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Embedded System for Wheelchair Using IoT

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Abstract : Those who have permanent disabilities due to accidents, paralysis, or old age are frequently dependent on others assistance when it comes to movement. This Embedded system is created to assist individuals, giving them access to remote health services via a health monitoring system and increases their independence because their health is regularly recorded and monitored by the sensors without any effort. Because disabled patients cannot afford to travel, smart healthcare systems assist them in gaining access to healthcare. A feasible solution to monitor the patient's health is by developing a health monitoring system with additional features since it is adequate for a wider range of audiences and it doesn't require tons of maintenance unlike the wearable systems. This project aims to develop a smart sensing embedded system for wheelchair by integrating sensors into its structure and developing an app that provides data visualization of all the monitored data along with automatic alerts when an anomaly is detected. With Internet of Things, sensors detect heart rate and sp02 levels, and embedded systems process them before sending them to the cloud that kicks off a trigger in case of any abnormalities. Depending on the user's preference, the trigger can be sent via SMS or e-mail.

Keywords: Healthcare, Embedded System, Sensors, Internet of Things, Smart assistance

1. INTRODUCTION

As human beings, we all have disabilities. If a person is unable to do something because of a condition of mind or body, it decreases their ability to perform that particular task and integrate it into their overall environment. It is the deformity of the body that prevents people with disorders from traveling from place to place and carrying out their daily activities. At some point in their lives, most people will experience disability, whether temporarily or permanently. Currently, over 1 billion people - about 15% of the global population - are disabled, and the number is growing due to the aging of the population and an increase in non-communicable diseases, among other factors. People with disabilities often cannot fully participate in society on an equal basis with others because of inaccessible environments.

The concept of smart healthcare has gradually gained popularity as Information Technology has advanced. Using new technologies such as the internet of things (IoT), big data, cloud computing, and artificial intelligence, smart healthcare completely transforms the traditional medical system to make it more convenient and personalized. IoT sensors transmit real-time information about health and vital parameters such as heart rate, blood pressure, and glucose levels. There has also been a rollout of IoMT devices including ultrasounds, thermometers, EKGs, smart beds, and a range of other medical devices.

In the forecast period of 2020 to 2027, the smart wheelchair market is expected to gain market share. In the forecast period, Data Bridge Market Research projects the market to grow at a CAGR of 7.0%. Patients becoming more aware of the benefits of smart wheelchairs will support the growth of the market. The high cost of the product and a lack of improved infrastructure are limiting the market growth of smart wheelchairs during the forecast period.

As technology advances in wheelchairs, robotics, telehealth systems, and other biomedical systems, it is becoming easier and easier to integrate standalone devices into a single device. The use of a wheelchair will not completely restore the life of the disabled therefore they would need assistance when operating a wheelchair.

2. EXPERIMENTAL METHODS OR METHODOLOGY

This article addresses the making and research of, a cost-effective Embedded System fir Wheelchair based on Node MCU, Sensors, Cloud, and IoT technology that will help disabled people gain more accessibility, especially poor people who cannot afford expensive Smart Wheelchairs. A machine learning algorithm will be applied to analyze sensor data to provide realtime feedback on risk factors to the users and their loved ones. The wheelchair will have biophysical sensors embedded in it that will take the patient's vital signs over short intervals and wirelessly transmit them to the cloud. When the user is offline (no WIFI connection), a GSM Module is provided so that monitoring continues. We have also developed an app that will record, visualize, and analyze patient data for the patient and their loved ones.

Ultimately, the smart wheelchair will allow patients to drive autonomously within a specific area with the help of the Obstacle Detection feature. Patients' vital signs can be collected and analyzed remotely. Future improvements can include

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the use of additional sensors and a GSM Module based on need and further development of algorithms to calculate a more accurate threshold to allow better management of the patient's chronic condition. Multiple sources of vital signs, including body temperature, blood pressure, heart rate, oxygen saturation, will be integrated into an integrated user interface and an autonomous wheelchair. An Android application will also be developed that focuses on data visualization, location tracking and overall health. By setting an alarm, patients will not need to remember the timing of their medicine dosage.
An alarm can be set for multiple medicines and timings, including date, time, and medicine description. The patients will receive a notification via email or a message from within the system, preferably chosen by them. Different articles about health care and medical fields are available to users, with the current covid situation, insights about covid are also provided to them. A good user interface and easy navigation are the main goals of the system. Such systems have been developed in the past where new hardware has been needed, but in our work, we have attempted to develop a system that is economical, timesaving and supports medication compliance.

3.1 Internal Architecture

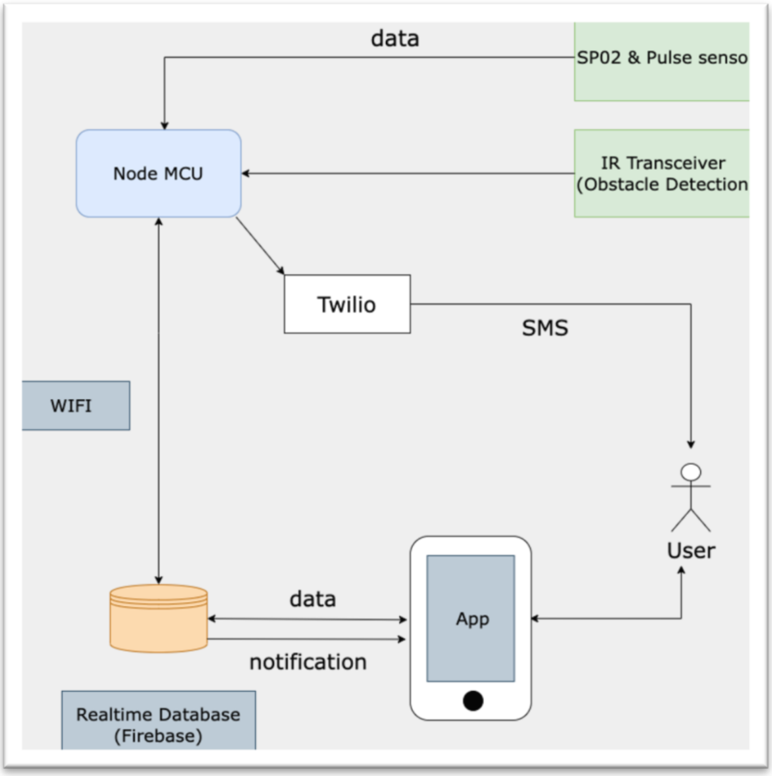

Fig. 1 Internal Architecture

I. Node MCU:
Node MCU is an open-source platform based on ESP8266 which can connect objects and allows data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, etc.
II. Firebase:
The Firebase Real-time Database is a cloud-hosted MySQL database that lets you store and sync data between users in Real-time. Firebase in used in our system as a way of storing the sensor data and app credentials.
III. Twilio:
Twilio is a messaging API that allows sending and receiving SMS, MMS, and OTT communications anywhere over the world. It uses intelligent sending features to ensure that messages reliably reach the users wherever they are making it the perfect messaging platform for this project.
IV. Android Studio:
Android Studio is an IDE which we used to develop our application. Android Studio provides a unified environment where you can build apps for all kinds of devices. Structured code modules allow you to divide your project into units of functionality that you can independently build, test, and debug.

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V. Flutter and Dart:

Flutter is an Open-Source UI SDK developed by Google. It allows the development of both Android and IOS apps. Dart is used as the programming language. We have used these for the development of our application.

3.2 Software and Hardware Requirements -

The software requirements are:

- Android Studio
- Arduino IDE
- Firebase Services (Real-time database and Cloud Messaging)
- Emulator (for running and testing the app)

The hardware requirements are:

- Node MCU
- Jumper wires
- IR Transceiver module (Obstacle detection)
- SP02 and Pulse sensor – MAX30102
- Other resources (Wheels, connecting wires, metal parts for wheelchair)

3.3 Features:

The following are the features of the system developed:

- Monitors the health and to detect any cardiovascular abnormality using the heart rate and also checks the SP02 levels for further confirmation of anomaly.
- The data is updated on the server and if any abnormality is found then it will be notified to the concerned person through emails/SMS via cloud. App notifications are also provided for anomalies of lesser severity.
- The location of the patient is provided so that the loved ones of the patient can know where the anomaly has occurred.
- Smart Obstacle detection using IR sensors making it versatile for any environment usage.
- Reminder system for medicines (if any) included with the app.
- The user objective is to have the system in a regular wheelchair and alert caretakers in case of abnormality.

WORKING MODEL

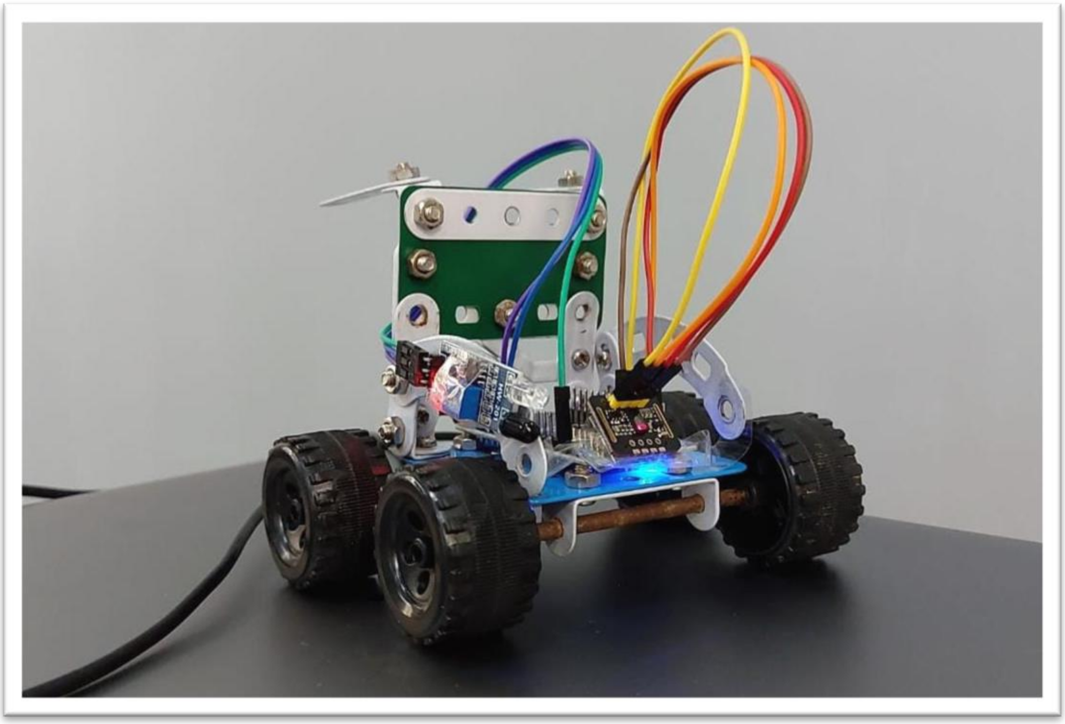

Fig. 2. Working Model

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In this model as shown in Figure 2, a wheelchair prototype is designed using metal parts, screws and wheels. The embedded system that we developed throughout this paper is then mounted on the wheelchair for demonstration purposes. As a result, we were successfully able to develop a system that monitors the patient's vitals and sends alerts whenever necessary, An android application was also built which provides a visualisation of all the data that is being provided by the sensors with a lot of other additional features.

CONCLUSION

This study demonstrated the working of a Embedded System for disabled people that can be used to give them access to health monitoring and to allow them to travel more independently. At the end of this study, we concluded that it is possible to develop an embedded system that can be mounted on an existing wheelchair and the system can be used effectively when implemented in real-time.
With the help of Internet of Things, a very feasible, cost effective and simple system is developed which helps the users to be more independent in day-to-day life.

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