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Real-Time Vehicle Over-Speed and High-Intensity Headlight Detection System for Night-Time Accident Prevention

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Abstract: *This integrating speed sensing, light intensity detection, RFID-based vehicle identification, GPS geo-tagging, and LoRa wireless communication. The system detects over speed and high-intensity headlight conditions and records time-stamped geo-location data using GPS. The event data is transmitted using LoRa to a monitoring station, where a Python-based dashboard displays real-time tracking and violation logs. The proposed system demonstrates low-power, long-range communication suitable for scalable smart city deployment.*

Keywords: LoRa, RFID, GPS, Vehicle Tracking, Geo-Tagging, Time Stamping, Over speed Detection, High-Intensity Headlight Detection IoT Monitoring

I. INTRODUCTION

Road safety is a major concern in India and worldwide. Over speeding and high-intensity headlights are common causes of accidents. Road accidents often happen because vehicles go too fast or because of bright headlights from oncoming traffic, which make it hard for drivers to see and react in time. This project is about a wireless vehicle safety system that warns drivers when these dangers occur.

A Hall effect sensor checks the vehicle's speed, and a BH1750 light sensor measures how bright the incoming light is. A small microcontroller looks at the sensor data and uses a simple rule: if the speed is too high or the light is too bright, The system also uses RFID to identify vehicles and LoRa wireless communication to send the information to a monitoring station. This system helps make driving safer by giving drivers real-time warnings about speeding and bright lights.

II. PROBLEM STATEMENT

High vehicle speed → accident risk
High headlight intensity → eye blur to opposite driver
If:
Speed is HIGH **OR** Light intensity is HIGH → **RF tag reader ON + Record data in Real time + LCD Display ON**
If both are HIGH → same action
Mathematical Condition:
IF (Speed > Threshold) **OR** (Lux > Threshold)
Activate RFID **+ Record data in Real time + LCD Display ON**
ELSE
System Normal

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III. FLOW CHART DIAGRAM

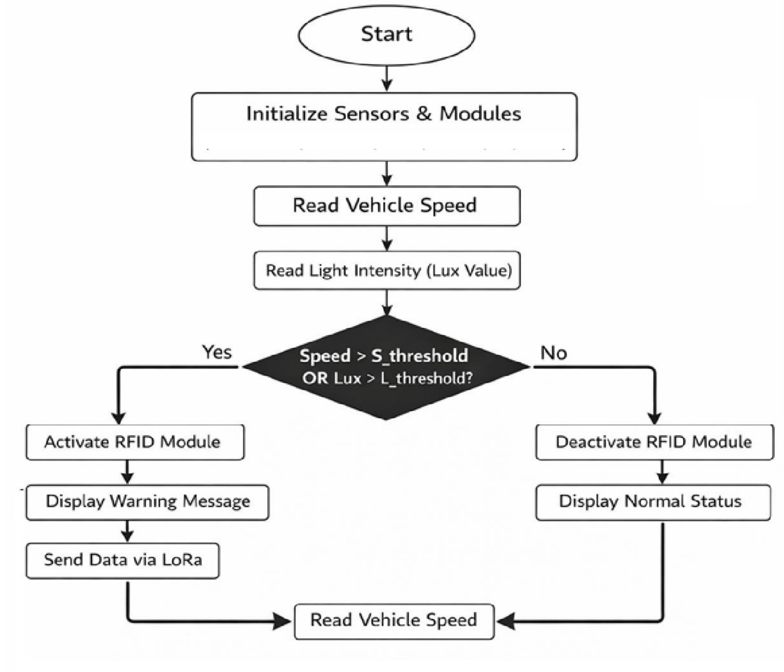

Figure No 1

IV. BLOCK DIAGRAM

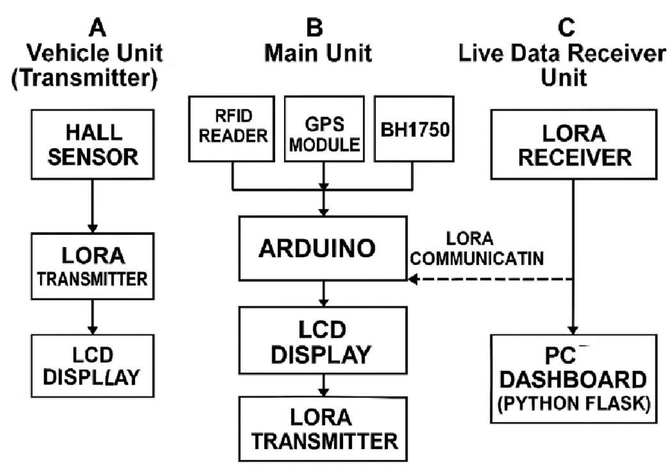

Figure No 2

The overall system consists of sensing, processing, communication, and alert modules integrated into a unified architecture. The speed sensing unit employs a Hall effect sensor mounted on the vehicle wheel to detect rotational pulses. These pulses are transmitted to the microcontroller, where the vehicle speed is calculated based on pulse frequency. Simultaneously, the light intensity sensing unit utilizes a BH1750 digital lux sensor connected via the I2C interface to continuously measure incoming light intensity from oncoming vehicles.

The microcontroller serves as the central processing unit, receiving inputs from both sensors and applying a logical OR decision algorithm based on predefined threshold values. If the measured speed exceeds the safe limit or the detected light intensity surpasses the glare threshold, the controller activates the alert subsystem. The alert subsystem consists of a buzzer for audible warning and an LCD display for real-time data visualization. Additionally, the RFID module is enabled during unsafe conditions to facilitate vehicle identification. The LoRa communication module transmits real-time data wirelessly to a remote monitoring unit. The power supply unit ensures stable voltage regulation for all subsystems. Thus, the block diagram represents a modular and hierarchical structure enabling reliable operation and future scalability.

V. HARDWARE DESCRIPTION

The proposed system consists of the following major hardware components:

Microcontroller Unit (Arduino)

The Arduino (Nano/UNO) based on the ATmega328P microcontroller acts as the central control unit. It processes sensor inputs, executes decision logic, and controls output devices. It operates at 5V with 16 MHz clock frequency and supports SPI, I2C, and UART communication protocols.

Hall Effect Speed Sensor

The Hall effect sensor (A3144) detects magnetic field changes produced by a rotating wheel magnet. Each rotation generates a pulse signal that is counted by the microcontroller using interrupt functionality. The vehicle speed is calculated using pulse frequency and wheel circumference.

BH1750 Light Intensity Sensor

The BH1750 is a digital ambient light sensor that communicates via I2C protocol. It provides lux readings directly without requiring complex analog conversion. The sensor operates at 3.3V and measures light intensity in the range of 1 to 65535 lux.

LoRa Module (SX1278)

The SX1278 LoRa module enables long-range wireless communication at 433 MHz. It uses SPI communication with the microcontroller and allows reliable transmission over several kilometers in open areas.

RFID Module (RC522)

The RC522 RFID reader operates at 13.56 MHz and communicates using SPI protocol. It is activated during unsafe conditions to identify authorized vehicle tags.

GPS Module (Neo 6 m)

GPS (Global Positioning System) module and is used for navigation. The module simply checks its location on earth and provides output data which is longitude and latitude of its position

Power Supply Unit

The system uses:

- 12V input supply
- 7805 voltage regulator for 5V
- AMS1117 regulator for 3.3V
- Decoupling capacitors for noise filtering

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VI. CIRCUIT DIAGRAM

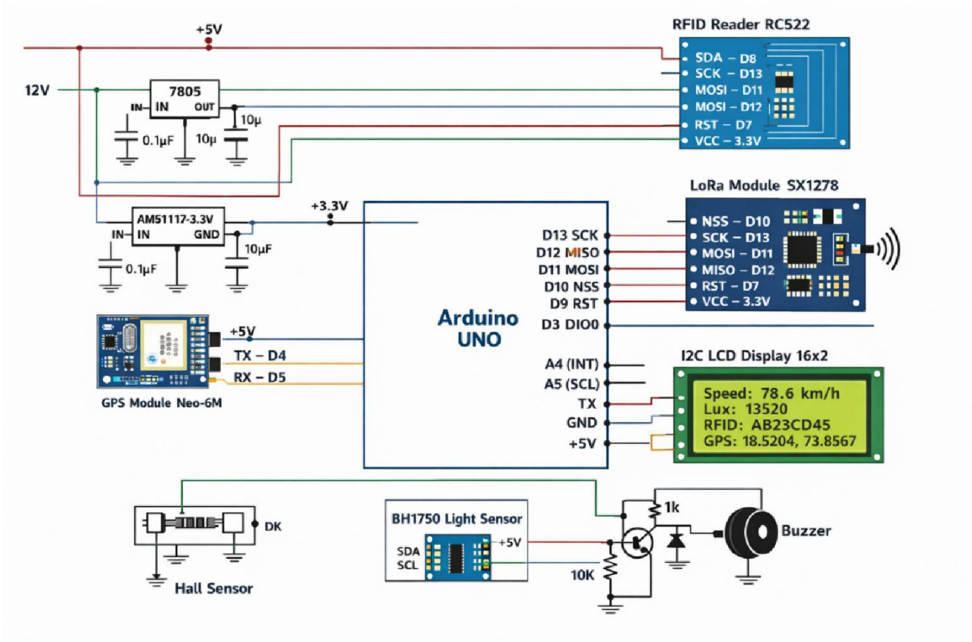

Figure No 3

VI. PROPOSED PROTYPE

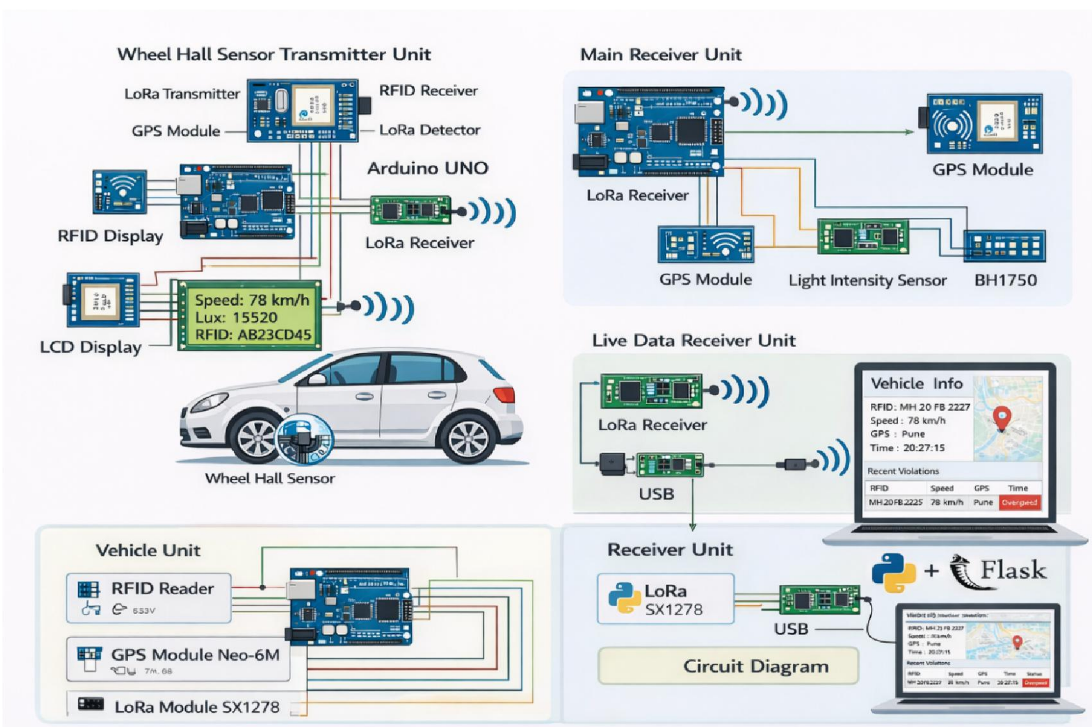

Figure No 4

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1) Vehicle Unit (Transmitter Side)

Components:

- Arduino UNO
- Hall Sensor (Speed measurement)
- BH1750 Light Sensor
- RC522 RFID Reader
- Neo-6M GPS Module
- LoRa SX1278 Module
- LCD Display
- Buzzer

2) Monitoring Station (Receiver Side)

Components:

- Arduino + LoRa Receiver
- PC running Python Flask server
- Real-time dashboard

3) Communication Interfaces:

- SPI → RFID + LoRa
- I2C → LCD + BH1750
- UART → GPS
- Wheel circumference = 2.1 meters (example bike/car)
- 1 pulse per revolution
- Speed threshold = 60 km/h
- Light threshold = 4000 lux
- LoRa frequency = 433 MHz

VII. SOFTWARE DESCRIPTION

1) Transmitter Code (Vehicle Unit)

```
#include <SPI.h>
#include <LoRa.h>
#include <Wire.h>
#include <BH1750.h>
#include <TinyGPS++.h>
#include <SoftwareSerial.h>

// -------------------- CONFIGURATION --------------------
#define HALL_PIN 2
#define LORA_SS 10
#define LORA_RST 9
#define LORA_DIO0 3

const float wheelCircumference = 2.1; // meters
const float speedThreshold = 60.0;    // km/h
const float luxThreshold = 4000.0;    // lux
```


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```
// -------------------------------------------------------
volatile unsigned long pulseCount = 0;
unsigned long lastSpeedCalcTime = 0;
float speedKmph = 0;

BH1750 lightMeter;
TinyGPSPlus gps;
SoftwareSerial gpsSerial(4, 5); // RX, TX

// -------------------- INTERRUPT --------------------
void countPulse() {
 pulseCount++;
}

// -------------------- SETUP --------------------
void setup() {
 Serial.begin(9600);
 gpsSerial.begin(9600);

 pinMode(HALL_PIN, INPUT_PULLUP);
 attachInterrupt(digitalPinToInterrupt(HALL_PIN), countPulse, RISING);

 Wire.begin();
 lightMeter.begin();

 LoRa.setPins(LORA_SS, LORA_RST, LORA_DIO0);

 if (!LoRa.begin(433E6)) {
  Serial.println("LoRa init failed!");
  while (1);
 }

 // Professional LoRa Configuration
 LoRa.setSpreadingFactor(9);
 LoRa.setSignalBandwidth(125E3);
 LoRa.setTxPower(17);

 Serial.println("System Initialized Successfully");
}

// -------------------- LOOP --------------------
void loop() {
 calculateSpeed();
 float lux = lightMeter.readLightLevel();
 while (gpsSerial.available()) {
  gps.encode(gpsSerial.read());
 }
```

```
  if (speedKmph > speedThreshold || lux > luxThreshold) {
    if (gps.location.isValid() && gps.time.isValid()) {
      String packet = "ALERT,";
      packet += "MH20FB2727,";
      packet += String(speedKmph, 2) + ",";
      packet += String(lux, 1) + ",";
      packet += String(gps.location.lat(), 6) + ",";
      packet += String(gps.location.lng(), 6) + ",";
      packet += formatTime();

      LoRa.beginPacket();
      LoRa.print(packet);
      LoRa.endPacket();

      Serial.println("Violation Packet Sent:");
      Serial.println(packet);
    }
  }

  delay(500);
}

// -------------------- SPEED CALCULATION --------------------
void calculateSpeed() {

  unsigned long currentMillis = millis();

  if (currentMillis - lastSpeedCalcTime >= 1000) {

    detachInterrupt(digitalPinToInterrupt(HALL_PIN));

    float revolutionsPerSecond = pulseCount;
    pulseCount = 0;

    speedKmph = revolutionsPerSecond * wheelCircumference * 3.6;

    lastSpeedCalcTime = currentMillis;

    attachInterrupt(digitalPinToInterrupt(HALL_PIN), countPulse, RISING);
  }
}
// -------------------- TIME FORMAT --------------------
String formatTime() {

  char timeBuffer[10];
  sprintf(timeBuffer, "%02d:%02d:%02d",
          gps.time.hour(),
          gps.time.minute(),
```

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```
        gps.time.second());

  return String(timeBuffer);
}
```

2) Main Receiver Unit Code

```
#include <SPI.h>
#include <LoRa.h>
// LoRa Pins
#define LORA_SS   10
#define LORA_RST  9
#define LORA_DIO0 3

void setup() {
  Serial.begin(9600);
  while (!Serial);

  LoRa.setPins(LORA_SS, LORA_RST, LORA_DIO0);

  if (!LoRa.begin(433E6)) {
    Serial.println("LoRa init failed!");
    while (1);
  }

  LoRa.setSpreadingFactor(9);
  LoRa.setSignalBandwidth(125E3);
  LoRa.setTxPower(17);

  Serial.println("LoRa Receiver Ready");
}

void loop() {
  int packetSize = LoRa.parsePacket();
  if (packetSize) {
    String incoming = "";

    while (LoRa.available()) {
      incoming += (char)LoRa.read();
    }

    // Send received data to PC
    Serial.println(incoming);
  }
}
```


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VIII. CONCLUSION

The proposed system successfully integrates RFID identification, GPS geo-tagging, speed and light detection, and LoRa communication into a unified smart vehicle monitoring solution.

The system demonstrates real-time violation detection, accurate geo-location tracking, and scalable architecture suitable for smart city infrastructure.

Future work includes cloud integration, AI-based traffic analytics, and NB-IoT migration for large-scale deployment.

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