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Dsigning system for observation of real-time patients via ICT In Health Institutions of Iraq

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ABSTRACT

ICT is becoming more and more popular in the field of remote control. In the healthcare system, patients are monitored in an intensive care unit after a surgical procedure until they are physically stable, then moved to a room for evaluation and recovery. Usually, ward evaluation does not imply continuous monitoring of physiological parameters, and therefore patient relapse is not uncommon. This paper describes the steps taken to design and build a prototype for a low-cost, modular monitoring system. This system is intended to provide mobile support to facilitate faster and better medical interventions in emergencies and has been developed using dedicated low-power sensor arrays for BPM, SpO2, and temperature, as well as room temperature and humidity. The interfaces for these sensors are developed according to the IoT model: the central console displays a web interface based on a REST API that ensures platform-neutral behavior and provides a flexible mechanism for integrating new components. Finally, this paper also investigates the technologies and systems related to e-health services with a better understanding of monitoring applications based on multiple models and different IoT sensors. Finally, this study contributes to scientific knowledge by identifying the main challenges of the topic and providing possible opportunities in this research area.

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1. Introduction

Developments in Information and Communication Technologies (ICTs) is shaping more and more. The use of ICT offers new opportunities and the possibility of exposure to new and unexpected situations. As a result, the overall quality of life can be improved, the quality of medical services is expected to be increased and medical costs are expected to be reduced. Health information system is the creation of a common way of sharing patient information through infrastructure, hardware and software solutions. Monitoring patient systems support the demand for self-management for people faced with chronic diseases, stress, psychological problems caused by overwork, loss of concentration, and anxiety, we propose that the technology already meets the necessary requirements. Opportunity to improve patients' quality of life in healthcare centers in Iraq. Depending on the treatment group and the patient's profile, the monitoring technology to be chosen is determined: fixed or mobile smart devices, mobile technology or PCs, local servers or cloud services, internal or external protocols, communication protocols, and data analysis [1].Communication devices are more user-friendly and are used by a large number of people all over the world, which has reduced communication gaps and simplified access to information using information and communication technology [2]. In 2005, the World Health Organization has urged member states, “to develop the infrastructure for information and communication technologies (ICT) for health as deemed appropriate to promote equitable, affordable, and universal access to their benefits, and to continue to work with information and telecommunication agencies and other partners in order to reduce costs and make eHealth successful" [3].

The system assists the doctor in maintaining continuous health monitoring of the patient's history and keeping track of the patient's current health status. In addition, the doctor can interact with the patient and prescribe medications [4]. The vision of bridging spatial distances between doctors and patients via phone, Internet, and video to address the aging population and age-related disabilities and diseases was realized decades ago [5]. Telehealth concepts, which refer to the delivery of healthcare services at a distance using information and communication technology (ICT), are unavoidable innovations for modern healthcare provision as a far-reaching effect of the digital revolution. Designing ICT-based solutions for medical applications is a new area of interest for medical informatics and related scientific disciplines. This indirectly improves the health of the country [6]. Within emergency and intensive care departments, information and communication technology can provide useful physiological information about patients' conditions. In this work the monitoring is beneficial for patients in critical condition who require continuous monitoring to reduce and avoid complications in inpatients. Wireless sensors are used to collect and transmit signals of interest, and the processor is programmed to automatically receive and analyze the signals from the sensors. The real-time patient monitoring system method is designed using a multi-purpose monitoring system, which extends medical care from traditional to real-time patient monitoring. The system was designed to collect data on the patient's SpO2, heart rate, and body temperature, as well as the temperature and humidity of the inpatient room.

2. Observation Real Time Patients

One of the primary domains of ICT implications is real-time remote monitoring [12]. The Heart Rhythm Society defines remote monitoring as "the automated transmission of data based on prevalent related to device functionality, clinical events, and clinical condition of patients" [13]. Real-time monitoring using state-of-the-art technology delivers valuable information to patients in real time. Remote monitoring in healthcare is promising because it is easy to implement for the elderly, vulnerable patients, and people living at home. Various remote monitoring methods have been proposed, such as phone calls or other advanced systems. For example, vital signs may be transmitted electronically through the device via an external, portable, or remote hemodynamic monitor and remote control. Independent healthcare equipment is included in the 'immune system'. A traditional disease management system complements the data collection and processing of previous generations of tools and various online services. Functions such as data collection and data collection as well as analysis and reporting to individual doctors and caregivers are also available [7-10]. The system's architecture is represented in three tiers [11], as shown in Fig. 1.

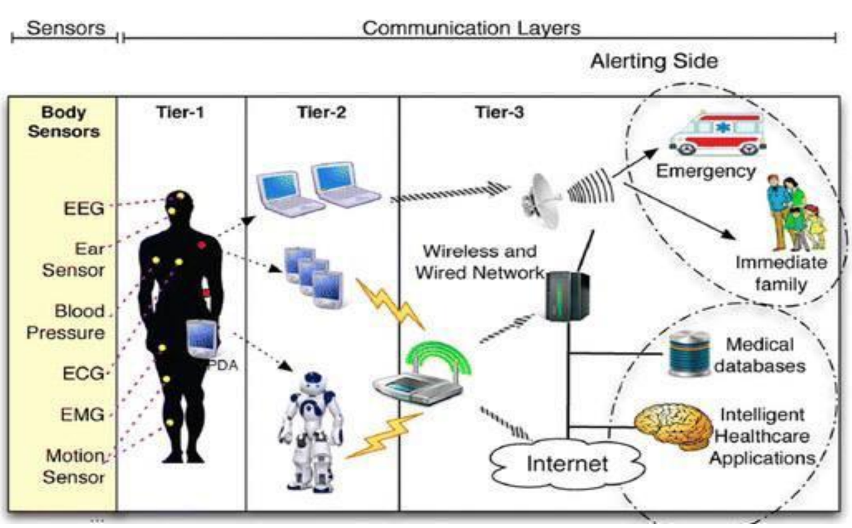

Fig.1- Three-tiered architecture of telemedicine system for real-time healthcare monitoring [11]

3. Literature Review

Through the development of databases and other activities, ICT can help resolve information conflicts that arise in the developing world's health sector between health professionals and the working public, as well as between health research providers and professionals in need [14]. The application of ICT in healthcare can be divided into four major categories, which are as follows: Health and Education: in this digital age, people can quickly seek, access, learn, and communicate with others. This makes education available and accessible to everyone as well as Health education ensures that the society is aware of infectious diseases, health problems, preventive measures and various diagnosis and treatment methods [15].

ICT assists hospital management in successfully leading the organization and overcoming the numerous challenges that the hospital faces. ICT also assists management in improving patient safety and satisfaction, staying up to date on the latest technology, having a clear understanding of population health and statistics, and staying on track with government mandates. The workplace, in particular, can be strengthened [16]. Health Research: The use of ICT in healthcare research aids in the discovery of potential disease-prevention measures. We can find new diagnostic technology that saves time and money. This saves many people's lives by providing treatment ahead of time. Information technologies can replace traditional medical systems and new, effective treatment methods can be developed. Health information management: basic use of ICT in hospitals and electronic databases of medical information. This information is easy to find. Information can be sent via ICT to the patient or doctor for consultation. A patient has access to medical records that can be used anywhere and anytime. Information Technology (ICT) offers many opportunities to improve the healthcare system. The healthcare sector must use ICT wisely to bring about further changes and improve the quality of healthcare services, which is important for the development of the country [17].

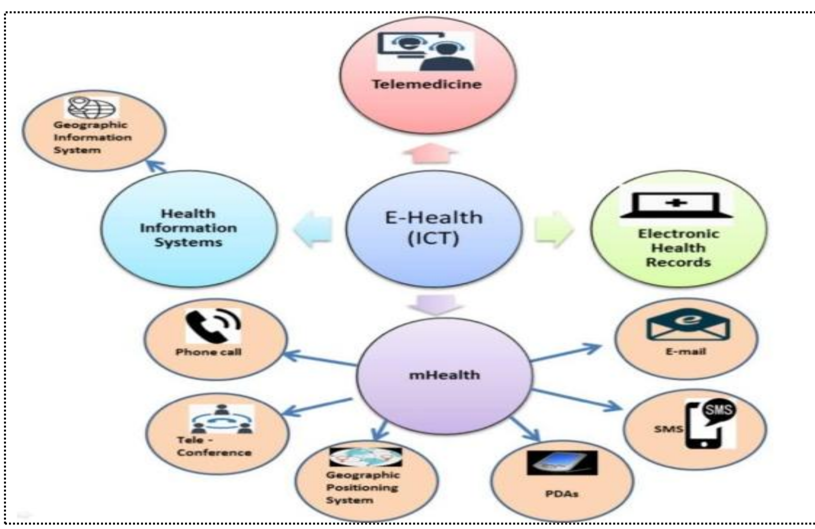

Fig. 2- ICT Applications in Health Care [20]

3.1 Essentials tools

ICT tools of healthcare help in specific areas and support better and more efficient healthcare using existing technology. Below we mention some tools used in health ICT:

a) NodeMCU ESP8266
b) Arduino Pro Mini
c) Body Temperature Sensor
d) Pulse Oximeter Sensor
e) Room Temperature Sensor

f) OLED Display Module

3.2 Vital Signs Parameters

Vital signs are important indicators of patients' clinical condition and inform required interventions [18]. Vital signs such as the patient's pulse, breathing, blood pressure, and body temperature are necessary and important information for assessing health status and identifying clinical deterioration through early detection and early diagnosis, as well as reducing the risk of fatal accidents. In all wards of Swedish hospitals, six measurable vital signs are monitored. Healthcare professionals use the National Early Warning Score to evaluate them subjectively [19].

3.3 Vital Signs Monitoring

Monitoring vital signs is an essential part of nursing care. Nursing school teaches us that a patient's pulse, respirations, blood pressure, and body temperature are critical in identifying clinical deterioration and that these parameters must be measured consistently and accurately [20]. The vital signs of a patient are measured to obtain basic indicators of his or her health status. If the values are outside of a normal range, they may indicate dysfunction or a disease state. Below four qualities of a perfect vital signs monitoring system:

1. Capability to collect high-quality data using devices and sensors.
2. Ability to interpret and present gathered data in a meaningful and valuable way.
3. Allow for decision support by applying professional knowledge to real-world situations.
4. Based on the data provided, the ability to make appropriate decisions and actions with the input of healthcare professionals.

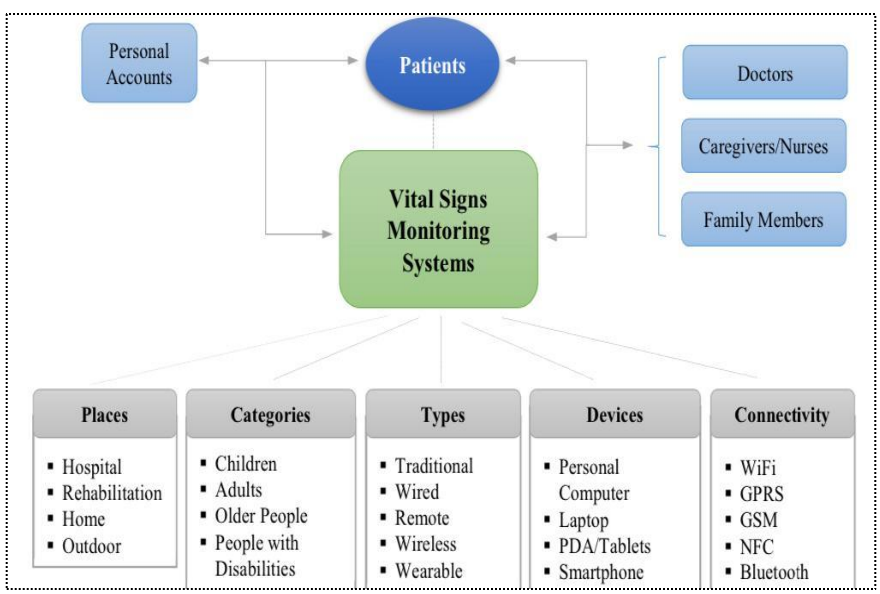

Fig . 3 - Vital signs monitoring system relationship diagram, modified from

According to [21], increasing the use of electronic technology is widely accepted as an important strategy for developing affordable and sustainable healthcare services and thus improving the quality of life of patients. Figure 5 shows the state of the art in basic signal monitoring systems, including their types, user categories, locations, devices and network connections. Monitoring vital signs in emergency and post-operative situations is a common practice; however, there is still one limitation regarding the ideal rate at which vital signs should be assessed. Most of the time, this rate is determined by hospital regulations, healthcare professionals' judgment or instruction, as well as the patient's perception and grievance [22]. The use of ICT in healthcare has significantly improved the delivery of daily healthcare services, the quality of healthcare practices, and the performance timeframe. Through previous studies and their findings, this research can identify important points that help in a confidential response to patient cases regardless of distance and treat them in a timely manner, relying on information technology.

4. Methodology and Purposed System

Information and communication technology (ICT) has altered the global landscape and led us to a more advanced technological world in many sectors, particularly the health sector. The emerging role of ICT in healthcare has had a significant impact by improving health and medical care quality, patient security, and data protection. It aims to improve the efficiency of the health care system, increase patient safety, and prevent medical errors, as well as to improve interaction between patients and health care providers [23]. Because of the deteriorating health conditions in Iraqi health institutions, as well as the inability to continuously monitor patients, and because of the central role that information and communication technology plays in the health sector, it has been approved to introduce this technology in Iraqi health institutions and change the health landscape. Furthermore, health care and patient monitoring are two of the most important and difficult tasks for health care professionals. As a result, we developed a proposed framework for developing patient health monitoring systems and transforming them into real-time 24-hour systems, in which patients are monitored in real time via a control room and wireless sensors. This framework aims to achieve a significant qualitative leap in the Iraqi health sector in continuous health monitoring by utilizing a patient monitoring system that allows health care professionals to continuously monitor the vital signs of patients in real time.

5. Real-Time Patient Monitoring System Design

Hospitals are intricate organizations comprised of numerous core clinical, diagnostic, and support service departments. A medical supervisor with a clinical background typically handles administrative cases in public sector hospitals [24]. As a result, as shown in Figure 5, we recommend allocating an observation room and monitoring the condition of patients in the emergency and postoperative departments. The observation room is managed by a health care professional who is in charge of monitoring patients' health status.

Fig. 4 - Monitoring of patients through the control room

The proposed monitoring system continuously records patients' vital signs in real time and transmits them to the control room via Wi-Fi, allowing health personnel to monitor and follow up on patients' health status in real time while reducing the error rate caused by communication between health staff and patients as shown in Figure 5.

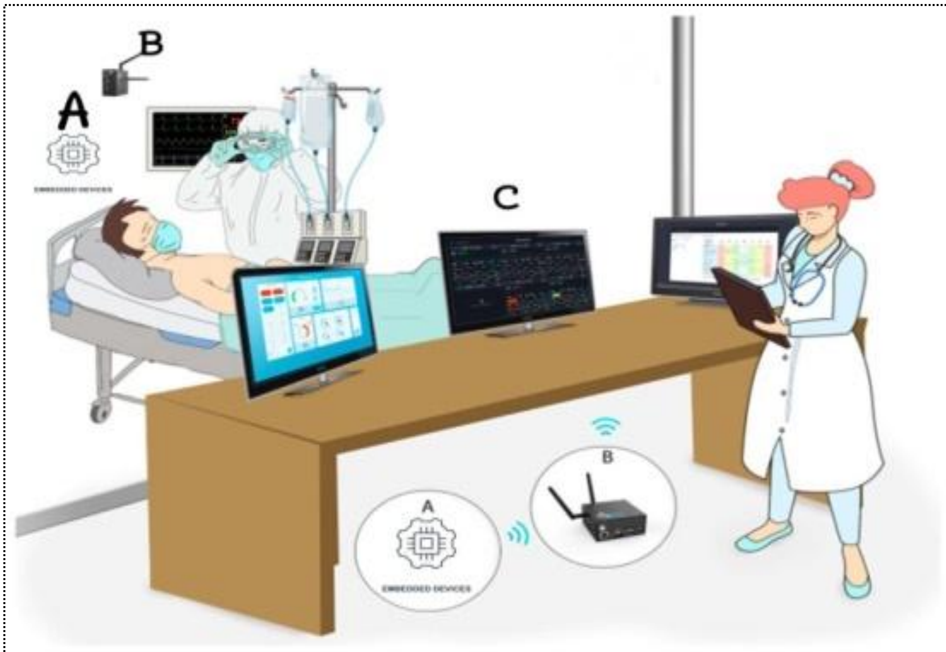

Fig. 5 - (A) patient monitor device, (B) Wi-Fi module, and (C) monitor room

In our proposed design, four sensors are used: the blood oxygen saturation sensor, the pulse rate sensor, and the body temperature sensor. A room temperature sensor has also been added to monitor the temperature and humidity of the patient's room.

6. Overall Framework of the System

We discovered that one of the most important things that must be monitored and requires continuous follow-up are the patients' vital signs after reviewing scientific studies and research on their health conditions. That is why we created a real-time continuous health monitoring system based on Wi-Fi. Figure 5 depicts the proposed monitoring system's structure.

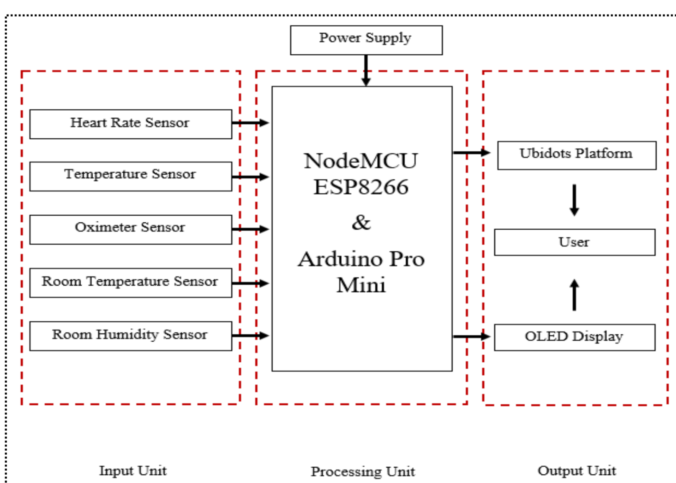

Fig. . 6 - Block diagram of the proposed system

7. Ubidots Platform

Ubidots is an Internet of Things platform that allows innovators and industries to prototype and scale Internet of Things projects to production. Use the Ubidots platform to send data to the cloud from any Internet-connected device. Device-friendly APIs (accessible via HTTP/MQTT/TCP/UDP protocols) provide a simple and secure connection for sending and retrieving data in real-time to and from their cloud service. Ubidot's time-series backend services are designed for high-performance IoT data storage, computation, Figure 7.

Fig. 7 - Ubidots Platform.

8. Hardware Connection

In this section, we connected the proposed system's components to prepare the system for programming. The process of connecting system components with software such as Fritzing. As shown in Table 1, we connected the sensors (MAX30100, LM35, and DHT22) to the NodeMCU ESP8266 control board.

Table 1 - Connect the sensors with NodeMCU ESB8266

MAX30100 Module	NodeMuc ESP8266	Wire Color	Description
GND	GND	Black	Connected to the ground of the system
Vin	Vcc	Red	Connect to +3.3V supply voltage.
SCL	D1	Pink	I2C clock pin, connect to NodeMCU esp8266 I2C clock line.
SDN	D2	Brown	I2C data pin, connect to NodeMCU esp8266 I2C data line.
INT	D0	Cyan	To generate an interrupt for each pulse
LM35 Sensor	NodeMuc ESP8266	Wire Color	Description
GND	GND	Black	Connected to the ground of the system
Vcc	Vcc	Red	Connect to +5V supply voltage.
DATA	A0	Yellow	Bus data wire connects to the analog pin on the NodeMCU esp8266 board.

DHT22 Temperature And Humidity Sensor	NodeMuc ESP8266	Wire Color	Description
GND	GND	Black	Connected to the ground of the system
Vcc	Vcc	Red	Connect to +5V supply voltage.
DATA	D5	Orange	Bus data wire connects to the digital pin on the NodeMCU esp8266 board.

DHT22 sensor because there is no 5v Vcc pin on the NodeMCU esp2866 board, the Vcc pin is connected to a 5v voltage source. The process of connecting the sensors to the NodeMCU esp8266 board is depicted in Figure 9.

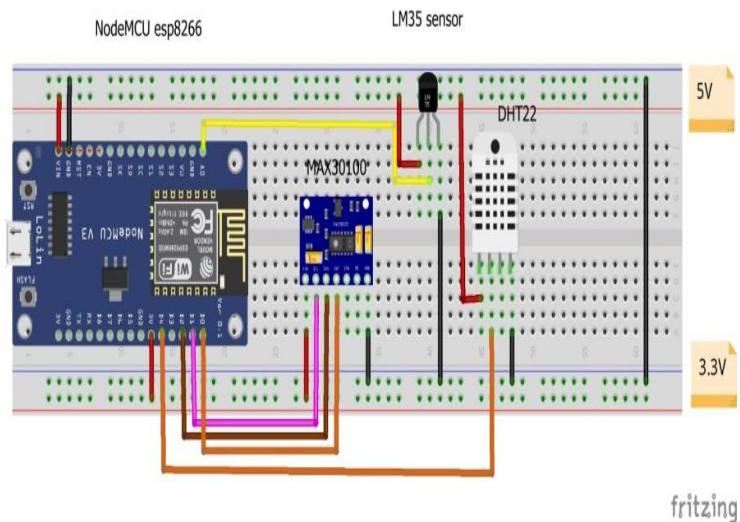

Fig 8 - Connect DHT22 Sensor with NodeMCU esp8266 using Fritzing software.

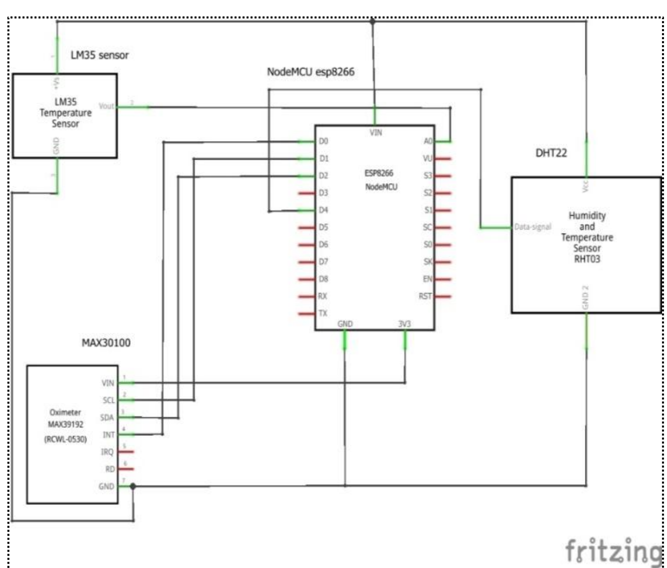

Fig .9 - Schematic diagram of the hardware components with NodeMCU esp8266

Arduino Pro Mini is used to create an interface to display the readings on the OLED screen.. Table 3 shows how to connect the sensors and the OLED display to the Arduino Pro Mini board.

Table 2 - connecting the sensors and the OLED display to the Arduino Pro Mini board.

LM35 Sensor	Arduino Pro Mini	Wire Color	Description
DATA	A0	Yellow	Bus data wire connects to the analog pin on the Arduino pro mini board.
DHT22 Sensor	Arduino Pro Mini	Wire Color	Description
DATA	D4	Orange	Bus data wire connects to the analog pin on the Arduino pro mini board.
OLED Display	Arduino Pro Mini	Wire Color	Description
GND	GND	Black	Connected to the ground of the system
Vcc	Vcc	Red	Connect to +5V supply voltage.
SCL	A5	Brown	The serial clock pin of the I2C interface.
SDA	A4	Purple	The serial data pin of the I2C interface.

The system is now ready for programming after the sensor and processor connections have been completed. Figures 10 depict the process of connecting all components of our proposed system.

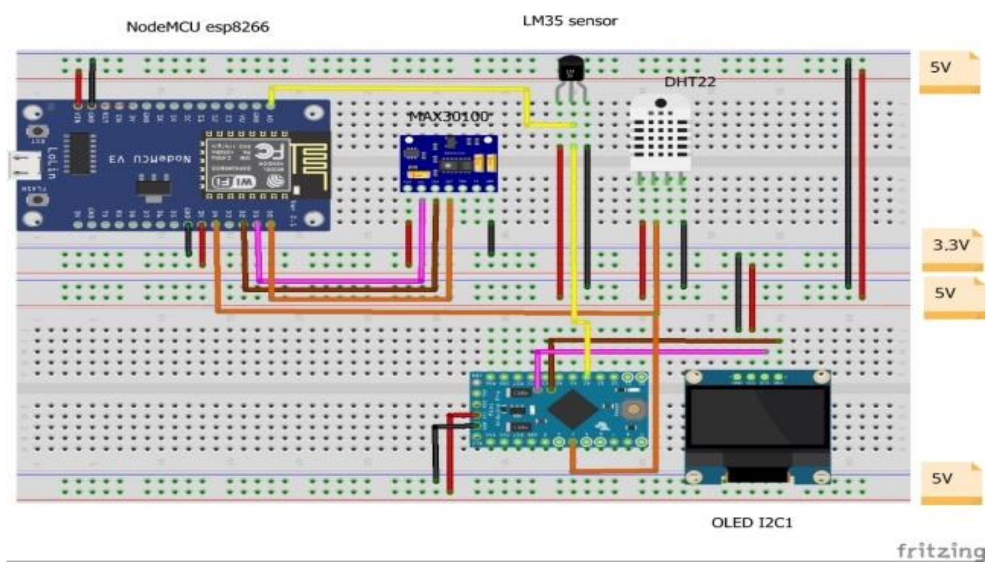

Fig. 10 - Connect the hardware components of the proposed real-time patient monitoring system

The connection process for all hardware components of our proposed system has been completed and is ready for the next stage, which is the system programming process. After connecting the sensors to the processors, we write the code for the NodeMCU esp2866 and Arduino Pro Mini processors in this section. Once the libraries have been installed, we can begin writing the script that will send the data correctly through Wi-Fi networks. In our proposed project, we will use NodeMCU to send data; the code is divided into five stages.

In the first stage: we enter the user code, device labels, and parameters that will be created in our Ubidots account, as well as the Wi-Fi network names and passwords and then choose the MQTT client name through which to set a broker for our device. After completing the Ubidots platform and device drivers, we select the DHT sensor type and define the sensor input pins on the NodeMCU esp8266. The 1000 ms reporting period is also defined for the MAX30100 sensor and then we initialize the DHT sensor, the LM35 sensor, and the MAX30100 sensor. We need to store the data so we use the mqttBroker variable to store the Ubidots proxy; the payload keeps memory space to send the data later.

In the second stage: we are configuring the required constructors, the first of which (ESP8266WiFIMulti WiFiMulti) will only be used to connect to a Wi-Fi network. Then we will create a wificlient (Ubidots) and pass it as a parameter to the constructor of PubSubClient. Next, we have to create a callback function. This function is very important because it deals with changing our variables in Ubidots. We have coded an add-on to reconnect if MQTT crashes, in case the device is not connected, the code will try to initialize the connection to the broker using the connect method (char * clientName , char * user , char * password). We also define a callback routine for the MAX30100 sensor that runs when a pulse is detected.

In the third stage: now the script should be familiar because now it only contains setup and loop functions. As the setup() function, we initialize the serial port at 115 kbps, configure the DHT22 and MAX30100 sensor, then connect to a Wi-Fi access point, and print some debug messages. We avoid any routine from starting if the device is not connected to the access point. Once the device is confirmed, it prints a debug message using the local IP address assigned to the device. We've included two interesting functions, setServer(), the PubSubClient method for setting the url of the broker and port to initiate connections. Additionally, setCallBack() which enables the predefined callback() function.

In the fourth stage: starting with the loop function, we test the connection of the NodeMCU esp8266 to the broker using our token connection and our MQTT client name. Then verify that the device is connected: If not, call an add-on for the previous reconnection. Next, we define the reading parameters (body temperature, oxygen saturation rate, and heart rate, room temperature, and room humidity) and store them locally.

In the fifth stage: we made sure to get in touch with the update ASAP for the MAX30100 sensor. To read the values of the MAX30100 sensor instead of the usual delay routine we used the millis() function to keep it running in the background and not blocking code execution. Then we stored the floating body temperature, SpO2, heart rate, room humidity and room temperature values as a char matrix to send the value to the median later in the dtostrf() function. After listing the aforementioned libraries, we wrote our code and used Wi-Fi to connect these sensors to the Ubidots platform. We have added three networks to help with communication and data transfer via the NodeMCU esp8266 connection to a network with a strong signal.

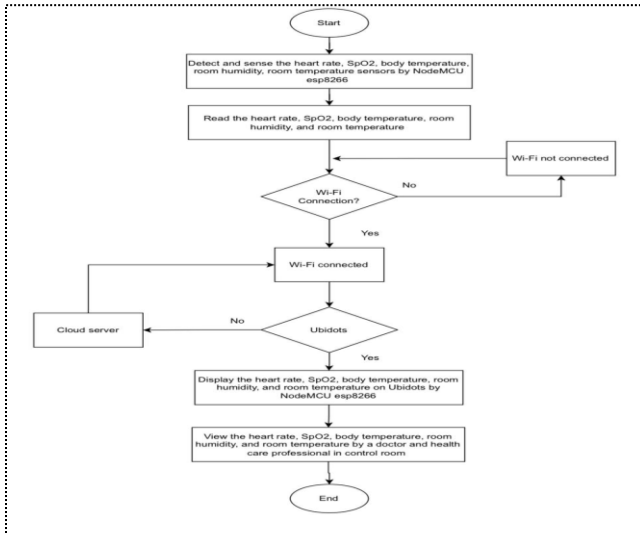

Fig. 11 - Flowchart of real-time patient monitoring system using NodeMCU esp8266.

9. System Setup

The complete hardware setup is shown in the Figure above, which includes the NodeMCU esp8266 controller boards and the Arduino Pro Mini with a power supply attached. The microcontroller is linked to all sensors, including a pulse oximetry sensor (heart rate and SpO2), a body temperature sensor, a humidity sensor, and a room temperature sensor. When the device is turned on, an OLED display connected to the Arduino Pro Mini controller displays a series of information such as body temperature, and room temperature and humidity. Finally, once the device is connected to the network, it displays all of the patient's information on it as well as any irregularities in the patient's vitls.

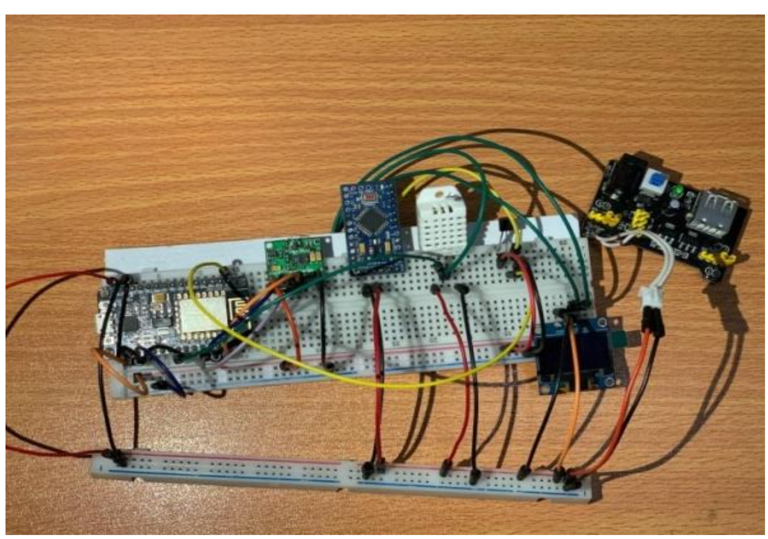

Fig. 12 - System setup

10. Operating system

In this part, we created a framework for a real-time monitoring system for recording vital signs of a patient in a hospital emergency room or intensive care unit. The proposed system takes readings from the patient's body (temperature, oxygen saturation rate, heart rate, room temperature, and humidity) and sends them to the control room for medical staff to monitor the patient. The proposed system is made up of two major components: hardware and software. The device part consists of the oximeter sensor, which measures the oxygen saturation level and heart rate, the patient's body temperature sensor and the room temperature, and humidity sensor that provides temperature readings about patient’s room, as well as the NodeMCU esp8266 board, which includes Wi-Fi, Arduino pro mini, and an OLED display that displays the full sensor readings. The sensors are linked with a NodeMCU esp8266, and the display is linked with an Arduino Pro Mini board. Then we moved on to the software section, where we programmed each of the sensors with the NodeMCU esp8266 using a special code, as well as the display with the Arduino Pro Mini board. After the entire system programming process is completed, it is capable of collecting patient data and transmitting it via Wi-Fi technology to the control and monitoring room, where the readings are displayed via an electronic platform known as the Ubidots platform. The codes is included in Appendix C and Appendix D.Ubidots platform displays all of the readings recorded by the monitoring system and stores the readings in the cloud, in addition to providing us with a high security system to protect all incoming data.

11. Results and Discussion

After completing the system programming process and designing a structure for the device using a 3D printer, the system is now running, as shown in Figure 14.

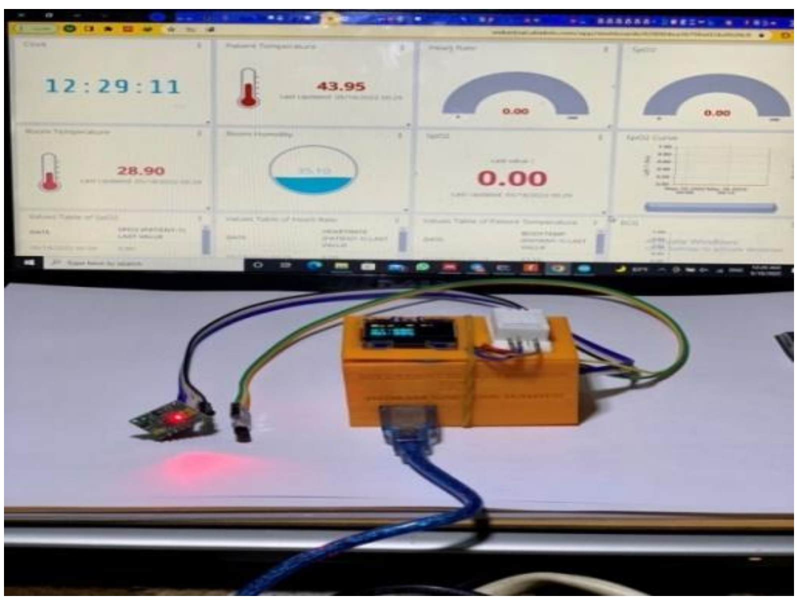

Fig. 13 - Operating mechanism of the system

The pulse oximeter sensor is installed in the patient's finger. This sensor output is given to NodeMCU esp8266 and Arduino Pro Mini, as shown in Figure 14. The LM35 is used as a sensor for the patient's body temperature. The output of this temperature sensor varies based on body temperature, and this output is also given by NodeMCU esp8266 and Arduino Pro Mini. The sensor is placed in the armpit or neck of the patient.

Fig. 14 - Pulse oximeter sensor

the temperature and humidity sensor varies with the change in room temperature and humidity. The output is also given by NodeMCU esp8266 and Arduino Pro Mini. This sensor is integrated into the device without contact with the patient's body.

12. Output in the OLED Display

The output is in digital form on the OLED screen and shows patient's body temperature results (Body T), room temperature (RT), and room humidity (R H), as shown in Figure 15.

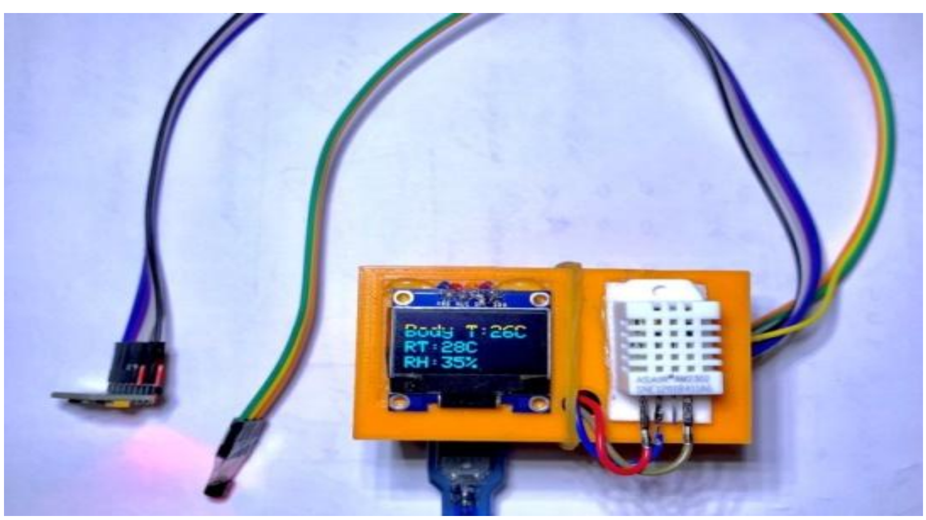

Fig. 15 - Output display in OLED display

13. Output in the Ubidots Platform

The output is displayed in digital form at a certain period. The Ubidots platform is very simple as it displays all digital and analog readings followed by timekeeping for each reading.

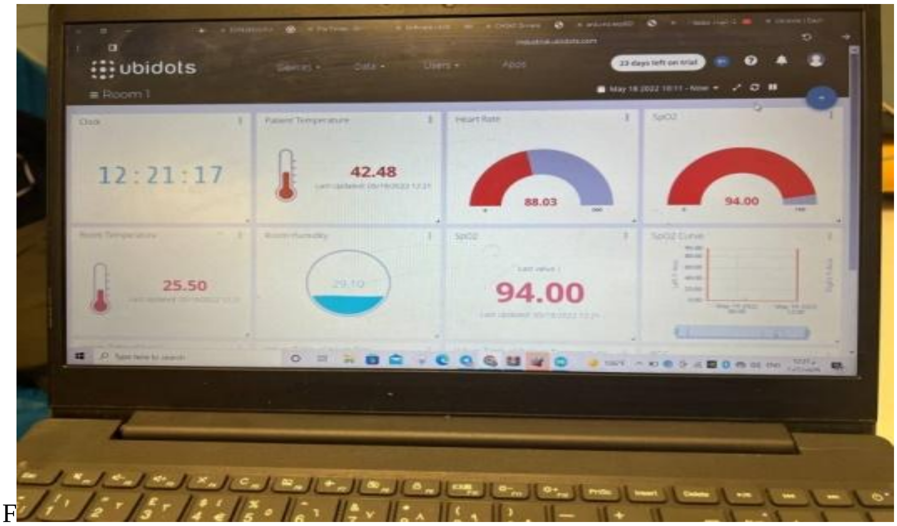

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Fig. 16 - Output display in Ubidots platform

14. Testing and Findings in Hospitals

The developed real-time patient monitoring system is tested using different people with normal to abnormal health conditions. It was applied and readings were taken from two hospitals (Al-Nasiriya Teaching Hospital and Souq Al-Shuyoukh General Hospital). Various tests and results that lead to results with a minimal error rate and feedback are listed below.

14.1. Heart Rate Findings

The Pulse Oximeter sensor is used to measure the pulse rate in the error range of + or – 6.

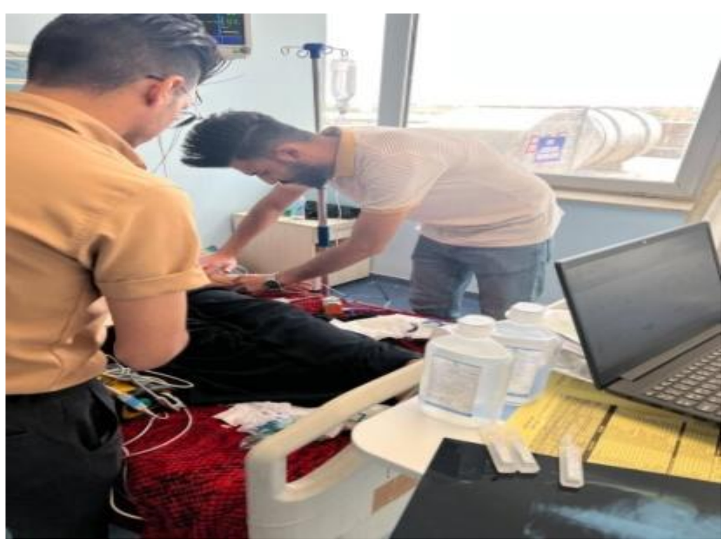

Fig. 17. Heart rate oximetry test on hospitalized patients

Table 3- Observed heart rate readings

Testing	Normal value	Observed value	Error rate	Hospital
Patient 1	95	98	3	Al-Nasiriya Teaching Hospital

Patient 2	89	90	1	Al-Nasiriya Teaching Hospital
Patient 3	91	93	2	Souq Al-Shuyoukh General Hospital

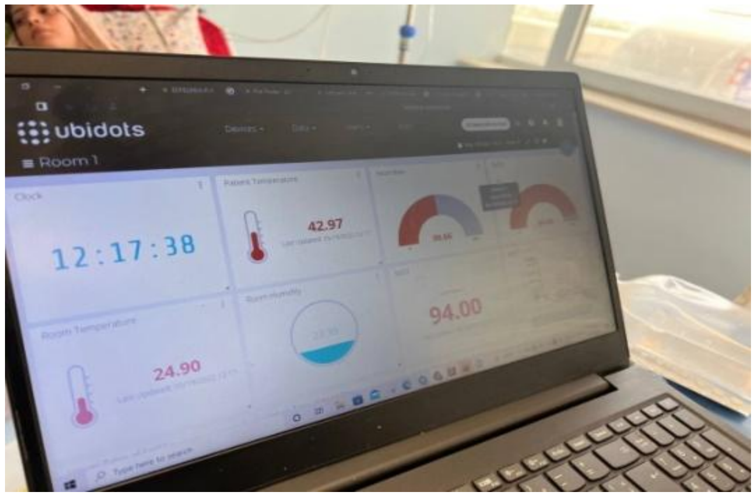

Fig. 18- The results of the SpO2 reading on the patients.

14.2. SpO2 Findings

The Pulse Oximeter sensor is used to measure the SpO2 in the error range of + or – 6.

Fig. 19- Oximetry test for oxygen saturation on hospitalized patients

Table 4 - Observed SpO2 readings.

Testing	Normal value	Observed value	Error rate	Hospital
Patient 1	95	94	1	Al-Nasiriya Teaching Hospital
Patient 2	95	95	0	Al-Nasiriya Teaching Hospital
Patient 3	95	93	2	Souq Al-Shuyoukh General Hospital

14.3. Body Temperature Findings

The LM35 used is programmed to display the value of body temperature for demo purposes with minimal error of + or – 7.

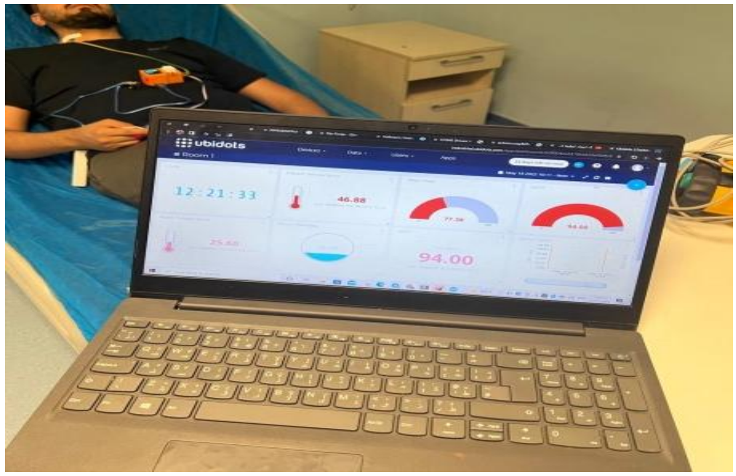

Fig. 20 - Body temperature test for hospitalized patients

Table 5 - Observed body temperature readings.

Testing	Normal value	Observed value	Error rate	Hospital
Patient 1	37	42	5	Al-Nasiriya Teaching Hospital
Patient 2	37	40	3	Al-Nasiriya Teaching Hospital
Patient 3	38	41	3	Souq Al-Shuyoukh General Hospital

14.4. Room Temperature Findings

DHT22 sensor is used to measure the room temperature in the error range of + or – 6.

Fig. 21- Patient room temperature test

Table 6 - Observed room temperature readings.

Testing	Normal value	Observed value	Error rate	Hospital
Room 1	23	26	3	Al-Nasiriya Teaching Hospital
Room 2	24	25	1	Al-Nasiriya Teaching Hospital
Room 3	23	25	2	Souq Al-Shuyoukh General Hospital

14.5. Room Humidity Findings

DHT22 sensor is also used to measure the room humidity in the error range of + or – 6.

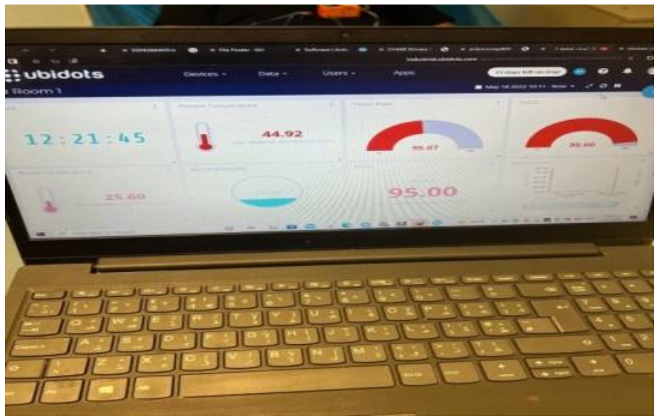

Figure. 22. Patient room humidity test

Table 7- Observed room humidity readings.

Testing	Normal value	Observed value	Error rate	Hospital
Room 1	30	27	3	Al-Nasiriya Teaching Hospital
Room 2	31	30	1	Al-Nasiriya Teaching Hospital
Room 3	34	37	3	Souq Al-Shuyoukh General Hospital

Fig. 23 - Real-time patient monitoring in the observation room

15. Performance Test Cases

Test Objectives: Time taken to send data to cloud

Table 8- Test case checking time taken to send data to cloud

Test condition	Output specification	Optimal
Time taken to send sensor data to database in cloud	Micro controller sends data every 15 seconds to cloud. Here network plays important role and time taken to send each record is <200ms including response time. But if	True

	there is issue with network bandwidth then performance will be deteriorated as system takes additional to check network connectivity and send data to cloud.	

Test Objectives: Time taken to relay patient data on Ubidots platform

Table 9- Test case checking time taken to fetch data from cloud relay on Ubidots

Test condition	Output specification	Optimal
Time taken to fetch data from cloud and view it on web	Time taken to run query and relay information on web page is <500ms	True

Test Objectives: Time taken to relay patient data on Micro controller

Table 10- Test case checking time taken to fetch data from sensor to Micro controller

Test condition	Output specification	Optimal
Time taken to fetch data from sensors to Micro controller	Time taken to fetch data from sensor and relay information to Micro controller is <50ms	True

16. Conclusion

This paper introduces the concept of the Internet of Things, as well as the real-time remote patient monitoring system that has been researched and developed. The patient's physiological data is collected, simulating the detection of heart rate, patient body temperature, humidity, room temperature, and SpO2 monitoring. The readings are saved in a cloud database and displayed in the Ubidots platform, where a doctor or healthcare provider can view them remotely.

The data can also be used to investigate medical issues affecting the elderly or those suffering from chronic diseases. The Ubidots platform is protected by the Advanced Encryption Standard in terms of data security (MQTT with TLS encryption). This establishes an encrypted connection between the client and server, and no attacker will be able to decipher the content of the connection. It also has token-based authentication, which can be used to decrypt patient records and ensure that only authorized users have access to the data.

This safeguards patient records against unauthorized users and hackers who may wish to intercept them. Vital signs are various physiological parameters that describe a patient's overall health status in patient monitoring systems. ICT and digital technologies are being used to improve vital sign monitoring and the healthcare sector in general. Vital sign monitoring is a tool used in various hospital departments to detect and prevent health complications. If the patient is ill and in critical condition, the use of traditional postoperative monitoring rounds of false alarms in emergency departments has resulted in the patient's health status not being detected or deteriorating early. The use of the National Early Warning System is essential in identifying and treating clinical deterioration, admission to intensive care, and treatment without adding to the workload of healthcare workers.

Many basic studies have shown that intelligent and regular monitoring of vital signs can improve health of patient. In the intensive care unit and emergency wards, there are already systems in place for continuous monitoring. These systems present a number of challenges in terms of performance, size, connectivity to other systems, and so on. The goal of this work was to investigate continuous vital signs measurement and monitoring practices in emergency and postoperative departments for SpO2, heart rate, patient temperature, room temperature, and humidity, as well as to understand and identify healthcare professionals' needs and desires to improve the various devices used to measure and monitor patients.

At the beginning of this work, the daily routine of medical professionals in each emergency department was identified. These insights were then used to develop and design a design model.

After developing this system to create a real-time vital signs monitoring system that measures and monitors SpO2, heart rate, patient temperature, room temperature, and humidity. The system produced good results, and it is a proposed framework that can be improved by incorporating additional sensors and manufacturing high-precision sensors. These devices potentially reduce healthcare professionals' workload, support better health monitoring, and most importantly help save human lives.

This paper provides value from both a human-centered Internet of Things (IoT) and a technological standpoint. Given the first perspective of a human-centered IoT, the participation of participants in the collaborative design process revealed the importance of professional development. In terms of technology, measurement equipment, continuous monitoring of vital signs, and the use of systems, if integrated into the work lives of healthcare professionals, will improve the daily operation and management of different hospital rooms.

Finally, there are some limitations that the work faces, including the difficulty of providing some medical devices and basic components, in addition to the necessity of having a specialized technical staff that can adapt and work on modern technologies, and the urgent need to develop health institutions in Iraq in order to deal with such advanced technologies when they are applied.

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References

[1] da Costa, T. P., Gillespie, J., Cama-Moncunill, X., Ward, S., Condell, J., Ramanathan, R., & Murphy, F. (2022). A systematic review of real-time monitoring technologies and its potential application to reduce food loss and waste: Key elements of food supply chains and IoT technologies. Sustainability, 15(1), 614.

[2] Rajan, S. P., & Abirami, T. (2022). Smart sensing technology. Smart Systems for Industrial Applications, 333-366.

[3] Mengiste, S. A., Antypas, K., Johannessen, M. R., Klein, J., & Kazemi, G. (2023). eHealth policy framework in Low and Lower Middle-Income Countries; a PRISMA systematic review and analysis. BMC Health Services Research, 23(1), 1-15.

[4] Gaur, L. (2022). Internet of Things in Healthcare. In Geospatial Data Science in Healthcare for Society 5.0 (pp. 131-140). Singapore: Springer Singapore.

[5] Ahmad, A., & Mozelius, P. (2022). Human-Computer Interaction for Older Adults: a Literature Review on Technology Acceptance of eHealth Systems. Journal of Engineering Research and Sciences (JENRS), 1(4), 119-126.

[6] Wallinheimo, A. S., & Evans, S. L. (2022, June). Patterns of internet use, and associations with loneliness, amongst middle-aged and older adults during the COVID-19 pandemic. In Healthcare (Vol. 10, No. 7, p. 1179). MDPI.

[7] Elawady, M., Sarhan, A., & Alshewimy, M. A. (2022). Toward a mixed reality domain model for time-Sensitive applications using IoE infrastructure and edge computing (MRIoEF). The Journal of Supercomputing, 78(8), 10656-10689.

[8] Zou, S., Tao, L. Q., Wang, G., Zhu, C., Peng, Z., Sun, H., ... & Ren, T. L. (2022). Humidity-Based Human–Machine Interaction System for Healthcare Applications. ACS Applied Materials & Interfaces, 14(10), 12606-12616.

[9] Mohammed, B. G., & Hasan, D. S. (2023). Smart Healthcare Monitoring System Using IoT. iJIM, 17(01), 141.

[10] Hentsch, L., Pereira, C., Pinon, N., Tahar, A., & Pautex, S. (2023). Identifying the palliative care needs of frail, older, housebound patients in the community: A cross-sectional study. Palliative & Supportive Care, 1-8.

[11] Jegan, R., & Nimi, W. S. (2023). On the development of low power wearable devices for assessment of physiological vital parameters: a systematic review. Journal of Public Health, 1-16.

[12] He, T., Wen, F., Yang, Y., Le, X., Liu, W., & Lee, C. (2023). Emerging Wearable Chemical Sensors Enabling Advanced Integrated Systems toward Personalized and Preventive Medicine. Analytical Chemistry, 95(1), 490-514.

[13] Rajeshwari, B. S., Namratha, M., & Saritha, A. N. (2023). Architecture, Current Challenges, and Research Direction in Designing Optimized, IoT-Based Intelligent Healthcare Systems. In Image Processing and Intelligent Computing Systems (pp. 223-233). CRC Press.

[14] Singampalli, D. T., & Pise, A. A. (2023). AI-Based Internet of Things (AIoT): Applications of AI With IoT. In Handbook of Research on AI and Knowledge Engineering for Real-Time Business Intelligence (pp. 105-130). IGI Global.

[15] Alseddiqi, M., Anwar, A. M., AlMannaei, B., & Najam, O. (2023). Implementing Health Information System in King Hamad University Hospital Benefits and Challenges. European Journal of Medical and Health Sciences, 5(1), 53-57..

[16] Singh, P., Mittal, S., & Sadhu, A. (2023). Recent Advancements and Future Trends in Indirect Bridge Health Monitoring. Practice Periodical on Structural Design and Construction, 28(1), 03122008.

[17] Habib, S., Dheyaa, A., & Rozinah, I. N. (2013). Devices of Computer Network Security and Visualization Control System: Design and Implementation.

[18] Lal, A., Ashworth, H. C., Dada, S., Hoemeke, L., & Tambo, E. (2022). Optimizing pandemic preparedness and response through health information systems: lessons learned from Ebola to COVID-19. Disaster medicine and public health preparedness, 16(1), 333-340.

[19] Nguyen, T. N. (2023). Developing health information systems in developing countries: Lessons learnt from a longitudinal action research study in Vietnam. The Electronic Journal of Information Systems in Developing Countries, e12268. M.

[20] Wadhwa, M. (2019). ICT Interventions for improved health service quality and delivery in India: A literature review.

[21] Jensen, J. K., Skår, R., & Tveit, B. (2019). Introducing the National Early Warning Score–A qualitative study of hospital nurses' perceptions and reactions. Nursing open, 6(3), 1067-1075.

[22] Areia, C., King, E., Ede, J., Young, L., Tarassenko, L., Watkinson, P., & Vollam, S. (2022). Experiences of current vital signs monitoring practices and views of wearable monitoring: a qualitative study in patients and nurses. Journal of Advanced Nursing, 78(3), 810-822.

[23] Basile, L. J., Carbonara, N., Pellegrino, R., & Panniello, U. (2023). Business intelligence in the healthcare industry: the utilization of a data-driven approach to support clinical decision making. Technovation, 120, 102482.

[24] Davico, C., Marcotulli, D., Succi, E., Canavese, C., Bodea, A. F., Pellegrino, M., ... & Vitiello, B. (2023). Working with Children with Autism Undergoing Health-Care Assessments in a Day Hospital Setting: A Perspective from the Health-Care Professionals. Children, 10(3), 476.