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INTEGRATION OF WEARABLE DEVICES IN A WIRELESS SENSOR NETWORK FOR E-HEALTH WEB APPLICATION

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Abstract

As in the present fast growing technology world, the evolutions of new area of concepts are derived in more advances, in a Multidisciplinary nature. In the last 10 years, the medical and diagnostics fields are much more advanced and handy to find server to server health issues in a short span of time and help to analyze in a much better way to cure the health issues. In pandemic situation we had seen RAPID test Kits etc., to find the virus details .in same manner in advanced technical way Wearable devices also plays a role of detection at handled device forms.

Particularly in remote patient management and delivery of care across the healthcare ecosystem, wearable technology, and product maturation have enabled providers with real-time data collection, increasing accuracy and informing decision making. Wearable's have the potential to improve patient outcomes by monitoring physical health, equipping providers with data they otherwise may not have access to. Miniaturizing Body Temperature, ECG, Blood Pressure, Heart Rate, etc. monitoring - these devices continue to disrupt traditional tools of patient data capture.

In this study, a design for an IOT Embedded-based concept is used to design and develop certain wearable devices in a wireless monitoring network with the help of web applications. Using Node-MCU32 and 8266 we define the network and process the data from a person with wearable devices. Generally it can be obtained from the wearable sensor like Blood pressure, Spo2 levels and Temperature of body using the applicable sensors. That collected data is published into a Web page where patient name and other details are noted in that page. Using this concept we can take more than 50-100 patients' data simultaneously with updating details in web page.

Keywords: Smart Wearable device, Medical Devices, Wireless Remote monitoring, Smart Sensors, web Server, Smart embedded IOT.

1. INTRODUCTION

In recent years, wearable technologies have become part of our life and are very popular with users. Many people like wearable fitness trackers and Sony has even created a wearable air conditioner! Healthcare is now embracing this technological advancement to improve patient care, and wearable health monitoring devices can now be integrated into various healthcare activities like smart electronic health record systems (SEHR). Wearable devices, aka wearable's, are mini-computers with built-in sensors that measure environmental parameters,

physical indicators like steps walked, and the level of activity. In this case, the devices are connected to a network and also synchronized with a computer or smartphone. Wearable medical technologies include fitness trackers, smart-watches, smart goggles, and even wardrobe items such as smart gloves that translate sign language into text. An electronic health record "is a digital version of a patient's paper chart. Are real-time, patient-centered records that make information available instantly and securely to authorized users? While a SEHR system does contain the medical and treatment histories of patients, a SEHR system is built to go beyond standard clinical data collected in a provider's office and can be inclusive of a broader view of a patient's care."

Impact of Wearable Medical Devices on the Healthcare Industry

Healthcare apps have become very popular with both doctors and patients, and it's evident that healthcare has gone mobile. This has led to an increased demand for wearable technologies. There are a variety of options that wearable monitoring technologies can offer to the healthcare industry. Some wearable's help with the maintenance of health conditions, they can prevent disease and can also help patients recover. Wearable device health care is all about tracking. They track the recovery progress by allowing doctors to see how the patient improves. Today, healthcare wearable devices are also used for fitness goals. Many people enjoy using weight loss wearable tech such as step trackers or fitness apps with exercise and diet suggestions.

Benefits of Integrating Wearable Medical Devices

The main advantage of wearable technologies for a doctor is convenience. They offer an opportunity to record a patient's data and track health conditions. Here are some ways they are used:

- **Rehabilitation and health maintenance.** Tracking trends through wearable medical technology saves time and cost for hospitals and is convenient for patients. During rehabilitation, patients must be constantly monitored and with wearable health monitoring device, this process has become more efficient. First, the patients can have rehab outside the hospital environment, and this reduces the cost of a patient's in-hospital care. Second, monitoring is more effective as tracking a patient's health and rehabilitation processes are easier with wearable medical technologies. This results in more accurate data about the patient.
- **Physical health activity monitoring.** Wearable fitness trackers or other health tracker technologies are good for those who want to track sports activities. This is not only about tracking steps or fitness training, but also about tracking the patient's overall movement and vitals.
- **Mental status monitoring.** This is a new domain for wearable medical devices. It's possible to monitor mental behavior and detect human psychology status as wearable health technology is equipped with sensors that track the mental health of the patient. Some sensors even can track heartbeat, body temperature, blood pressure, and other vital signs through mental health wearable.

- **Education.** Medical education is another benefit of wearable device health care, as you can easily get all necessary information, essays, articles, case studies, and other research from your smartphone.
- **Integration into SEHR.** According to Primary-care, "the integration of patient-generated fitness or medical data with big data such as prevailing health data into the EMR along with other biological and genetic data is very powerful and robust."

Challenges of Medical Wearable's Integration

The challenges of wearable medical technology in healthcare integrations include the cost for medical organizations, and not everyone can afford to implement them. Patients may be uncomfortable using wearable medical devices, as they can be quite heavy. These technologies are assembled with different components in order to be attached to the body.

1. **Reliability and validity.** There is no proof that wearable technologies are always accurate as there are variations in data.
2. **Privacy and security of personal medical data.** Users have some data privacy concerns as they do not own their own data. Also, when installing apps, users need to give access to personal data and there is always a danger of scams and data loss.
3. **Interoperability and connectivity.** In health wearable technologies, there is a lack of system interoperability and connectivity because the integration of patient data through wearable tech is a relatively new area in health.
4. **Data overload.** There is too much personal data on health conditions that wearable medical devices record. It can cause stress to patients and can create a feeling of over-monitoring. Also, the medical community cannot handle all this data.

Proposed system:

This is system is completely design based on Node MCU Esp32.The ESP32 is a dual-core system with two Harvard Architecture Xtensa LX6 CPUs. All embedded memory, external memory and peripherals are located on the data bus and/or the instruction bus of these CPUs. With some minor exceptions (see below), the address mapping of two CPUs is symmetric, meaning that they use the same addresses to access the same memory. Multiple peripherals in the system can access embedded memory via DMA. The two CPUs are named "PRO_CPU" and "APP_CPU" (for "protocol" and "application"); however, for most pur-poses the two CPUs are interchangeable.

It consists of
– Symmetric address mapping
– 4 GB (32-bit) address space for both data bus and instruction bus
– 1296 KB embedded memory address space
– 19704 KB external memory address space
– 512 KB peripheral address space
– Some embedded and external memory regions can be accessed by either data bus or instruction bus
– 328 KB DMA address space

– Supports up to 16 MB off-Chip SPI Flash.
– Supports up to 8 MB off-Chip SPI SRAM.
– inbuilt 41 peripherals

ESp32 System structure and Reset: The ESP32 has three reset levels: CPU reset, Core reset, and System reset. None of these reset levels clear theRAM.

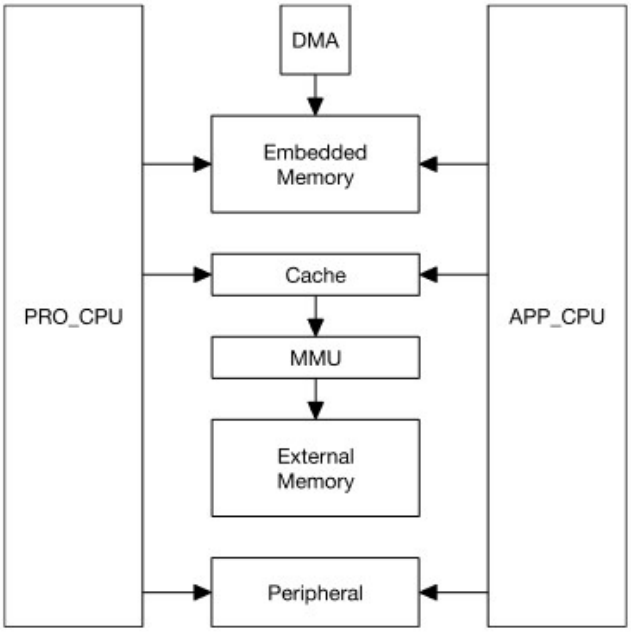


Figure 1-1 System Architecture

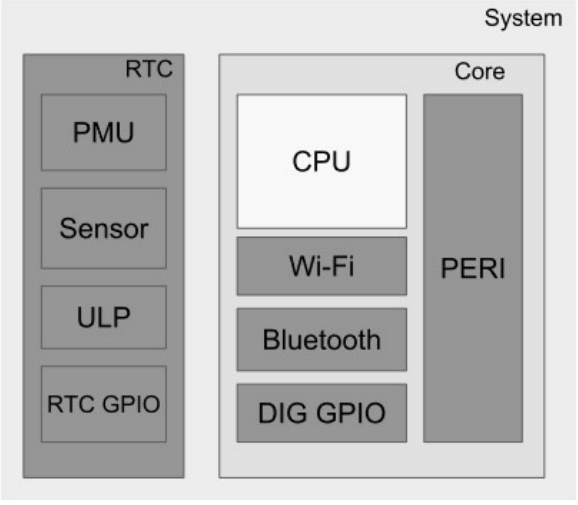


Figure 1-2 shows the subsystems included in each reset level

We use the GPIOs, Bluetooth and Wi-Fi in Esp32 to build an integrated Wearable device ecosystem.

	ESP32	ESP8266	Arduino UNO
Number of Cores	2	1	1
Architecture	32 Bit	32 Bit	8 Bit
CPU Frequency	160 MHz	80 MHz	16 MHz
WiFi	YES	YES	NO
BLUETOOTH	YES	NO	NO
RAM	512 KB	160 KB	2 KB
FLASH	16 MB	16 MB	32 KB
GPIO PINS	36	17	14
Busses	SPI, I2C, UART, I2S, CAN	SPI, I2C, UART, I2S	SPI, I2C, UART
ADC Pins	18	1	6
DAC Pins	2	0	0

Proposed Block Diagram:

Sensor system:

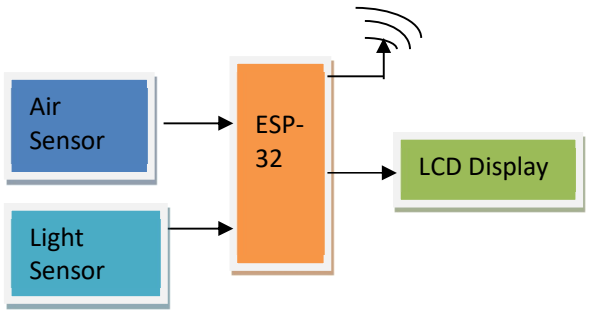


Fig: 2.1 Proposed Sensor block

Wearable device with BLE:

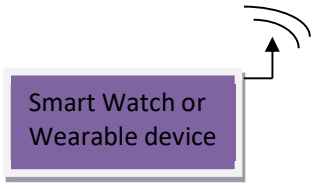


Fig: 2.2 Proposed Wearable device block

Practical Hardware Implementation:

In first case will try to establish wireless connection in between an Android app and Esp32 module. The following steps show how hand shaking Communication held in between Mobile App and Esp32 module.App send text to ESP32. Show on the Serial Monitor. (220.5Kb)

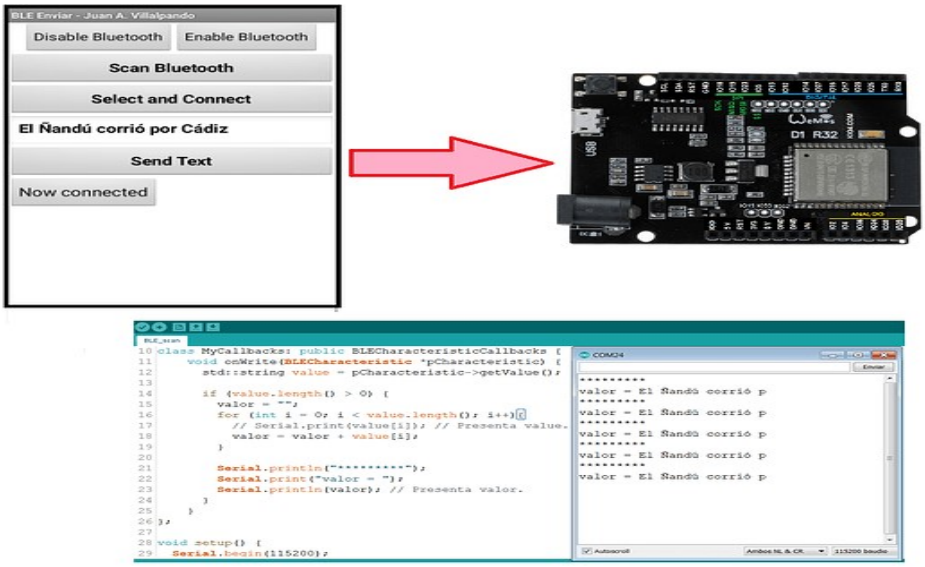


Fig3.1: Hardware dumping prototype

Write and Send a text.

Texts are sent in packages of 20 characters.

App sends text and receives random number. With Clock. (221.0

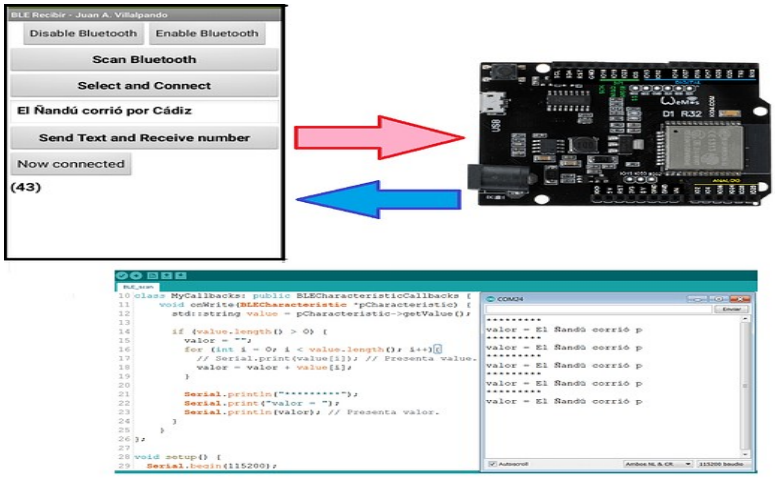


Fig3.2 To and pro communication

- **ESP32 sends automatically (Notify) a random number to App.**

The Bluetooth LE specification includes a mechanism known as ***notify*** *that lets you know when data's changed. When notify on a characteristic is enabled and the sender writes to it, the new*

value is automatically sent to the receiver, without the receiver explicitly issuing a read command.

- ESP32 code generates a random number every 500 millisecond and **notifies** (sends) it to the application.

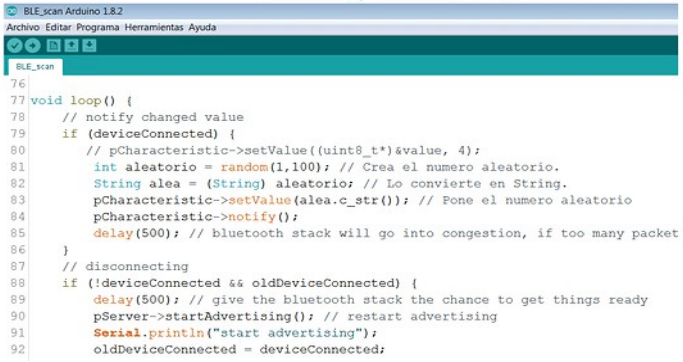
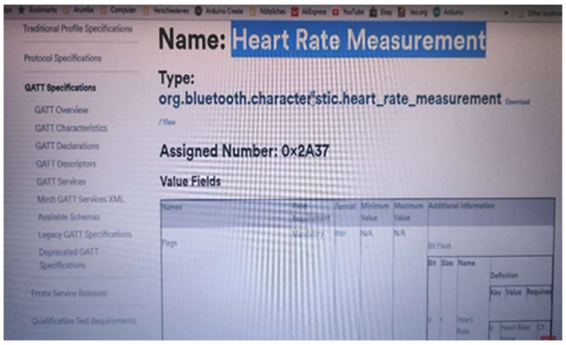


Fig3.3 ESP32 communication for every 500ms

As in such case we use wearable device sensing using a smart watch -Noise Color fit Pro watch to establish a communication to get heart rate information.

Fig3.4 Hardware prototype



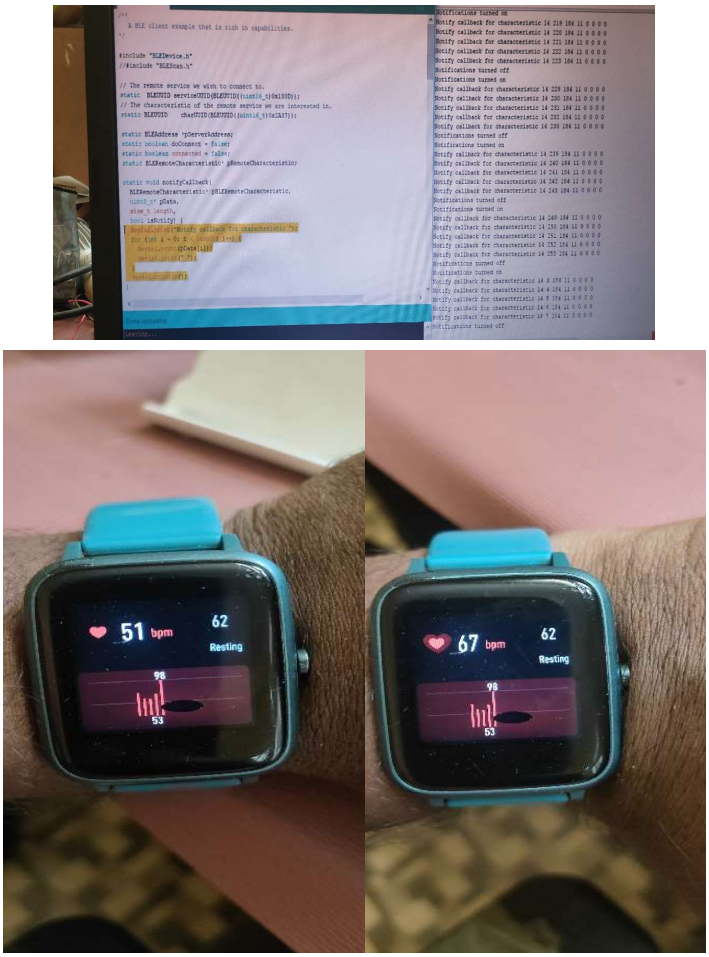


Fig3.5: Experimental setup with IOT

Sucussefully connection and transfer of data happened in between smart device and ESP32. Meanwhile the heatrate will calculate,body temperautre is captured in other side of Web page. Now will construct a Sensor network to see the enviorment of patient to get appropriat values. These sensors are installed in Room where Patient rest and been treated.Mainly will take a reading of Temperature ,CO2 Pollution air and Ambient light value in Lux.

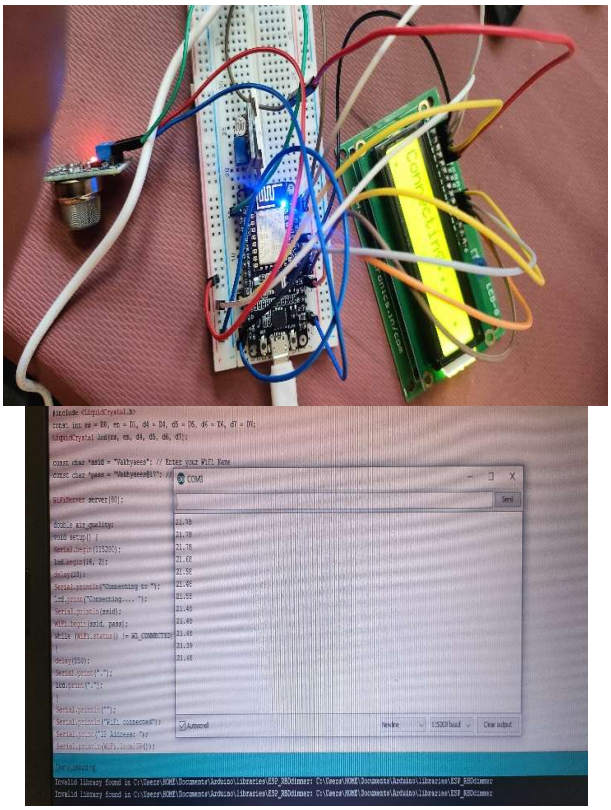


Fig:4.1 Proposed Sensor side hardware

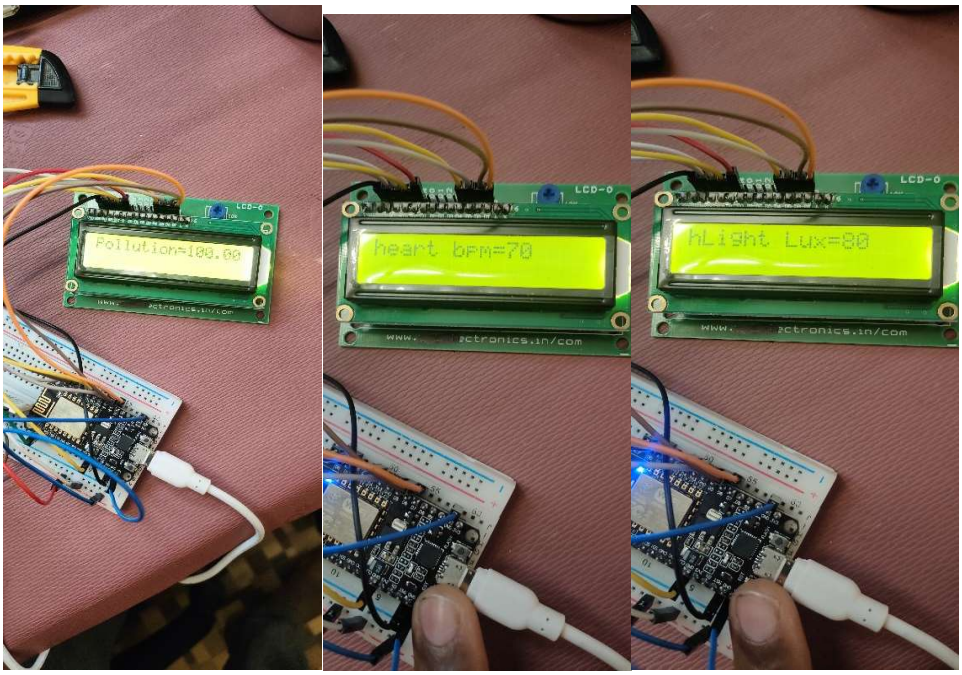


Fig: 4.2 Proposed Sensor side hardware with experimental analysis

Above images shows the output of Wireless sensors and Patient information on above images, and final results shows on Webpages as shown in below figures.

Webpage result:

Fig4.3 Cloud uploading

Sensors:

We used here MQ5 sensor to detect the environmental Air Quality and other dangerous gases which are harm full to human being, DS1820 is used for taking the room temperature instantly, as same humidity measures using DHT11 sensor. At the end of Patient we used Spo2 and Heart Rate Sensor BLE2902 for monitoring and the entire sensor are connected to Es32 controller to take inputs and displays on 16x2 LCD and HTML Page.

Conclusion:

This paper show the statistical data on SEHR to monitoring a patient data via wearable band and different sensor device on Webpage and alerts the doctor/Nurse to take necessary action. Wearable's are primed to play an integral role in the management of chronic disease management and diagnosis. We've seen a shift in the healthcare landscape where patients no longer have to seek in-person consultations with a physician, as these services can now be rendered digitally. With AI and data-driven decision making entering the realm of care delivery, wearable technology stands to play a pivotal role in empowering payers and providers to effectively target, treat and triage their patient populations. Globally, more than 325 million people have medical wearable's, and more than 2.5 billion have smartphones. The use of wearable health devices can provide tremendous benefits, but there are also challenges you need to take into consideration. To improve hospital or at home workflow via integrating wearable medical devices into your Monitoring system, have to do more advance research in integration of device with more safe and scalable features.

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