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Behavioral and Vital Analysis of Immobilized Patients

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ABSTRACT
The Internet of Things (IoT) has become ubiquitous in our daily lives, permeating every aspect, from smart homes to smart cities, smart agriculture, and beyond. Over the last decade, IoT has also made its way into the healthcare industry. Failure to promptly evaluate and address bedridden patients' health conditions can result in them worsening to a severe level. Additionally, immobile or elderly patients require regular checkups to avoid untimely death from cardiac issues. The absence of timely, effective medical care is the primary cause of these heart attacks. For patients suffering from a variety of issues, such as neurological disorders, head injuries, and mental illness, analyzing their behavior is an essential component of treatment. Our proposed method aims to evaluate patients' physical and behavioral health. To collect and process data from IoT devices, we use a heart rate and body temperature collector interface on smartphones. To evaluate the patients' mental health, we use the DeepFace algorithm. The system is designed to be compact and efficient, requiring a reliable internet connection for data transmission and proper lighting for accurate emotion detection. This development promises to improve patients' quality of life and benefit a vast portion of the population.
Keywords – *IoT, DeepFace algorithm, Emotion Detection, Data transmission*

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I. INTRODUCTION

Bedridden patients are required to stay in bed for extended periods, leading to various mobility problems such as reduced muscle mass, bone mineral density, and physical impairment, resulting in a lengthy recovery process. The number of older adults worldwide is increasing rapidly, from 1 billion in 2019 to an estimated 1.4 billion by 2030, which is also leading to an increase in the number of bedridden patients. However, monitoring these patients is a challenging task for paramedical staff due to the low proportion of staff to patients, making it difficult to monitor each patient continuously. Hiring someone to watch a critically ill person can be quite costly and requires experienced staff, making continuous supervision with paramedical assistants' error-prone, which may cause further complications. According to WHO statistics, lack of health workers is responsible for the deaths of about 6.9 million children under the age of 5 due to treatable and preventable diseases each year, and around 55% of 57 countries worldwide are facing a health workforce crisis. Therefore, it is essential to propose an automated health monitoring system for bedridden patients. The proposed system can monitor patients' vital signs such as heart rate, breathing rate, blood pressure, and oxygen saturation. The system can detect any anomalies in the patients' vital signs and notify healthcare professionals, enabling them to take prompt action. The system uses various technologies, including sensors, artificial intelligence, and machine learning algorithms, to monitor patients continuously and accurately, reducing the burden on healthcare professionals. This system can improve patient outcomes, decrease the recovery period, and save the lives of many people who would otherwise be neglected due to a lack of resources. Healthcare systems that maintain vital information records of patients through manual means are inadequate for continuous monitoring. Patient Monitoring Systems allow doctors to remotely monitor multiple patients and their parameters simultaneously.

The advancements in technology, particularly in embedded systems and telecommunications, have significantly impacted our lives, making it possible to continuously monitor health-related parameters using wireless sensors. These systems provide real-time information that physicians can use to monitor and analyze a patient's current and past health conditions.

II. LITERATURE SURVEY

1. "Smart Health Monitoring System using IoT" - Dr. N. Dhanasekar, S. Soundarya [1]

This paper presents a patient health monitoring system that utilizes a variety of sensors, including heartbeat, blood-pressure, temperature and humidity sensors. The system is capable of sending real-time alerts to doctors in the event of critical conditions and enables remote viewing of measured parameters from anywhere in the world. One advantage of the system is that doctors can easily monitor patient health parameters through a website or URL. Another advantage is the ability to remotely monitor patients. However, the system is limited by the lack of a quality control system for web applications.

2. "Smart Health Monitoring System" - Tarannum Khan, Manju K. Chattopadhyay [2]

This study introduces a smart health monitoring system that employs biomedical sensors to monitor patient health and communicates critical information through the internet. The system utilizes an Arduino UNO controller to collect data from the sensors, which is then transmitted to a server and stored for easy access. To facilitate easy viewing of patient information, an android app has been developed for medical professionals. One benefit of the system is that doctors can remotely monitor patient health using a website or URL, and remote patient monitoring is enabled. However, a limitation of the system is that it does not account for mental health monitoring.

3. "Facial Expression Recognition with Auto-Illumination Correction" - S. Ashok Kumar [3]

This paper presents a system for facial expression recognition using Action Unit (AU) localization without labeling. The system identifies the face using skin and chrominance of the image and maps the extracted eyes and mouth using a mapping technique. To separate skin and non-skin pixels and isolate the face from the background, the Haar-Cascaded method is utilized. One advantage of the system is its ability to detect single or multiple faces. Additionally, the color consistency algorithm automatically corrects for limitations in illumination. However, the recognition rate for multiple face images is only 60%, indicating a need for greater accuracy. Furthermore, the system is not effective in very poor lighting conditions.

4. Identification-driven Emotion Recognition System for a Social Robot" - Mateusz Zarkowski [5]

This paper introduces a personalized emotion recognition system that includes an identification step before emotion classification. The system utilizes Active Space models and Active Appearance models to identify facial expressions, while face tracking is employed for face detection. One advantage of the system is that including prior knowledge of the subject enhances the quality and speed of classification. Additionally, the system achieves an 82% recognition rate for facial images captured in a social robot working environment with varying lighting conditions, positions, and orientations. However, there are limitations to the system, including the requirement for training before it can be used as an application of social robot emotion recognition and the need for appropriate templates in the tracking data to cover the entire 5-feature space for emotion recognition.

5. "Emotion Recognition Using Convolutional Neural Network" - Nur Nabilah Abu Mangshor [5]

The objective of this study is to develop a mobile application that uses facial expression recognition to detect emotions in real-time, utilizing Convolutional Neural Network (CNN), a deep learning technique. The study focuses on identifying four different facial expressions. One advantage of the developed application is its average accuracy rate of 92.50%. Additionally, real-time emotion recognition is made possible with this application. However, there are limitations to the application, including the high memory usage required and the fact that it only covers four types of facial expressions.

III. PROPOSED METHOD

The proposed system is a comprehensive health monitoring solution that utilizes connected sensors to continuously measure vital signs such as temperature, oxygen levels, and heart rate. The readings are analyzed in real-time, and an alert is generated if any value exceeds its predefined threshold. Additionally, the system employs an ESP32 camera to detect emotions and classify them as positive or negative. Thus, the system helps in timely patient monitoring, which produces better health outcome, improved patient satisfaction, cost savings, improved efficiency and reduced liability. Timely monitoring can reduce disease progression up to an extent and can increase lifespan of a bedridden patient. Negative emotions such as disgust or sadness are considered abnormal, and if detected, an alert is triggered. All of these functions are integrated into an ESP32, and the readings are continuously recorded, making it easy for medical professionals to monitor a patient's health. If any abnormality is detected, an alert is sent to smartphones through a website, providing real-time information to caregivers. While the system is designed to be compact and efficient, it does require a reliable internet connection to transmit data, and the ESP32 camera may require proper lighting to accurately detect emotions. Overall, the system offers a powerful tool for remote patient monitoring, enabling caregivers to intervene quickly in the event of any abnormality.

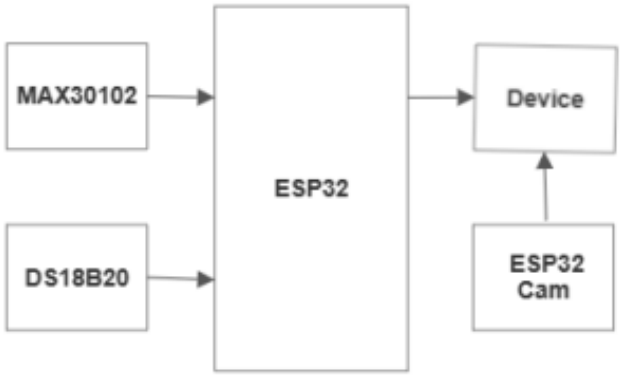

Fig1. Block Diagram of Proposed Methodology

IV. SOFTWARE

1. Arduino IDE

Arduino IDE is an open-source platform used for programming microcontrollers, such as the ESP32. It is a user-friendly and easy-to-use Integrated Development Environment that enables users to write, compile, and upload code to a microcontroller board. Arduino IDE supports various programming languages, including C and C++, and it is compatible with many different microcontroller boards, including the ESP32. Programming the ESP32 using Arduino IDE involves several steps. First, the ESP32 board needs to be connected to the computer through a USB cable. Next, the appropriate driver needs to be installed for the computer to recognize the ESP32 board. Once the board is recognized, the user can select the board type and port in the Arduino IDE. After that, the user can write their code in the Arduino IDE and upload it to the ESP32 board through the USB cable. Arduino IDE provides various built-in functions and libraries that can be used for programming the ESP32. These functions and libraries simplify the programming process and enable users to control the ESP32 board's various components, such as sensors, motors, and displays. Additionally, Arduino IDE has a vast community of developers and users who share their codes and projects, making it easier for beginners to learn and create their own projects.

2. Python

Python is a user- friendly and adaptable high-level programming. It is open-source, meaning it can be freely modified and distributed, and is widely used for various applications such as data analysis, machine learning, web development, and more. One of the most common uses of Python in recent years is in emotion detection. Python libraries such as OpenCV and Keras allow developers to easily build models to detect facial expressions and emotions in real-time. Additionally, Python is widely used for website development, with frameworks such as Flask and Django being popular choices. Flask is a lightweight framework that allows developers to quickly create web applications using Python, while Django is a more robust framework with built-in authentication and database support. Flask is a micro web framework that enables rapid web application development. It provides built-in development server and debugging tools, URL routing, templating support, and more. Flask is easy to learn, with a minimalistic approach, allowing developers to create simple yet effective web applications. Additionally, Flask supports the use of WebSockets, which allows for real-time communication between the server and the client, making it a great choice for developing applications such as chatbots or IoT systems. Socket is a library in Python that enables network communication between devices. It is commonly used in combination with Flask for building real-time applications. Flask- Socket IO is an extension for Flask that adds support for WebSockets to Flask applications. This allows developers to build real-time, bi-directional communication between the server and client, making it ideal for applications such as online gaming, chat rooms, or IoT systems. Overall, Python is a flexible and potent language that can be utilized for various applications. Its simplicity, user- friendliness, and vast array of libraries and frameworks make it a great choice for beginners and experienced developers alike.

V. COMPONENTS REQUIRED

1. ESP32

The ESP32 is a popular low-cost, low-power system-on-achip (SoC) microcontroller designed by Espressif Systems. It is widely used in various applications such as Internet of Things (IoT), automation, and robotics. The ESP32 features a dual-core processor, 448KB of ROM, 520KB of SRAM, and a variety of peripherals such as Wi-Fi, Bluetooth, and various sensor interfaces. One of the main advantages of the ESP32 is

its built-in wireless capabilities, which enable it to connect to Wi-Fi and Bluetooth networks. This renders it a perfect answer for projects that require wireless connectivity, such as home automation systems, environmental monitoring devices, and wearable technology. The ESP32 also has a wide range of input/output (I/O) pins, making it easy to interface with various sensors and devices. Programming the ESP32 is relatively easy, thanks to the availability of a variety of programming languages, such as C/C++, Python, and Micro Python. Additionally, the ESP32 has a built-in development board, which makes it easy to prototype and test new projects. The ESP32 is also known for its minimal power usage, so it is well suited for applications that rely on battery power. It features a variety of power-saving modes, allowing it to run on a small battery for extended.

2. ESP32 Camera Module

The ESP32 Camera Module is an add-on board that can be used with the ESP32 microcontroller to add image and video capabilities to projects. It features a 2-megapixel camera, and supports up to 1600x1200 resolution for still images and 640x480 resolution for video. The module includes a built-in Wi-Fi antenna, making it easy to connect to wireless networks and stream video or images to other devices. It is capable of being programmed using the Arduino IDE or other development environments, and comes with a software development kit (SDK) that provides tools for configuring and customizing the camera settings. The ESP32 Camera Module is commonly used for applications such as home security, remote monitoring, and robotics, where image and video processing capabilities are required.

3. DS18B20 Temperature Sensor

The DS18B20 is a digital temperature sensor that uses a single-wire interface to communicate with a microcontroller. It is popular among hobbyists and professionals for its ease of use and accuracy. The sensor can measure temperatures ranging from -55°C to 125°C with an accuracy of ±0.5°C, making it ideal for a wide range of applications. The DS18B20 also has a unique 64 - bit serial code that allows multiple sensors to be connected to the same data line, enabling temperature sensing in multiple locations with a single microcontroller. The sensor comes in various forms such as waterproof and non-waterproof, and can be interfaced with various microcontrollers including Arduino, Raspberry Pi and ESP32. With its low cost, accuracy and ease of use, the DS18B20 is a popular choice for temperature sensing applications.

4. MAX30102

The MAX30102 is a compact, integrated pulse oximeter and heart-rate sensor module that is designed to accurately measure heart rate and blood oxygen saturation levels. It uses two LEDs to emit light through the skin, and a photodetector to measure the amount of light that is absorbed by the blood. This information is then processed by an on-board microcontroller, which can output accurate pulse and oxygen saturation readings in real-time. The module is typically used in wearable fitness trackers, health monitoring devices, and medical equipment. It features low power consumption and high accuracy, making it an ideal choice for portable and battery-powered applications.

VI. APPLICATIONS

The device being discussed is an innovative tool that can revolutionize healthcare delivery in rural areas. It serves multiple purposes, facilitating the easy measurement of a wide range of medical conditions. Its user-friendly design makes it easy to operate, and it outperforms compact sensors in terms of overall performance. However, what truly sets this system apart is its unique ability to analyze emotions. Unlike most health monitoring tools that focus solely on physical health, this device takes a patient's emotional well-being into account, bridging the gap between patients and doctors. By offering a more thorough comprehension of medical conditions to healthcare providers, healthcare outcomes in rural areas and beyond can be significantly increased. The device's ability to analyze emotions is especially important, as it addresses a critical aspect of healthcare that is often overlooked. Overall, this innovative technology has the potential to transform healthcare delivery, bringing doctors and patients closer together and improving health outcomes for all.

VII. RESULTS

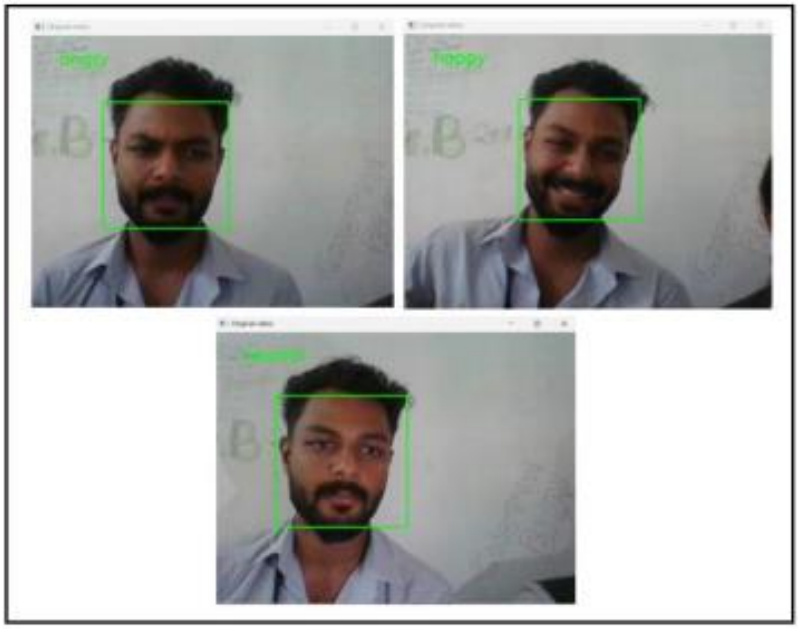

Fig2. Emotion Detection

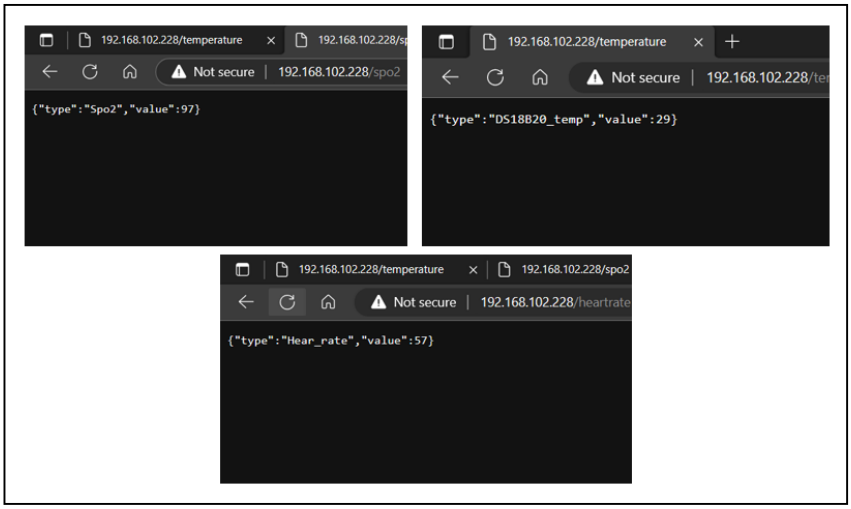

Fig3. Vital Analysis

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