PROJECT PROPOSAL

Title

Design and Implementation of a GSM and GPS-Based Smart Helmet with Hard Braking Detection and False Alarm Prevention

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1. Introduction

Road accidents involving two-wheelers are a major cause of fatalities, especially in developing countries like Bangladesh. One of the primary reasons for increased casualty rates is the **delay in emergency response** and the **absence of accurate accident location information**. Conventional helmets only provide passive safety and lack intelligent accident detection and communication capabilities.

This project proposes a **Smart Helmet system** capable of detecting accidents, sudden hard braking, and abnormal motion using motion sensors. Upon detecting a critical event, the system automatically sends an **emergency SMS containing precise GPS coordinates** to a predefined contact number using a GSM module. To improve reliability, a **false alarm cancellation mechanism** is incorporated, allowing the rider to cancel emergency alerts in non-accident scenarios.

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2. Objectives

Main Objective

To develop a low-cost, standalone smart helmet that can automatically detect accidents and notify emergency contacts with accurate location data.

Specific Objectives

- To detect **hard braking and sudden acceleration** using accelerometer data
- To detect **fall and abnormal tilt** using gyroscope data
- To obtain **high-accuracy location** using a multi-constellation GPS module
- To send emergency alerts using a **GSM module without internet dependency**
- To implement a **false alarm cancel button** to reduce unnecessary alerts

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3. Novelty and Research Contribution

The proposed system introduces the following improvements over existing smart helmet designs:

- Detection of **hard braking behavior**, not just collisions
- Use of **multi-constellation GPS (NEO-M8N)** for improved location accuracy
- **False alarm prevention logic** using a timed cancel button
- Fully **standalone operation** (no smartphone or internet required)
- Optimized for **low-cost deployment in developing countries**

These features make the project suitable for **academic publication**.

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4. System Overview

The system consists of:

- A **motion sensing unit** (accelerometer + gyroscope)
- A **processing unit** (microcontroller)
- A **communication unit** (GSM)
- A **localization unit** (GPS)
- A **user interaction unit** (cancel button & vibration motor)
- A **power management unit**

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5. Equipment List with Model and Description

5.1 Microcontroller

- **ESP32 Dev Module**
    - Handles sensor processing, decision-making, and GSM communication
    - Chosen for high processing speed and multiple UART support

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5.2 Motion Sensor

- **MPU6050 (6-DOF IMU)**
    - 3-axis accelerometer: detects sudden acceleration and hard braking
    - 3-axis gyroscope: detects tilt, rotation, and fall

5.3 GPS Module

- **NEO-M8N GPS Module**
  - Supports GPS, GLONASS, and Galileo
  - Accuracy: ~1–2 meters
  - Provides real-time latitude and longitude

5.4 GSM Module

- **SIM800L GSM Module**
  - Sends SMS alerts to emergency contacts
  - Works independently of internet connectivity

5.5 User Interaction Components

- **Push Button** – false alarm cancellation
- **Vibration Motor** – alert before SMS transmission
- **Buzzer (optional)** – audible warning

5.6 Power Supply

- **18650 Li-ion Battery (3.7V, ≥2600 mAh)**
- **TP4056 Charging Module (with protection)**
- **DC-DC Buck Converter (LM2596)** – ensures stable voltage for GSM
- **ON/OFF Switch**

5.7 Miscellaneous

- PCB or breadboard
- Jumper wires
- Enclosure
- Helmet

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6. Estimated Budget (Bangladesh)

Component	Model	Estimated Cost (BDT)
Microcontroller	ESP32 Dev Board	600
Motion Sensor	MPU6050	250
GPS Module	NEO-M8N	1,700
GSM Module	SIM800L	850
Li-ion Battery	18650	280
Battery Holder	18650 Holder	50
Charging Module	TP4056	70
Buck Converter	LM2596	120
Vibration Motor	Coin Type	140
Push Button	Tactile	20
Buzzer	Active	40
PCB, Wires, Switch	—	200
Helmet	Standard	1,000

Total Estimated Cost

👉 **Approximately 5,300 – 5,500 BDT**

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7. Methodology / Procedure

Step 1: Sensor Data Acquisition

- The MPU6050 continuously measures:
  - Linear acceleration (X, Y, Z axes)
  - Angular velocity (roll, pitch, yaw)

Step 2: Hard Braking Detection

- Sudden negative acceleration exceeding a predefined threshold indicates hard braking
- Acceleration magnitude is calculated using:

$$A = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

Step 3: Fall Detection

- Gyroscope data is analyzed for abnormal tilt angles
- If tilt angle exceeds a predefined safe limit, fall condition is triggered

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Step 4: Pre-Alert Warning

- Upon detection of a critical event:
    - Vibration motor is activated
    - A delay (e.g., 10 seconds) is introduced

Step 5: False Alarm Cancellation

- During the delay, the rider may press the cancel button
- If pressed, the alert process is terminated

Step 6: GPS Location Acquisition

- If not canceled, GPS module retrieves current latitude and longitude
- Coordinates are formatted into a Google Maps link

Step 7: Emergency Alert Transmission

- GSM module sends SMS containing:
    - Accident alert message
    - GPS coordinates / map link

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8. Expected Outcomes

- Accurate accident and braking detection
- Reduced emergency response time
- Reliable operation without internet
- Low-cost, deployable safety system
- A **publishable research prototype**

9. Future Work

- Integration of cloud data logging
- Helmet-to-vehicle communication
- Machine learning-based accident classification
- Mobile application support

10. Conclusion

This project presents a practical and low-cost smart helmet solution incorporating motion detection, GPS localization, GSM-based communication, and false alarm prevention. The proposed system enhances rider safety and has strong potential for real-world deployment and academic publication.