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RESEARCH ARTICLE OPEN ACCESS

Design of a Client Server Based Body Signal Monitoring System

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ABSTRACT
This paper deals with the development of a client server based model for monitoring the various body signals such as body temperature, heart rate, oxygen saturation (SpO_2) and blood pressure, designed using two ESP 32 Node MCU boards, one as server while other acts as client. The data acquisition system has been developed on server side using Node MCU. The necessary signal conditioning circuit has been designed for processing various body signals using off the shelf components in the laboratory. Acquired data is represented on client side either on OLED or on PC, Mobile web server. Server model creates its own wireless network so that other Wi-Fi devices automatically access server data just by entering IP address. Client model is set as station using another Node MCU. The result shows the effective use of Wi-Fi technology to access various body signals. The designed system provide advantage of low complexity, low power consumption and highly portable for body signals monitoring of patient at remote places.

Keywords – Body signal, Data acquisition system, Node MCU, Web server

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I. INTRODUCTION

Technology plays the dominant role to make human life more comfortable and simple. It has influenced the various aspects of everyday life and medical field is not an exception. Instruments based on latest technology having capability to analysis internal diseases are in great demand these days. Patients prefer their own devices to monitor important parameters and help specialist to have immediate access in emergency e.g. Apple watches [1]. Such devices are costly and only few can afford it. Advancement in mobile technology and smart devices has created incredible impact in the area of Biomedical engineering. Medical engineers are progressively taking the advantage of producing better devices with latest technology [2]. In the past, it was difficult to monitor patients continuously in remote area during critical conditions. But advancement in technology enables monitoring of a patient continuously and sends data to the server. Using this approach doctors can access data and inform care taker when some critical condition arises [3]. The server has flexibility of monitoring and controlling of electronic gadgets in which client can be freely set without installing additional client software. It allows any one user having internet access on his devices [4]. Internet of Things where 'things'-sensors and devices sends information to the internet has become great innovation with several applications areas. Since the technology includes many sensors, microcontrollers, cloud based service, wireless networking, mobile apps, web pages; practical implementation of IoT is complex [5]. Internet of things in the medical field provides solution for successful patient monitoring at lower cost and furthermore minimizes the tradeoff between observed result and disease management. Since IoT based health monitoring devices sense and transmit patient data digitally, it reduces human errors and hardware complexity [6]. IoT enables web server based applications for health monitoring. The client can utilize the web browser and giving URL of website into that browser having authentication can view the web page. A web server does not require dedicated high configuration computer [7]. Body temperature, Heart rate, Oxygen Saturation and Blood pressure are basic parameters which are routinely monitored by medical experts to get status of human health.

In the present work, various sensors for measurement of Body temperature, Heart rate, Oxygen saturation and Blood Pressure are interfaced with Node MCU which acts as server. These parameters are acquired remotely using Wi-Fi and displayed on OLED and Mobile devices just by accessing IP address of server.

II. EXPERIMENTAL

Figure 1 shows functional block diagram of proposed system. Client Server based biomedical signal monitoring system has been designed and implemented using off-the-shelf component in the laboratory. The designed non invasive system

supports monitoring of body temperature, heart rate, oxygen saturation (SpO_2) and Blood pressure. Sensors are integrated into a wearable device capable of observing the various biomedical parameters. The acquired data has been sent wirelessly to client. Using this designed prototype, we can monitor critical health parameters anywhere within Wi-Fi range with an availability of an internet.

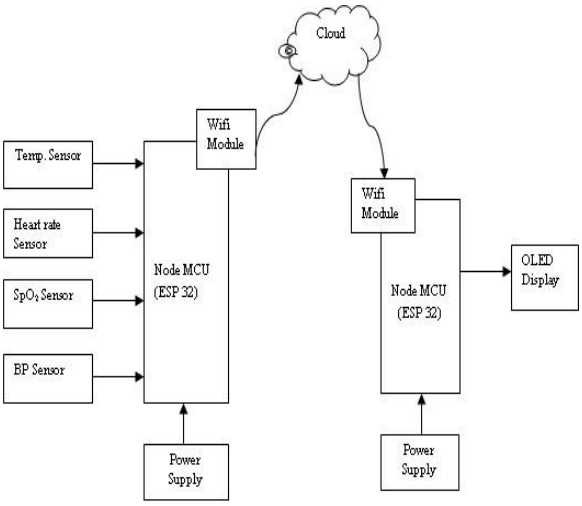

Fig. 1: Block diagram

III. HARDWARE DESIGN

The designed system consists of a Node MCU (ESP32) as the main processing unit and respective sensors have been connected to the node microcontroller. Node MCU provides features of I^2C interface, UART and Wifi which makes it perfect for this work. The system is designed for monitoring of biomedical signals: body temperature, heart rate, oxygen saturation (SpO_2) and blood pressure with DS18b20 as temperature sensor, Sunrom 1437 as blood pressure sensor and MAX30100 as heart rate and oxygen saturation sensor. Node MCU has 30 GPIO pins. Necessary signal conditioning circuits have been designed for providing outputs of respective sensors to node MCU. As the DS18b20 provide digital output, so it is connected to GPIO 32 pin of Node MCU. MAX 30100 provides feature of I^2C interfacing having SCL and SDL. These SCL and SDA pin are connected to GPIO 22 and GPIO 21 pins of Node MCU via signal conditioning unit. Blood pressure sensor transmits data serially at baud rate 9600, T_{XD} output of this sensor connected to R_{XD} input located at GPIO 16 pin of Node MCU. On the client side other node MCU board has been used. OLED module is interfaced to client side Node MCU using I^2C interface where various acquired parameters have been displayed. The components used for hardware design are shown in figure 2.

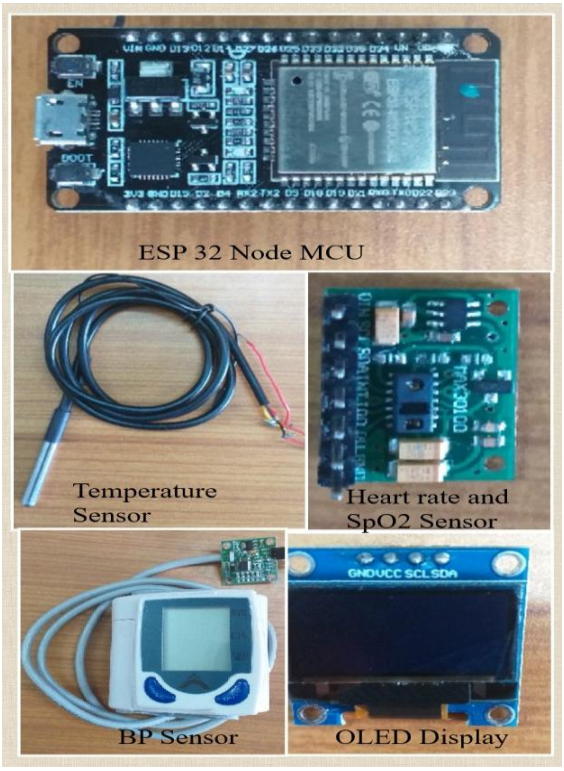

Fig.2 Sensors used in the present work

IV. SOFTWARE DEVELOPMENT

The software includes acquisition of sensor data, processing of data using Node MCU, establishment of Wi-Fi connectivity and display of data on client side. The program is written in Arduino integrated development environment (IDE) using C. Appropriate libraries for the sensors and OLED has been downloaded from online sources. After installing the libraries and making circuit connection, source code is deployed into Node MCU through standard USB port by selecting proper COM port. A communication link between the client and the server is established by accessing IP address of the server. Code is developed for getting IP address of server and accessing this IP address on client side to observe parameters on OLED and Mobile. Figure 3 shows the flowchart of the operation of the developed prototype.

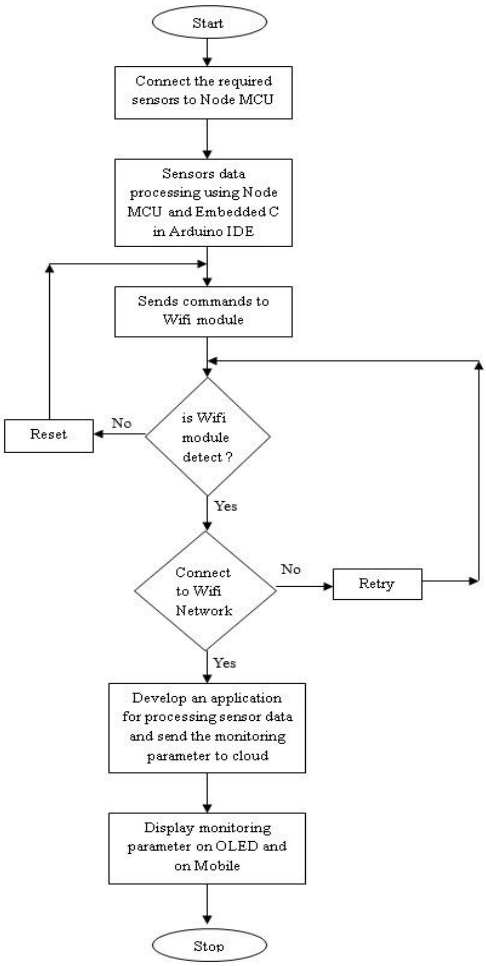

Fig. 3 Flowchart of the designed system

V. RESULTS

a. Hardware Implementation of Transmitter Section

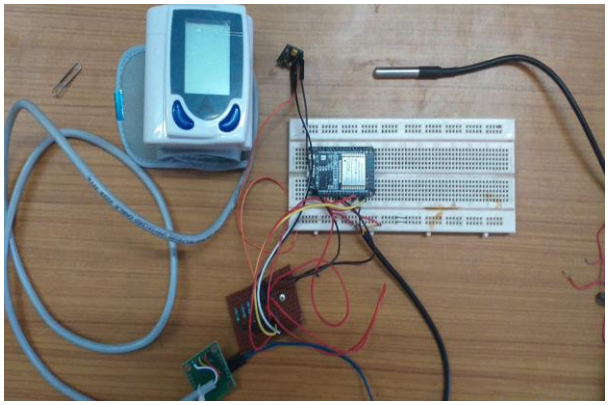

Fig. 4 Testing of various sensors

b. Hardware Implementation of Receiver Section

Fig. 5 Prototype unit developed in laboratory

c. Output reading on receiver section:

Acquired data from transmitter section is fed to the receiver using Wi-fi and displayed on OLED using Node MCU ESP32. The parameters such as body temperature, heart rate, oxygen saturation, Systolic and Diastolic blood pressure are displayed on OLED.

d. Output reading on Mobile

The various body signals are transferred by enabling Wi-Fi using ssid and password. After establishing TCP connection, we can send the acquired data to the client just by entering IP address of server on mobile.

Fig. 6 Screenshot of output of an App

VI. CONCLUSION

Present work describes the development of smart, self adaptive and interactive portable health monitoring system for a person. The developed

prototype uses off-the-shelf components in laboratory and remotely enabled biosensors used for electronic health monitoring applications. The designed set up permits client and person assisting the patient complete information regarding health in real time. Thus, it is possible to acquire data from various sensors and able to successfully transfer information through inbuilt Wifi module by using TCP protocol. After establishment of Wifi connection, data from sensors is sent to the cloud and retrieved on OLED and Mobile on the client side.

The designed prototype is cost effective, user friendly and reliable to cater the needs of the personal health care system. The person without any technical background can easily access this system.

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