturing have advanced. Since there are inadequate emergency facilities, the survival rate following an accident is incredibly low. Our plan would assist in identifying and finding an accident, which would then be communicated to both the rider's emergency contacts and the rescue crew. Accident detection systems use car sensors to determine whether an accident has occurred. These technologies rapidly deliver emergency medical personnel to major accidents. The rapid arrival of emergency personnel at the scene of an accident reduces mortality. Consequently, the Arduino Uno board, which is fastened to every sensor, is used in this project. In addition, an impact sensor is employed to detect collisions. The software ADXL335 is used to determine the acceleration and flip angle. Alert messages are sent and the location is determined using GPS and GSM technologies [1].

2. Sensors and Modules

2.1 Impact Sensor

Impact sensors are designed to detect when a collision occurs. Its other name for it is a collision signal sensor. The impact sensor has at least two terminals between which the sensor material is electrically coupled, as well as at least one strain-sensitive sensor element made of a sensor material.

2.2 GPS Module

A satellite-based navigation system that gives position and time data is called the Global Positioning System (GPS). Anyone with a GPS receiver and a clear view of four or more GPS satellites can utilize the method for free.

2.3 GSM Module

The European Telecommunications Standards Institute created the GSM (Global System for Mobile Communications) standard. The GSM Module is used to send alert messages. A mobile device and a GSM or GPRS system can communicate thanks to a circuit known as a GSM module [2].

2.4 ADXL335 Sensor

It is used to measure acceleration. The ADXL335 is a thin, small, fully functional three-axis accelerometer with signal-conditioned voltage outputs. An accelerometer is a type of

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
e ISSN: 2584-2854
Volume: 02
Issue: 02 February 2024
Page No: 20-26

electromechanical device used to detect acceleration force. It only shows acceleration when the force of gravity, or g force, is at work. It measures acceleration in g units. It uses a minimum range of 3 g full scale to track acceleration.

2.5 Arduino Uno

The Arduino Uno microcontroller board is built around the ATmega328P. Six analog inputs, fourteen digital input/output pins (six of which can be used as PWM outputs), a USB connector, a power jack, an ICSP header, a reset button, and a 16 MHz ceramic resonator are among its features [3-5].

3. Methodology

In this project, vehicle collision detection is proven. It utilizes various components, including an impact sensor, ADXL335 for orientation determination, Arduino for data processing, a GSM module for alert messages, and a GPS module for location identification. The key components and their functions in your collision detection system:

3.1 Impact Sensor

- **Function:** Detects collisions or sudden impacts during an accident.
- **Placement:** Installed on the car's bumper to capture impact information.

3.2 ADXL335 (3-Axis Accelerometer)

- **Function:** Determines the orientation of the vehicle.
- **Output:** Generates analog voltages proportional to acceleration in three axes.
- **Processing:** The Arduino processes data from the ADXL335 to understand the vehicle's position.

3.3 Arduino Microcontroller

- **Function:** Processes data from the impact sensor and ADXL335.
- **Features:** Open-source microcontroller board with digital and analog input/output pins.
- **Integration:** Interfaces with other circuits and expansion boards for versatile applications.

3.4 GSM Module

- **Function:** Sends alert messages to nearby emergency services, hospitals, or private contacts.
- **Power Source:** Uses a 5V power source.
- **Capabilities:** Connects to the internet, sends/receives SMS, and makes voice calls [5].

3.5 GPS Module

- **Function:** Identifies the vehicle's location.
- **Power Source:** Uses a 3.3V power source.
- **Components:** Typically includes a GPS sensor and associated components.

3.6 Power Sources

- **5V Power Source:** utilized by the impact sensor and GSM modules.
- **3.3V Power Source:** Used with the ADXL335 and GPS module.

3.7 GSM Shield

- **Function:** Enables an Arduino board to use the GSM library for internet connectivity, SMS communication, and voice calls [6].

3.8 Impact Switches

- **Function:** When they sense abrupt hits, a circuit or gadget will either activate or deactivate.
- **Output:** Provides a value from the impact sensor.

3.9 Emergency Contacts

- **Alerts:** Messages are delivered to emergency contacts in the event of a collision.

The combination of impact sensors, accelerometers, GPS, and GSM technology allows your system to not only detect collisions but also determine the vehicle's orientation, and location, and communicate this information to emergency services and other designated contacts [7]. The integration of these components provides a comprehensive approach to improving response times and assistance in the event of an accident.

4. Detection Protocol

For network communication, including Internet communication, a standardized set of protocols known as TCP/IP (Transmission Control Protocol/Internet Protocol) is utilized. The TCP/IP model is organized into layers, each serving a specific purpose. The key layers include the

International Research Journal on Advanced Engineering and Management

https://goldncloudpublications.com

e ISSN: 2584-2854
Volume: 02
Issue: 02 February 2024
Page No: 20-26

Application Layer, Transport Layer, Network Layer, and Link Layer. The transport layer is in charge of overseeing end-to-end communication and providing dependable data transfer across applications. Protocols like Transmission Control Protocol (TCP) operate at this layer. When data is sent from ONE application to another, the transport layer adds a header to the user data. This header contains information such as source and destination ports, sequence numbers, and other control information [8]. The purpose of attaching headers, trailers, and checksums (sigma) is to facilitate error checking, ensure data integrity, and enhance overall security during the transmission of data. GNSS stands for Global Navigation Satellite System, and one well-known example is the NAVSTAR-GPS (Navigation Satellite Timing and Ranging Global Positioning System). The GPS comprises approximately 77 satellites, with 31 satellites in orbit at any given time. There are six groups of these satellites, each with four satellites. The groups follow different fixed orbital tracks around the Earth. Satellites orbit at an altitude of about 20,000 miles, equipped with radio transmitters to cover a wide geographical area. GPS enables real-time localization, positioning, and time synchronization by receiving signals from multiple satellites. GPS is commonly used in vehicles for navigation, localization, positioning, and time-related applications [9]. The continuous operation of satellites ensures that location information is available at any time.

4.1 How The Protocol Work

Below is the pseudocode that will function over the transport layer for the TCP/IP protocol. In this protocol, the transport layer assigns a sigma value of (1, 2) to each function.

111 = chance_of_collision_occurrence ();
112 = alarm_to_warn_the_driver ();
121 = auto_brake_apply ();
122 = fully_headlight_on ();
211 = collesion_accure ();
212 = alarm_the_save ();
221 = switchoff_the_alarm ();

It is written a class for the transport layer that will carry out designated functionality.

```
class vehicle
{
chance_of_collision_occurrence ();
{
if (chances<50)
Continue;
else if(chances>=50)
{
alarm_to_warn_the_driver ();
 if (action==yes)
chance_of_collision_occurrence ();
 else if (action==no)
{
auto_brake_apply (); fully_headlight_on ();
collision_accure ();
if (collision==no)
          chance_of_collision_occurrence ();
 else
{
alarm_the_save ();
if (passenger_injured==yes)
continue;
else
switchoff_the_alarm ();
}
}
}
}
};
```

When the engine of a car begins, then “and after the fix period” The system initiates the collision probability check after the vehicle's engine starts. There is a specified fixed period after the engine starts before the collision probability is assessed. This delay may allow the vehicle to stabilize or gather necessary data before deciding. The probability of a collision occurring is assessed by the system [10]. Nothing is done if the likelihood is less than 50%. This implies that the system considers the situation relatively safe, and no intervention is required. If the likelihood is 50% or higher, the system triggers the chance_of_collision_occurrence () function. The

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
e ISSN: 2584-2854
Volume: 02
Issue: 02 February 2024
Page No: 20-26

chance_of_collision_occurrence () function generates interrupts to initiate necessary activities. These activities could include alerting the driver, engaging collision avoidance systems, or taking other preventive measures. The specific actions taken in response to the collision probability exceeding 50% depend on the system's design. They might involve activating safety mechanisms, applying brakes, adjusting speed, or signalling warnings to the driver. Two scenarios can be distinguished in Figure 1:

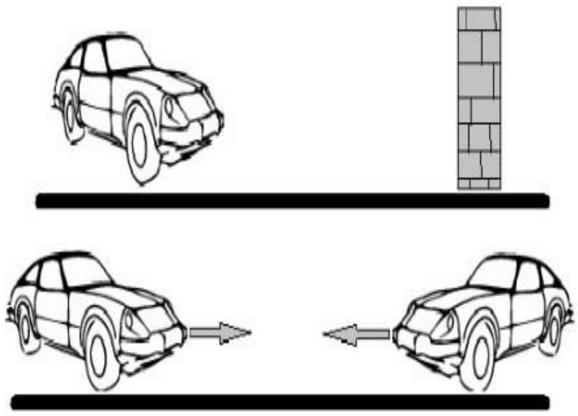

Figure 1 Probability of collision occurrence

4.2 Scenario 1: Car Approaching an Obstacle/Wall Situation Description

An automobile is approaching a wall or obstruction at an unknown speed.

4.2.1 Probability Assessment

The probability of collision is estimated to be 80% to 90%.

4.2.2 Actions for Driver Warning

If the probability is 80% to 90%, the alarm_to_warn_the_driver (); function is triggered to alert the driver through an audio alarm.

4.2.3 Driver Response

If the motorist pays attention or has been warned, the program does not take any action and returns to chance_of_collision_occurrence (); to reevaluate the circumstances [11]. In the event that the driver does nothing, two functions are called:

- **auto_brake_apply ();** applies the brakes automatically to prevent collisions.
- **fully_headlight_on ();** activates all of the headlights to warn other vehicles.

4.2.4 Collision Check

If no collision occurs after these actions, the program goes back to the initial stage by calling chance_of_collision_occurrence ();

If a collision occurs:

- If the obstacle is a wall, auto brakes are applied only.
- If it's another vehicle, alarm_the_save (); is triggered to alert police or rescue services using a GPS modem.

4.2.5 Rescue Process

Two alarms are activated: one in the colliding car and the other in the rescue office.

- Rescue services use GPS to track the location.
- If the passenger is not severely injured, they can turn off the alarm to save rescue team response time.

4.3 Scenario 2: Two Cars Approaching Each Other on a Single Road

Similar steps are followed, including driver warning, auto-braking, and turning on headlights to avoid a collision.

Figure 2 Collision Occurrence

Figure 2 shows a collision involving two vandalized autos that have collided with one another. The goal of the suggested collision avoidance system is to reduce these kinds of accidents by 75% to 85%. Additionally, it is designed to improve the overall response time of rescue teams by reducing it by 6% to 8%. The system, as described in the pseudo-code, incorporates proactive measures to warn drivers,

International Research Journal on Advanced Engineering and Management

https://goldncloudpublications.com

e ISSN: 2584-2854
Volume: 02
Issue: 02 February 2024
Page No: 20-26

automatically apply brakes, and alert rescue services in case of a potential collision. These features contribute to enhancing road safety and expediting the response time of emergency services in the unfortunate event of a collision. The overall goal is to reduce the frequency and severity of collisions, thereby enhancing both driver safety and the efficiency of emergency response efforts. A flowchart is shown in Figure 3.

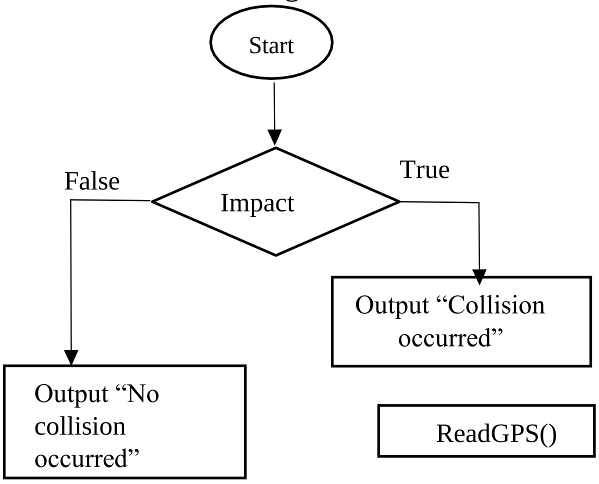

Figure 3 Flowchart

5. Design

The function of the impact sensor is collision detection. The Pin Configuration is shown in Figure 4. The key components and their functions:

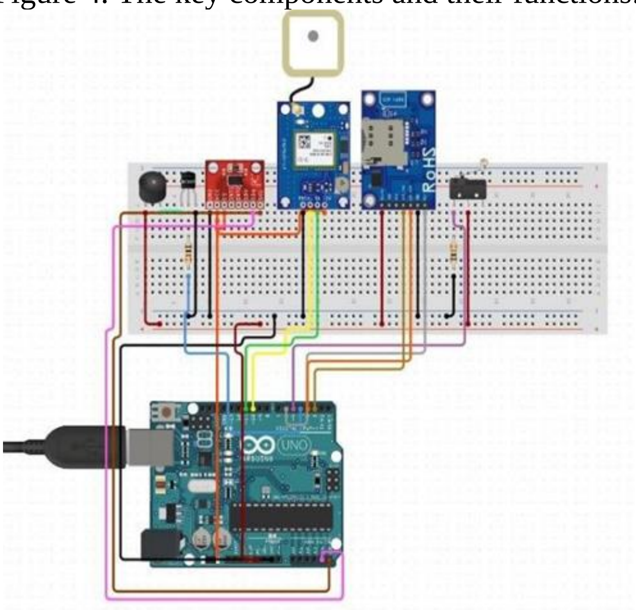

Figure 4 Pin Configuration

5.1 Impact Sensor (Collision Signal Sensor)

Function: Detects collisions or impacts.
Implementation: Uses the Touchpad tool in the Proteus program to simulate impact sensor behavior for an input that is treated as a collision if tapped.

5.2 Buzzer

Function: Alerts passengers that an emergency message has been sent following a crash or flip.
Implementation: The buzzer is activated to provide an audible alert.

5.3 Linear Potentiometers

Function: Serve as a variable voltage source for each axis to simulate the behavior of the ADXL335 sensor.
Implementation: As the ADXL335's acceleration is inversely proportional to the output voltage of each axis, three linear potentiometers are used to mimic this behavior without direct support for the ADXL sensor in the Proteus program.

5.4 GSM1 Module

Function: Transmits emergency messages.
Implementation: Programmed in Arduino to collect sensor readings, determine the current location, and transfer this data to the GSM code. The message transmitted contains details about and readings from the sensors.

5.5 Arduino

Function: Collects sensor readings, establishes the current location, and transfers data to the GSM code.
Implementation: Designed to communicate with different parts, collect information, and start sending emergency signals via the GSM1 module [12].

5.6 Equivalent Model for ADXL Sensor in Proteus

Implementation: Since the program does not directly support the ADXL sensor, it uses three parallel potentiometers as an equivalent model for the ADXL sensor in the Proteus simulation.

Results

The project's final product is an application that integrates sensors for transmitting requests for help and providing location information adding a valuable dimension to emergency services. The primary goal is to assist individuals who may be in distress or unable to communicate verbally by allowing them to send a request for help through the application. Users can use the application to send a request for assistance. The application includes functionality to transmit the user's location at the accident scene, enhancing the effectiveness of emergency services. The use of inexpensive sensors suggests a cost-effective approach to achieving the project goals. It’s implied that the sensors are utilized to determine and transmit the user's location. The application's design should prioritize simplicity and ease of use to ensure that individuals in distress can use it without complications. The transmitted location data can assist emergency services in reaching the scene as quickly as possible. Efficient coordination with emergency services can be crucial for a prompt and effective response. The mention of using only a few cheap sensors suggests a focus on affordability and accessibility, which is important for widespread adoption and impact. Depending on the application's specific requirements, the sensors could include GPS modules for location tracking, accelerometers for detecting impacts, or other relevant sensors for gathering necessary data. Ensure that the application adheres to data security and privacy standards, particularly when dealing with sensitive location information. Consider incorporating features that raise awareness among users about the functionalities of the application and how to use it effectively. Rigorous testing of the application's functionality and user interface is essential to ensure its reliability in real-world scenarios.

Conclusion

In this collision detection system, an accident detection and alert system is provided, and it delivers SMS messages to user-specified mobile numbers. A GSM alert system and GPS tracking have been used to create an algorithm. The recommended Automobile Accident Detection System might send an SMS accident alert and automatically track geographic data. The suggested method is expected to have a significant positive impact on the automobile sector. This system is specifically designed for society to reduce the number of deaths due to road accidents.

Future Scope

Our suggested technique can potentially be utilized in the future with machine learning (ML) algorithms, convolutional neural networks (CNNs), and Reinforcement Learning (RL). These technologies could enhance the decision-making process by analyzing complex patterns in traffic flow, enabling more adaptive and efficient traffic control. RL (Reinforcement Learning) could be employed to allow the system to learn and adapt to different traffic scenarios over time. The system could learn how to react at different traffic lights, optimizing decisions based on historical data and real-time feedback. The combination of an auto-brake system and automatically turning on headlights can significantly enhance vehicle and driver safety. Auto-brake systems contribute to collision prevention, while headlights improve visibility and awareness, especially in low-light conditions. The provided protocol for auto collision detection and avoidance serves as a foundation for reducing road accidents. The integration of functions for collision avoidance, coupled with a GPS-based rescue mechanism, adds a layer of safety and emergency response to the system. The ultimate goal of the proposed system is to reduce road accidents and save lives. By combining advanced technologies, proactive collision avoidance measures, and efficient rescue mechanisms, the system aims to contribute to a safer and more secure road environment.

References

[1] T. Tahmid and E. Hossain, "Density-based smart traffic control system using canny edge detection algorithm for congregating traffic information," 2017 3rd International Conference on Electrical Information and Communication Technology (EICT), 2017, pp.1-5, doi: 0.1109/EICT.2017.8275131.

[2] M. Amaresh, K. Shivanand Bhat, G. Ashwini, J. Bhagyashree and P. Aishwarya, "Density-Based Smart Traffic Control System for Congregating Traffic Information," 2019 International Conference on Intelligent Computing and Control

International Research Journal on Advanced Engineering and Management

https://goldncloudpublications.com

e ISSN: 2584-2854
Volume: 02
Issue: 02 February 2024
Page No: 20-26

Systems (ICCS), 2019, pp. 760-763, doi: 10.1109/ICCS45141.2019.9065691.

[3] M. R. Islam, N. I. Shahid, D. T. ul Karim, A. A. Mamun and M. K. Rhaman, "An efficient algorithm for detecting traffic congestion and a framework for smart traffic control system," 2016 18th International Conference on Advanced Communication Technology (ICACT), 2016, pp. 1- 1, doi: 10.1109/ICACT.2016.7423565

[4] S. S. R and L. Rajendran, "Real-Time Adaptive Traffic Control System for Smart Cities," 2021 International Conference on Computer Communication and Informatics (ICCCI), 2021, pp. 1-6, doi: 10.1109/ICCCI50826.2021.9402597.

[5] Anil, V. K. Shukla, and V. Naranje, "Tracking Vehicles through GPS Module and Arduino UNO," in 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2021, pp. 1-6

[6] S. P. Shubham, M. Kumar, and S. Jain, "A Survey on IoT based Automatic Road Accident Detection," in 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS), 2021, pp. 1-7.

[7] Luisito L. Lacatan;Rico S. Santos;Joel W. Pinkihan; Roderick Y. Vicente;Roger S. Tamargo; (2021). Brake-Vision: A Machine Vision-Based Inference Approach of Vehicle Braking Detection for Collision Warning Oriented System. 2021 International Conference on Computational Intelligence and Knowledge Economy (ICCIKE), (), –. doi:10.1109/iccike51210.2021.941075

[8] C. Ijeh, "A collision-avoidance system for an electric vehicle: a drive-by-wire technology initiative," SN Applied Sciences, vol. 2, pp. 1-20, 2020

[9] Mrs. Harshita Wankhede, A Novel Approach for Human Emotion Detection with Speech Recognition Using Support Vector Machine in Machine Learning, site online vol 46, pp-110-117,2023

[10] Mukherjee, M., et al. "Improvement of the properties of PC/LCP blends in the presence of carbon nanotubes." Composites Part A: Applied Science and Manufacturing 40.8 (2009): 1291-1298.

[11] Ayyar, Manikandan, et al. "Preparation, characterization, and blood compatibility assessment of a novel electrospun nanocomposite comprising polyurethane and ayurvedic-indhulekha oil for tissue engineering applications." Biomedical Engineering/Biomedizinische Technik 63.3 (2018): 245-253.

[12] Rajasekar, R., et al. "Development of compatibilized SBR and EPR nanocomposites containing dual filler system." Materials & Design 35 (2012): 878-885.