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ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)

Vol 8, Issue 8, August 2021

Use of Smart watch for Presymptomatic Detection of Covid

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Abstract--- **A smart watch is a unique and small portable device which helps user to carry it anywhere. In this time of corona pandemic, taking care of health is important, so this smart watch will monitor person's health parameters. Now the smart watch have all types of sensors to keep ourselves in check and to ease our way of living. The motive behind smartwatch is to indicate symptoms of Corona. Once the symptoms are detected the notification will pop up on the device-smart watch. This device is Arduino based with different biomedical sensors interfaced for measuring various biomedical parameters like body temperature, pulse rate and oxygen level. The other features in the device are Bluetooth and WiFi modules for maintaining social distancing. The smart watch designed has some key factors that make it different than watches available in the market with respect to healthcare. This device helps us maintaining social distancing as well as monitors our health.**

Index Terms**— COVID-19, Healthcare, Smartwatch, Social distancing**

I. INTRODUCTION

Smartwatches were introduced commercially in the early '80s. The publicity or public use of these watches was limited. However, over recent years, its demand graph showed massive increase and the year 2013 was believed to be " the year of the smartwatch". That notion was marked by the release of smartwatches like Pebble, Razor Inc., Arches, LG, Motorola, and Google Android Wear.

Wearable devices have been used to digitally measure vital signs, monitor health and might be used to track and detect disease in real time.Early identification of infectious disease is crucial for preventing the spread of illness by self-isolation and therapy.

Now-a-days most diagnostic methods include sampling saliva or blood, nasal fluids, accompanied by nucleic acid-based tests for detection of infections. But these diagnostic methods are difficult to be used on daily bases with low cost and shortage of reagents. Pulse oximeter equipped smartwatches can monitor heart rate and oxygen level to detect various respiratory infections, including asymptomatic infections. Wearable sensors also detect atrial fibrillation.

The wearable devices can play a significant role in reducing the COVID-19 pandemic. COVID-19 has already infected millions of individuals, resulting in 502,278 deaths worldwide. RT-PCR (Reverse Transcription polymerase chain reaction) assays are currently use to keep tabs on active infections. In addition to that, the test can not be provided everyday. Wearable sensors/devices are already been used by millions of users to measure various physiological parameters. In this paper, the use of smartwatch for pre-symptomatic detection of COVID-19, along with the use of wearable-detected physical parameters for surveillance of health.

The smartwatch as a wearable device is equipped with many biomedical sensors to check various health parameters of the wearer so as to detect the symptoms of COVID. Once the symptoms are detected, the notification will pop up on the device-smartwatch. This device is Arduino based with different biomedical sensors interfaced for measuring various biomedical parameters like body temperature, pulse rate and oxygen level. In order to prevent the community spread, the need for social distancing is important. Here, the problem of crowd gathering has been addressed by using RSSI (received signal strength indication) method (using low energy bluetooth) to ensure social distancing. Due to the explosion of technology and technology-enabled devices, easy access to a wireless device and wearable devices is possible. Smartwatches are equipped with biomedical sensors to ensure the pre-symptomatic detection of COVID.

II. LITERATURE SURVEY

Pulsar, the world's first digital watch, was debuted in 1972 by Hamilton Watch Company. This watch gained fame and was later acquired by *Seiko* in 1978. This was the first watch to have a user-programmable memory.[1] Later on with the development of computers, in 1983 a watch named *The Data 2000* watch was introduced. An external keyboard for data-entry was provided with it. In the following year 1984, RC-1000 watch was released. It was the first *Seiko Espon* developed model which collaborated with a computer. During these years *Casio* also started marketing successful computer watches with simple computational abilities.[2]

In 1994 *Timex Datalink* wristwatch was launched. The models were provided with wireless data transfer mode to connect with a PC. *Steve Mann, in 1998*, mapped out the first *Linux* wristwatch and conferred IEEE on 7th of February 2000,[3] where he was awarded as *father of wearable computing*.[4] In that year *Seiko* launched *Ruputer* in Japan with a processor of 3.6MHz and a small screen 102x64. In 1999, *Samsung* introduced its own watch *SPH-WP10*. It was provided with a monochrome LCD screen and a standby time of 90 minutes meshed with speaker and microphone.[5]

In June 2000 , a prototype was launched by *IBM* that ran *Linux which had six* hours of stand-by time.[6] In the upgraded model battery life was further improved to 12 hours and an accelerometer , vibrating mechanism and a fingerprint sensor was also integrated to it. Later on *Watch-pad* was introduced by *IBM* integrated with a 320x240 *QVGA* monochrome touch sensitive display that ran *Linux 2.4*. It was featured with calendar software, Bluetooth, 8 MB of RAM and 16 MB of flash memory.[7] *Fossil* in 2003, released a *Wrist PDA* watch that used *Palm OS*. The display was a monochrome display of resolution 160x160 pixels.

From the start of year 2010, the smartwatches started attracting the market and smartwatches were been released by *Sony Ericsson* (named *Sony Ericsson LiveView*), *Vyzin Electronics Private Limited*(a *ZigBee* enabled smartwatch having cellular connectivity for health monitoring called *VESAG*.), *Motorola* (named *MOTOACTV*). In April 2012, an innovative smartwatch *Pebble* watch was released. It was provided with a 1.26in. 144x168 pixel black and white memory LCD with ultra low power mode, vibrating motor, ambient light sensor, magnetometer and an accelerometer. Also low power Bluetooth was used to communicate with IOS or Android devices. A USB charger was provided for charging the watch and battery on stand by time can last upto 6 days.[8] As of 2013 Acer, Apple, BlackBerry, Google, LG, Microsoft, Toshiba, Lenovo and many other companies were involved in smartwatch development. Now, with the advancement of micro technologies, the smartwatches are now equipped with not only a touch sensitive AMOLED screens with higher processing power but also with various sensors and software (like calling, notification, etc.) to provide easy user smartwatch interaction. Hence, in this paper focus is on the medical aspects of smartwatch and its configuration to provide better healthcare services to the wearer.

III. SYSTEM DESIGN

The application of smartwatches in detection of COVID-19 is at preliminary stage. In this work, a smartwatch serves two different purposes. The very first purpose is to detect symptoms of corona disease using some biomedical sensors and the second is to inform wearers to follow/maintain social distancing using the RSSI method. The proposed system uses Internet of Things (IoT), that gathers the information through various sensors to monitor a patient's heart rate, temperature, and blood oxygen level. The basic block diagram is shown in figure (1). Smartwatch is powered by a *Lithium Polymer* (LiPo) battery. This battery has a capability of 100mAH. Biomedical sensors are connected to the Arduino pro-mini board. When the input is given to the sensor, output is displayed on OLED (Organic Light Emitting Diode). Analog input is converted into digital output. Real-time and date will be displayed on OLED by using the DS1307N RTC (Real time Clock) module. WiFi and Bluetooth connectivity is provided by the ESP module.

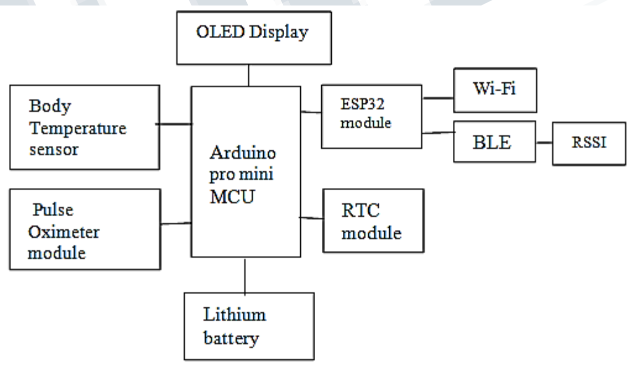

Fig.1. Block diagram of proposed scheme

IV. SYSTEM HARDWARE AND SOFTWARE SPECIFICATIONS:

Table 1: Hardware and Software required

Hardware requirements	Software requirements
➢ Arduino pro mini	➢ Proteus 8.9
➢ Max30100 pulse oximeter sensor module	➢ Arduino IDE
➢ MCP9808 temperature sensor	➢ Fusion 360
➢ ESP32	
➢ OLED	
➢ Lithium Battery	

Arduino ATmega 328P Pro mini :

A small micro-controller board based on AT328P 8 bit AVR controller, which consists of 14 digital input/output pins, 6 analog inputs, a reset button, and holes for

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)

Vol 8, Issue 8, August 2021

mounting pin headers. It has six-pin header which is used to connect FTDI cable that will provide power through USB and establish a connection with the Arduino board.

MAX30100

The pulse oximeter and heart-rate monitor sensor module having two LED's, a photodetector, has low-noise analog signal processor which will detect blood oxygen level and heart-rate in BPM. The operating voltage is between 1.8V and 5V. It possesses minimum current so that the software can be used to power it down, by allowing the supply to remain connected at all the time. It has I2C interface through which communication with Arduino Pro mini is established.

Figure 2 and 3 shows the survey of heart rate and blood pressure readings for different gender and ages.

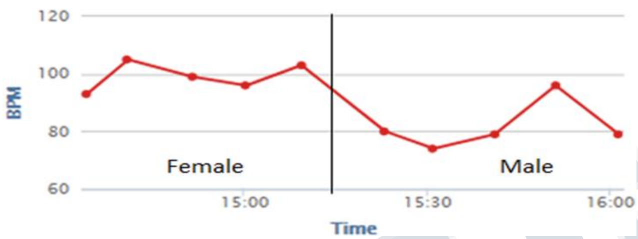

Fig.2. Survey of Human heart rate reading for different gender

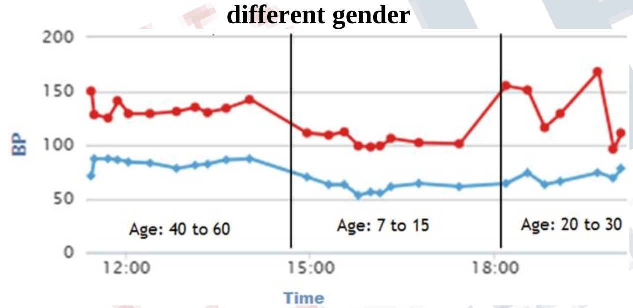

Fig.3. Survey of human blood pressure reading for different ages

MCP9808:

The digital temperature sensor module MCP9808 are used in wearable devices which converts temperature between -20^{0}C to 100^{0}C. It has accuracy between 0.25 to 0.5(max). It supports I2C communication through which connection is established. Operating current is very low around 200 µA (typical). It is available in two packages, first one is 2x3 DFN-8 (dual-flat no-leads) and second is MSOP-8 (micro small outline package). The sensor operates at voltage between 2.7V - 5.5V. MCP9808 has user-programmable registers which makes it flexible for temperature sensing applications. Figure 4 shows the human body temperature readings for different ages.

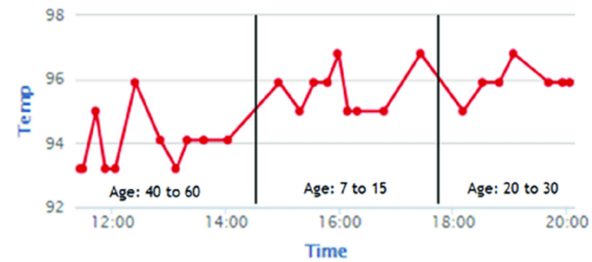

Fig.4. Survey of human body temperature reading for different ages

SSD1306:

The **OLED (SSD1306**) is used to display the output. It has features like contrast control, oscillator, display RAM. Because of these features it reduces power consumption. The resolution of SSD1306 is 128 x 64 dot matrix panel. It operates typically at 7V - 15V. Used in mobile sub-display, calculators, etc.

PROTEUS

Proteus is an electronic hardware design suite. It is a software which is used for electronic design and simulation of designed circuit. The tool is specifically used for designing and testing of hardware schematics for manufacturing PCB's.

ARDUINO IDE

It is a software used by many hardware as well as software engineers for programming any Arduino board. It is an open source software through which we can program any sensor with any Arduino board.

V. METHODOLOGY

The interfacing of temperature sensor, heart rate and pulse oximeter sensor modules is done to measure temperature, pulse rate and oxygen level. Social distancing feature has been implemented using RSSI method.

Working of Pulse oximeter

An oximeter and Pulse rate sensor module consists of two LED's and a photodetector that measures blood oxygen level and heart-rate in BPM (beats per minute). The first LED emits red light and second emits infrared light that helps in measuring the blood oxygen level. When heart pumps the blood, oxygenated blood increases and when heart is in relax position, oxygenated blood decreases. By calculating time between rise and fall of oxygen level in blood, pulse rate is measured. From this we can say that, infrared light is absorbed by oxygenated blood and red light is absorbed by deoxygenated blood. The main function of the sensor is to read and store absorption levels

ISSN (Online) 2394-6849

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Vol 8, Issue 8, August 2021

of both light sources via I2C interface. Fig.5 shows the working of Max30100.

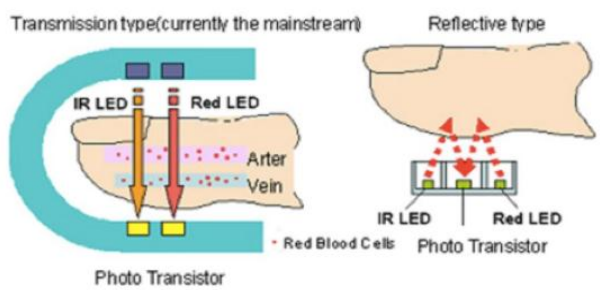

Fig.5. Working of MAX30100

Working of temperature sensor

The digital temperature sensor MCP9808 has user programmable registers which make it flexible for temperature sensing applications. The change in temperature above the specified boundary limit, events a signal at output. User can set output signal polarity as active-low or high for thermostat operation. Sensor has industry standard two-wire I2C compatible serial interface.

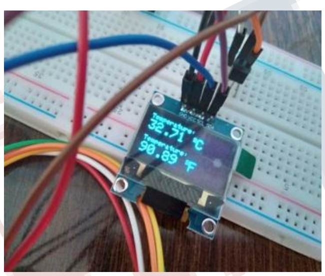

Fig.6. Implementation of Temperature sensor

RTC interfacing

For interfacing, a real-time clock **DS1307** RTC module is being used. Data is stored in the module even if the power provided to Arduino is removed. "RTClib" is the library used for programming. This library should be download from the internet and added to the Arduino library database.

There is one feature available in "RTClib" to upload the current time and date into DS1307. Using this feature, the time and date will be uploaded from the computer while uploading the program.

RSSI method

In a telecommunication system, RSSI (Received Signal Strength Indicator) is used to determine power present in the received radio signal. It is not visible to receiving device user. RSSI is 802.11 standard for wireless networking. As signal strength can vary and can affect functionality in wireless networking, these IEEE standards often make the measurement available to users. Signal strength (field strength) is known as transmitter power output received by the reference antenna at a distance from receiving antenna. High-powered transmission mainly used in broadcasting is measured in dB-mV/meter. In a low-power system, i.e mobile phones, the field strength is measured in dB-µV/meter. Received Signal Strength can be measured over any wireless network.

For our project, we are calculating RSSI values for nearby WiFi or BLE-enabled devices mainly for mobile phones. If we have the measured value of RSSI, it is easy to calculate the distance to the devices. Following equation is used to calculate RSSI value.

$$RSSI = A - 10 * n * \log_{10}(d)$$

Where,

A- indicates the signal strength is received from a reference node, normally at a distance of 1m.

n - indicates the path loss index in a specific environment.

d - undetermined distance.

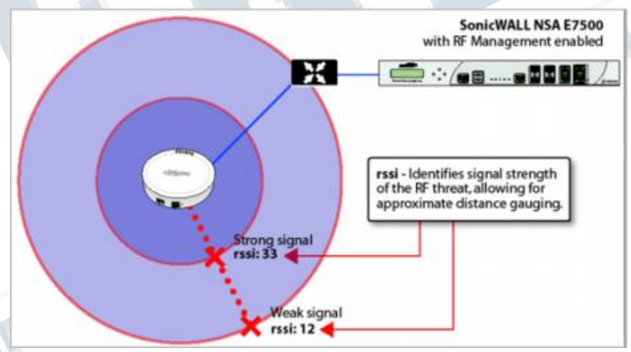

Fig.7. Overview of RSSI

VI. ALGORITHM

1) Power ON, Display ON
2) Display Real-time and date on the screen.
3) Select health parameters (Heart-rate, Blood Oxygen, or Temperature)
4) If the heart rate is selected store and display the value.
5) If Blood oxygen is selected store and display the value.
6) If Temperature is selected store and display the value.
7) If a person wearing the watch is closer to the other person, the notification will pop up on display.
8) Display time and display off.

VII. IMPLEMENTATION OF SYSTEM

1. Arduino board testing

Running a LED blinking program to test Arduino pro mini using FTDI module and Arduino IDE. Fig.8 shows the execution of program using Arduino board.

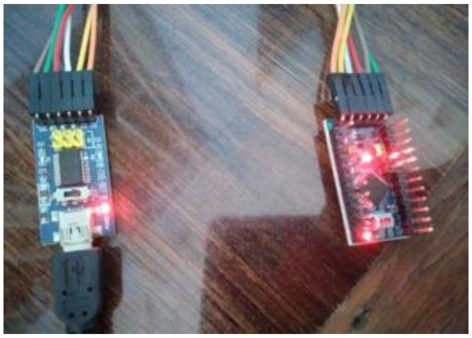

Fig.8. Arduino board testing

2. OLED testing

Checking the OLED display with Arduino using FTDI module and Arduino IDE. Fig.9 shows the interfacing of OLED with Arduino board.

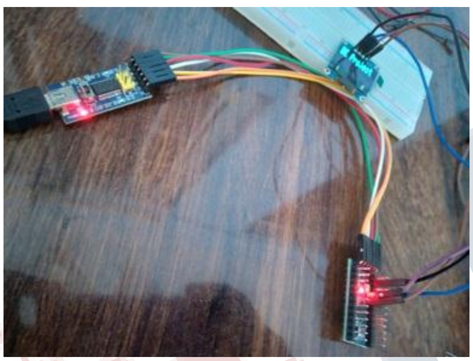

Fig.9. testing of OLED

VIII. CONCLUSION :

It's always tough to review a new platform in the early days. According to the design and algorithms proposed in the report, the smartwatch when integrated with various biomedical sensors is helpful in monitoring health conditions and pre-symptomatic detection of COVID. The smartwatch is affordable as well as an easy healthcare tool for regular health checkups and maintaining social distancing.

Many features can be implemented in it such as, the watch can provide weekly report of the wearer's immune system and it will notify when there is a need for a checkup.

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