Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Integrated Driver Health and Safety System

Jade Williams - 2205436

BEng (Hons) Electrical and Electronic Engineering

School of Applied Computing

Abstract

This project presents the design and development of an Integrated Driver Health and Safety System aimed at improving road safety by monitoring key physiological indicators of drivers in real time. The system addresses the growing need for non-intrusive health monitoring in vehicles, particularly for long-distance and commercial drivers who are at increased risk of fatigue and medical emergencies. Using embedded system technology, the prototype measures heart rate and body temperature through the MAX30102 and MLX90614 sensors, with data processed by a PIC16F18877 microcontroller. The system continuously analyses sensor inputs and provides immediate visual feedback through a set of LED indicators representing normal, warning, and emergency conditions.

An iterative development approach was adopted, involving research, prototyping, and testing using a breadboard-based hardware setup. The system was programmed in C using the MPLAB development environment and designed to operate in real time. Key design considerations included low power consumption, reliability, and simplicity of interpretation. Although initial plans included additional sensors for motion detection and audible alerts, these were removed to reduce system complexity and focus on core physiological monitoring functions.

Testing highlighted several hardware and software challenges, including power instability due to battery-based operation and limitations in compiler configuration and sensor integration. As a result, full system integration was not achieved within the project timeframe.

The project concludes that while the system effectively demonstrates the potential of embedded health monitoring for driver safety applications, further development is required to improve power regulation, system integration, and long-term reliability. Recommendations for future work include PCB implementation, enhanced sensor integration, and the addition of wireless communication and data logging capabilities to support real-world deployment.

Aims and Objectives

The project aims to develop a multimodal driver health monitoring system with the following objectives:

- Track real-time physiological signals such as heart rate, SpO_2, and body temperature.

- Identify behavioural conditions that indicate drowsiness or loss of consciousness.

- Deliver in-vehicle alerts, with the potential to expand into remote emergency notification systems.

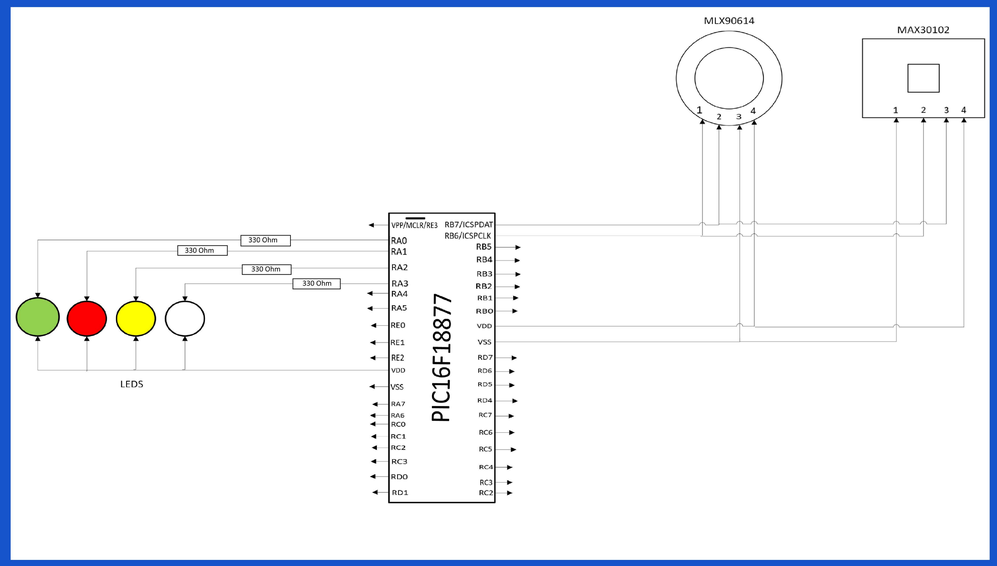

Figure 1: Schematic Drawing

Design Analysis

The Integrated Driver Health and Safety System is a low-cost embedded prototype designed to monitor heart rate and body temperature in real time and provide visual alerts when abnormal readings are detected. It uses a MAX30102 heart rate sensor and MLX90614 temperature sensor connected to a PIC16F18877 microcontroller, which processes the data and controls LED outputs.

Four LEDs indicate user condition: green for normal readings, yellow for high temperature, red for abnormal heart rate, and white when both readings are abnormal. The system is programmed in C and operates continuously, comparing sensor data against predefined thresholds. Designed on a breadboard for testing, the system aims to provide reliable, real-time physiological monitoring while remaining simple, energy-efficient, and easy to interpret.

Research

Embedded systems are specialised computing systems designed to perform dedicated tasks efficiently and reliably within larger electronic or mechanical systems. Unlike general-purpose computers, they have limited processing power and memory and are optimised for real-time performance, making them suitable for safety-critical applications. They typically include a microcontroller, sensors, actuators, and embedded software that work together to collect, process, and respond to data in real time.

In the automotive industry, embedded systems are widely used to improve vehicle performance and safety. Examples include engine control units (ECUs), anti-lock braking systems (ABS), airbags, adaptive cruise control, and transmission control units (TCUs). These systems continuously analyse sensor data to optimise vehicle operation and respond rapidly to changing conditions.

Embedded systems also support driver safety through monitoring technologies that detect fatigue, distraction, or unsafe behaviour using cameras and sensors. Vehicles from manufacturers such as Tesla, BMW, Mercedes-Benz, Volvo Trucks, and Scania use these systems to enhance road safety. More advanced developments integrate physiological monitoring with Advanced Driver Assistance Systems (ADAS), enabling automated responses such as slowing the vehicle or stopping safely if driver incapacitation is detected.

The use of health-monitoring embedded systems also raises technical and ethical challenges. Technically, systems must process physiological data accurately and in real time despite limited resources. Ethically, concerns around biometric data privacy, security, and user consent are becoming increasingly important in modern vehicle design.

Results

The development of the Integrated Driver Health and Safety System faced hardware and software challenges that limited full integration testing. Replacing the original regulated power supply with a 3.7V battery caused unstable voltage, overheating, and unreliable performance in components such as the PIC16F18877, MAX30102, and MLX90614. The use of a breadboard and the removal of voltage regulation components further increased heating and instability.

Software issues, including compiler configuration and code-uploading problems, also slowed development and prevented complete system testing. As a result, simplified software was created to test components individually, making debugging and fault identification easier.