# ***Functional Document***

### 1. Introduction

### This document outlines the functional requirements of the system titled “Embedded Machine Learning for Early Detection of Heart Attack Symptoms.” The system uses an embedded GSR sensor, heart rate, SpO2, HRV, and sweat levels to detect early signs of heart attacks in real-time. It is designed to alert users, especially drivers, for quick response and safety.

### 2. Product Goal

* The primary goal of this project is to develop a smart, real-time health monitoring system that utilizes embedded machine learning (ML) to detect early symptoms of a heart attack. By integrating multiple physiological sensors — including those for heart rate, blood oxygen levels (SpO2), heart rate variability (HRV), and sweat levels via a GSR (Galvanic Skin Response) sensor — the system continuously tracks the driver’s health status during vehicle operation.
* The device is designed to process this multi-sensor data locally using an on-device ML model running on an Arduino Nano 33 BLE Sense Rev2 board. If potential symptoms of a heart attack are detected, the system will issue instant alerts to the user, enabling timely response and reducing the risk of serious complications or fatalities.
* This system aims to address the growing concern of health emergencies, especially cardiovascular issues occurring during long or stressful driving hours, which are often undetected until too late. The integration into electric and fuel-powered vehicles further ensures that the technology is adaptable and scalable for commercial fleets, personal vehicles, and public transport. Ultimately, the system enhances road safety by proactively safeguarding the driver’s health through a combination of wearable sensing, intelligent analysis, and immediate feedback.

### 3. Demography (Users, Location)

Primary Users:

* Drivers of Electric Vehicles (EVs)
* Drivers of Fuel-Powered Vehicles
* Fleet management and logistics companies

Secondary Users:

* Traffic safety authorities
* Vehicle manufacturers integrating health monitoring features
* Emergency responders

Target Locations:

* Highways and expressways
* Long-distance routes
* Urban traffic zones
* Commercial fleet operations

### 4. Business Processes

The Embedded Machine Learning-based Heart Attack Detection System operates through a well-defined sequence of processes to monitor, detect, and alert in real-time. Below is the detailed step-by-step business process:

* Continuous data acquisition from sensors (Heart Rate, SpO2, HRV,Sweat)
* Real-time data preprocessing on the Arduino board
* On-device ML inference to detect anomalies
* Alert generation via audio, visual, or haptic feedback

### 5. Features

### **5.1 Feature – Heart Rate Monitoring System Integration**

### **Description**: The system continuously monitors the driver’s heart rate using onboard sensors.

### **User Story**: As a driver, I want the system to continuously monitor my heart rate so that I can be aware of any sudden changes indicating potential health risks.

### **Acceptance Criteria**: System accurately monitors heart rate within ±2 bpm in real-time.

### **5.2 Feature – Data Processing Unit for ML Model**

### **Description**: Edge computing module processes sensor data using a trained ML model to detect early symptoms of a heart attack.

### **User Story**: As a developer, I want the system to process health data using ML so that we can detect early symptoms of a heart attack accurately.

### **Acceptance Criteria**: ML model processes data with at least 95% accuracy and inference time under 100ms.

### **5.3 Feature – Alert System Development**

### **Description**: Alerts (visual/audio) are triggered if the system detects dangerous patterns.

### **User Story**: As a driver, I want to receive alerts if the system detects any symptoms of a heart attack so that I can take immediate action.

### **Acceptance Criteria**: Alerts are triggered within 5 seconds of detecting critical health anomalies and are noticeable even in noisy environments.

### 6. Authorization Matrix

Define the roles and their corresponding access levels:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ROLE** | **ACCESS DEVICE** | **VIEW DATA** | **MODIFY SETTINGS** | **RECEIVE ALERTS** |
| **DRIVER** | YES | YES | LIMITED | YES |
| **DOCTOR** | NO | YES | NO | YES |
| **TECHNICAL ADMIN** | YES | YES | YES | OPTIONAL |

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### 7. Assumptions

1. Drivers are willing to wear or integrate the device during driving sessions.
2. The ML model is trained on relevant datasets for detecting early symptoms.
3. Device will function reliably under normal driving conditions and vibrations.
4. Alerts and interface are designed to be non-distracting but effective.
5. Power supply from the vehicle or rechargeable battery is sufficient for continuous monitoring.
6. Emergency contact integrations are optional and depend on app development.