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Ai Micro Expression-Based Early Heart & Stroke Alert System

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Abstract: The heart attacks and stokes are among the leading causes of death worldwide. Early detection of warning sings can significantly reduce mortality and improve survival rates. However, many early symptoms are subtle and often go unnoticed by individuals or healthcare providers. This project proposes an AI-based Micro-Expression Early Heart and Stroke Alert System that analyzes facial micro-expressions to identify potential cardiovascular distress at an early stage.Micro-expressions are very brief and involuntary facial expressions that reveal underlying emotions or physiological stress. Changes in facial muscle movements, skin tone, and subtle expressions may indicate discomfort, pain, stress, or neurological irregularities associated with heart attacks and strokes. The proposed system uses Artificial Intelligence, Computer Vision, and Machine learning algorithms to capture and analyze facial expressions through a camera in real time. The System works by collecting facial image data and processing it using deep learning models such as Convolutional Neural Networks (CNNs) to detect abnormal micro-expressions related to cardiovascular distress. The AI model is trained on datasets containing facial expression patterns associated with medical emergencies. When the system detects suspicious patterns, it generates an early alert notification to the user, caregivers, or medical professionals through a connected application. The technology can be integrated into smartphones, wearable devices, or hospital monitoring. By detecting warning sings earlier than traditional symptom-based methods, thee system aims to enable faster medical intervention and reduce the risk of severe complications.

Key Terms: Camera Module(USB-ESP32-CAM), Pulse Sensor, MAX30102(Heart Rate&SpO Sensor), GSM Module(SIM800L), ESP32/STM Microcontroller, 16*2 LCD Display, Buzzer, Power Supply(5V Regulated Supply), Python, Thonny IDE, Embedded C, power Supply Unit, Wi-Fi Module (inbuilt ESP32), Connecting Wires, Electrical Load - Lamp, Embedded C, Python language, CNN, Platform I

1. INTRODUCTION

The increasing number of heart attacks and strokes has become a major global health concern. Cardiovascular diseases are one of the leading causes of death worldwide. Many patients experience early warning signs such as facial discomfort, stress, fatigue, or sudden pain. However, these symptoms are often subtle and difficult to recognize at an early stage. As a result, delayed medical attention can lead to severe health developing an efficient early detection system is essential for improving patient safety and reducing mortality rates.Traditional health monitoring systems mainly rely on physical symptoms, medical tests, or wearable sensors to detect heart-related problems. Although these methods are effective, they may not always detect early warning signs in real time. Many subtle physiological changes occur in the human face before major medical events such as heart attacks or strokes. These changes appear as micro-expressions, which are very brief and involuntary facial movements that reveal hidden stress, pain, or discomfort.

Recent advancements in Artificial Intelligence(AI), Machine Learning, Computer Vision have made it possible to automatically analyze facial expressions using cameras and intelligent algorithms. AI-based systems can capture facial images, detect micro-expressions, and identify abnormal patterns that may indicate cardiovascular distress. By using deep learning models such as Convolutional Neutral Networks(CNN), the system can process facial data efficiently and provide accurate as analysis in real time. The proposed AI Micro-Expression-Based Early Heart & Stroke Alert System aims to detect subtle facial changes and provide early warning alerts. The system monitors facial expressions through a camera and analyzes them using AI algorithms. When abnormal micro-expression patterns are detected, the system generates an alert notification to the user or healthcare provider. This approach provides a non-invasive, intelligent, and real time health monitor the solution that can support early medical intervention and improve survival rates.

Artificial Intelligence in playing an important role in modern healthcare systems by providing intelligent solutions for early disease detection and monitoring. In recent years, computer vision technology has enabled machines to analyse human facial expressions with high accuracy. Facial micro-expressions are very brief and involuntary movements of facial muscles that reveal hidden emotions, stress, or physical discomfort. These subtle facial changes can sometimes indicate underlying health issues such as cardiovascular stress or neurological imbalance. By analysing these expressions using advanced AI algorithms, it becomes possible to identify abnormal patterns that may occur before a heart attack or stroke.

2. ARCHITECTURE DIAGRAM

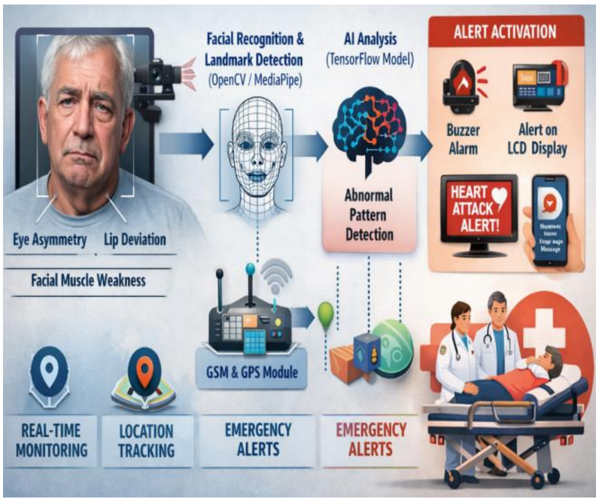

Figure (1)

The figure shows the proposed AI Micro-Expression-Based Early Heart & Stroke Alert System architecture. The system integrates facial expression monitoring, artificial intelligence analysis, and alert notification mechanisms into a unified healthcare monitoring framework. The system continuously observe facial micro-expressions using a camera and analyses them using deep learning techniques. This approach helps in detecting early warning signs of heart attack.

1. Data Acquisition Layer

a) Camera and Image Capture

- The camera or smartphone camera is used to capture facial images and expressions of the user in real time.
- The captured images provide the primary input for detecting facial micro-expressions.

B) Image Pre-Processing

- The captured images are processed to improves quality by removing noise, adjusting, brightness, and normalizing image size.

2. Feature Extraction Layer

a) Facial Landmark Detection

- The system detects important facial points such as eyes, eyebrows, nose, and mouth regions.

b) Micro-Expression Feature Extraction

- Subtle facial muscle movements are analysed to identify micro-expressions related to stress, discomfort, or pain.

3. AI Processing Layer

a) Deep Learning Model (CNN)

- The convolutional Neutral networks (CNN) are used to analyze facial features and classify expression patterns

b)Pattern Analysis

- The AI model compares the detected expressions with trained datasets to identify abnormal patterns.

4. Alert and Notification Layer

a) Alert Generation

- When abnormal micro-expression s are detected, the system generates an early warning alert.

b) Notification System

- Alerts are send to the user, caregivers, or healthcare provides through a mobile application or monitoring system.

5. Data Storage and Management Layer

a) Database Storage

- The system stores captured facial data and analysis results in a secure database.
- It helps in improving AI model performance through continuous learning.

b) Data Management

- The stored data is organized and managed for easy access and analysis.
- The data stored is organized and management for easy access and analysis.

Proposed Block Diagram

The figure (2) the proposed block diagram represents the working process of the AI micro-expression based early heart and stroke alert system. Initially, the image or video capture module collects real-time facial images of the patient using a camera. The captured images are then processed in the face detection and preprocessing stage.

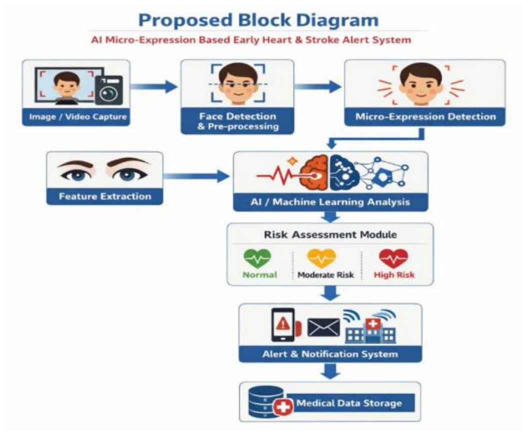

Figure (2)

- **Image/ Video Capture Module** The system captures real-time facial images or video using a camera, These images are used to monitor the patient's facial expressions continuously.

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- **Face detection and Pre-Processing**
  The captured image is processed to detect the face region. Noise removal, image resizing, and normalization are normalization are performed for accurate analysis.

- **Feature Extraction**
  Important facial features such as eyes, eyebrows, mouth, and facial muscles are extracted.

- **AI / Machine Learning Analysis**
  Extracted featues are analyzed using AI or machine learning learning algorithms. The model predicts possible heart attack or storke risk facial micro-expressions.

- **Risk Assessment Module**
  The system classifies the patient's condition into Normal, Moderate Risk, or High Risk.

- **Alert and Notification System**
  If high risk is detected, the system sends alerts to doctors, caregivers, or family members.

- **Medical Data Storage**
  All patient data and predication results are stored in a database. This data can be used for future monitoring and medical analysis.

Software Side
The figure (3) represents the software workflow of the AI Micro-Expression Based Early Heart and Stroke Alert System. While the System the connection between devices and sensors, this diagram mainly focuses on data collection, processing, prediction, and intelligent using AI.

Data Acquisition Stage
The Camera captures facial micro-expressions. The temperature sensor records body temperature.

Pre-processing Stage
The Collected data is cleaned and prepared for analysis. Noise and unwanted signals are removed using filtering techniques. Image enhancement and normalization improve the quality of the input data.

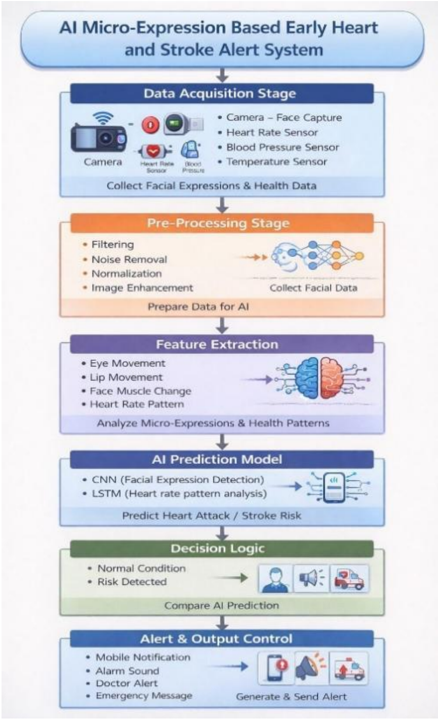

Figure (3)

Feature Extraction and Model Input
Important features are extracted from facial expressions and sensor data. Eye movements, lip movement, and facial muscle changes are analyzed. These features help identify possible abnormal health patterns.

Prediction Model (AI Algorithm)
Artificial intelligence models analyze the extracted features. CNN detects facial expressions while LSTM analyses heart rate patterns. The system predicts the possibility of heart attack or stroke risk.

Decision-Making Logic
The system compares the AI prediction results with normal helath conditions. If abnormal patterns are detected, it identifies a potential risk. Otherwise, the system continues monitoring the user.

IoT Integration
Health data and prediction results are send to a cloud server through wi-Fi. The IOT dashboard displays patient health information in real time.

- Heart Rate Data
- Blood Pressure Data
- Facial Expression Analysis
- Health Risk Prediction
- Patient Health Reports

Output Control
Based on AI prediction and real-time monitoring, the System generates alerts when abnormal health conditions

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are detected. Notifications are send to mobile devices or emergency contacts for response.

Display

Patient health parameters and system status are displayed on the LCD screen and IOT dashboard. Doctors and caregivers can monitor the patient condition remotely in real time.

Power Supply Circuit Diagram

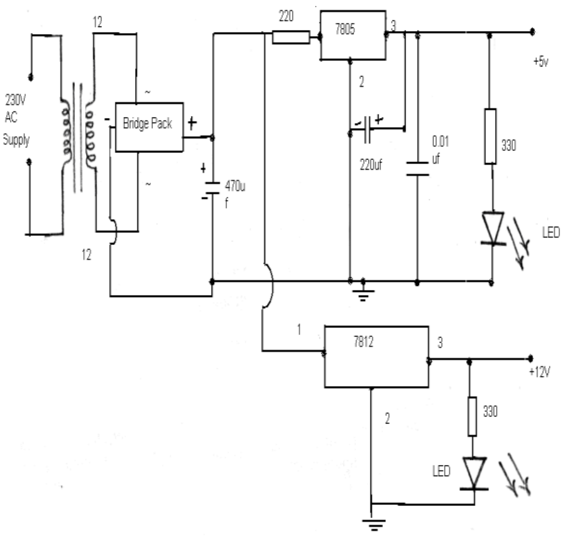
The figure (4) illustrates the regulated power supply circuit used in the proposed AI-Micro Expression Based early heart and stroke which are required to power the microcontroller, sensors, relay modules, and other components.

Step-Down Transformer (230V/12V)

The step-down transformer is used to reduce the high voltage AC from the mains supply to a lower AC voltage suitable for electronic circuits.

Bridge Rectifier (Bridge Pack)

A bridge rectifier converts the AC voltage from the transformer into pulsating DC voltage. It consists of four diodes connected in a bridge configuration.



Figure(4)

Filter Capacitor (470µF)

The after rectification, the DC voltage contains ripples (small AC variations) filter capacitors are used to smooth the DC voltage. The capacitor stores electrical energy when voltage increases and relative this process reduces ripple and DC.

Voltage Regulator 7805

The 7805 IC regulates the DC voltage it voltage provide a constant and stable DC output voltage even input voltage this circuit uses two liner voltage regulators.
Additional components:

- 470Ω resistor
- 220µF capacitor
- 0.01µF capacitor
  These components provide filtering and stabilization for improved output regulation.

Voltage Regulator 7812 (+12V Output)

The 7812 IC regulates the voltage to a stable +12V output. This supply is typically used for relay modules and other high-voltage

CONCLUSION

The proposed AI Micro-Expression-Based Early Heart Attack Alert System effectively addresses the critical need for early cardio risk detection. By integrating artificial intelligence-based facial micro-expression analysis with real-time physiological monitoring, the system is capable of identifying early signs of cardiac distress before severe symptoms occur.The combination of Python-based AI processing with embedded microcontroller control ensures efficient handling of computationally intensive facial analysis while maintaining reliable real-time sensor monitoring and alert generation. AI-driven micro-expression detection enhances accuracy by distinguishing stress and pain-related facial cues from normal emotional variations, thereby reducing false alarms and improving reliability. The integration of heart rate monitoring, SpO2 measurement, and facial expression analysis creates a multi-parameter health monitoring framework that improves prediction accuracy through sensor fusion. Real-time communication via UART/Wi-Fi/GSM and optional cloud-based dashboard monitoring further enhances system responsiveness, remote accessibility, and scalability.The modular and scalable of the proposed system demonstrates strong potential for deployment in smart healthcare environments, elderly care centre, hospitals, workplaces, and home based-based monitoring systems. With future enhancements such as advanced deep learning models, integration with wearable ECG devices, predictive analytics uses large-scale medical datasets, and telemedicine connectivity, the system can be further optimized for real clinical applications. Overall, the proposed system offers a cost-effective, intelligent, not-invasive, and proactive solution for early heart attack risk detection, contributing significantly to improved patient safety and preventive healthcare.

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