Development of Wireless Monitoring System for Inspection of Patient Health in Healthcare Industry

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Abstract—The healthcare sector encounters several challenges in delivering the best patient care, such as a shortage of healthcare helpers, growing volumes of patients and escalating healthcare costs. Wireless helpers can easily ease some of these burdens by improving communication and coordination between healthcare workers. This is particularly important in hectic medical settings where each minute matters in the management and treatment of patients.

The major purpose of implementing wireless assistants in the healthcare environment is to enhance communication between healthcare workers. Proper communication is critical to delivering quality patient care. Due to the growing number of patients and the time constraints of having to meet deadlines, healthcare workers tend to struggle with communicating important patient information. Wireless assistants that have real-time monitoring systems for patients are capable of filling this gap by ensuring important information is communicated in a timely manner. Apart from facilitating communication and coordination, wireless assistants also help make healthcare cost-efficient through the minimization of unwarranted admissions and readmissions. By providing comprehensive care instructions and follow-up support, these assistants can help patients understand their condition and treatment plan, thereby lowering the possibility of problems as well as follow-up appointments. In along with helping patients, this all-encompassing method also aligns with healthcare trends aimed at improving outcomes while reducing costs.

Index Terms—Wireless technology, sensors, monitoring, communication, Real time monitoring.

I. INTRODUCTION

As the world advances with new technologies the prime objective of the work is to monitoring on patient health and medicines from one block to another in the hospitals and monitoring on patient health. Development of Wireless Assistant System, the name itself says that it will reduce the human interference to carry a load from one place to another and monitor the health of the patient. So, it will increase the comfort of both employees and employers in hospitals.[1]

In recent years, the healthcare industry has been increasingly adopting technological advancements to enhance patient care and operational efficiency. Among the critical challenges encountered by the medical field providers remains effectively monitoring patients, especially those in remote or critical conditions. To address this issue, creative solutions are becoming more and more necessary, and one such promising approach is the development of wireless assistants. This paper explores the concept of wireless assistants and their potential in resolving the challenges of healthcare monitoring.

According to reference 5, Health is characterized as a full state of physical, mental, and social well-being and not merely a lack of illness. One essential component of people's desire for a better life is their health. Unfortunately, a number of variables, including inadequate health services along with large gaps, have made the global health issue problematic between rural and urban areas, physicians, and medical staff unavailability during the hardest time.

The advances in wireless communication technology, the convenience of deployment, the ubiquity of information, and the low installation applications for healthcare monitoring have become more expensive.

substantial benefits for medical monitoring technology. By combining two contemporary technological domains—wireless communications as well as embedded systems—a novel architecture for wireless sensor networks (WSNs) has emerged in the

last ten years, and it has been effectively applied in real-time applications. [6]

In this paper, Development of wireless assistant system for monitoring in healthcare industry is intended to support patients as well as nurses in healthcare settings. Implementing both the hardware and software design was part of this project. For the hardware architecture that regulates input and output instructions, the ESP32 is used as the microcontroller. An ultrasonic sensor is employed as an obstacle detector to prevent collisions with objects while moving. This project uses a motor driver as its movement component. The various type of sensors are used for control the system and with help of software and programming implementation this system is developed.

The primary goal of our work is to give the user a technological tool—a system that can be readily scaled. It is easy to handle, contains detailed information about the patient, including his data, his medical history, do transportation, and contain other information. When a patient admitted to the hospital, they connected to system making use of the phone's installed mobile program.

II. LITERATURE SURVEY

In the study by Afiq Naufal Rabbani et'al, presented the development of a motorized hospital bed aimed at improving patient mobility. This system utilizes an Arduino Uno to facilitate the movement of the bed, offering a practical solution for enhancing the mobility of hospitalized patients. However, the system, as designed, lacks a feature for monitoring patient health or condition. The authors suggest that while the motorized bed significantly addresses mobility issues, there is a need for further advancement to integrate patient monitoring capabilities alongside the mobility functions. This could enhance the bed's overall utility in healthcare settings, providing both movement and real-time patient tracking.

In the work by Aswin P. N. et'al, the authors design a load-carrying device managed by an Arduino microcontroller to operate according to predetermined instructions. Although the system presents a practical solution for automating the trolley movement, the system has some limitations. In particular, the trolley is said to be heavy and to have advanced automation missing. The authors recognize these limitations and propose that the addition of further features, like obstacle avoidance and weight sensing, would greatly increase the usability of the trolley. Such updates would increase the efficiency and ease of use of the system and offer a more flexible solution to load transport tasks. In the work by N.

M. Saad, et'al the authors present a system that is aimed at automating the transportation of surgical and medical equipment. Though the system is effective in its primary role, it has limitations in its weight capacity, which could limit its use in situations where greater load-carrying capacity is necessary. The authors point to further development for increasing the trolley's efficiency and patient safety. These enhancements might include increasing the system's weight handling ability as well as adding more functionalities to achieve improved performance in various medical environments. In Md. Milon Islam, et'al's research, the authors propose an IoT-based system that is meant for monitoring general health parameters.

Although the system offers useful real-time health information, it has the limitation of monitoring only the most important health parameters. The authors recognize that the system has to be enhanced further to accommodate more functionalities. In particular, the inclusion of automatic movement aspects can be examined to enhance the versatility and usage of the system in healthcare contexts, making the system more integrated and effective in assisting patient care. In Dr. P. Joel Josephson's study, the author describes a clever trolley system designed by using Arduino and Bluetooth technology that is intended for the delivery of vital commodities like medicine, food, and other materials in health care environments. Although the system efficiently facilitates such delivery operations, it does not have any provision for full automation and monitoring.

The author points out that the integration of automation features, like self-navigating and real-time monitoring, could make the system more efficient and functional, appropriate for various medical applications and patient care and operating effectiveness. IIn Vaneeta Bhardwaj's study, it'll be the authors who come up with a system intended for patient monitoring using IoT technology. The system would monitor key health metrics of COVID-19 patients in real time and offer precious insights to medical professionals.

However, the authors acknowledge that the system may face challenges related to data security, including risks of data breaches and data spoofing. Additionally, the need for multiple sets of sensors for each patient can make the system resource-intensive, potentially limiting its scalability and efficiency in large healthcare settings. Enhancements in data security and sensor integration could improve the system's reliability and effectiveness in managing patient care.

III. PROPOSED METHOD

The medical sector is confronted with a variety of challenges, such as the requirement for better patient monitoring, customized care, and enhanced resource allocation. Traditional medical practices often rely on reactive measures as well as periodic checks, which can hamper the potential to identify and treat health complications in a timely fashion. It is here that wireless assistant systems come into the picture as an effective solution, offering a proactive and holistic means of managing healthcare.

The principal issue targeted by wireless assistant systems is the distance between health monitoring and medical service provision. Wireless technologies empower the systems to obtain and share continually updated key health information, helping healthcare practitioners to make smart choices, enhance their ability to manage care coordinatively, and make patients take an active participation in their well-being. The goal is to be able to effectively create an Assistance system capable of reaching the patient by moving around the ordinary home setting without hitting any potential human/things that are also moving around the area. Therefore, the Assistance system has to be able to perform the project's challenge of indoor navigation and indoor positioning as well. Regarding the Assistance system ability to recognize and communicate with the patient, an appropriate algorithm is going to be used and convenient interfaces will be explored.

This system is designed to transmit data wirelessly to healthcare professionals, enabling timely interventions and improved patient safety by minimizing human error through automated data collection and alerts for critical health.

To discover what kinds of technological tools and services could make work easier, safer, and more effective for the health care workers. To help healthcare workers and volunteers by suggesting technology that can improve communication, coordination, and patient care in challenging situations. To explore how wireless technology can help reduce the stress and strain of the job by making important information more accessible and making communication easier.

IV. FLOWCHART

This flowchart represents the structured approach followed in the research and development of a Wireless Assistant System for Monitoring in the Healthcare Industry. this can be described as follows: The flowchart contains the following points problem identification, market/literature survey, conceptual design, selection of material, development of the system, analysis and testing, result evaluation, design modification (if needed), implementation. On the basis of this point the development of system has started with hardware gadgets and software implementation in addition AI technology and Data science and cloud computing
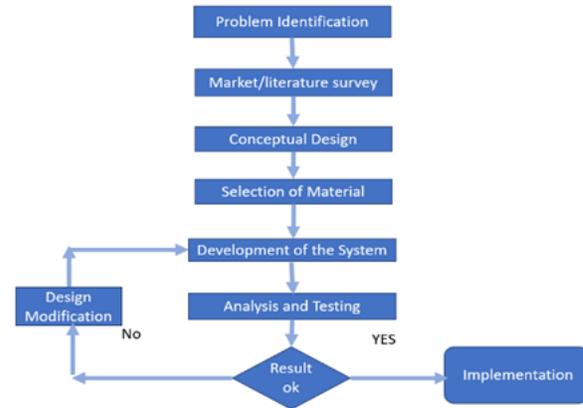

Fig. (1) Flowchart: Development of Wireless Assistant System for Monitoring in Healthcare Industry.

The research begins by identifying the key challenges in healthcare monitoring, such as the need for real-time patient data tracking, reducing manual intervention, and improving healthcare efficiency. comprehensive review of existing healthcare monitoring systems is conducted. This includes analyse similar wireless monitoring solutions, studying technological advancements, and identifying gaps like speed limitation, improvement in monitoring, and other in current systems. Based on the

literature review, the conceptual framework of the wireless assistant system is designed.

This involves defining system architecture, selecting monitoring parameters (e.g., heart rate, oxygen levels), and determining the communication protocols (such as IoT-based or Bluetooth-enabled monitoring). At this stage, the appropriate sensors, microcontrollers, and communication modules are chosen to ensure reliability and efficiency in data transmission. The process circuit design had been started using proteus software. A selected material is used for the circuit design.

Development of the system is the actual implementation of the wireless assistant system takes place, including hardware integration and software development for data collection, processing, and display. The developed system undergoes rigorous testing to ensure accuracy in monitoring, proper functionality, and compliance with healthcare standards. If the results meet expectations, the system proceeds to implementation. If not, modifications are made to improve design, efficiency, and accuracy. Next is the design modification if the analysis identifies errors or inefficiencies, modifications are made to the hardware or software, followed by another round of testing and the final step is implementation once validated, the system is deployed for real-world application in hospitals or remote healthcare facilities.
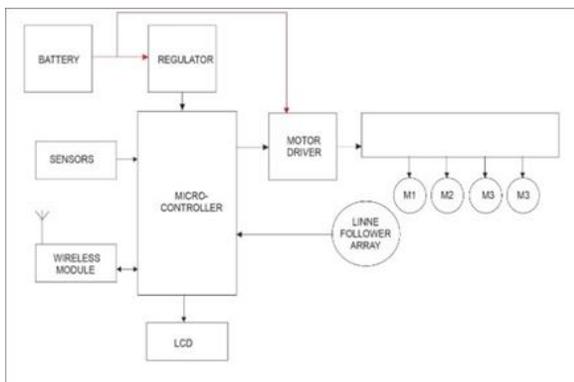
V. BLOCK DIAGRAM

Fig. 2: Block diagram of Development of Wireless Assistant System for Monitoring in Healthcare Industry

The ESP32 microcontroller is loaded with the program, then a Bluetooth module is used to connect it to a smartphone. The ESP32 microcontroller interfaces with electronic devices, including motor drivers, Bluetooth modules, buzzers, DC motors, inductive proximity sensors, as well as ultrasonic sensors. Software that is open-source is used to offer input application and the system operates accordingly. The system comes to the original position after carrying necessities. The trolley is operated for different cases and required changes can be done accordingly
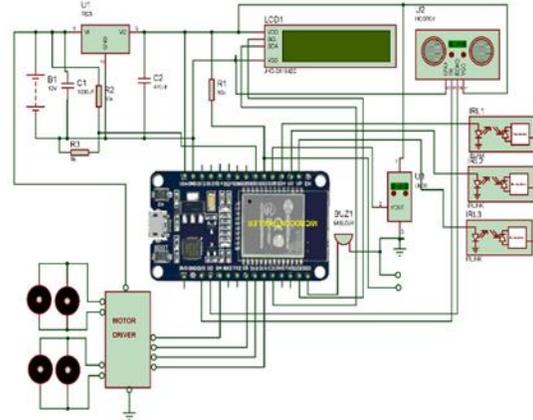

Fig. 3: Schematic Diagram Implementation of Wireless Monitoring System for Inspection of Patient Health in Healthcare Industry

VI. IMPLEMENTATION DETAILS

Hardware components are used in combination to implement the system. During the implementation step, every piece of hardware is put together. Fig. 2 shows the circuit schematic for the created system. Physical pins are employed to connect each sensor to the ESP32. Because it features a built-in WiFi and Bluetooth connectivity module, the ESP32 is employed as a processing device. The Vcc and GND pins of the ESP32 are connected to the Vcc and GND of every sensor. The signal pin of the motor driver is linked to the ESP32's data pin. The hardware components pins are mapped with pin of microcontroller (ESP32).

The system we intend to implement will make advantage of the wireless technology. The system consists of ESP32 microcontroller and sensors,12v battery, motor driver, LCD display wireless module .and various type of sensor which used to monitoring on patient. Ultrasonic sensor is connected with the system used to move the system to locate the medicine and other material in the hospitals. All products have a room have their own ID, with this code can be identify

the patient as well as automatically it goes to the destination where all the products are stored. The aim is to create a assistant system that monitor the patient and transportation of the product smartly using wireless machines. The system is intended to improve hospital service quality, improve the patient wisdom, along with offer tailored assistance depending on the patient's medical background. Recent studies have shown that wireless assistance systems improve patient monitoring, enhance hospital workflows, and increase healthcare accessibility. Nonetheless, obstacles like data privacy issues, interoperability challenges, and battery efficiency in wearable devices persist as areas needing enhancement.

VII. HARDWARE AND SOFTWARE REQUIREMENT

The hardware and software used in program are as follows:
Wireless health monitoring systems depend on a mix of sophisticated sensors, wireless communication technologies, cloud computing, and AI-driven analytics to improve patient care and facilitate real-time health monitoring. These technologies facilitate smooth data gathering, safe transfer, and smart analysis to enhance medical decision-making.

7.1 ESP32 PROCESSOR:
The ESP32 microcontroller is a low-cost System on Chip (SoC) from Esp Systems, which created the well-known ESP8266 SoC. It is a 32-bit Xtensa LX6 microprocessor with built-in WiFi as well as Bluetooth that is available in single-core and dual-core variants. It is the successor to the ESP8266 SoC.

Fig. 4: ESP32 Module

The advantages of ESP32, similar to ESP8266, include integrated radio frequency components including an antenna switch, low-noise receiver amplifier, a power amplifier. Filters and RF Balun. This makes designing hardware around ESP32 very easy as you require very few external components.

7.2 Motor Driver:
As shown in fig. no 4 a motor driver's function is to control a motor's speed, direction, and torque. It's an
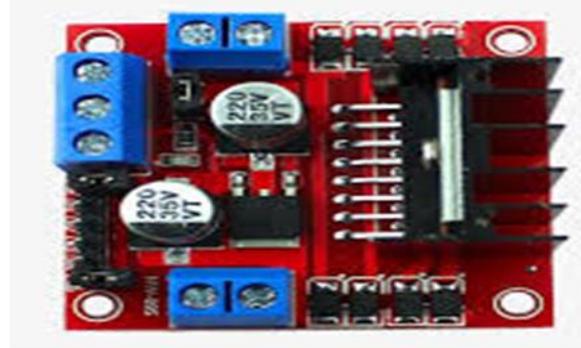

Fig. 5: Motor driver

electronic device that acts as an intermediary between the Motor and the host controller. Choosing the right motor driver depends on factors like motor type, voltage, current requirements, and control precision. As shown in fig 3 The used of motor drivers for this project is for the power amplification, speed control, and direction control, direction control.

7.3 Line follower array
A line follower array is a set of infrareds (IR) sensors used in robotics to detect and follow a path, typically a black or white line on a contrasting surface. These sensors are arranged in a linear or slightly curved formation at the front of a line-following robot.
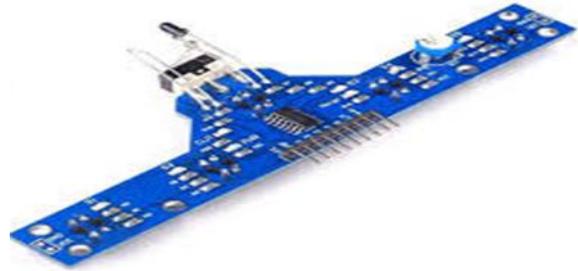

Fig. 6: Line follower Array

7.4 Regulator IC:
Input (Vin) – Receives the unregulated voltage.
Output (Vout) – Provides a stable, regulated voltage.
Ground (GND) – Common reference point for both input and output. As shown in fig. no 5
An IC voltage regulator is an integrated circuit (IC) that provide a stable output voltage despite variations in input voltage, load current, and temperature.

7.5 Wireless Sensors
Wireless sensors gadgets are vital for ongoing health monitoring, enabling real-time observation of vital signs and physiological metrics. These gadgets enable

non-invasive, precise, and automated data gathering, minimizing the necessity for regular hospital appointments.

7.6 Oximeter

An oximeter, more commonly known as a pulse oximeter serves as a medical gadget that determines someone's blood's oxygen saturation level (SpO_2). as well as their heart rate. It is a non-invasive tool that provides quick, real-time measurements, making it widely used in both healthcare settings and at home.
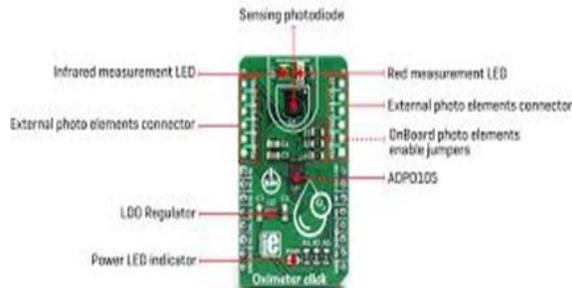
7.8 Temperature Sensor:

A "body temperature sensor in wire" usually refers to thermistor, specifically a type called an NTC (Negative Temperature Coefficient) thermistor, which is a small resistive element embedded within a wire that changes its electrical resistance based on the surrounding temperature

Fig 9: Temperature Sensor

7.9 Ultrasonic sensor:

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. Ultrasonic sensor is used for the indoor and outdoor navigation for the obstacle avoidance. It is used for the detection of objects with the help of sound waves. Ultrasonic sensor is connected to the microcontroller and get the command form the ESP32 microcontroller.

Fig 10: Ultrasonic sensor

7.10 LCD display:

One kind of flat-panel display technology that is frequently found in electrical gadgets is an LCD (Liquid Crystal Display) for presenting visual information.

Fig 11: 16x2 LCD Display

Other hardware components are capacitor, resistor, PCB board, connecting wires, battery, DC motors, are required for the development of the system. all the hardware part which are required to develop the system are connected on the PCB board using soldering technique. Other machines are used to complete the process of joining the system. The complete system is used ESP32 microcontroller, motor driver, line follower array, ultrasonics sensor, and other components for the monitoring are oximeter, temperature sensor, blood pressure sensor are required.

System Design

The core concept within the suggested system is live online patient as well as room condition monitoring. Consequently, the healthcare monitoring system makes use of the three-stage system features, which include (1) Sensor Module (2) Data Processing Module (3) Web User Interface. The sensors are wired which are used to collect data from the patient's body and the environment by gathering physiological signs. The collected data are then processed via an ESP32 module and send to the gateway server. For the web user software tools are used to interface display of collected results. A software tool displays the transactions' current status as well as progress. Connectivity among a web server with a Wi-Fi module is made simple by the Bluetooth protocol. Real-time patient tracking is made possible by the user interface, which is updated every 15 seconds.

In Figure 2, the created system's general system architecture is depicted. All of the sensors are utilized to gather information from the hospital setting, as

shown in Fig. 2. The ESP32 is the processing unit to which all of the sensors are attached. The ESP32 becomes the central component of the network after these (temperature, pulse) sensors are connected. Data from sensors is gathered by ESP32 and wirelessly sent to data servers. Following that, the sensor output is connected to an IoT server. Any device that is compatible with a network can access the data. It is a channel-based system where the data is shown graphically, and a password is required each time to access it.

Software implementation:

For the ESP32 microcontroller to be controlled, software implementation is required. First and foremost, every command must be specified at the start of every code segment. It is declared that the code will activate the ultrasonic sensor. To turn on the ultrasonic sensors, the source code is displayed in the figure. Once the ultrasonic is properly set up, the sensor will identify any obstructions within the 400–500 cm maximum range. To regulate the movement of the wireless system, the ESP32 microcontroller is programmed using source code. To control the motor forward, backward, right, or left, the ESP32 microcontroller is then connected to the motor driver. Additionally, this system is made to halt when the sensors identify obstructions.

To create a wireless assistant system for patient monitoring in healthcare, you would have to implement software containing: data collection from wearable sensors, real-time data processing, secure cloud storage, easy-to-use interfaces for patients and healthcare providers alike, alerting mechanisms for unusual readings, and powerful data analysis capabilities, with strict healthcare regulations for data privacy and security in mind. Wireless assistant systems for patient monitoring are becoming ever more important in the healthcare sector.

These systems use embedded C and C++ languages to enable efficient software implementation and control of microcontrollers and sensors. Embedded C, which is a variant of C, is tailored for environments that are resource limited, such as those used in medical devices, and it supports exact control over hardware peripherals, real-time processing of sensor information, and low-level system interaction.

Proteus software is an important aid in this process of development. It provides a virtual prototyping environment where software and hardware can be simulated and tested before actual implementation. This allows for rapid prototyping, debugging, and optimization of the system's design. By utilizing embedded C and C++ in conjunction with Proteus, developers can create robust and efficient wireless assistant systems that enable continuous and remote tracking of a patient's vitals, compliance with medication, and general health. In addition to enhancing treatment for patients as well as lessening the workload for medical staff, this also gives individuals the confidence to actively manage their personal health.

VIII. CONCLUSION

After thorough literature review of the existing assistant systems used in the healthcare sector, the limitations of these systems are identified. The gaps identified which are speed limitations, load carrying, error in data handling etc.

Therefore, it became clear that there is a significant need for an advanced and tailored solution like a Wireless Assistant System (WAS) to improve the efficiency of the wireless Assistant System and make it effective. The monitoring proposed capabilities WAS within is healthcare designed settings.

The projected benefits of implementing the WAS are to enhanced patient care, improved efficiency in healthcare operations, and better decision-making for healthcare providers. The system's ability to provide immediate access to vital patient information and rapid response to alarms will significantly contribute to improving healthcare outcomes. Additionally, the integration of the WAS into existing healthcare information systems will streamline data management and support system ongoing concept performance exploration, improvement system efforts.

the development of a WAS is a critical step in addressing the gaps in existing wireless monitoring systems in the healthcare industry. The WAS will provide tailored, efficient, and effective monitoring solutions that significantly enhance healthcare delivery. Its integration into healthcare settings will improve patient outcomes, operational efficiency, and decision-making, ultimately contributing to a more system, sustainable I and am patient-centred excited healthcare about system.

REFERENCES

[1] Aswin P N, S Akil kumar, Shanavas S, Sooraj A, Mubeer M P "Arduino assisted automatic trolley" published in International Research Journal of Engineering and Technology (IRJET) Volume: 08 Issue: 07 | July 2021.

[2] Dr. P. Joel Josephson "Trolley Based Smart System for Medical Applications" published in ISSN Volume XIV, Issue 1, 2022.

[3] N. M. Saad, A. R. Abdullah, N. S. M. Noor, N. A. Hamid, M. A. Muhammad Syahmi, N. M. Ali "Automated medical surgical trolley" published in International Journal of Electrical and Computer Engineering (IJECE) Vol. 9, No. 3, June 2019.

[4] Ariq Naufal Rabbani, Budi Hadisujoto and Radon Dhelika "Motorized hospital bed for mobility of patients: a review on wheel type design" published in Journal of Engineering and Applied Science, 2024.

[5] Md. Milon Islam Ashikur Rahaman· Md. Rashedul Islam "Development of Smart Healthcare Monitoring System in IoT Environment" Published online: 26 May 2020 Springer Nature Singapore Pte Ltd 2020.

[6] Hazilah Mad Kaid, Mohd Azri Mohd Izhar, Rudzidatul Akmam Dziyauddin, Nur Ezzati Shaiful, And Robiah Ahmad, "A Comprehensive Review on Wireless Healthcare Monitoring: System Components" publication 16 February 2024 in IEEE, VOLUME 12, 2024.

[7] Akila m, ashika s, rubini s "wireless patient health monitoring using iot" Published in international journal of engineering and manufacturing science. Issn 2249-3115 vol.8, no.3, (2018).

[8] Manisha Shelar, Jaykaran Singh, Mukesh Tiwari "Wireless Patient Health Monitoring System" published in International Journal of Computer Applications Volume 62– No.6, January 2013.

[9] [9] Aminian, M., & Naji, H. R. (2013). A hospital healthcare monitoring system using wireless sensor networks. J. Health Med. Inform, 4(02), 121.

[10] T. Liang and Y. J. Yuan, "Wearable Medical Monitoring Systems Based on Wireless Networks: A Review," in IEEE Sensors Journal, vol. 16, no. 23, pp.

[11] N. Dey, A. S. Ashour, F. Shi, S. J. Fong and R. S. Sherratt, "Developing residential wireless sensor networks for ECG healthcare monitoring," in IEEE Transactions on Consumer Electronics, vol. 63, no. 4, pp. 442-449, November 2017, doi: 10.1109/TCE.2017.015063.