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Smart Guard: IoT based Driver Health Monitoring and Safety System

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Abstract

The research presents the design and implementation of an embedded system for monitoring and enhancing driver safety using a combination of health and environmental sensors, along with location and communication modules. The system integrates a heartbeat sensor, sweat sensor, ultrasonic sensor, GPS, and GSM module to provide real-time monitoring and alerts. The heartbeat sensor and sweat sensor track the driver's physiological conditions, detecting signs of stress or health issues. The ultrasonic sensor monitors the vehicle's surroundings to prevent collisions. The GPS module tracks the vehicle's location, and the GSM module enables communication with a central server and the emergency contacts. This system aims to improve driver safety by providing real-time health monitoring, environmental awareness, and emergency response capabilities, representing a significant advancement in the integration of embedded systems and IoT technologies in automotive safety applications.

Keywords: Internet of Things (IoT), Automotive Safety, Real-Time Health Monitoring, Driver Safety

1. Introduction

In today's rapidly evolving world, the Internet of Things (IoT) has advanced significantly, introducing innovative ideas that contribute to a smarter world. According to a recent study by the World Health Organization (WHO), most accidents in India are caused by heart attacks while driving. According to research, approximately 336 people die every day due to heart failure in traffic accidents.

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In India, road traffic accidents are a significant public health and safety concern, resulting in a high number of fatalities and injuries each year. According to data from the Ministry of Road Transport and Highways, India recorded over 150,000 road traffic fatalities in 2019 alone, making it one of the countries with the highest number of road accident-related deaths globally.

The research study aims to develop an embedded system that revolutionizes health monitoring and safety enhancement through the integration of advanced sensor technologies and communication modules. With a focus on real-time data acquisition and analysis, the system monitors vital signs, such as heartbeat, sweat, ultrasonic, GPS, and GSM sensors to provide the individuals with knowledge about their health status. Concurrently, the ultrasonic sensor ensures safety by detecting obstacles and preventing collisions, while the GPS module enables precise location tracking functionalities. Moreover, the inclusion of a GSM module facilitates seamless communication, allowing for immediate alerting in emergencies and remote monitoring by caretakers or authorities. By integrating these components, the embedded system enables the users to manage the health and, develop a sense of security and well- being in their daily lives. Through innovation, the study aims to redefine the standards of personal health monitoring and safety in an increasingly interconnected world.

Heart disease occurs when a person's blood pressure rises or falls, so we use heart rate sensors to monitor the driver's heart rate while driving. The heart rate sensor constantly monitors the driver's heart rate and sets it in the monitoring state, then the heart rate sensor monitors the heart rate and sends a message to the ARM processor. After receiving the heart rate sensor's message the ARM processor performs the necessary action. Allowing the driver to drive or not, sending messages to users and nearby hospitals through GPS and GSM modules. The sweat sensor will detect if the driver sweats and open the car window. If the vehicle is involved in an accident, the vibration sensor will be activated and will send a message to the user and nearby hospitals through GPS and GSM modules.

2. Literature Survey

The increasing usage of vehicles has led to increased accidents due to distractions, stress, and health issues. The Internet of Things can help make life safer. However, the mortality rate in India has risen to 4.6 from 140,000 in the previous year, often due to driver ignorance or poorly maintained roads [3,4].

Aggressive driving also is a major cause of traffic accidents, posing a risk to life and property. Researchers are focusing on remote monitoring and analyzing driving patterns using IoT technology. This research aims to provide real-time understanding of driving conditions using electric motors, collecting local data and reporting it to a remote interface. Data systems, including CAN bus and OBD-II models, are used to monitor vehicle performance [1].

A low-cost, decentralized sensor model is designed to measure driver's eye blinks, attitude, and hand position on the steering wheel, detecting driver fatigue and accident prevention. The sensor module integrates various sensors into the steering wheel, preventing driver removal and detecting dangerous driving. However, the driver blink sensor frame can fail, causing the wheel to slow down or stop [2].

This study aims to develop a smart alert technique for intelligent vehicles to automatically avoid drowsy drivers. The system uses Video Stream Processing (VSP) and eye blink concepts, Eye Aspect Ratio (EAR), Euclidean distance, and face landmark algorithm for eye detection. When fatigue is detected, the IoT module issues a warning message, impact of collision, and location information, using a Raspberry Pi monitoring system.[5]

This research presents a smartphone-based system for detecting drowsiness in automotive drivers. The system uses three stages: eyelid closure (PERCLOS), near-infrared lighting, voiced to unvoiced ratio, and a touch response. The system is reliable, easy to implement on Android smartphones, and uses SMS service to inform the control room and passengers about the driver's loss of attention. It provides 93.33% drowsiness state classification compared to a single stage at 86.66% [6].

This study presents a simple, effective drowsy driver detection system using Python and Dlib model. The system uses Dlib's shape detector to map facial landmarks and detect drowsiness by monitoring eye and mouth aspect ratios. Performance evaluation shows a maximum recognition accuracy of 96.71% for dataset video input [7].

Air buses are a high-speed, luxury public transport system, but their safety issues are often overlooked. Despite the development of automobile industries, these vehicles have become luxurious confines, causing fatalities. To address this, an Intelligent Transportation System for Safety and Driver Assistance is being developed using the Internet of Things (IoT). The system uses sensors to sense signals and functions of the vehicle, analyzing various factors to prevent collisions. If any factor fails, a buzzer unit is activated and fuel supply is blocked, preventing disasters. Simulation results are obtained using AutoCAD [8].

A vehicle tracking system is a useful tool for tracking a vehicle's movement from any location at any time. This system uses GPS and GSM technology to track the vehicle's position in real-time. An Arduino UNO controls the GPS receiver and GSM module, providing real-time updates via SMS. The GPS coordinates are sent to the user via SMS, and the location is displayed on an LCD. The system allows users to monitor the vehicle's movement on demand, determining estimated distance and time for arrival at a given destination [10].

The location tracking system uses GPS and GSM technologies through a microcontroller to detect vehicle or object locations. It uses a smartphone and Arduino UNO, with GPS providing accurate location information. The GSM module transmits location updates to a database, while the GPS receiver sends data in the National Marine Electronics Association protocol. The Arduino is linked to the GPS and GSM module, allowing for easy estimation of vehicle location and time to reach a destination [9].

The Global Positioning System (GPS) is increasingly used for real-time vehicle tracking and monitoring, providing affordable and efficient solutions. The GPS-GPRS-based system uses a GPS device to acquire the current vehicle's position and send location coordinates through the GSM network. The GPS receiver provides latitude and longitude information. The system can be built using a microcontroller, which connects to the GPS receiver and transmits the location information to a tracking server through GPRS modem [11].

The study paved the way for the design and the development of the proposed system to monitor the health status of the driver on drive

3. Methodology

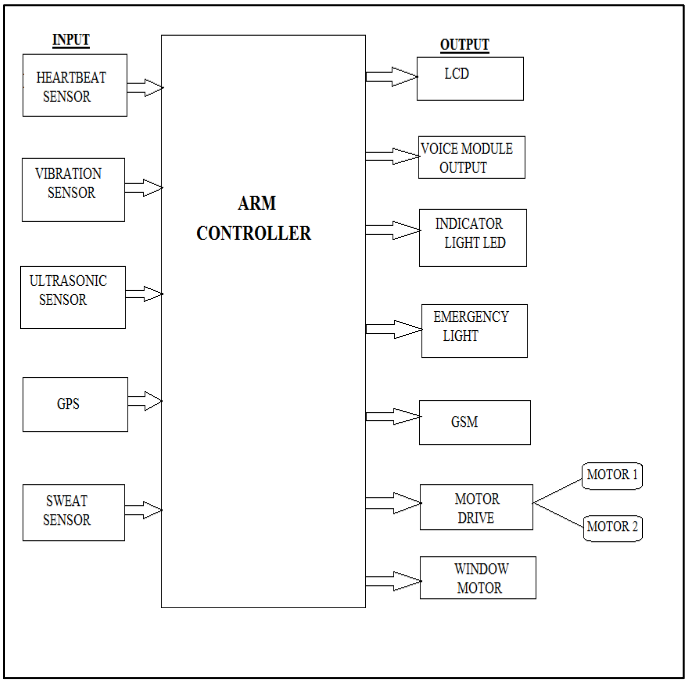


Figure 1. Block Diagram of Health Status Monitor

The Figure .1 represents a real-time monitoring and control system using an LPC2148 ARM microcontroller as the central processing unit. The system consists of multiple input sensors that collect vital signs of the driver and environmental data. These data are processed by the microcontroller to generate appropriate outputs. The outputs include notifications through LCD displays, audio alerts, notification to the respective persons. The actuator controls the motors for window glass movement and ventilation. The system is designed for automated decision-making, ensuring real-time alerts and actions based on sensor inputs

3.1 Input and Output Components

The input section includes heartbeat sensor (MAX30100) for heart rate and SpO2 monitoring, vibration sensor (SW-420) for detecting tremors or movement, ultrasonic sensor (HC-SR04) for obstacle detection, GPS module (NEO-6M) for real-time location tracking, and sweat sensor (Grove GSR) for detecting stress levels. These sensors provide continuous data to the LPC2148 ARM7-based microcontroller, which processes the information and triggers corresponding outputs. The output section includes a 16x2 LCD with an I2C module for displaying real-time data, DFPlayer Mini voice module for audio alerts, GSM module

(SIM800L) for sending alerts via SMS, L298N motor driver to control two DC motors, and a 12V window motor for automatic ventilation.

3.2 Working

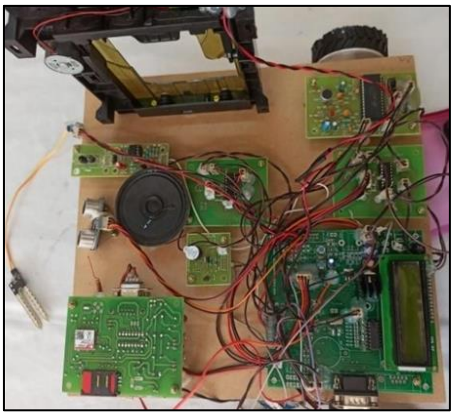
The system continuously monitors health condition of the person and the environmental conditions using the connected sensors. If any critical thresholds were detected, such as abnormal heart rate, excessive vibration, an obstacle in the path, high-stress levels, the system reacts immediately to take the necessary actions The LCD displays sensor readings, the voice module provides audio feedback, and the GSM module sends SMS notifications in emergencies. Additionally, the motor drive controls movement-based responses, such as adjusting ventilation using the window motor or stopping the vehicle when it is necessary. The entire process is automated, ensuring a responsive and efficient real-time monitoring system

3.3 System Implementation

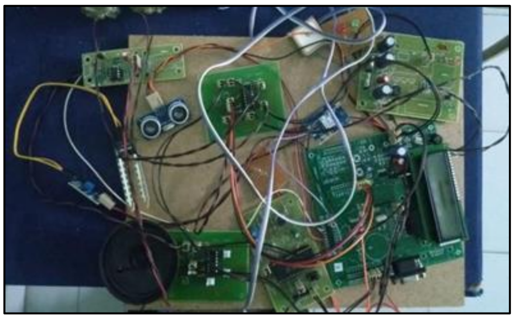
The system is programmed using C language in Keil µVision IDE with Flash Magic used for flashing firmware onto the LPC2148 microcontroller. The microcontroller communicates with sensors through UART (GPS, GSM, voice module), I2C (LCD, heartbeat sensor), GPIO (LEDs), and PWM (motor control). The PCB is designed using EasyEDA, and simulation is performed using Proteus 8. The firmware follows an optimized logic flow, such as initializing peripherals, reading sensor data, processing conditions, displaying relevant alerts, and triggering actuator responses based on predefined thresholds.

4. Result

The research successfully developed an embedded system integrating a heartbeat sensor, sweat sensor, ultrasonic sensor, GPS, and GSM module. The system demonstrated effective real-time health monitoring, accurately measuring heart rate and sweat levels to detect abnormalities such as stress or dehydration. The ultrasonic sensor reliably detected obstacles, enhancing safety by providing timely collision warnings. The GPS and GSM modules enabled precise location tracking and communication, sending alerts with location data during emergencies. Overall, the system proved to be a comprehensive solution for monitoring health and safety, with applications in personal health management, driver safety, and emergency response. The Figure 2 (a) and (b) shows the hardware prototype developed for the proposed system.



(a)



(b)

Figure 2. Hardware Prototype

Figure 3 shows the alert message sent from the device to the respective person

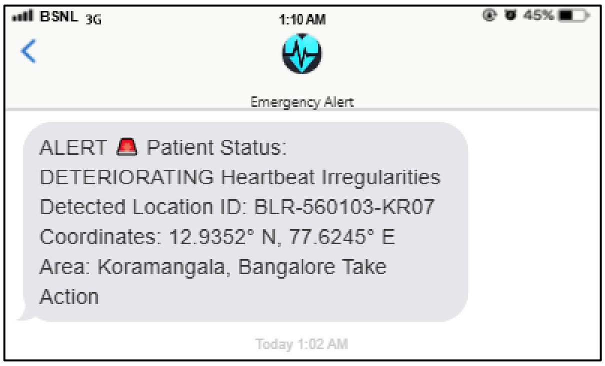


Figure 3. Alert Message Sent from the Device

5. Conclusion

The health status monitoring system integrates the LPC2148 microcontroller, sensors, and wireless communication for real-time vital tracking and emergency alerts. Using IoT, it enhances remote healthcare, enabling early disease detection and timely intervention. Future improvements include cloud storage, AI-driven analytics, and wearable integration for optimized health management.

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