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IoT Based Advanced Universal Patient Health (UPH) Observation System Using Raspberry Pi 3B

J.M. Dharani, C. Divya, R. Fareen Firdous Fathima, A. Rajoonathul Mizriya

***Abstract*— The modern society is facing a major change in the aging society. Health monitoring is an essential application of mobile sensor systems, especially for women, children and aged people. Recent advances in sensor techniques, wireless communication, power supply technologies and wearable sensor systems have enabled the creation of a new generation of constant health monitoring. The exponentially growing health care cost and increasing patient have promoted a serious need to revolutionize health care systems. The need to bring health care cost into a sustainable range is urgent issue that needs to be addressed. One possible way to address the challenges facing the health care industry is by caring for patient in their environments such as their residences. A universal patient health monitoring (UPHM) system infrastructure is developed to provide remote monitoring of patients. UPHM is placed on integrated cloud computing and internet of things technology. Continuous monitoring is performed when an intensive monitoring is needed for patients. In this case, sensors continuously collect vital data and send it to the personal server. The on-demand monitoring occurs when a request from any authorized person within the system such as patients, doctors or nurses is generated.The database on patient's health is maintained and the data can be retrieved whenever needed. An alert system is provided in case of emergency.**

***Index Terms*— BASN, Cloud technology, IoT, UPHM**

I. INTRODUCTION

Patient care is the focus of many clinical disciplines-medicine, nursing, pharmacy, nutrition, therapies such as respiratory, physical, and occupational, and others. Although the work of the various disciplines sometimes overlaps, each has its own primary focus, emphasis, and methods of care delivery. Each discipline's work is complex in itself, and collaboration among disciplines adds another level of complexity. In all disciplines, the quality of clinical decisions depends in part on the quality of information available to the decision-maker.The process of care begins with collecting data and assessing the patient's current status in comparison to criteria or expectations of normality. Through cognitive processes specific to the discipline, diagnostic labels are applied, therapeutic goals are identified with timelines for evaluation, and therapeutic interventions are selected and implemented. At specified intervals, the patient is reassessed, the effectiveness of care is evaluated, and therapeutic goals and interventions are continued or adjusted as needed. If the reassessment shows that the patient no longer needs care, services are terminated.

J.M. Dharani, C. Divya, R. Fareen Firdous Fathima, A. Rajoonathul Mizriya, UG Student, Department of ECE, SNS College of Technology, Coimbatore, India.

The paper is organized as follows. Literature survey, existing system, proposed system and implementation is explained in the following sections.

II. LITERATURE SURVEY

IOT is an emerging technology, which permits devices and people correlated in an organized manner. In the era of IOT, the body sensor network technology is a part of it and has been rapidly increasing in the field of medical scope. Some of the applications of IOT are real time monitoring, patient information management and healthcare management. The patients are adhered with tiny sensors so that the patient information can be remotely monitored by the doctor. The patient health monitoring system creates a remote interaction between the patient and doctor. The tiny sensors like temperature, Heartbeat, Blood pressure are arranged in a manner to the patients to form an efficient Body sensor network. In this developed patient health care management system, frequent visit of doctor by the patient's is completely eliminated. The patient's health care management system has many challenging goals in the area of security. Many enhancements are ongoing for the implementations of the patient's health care management system.[9].A large data fusion method based on wireless sensor networks is designed. Based on the analysis of the structure and learning algorithm of RBF neural networks, a heterogeneous RBF neural network information fusion algorithm in wireless sensor networks is presented. The effectiveness of information fusion processing methods is tested by RBF information fusion algorithm. This algorithm is applied to heterogeneous information fusion of cluster heads or sink nodes in wireless sensor networks. The information fusion is defined as the computer processing system which makes full useof multi-sensor information resources of different time and space.

Under certain criteria, computer technology is used to automatically analyze the observations of a number of sensors obtained by time series. This information process is carried out after optimization and synthesis to complete the required decision-making and estimation tasks. Sensors are the basis of information fusion. Multi-source information is the processing object of information fusion. Coordination, optimization and integrated processing are the core of information fusion.Heterogeneous information processing needs to be carried out in a timely manner in order to utilize the information to obtain the exact state of the observation target or the complete real-time evaluation results.[7].

Multi-functional wearable devices and the widespread use of smartphones, MHN becomes a promising paradigm of ubiquitous healthcare to continuously monitor our health conditions, remotely diagnose phenomena, and share health information in real time. However, MHNs raise critical

security and privacy issues, since highly sensitive health information is collected, and users have diverse security and privacy requirements about such information In addition, the costs of security protections vary with users' diverse demands, and may impact users' experiences of MHN applications. For example, complicated encryption techniques may offer users more security guarantees but with higher computational overheads and latency than lightweight ones. To satisfy users' diverse security requirements and balance the trade-off between the performance and security protections, quality of protection (QoP) has become a newly emerging security concept that allows applications to seamlessly integrate adjustable security protection.[2].

Currently, HealthIIoT is still in its preliminary stages with regards to design, development, and deployment. However, IoT-based solutions are presently displaying a remarkable impact, and carving out a growing market in today's healthcare industry and tomorrow's emerging IIoT-based healthcare monitoring solutions. It promises patient well-being and safety by coordinating critical patient information and synchronizing related resources (e.g., healthcare staff , facilities, wearable smart devices to capture real-time patient data such as vital signs, and patient-related electronic information) instantly through interconnected devices and sensors. Research reveals that IoT in the healthcare industry can facilitate better care with reduced costs, reduced direct patient-healthcare staff interaction, and ubiquitous access to quality care. Accordingly, healthcare data security and patients' privacy are important issues that will have a great impact on the future success of HealthIIoT. One of the major issues in the IIoT based healthcare system is the protection of privacy.

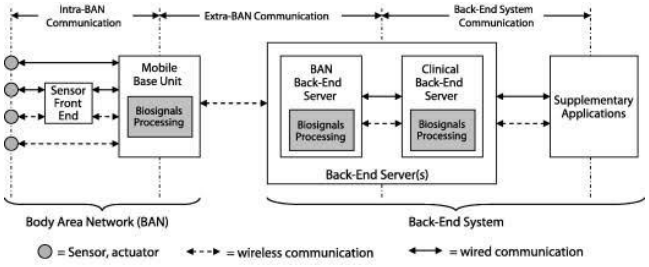
The provider may also distribute the data to health insurance companies and pharmaceutical companies. Moreover, patient data can be vulnerable to hackers during cloud transfer or synchronization with interconnected devices. Therefore, we need to protect this information from unauthorized access, which may result in the posting of personal information in the public domain, or in interference with essential medical equipment, such as a pacemaker. A security breach of a patient's monitoring devices and data may cause the patient social embarrassment, mental disorders, or adverse physical eff ects such as a fatal heart attack. Hence, data protection in the form of watermarking and authentication is very important in an IIoT-based healthcare system. To this end, this paper describes an IIoT-based health monitoring framework, where health monitoring signals are authenticated.[5].

III. EXISTING SYSTEM

UPHM is based on integrated cloud computing and Internet of Things technologies, which provide Healthcare systems with inexpensive but flexible and scalable universaltechnologies that enable long-term remote patient health status monitoring.

A. BASN- BASED MOBILE HEALTH CARE SYSTEM

The BASN m-Health systems based on the Internet of Things concept is shown in fig.3.1, where the medical treatment emphasizes the object management. This concept urges the mobile medical technology to adapt. "Things" in the m-Health systems include doctors, patients, medical devices, and sensors. The focus of this research work is on the development of a cloud-based m-Health system, consisting of a healthcare middleware in the BASN domain and a distributed data processing system. The system contains three tiers as follows 1. Wearable Body Area Sensor Network (WBASN) 2. Automated Intelligent Central Node (AICN) or Sink 3. Cloud-based Central Server (CICS).



B. REMOTE HEALTH STATUS MONITORING FRAME WORK

These sensors can be implantable, worn or attached, to everyday objects such as clothes unobtrusively to gather specific physiological parameters such as a patient's blood sugar levels, blood glucose, capnography (i.e., CO_2 level and breathing), and pulse oximetry and ECG continuously or on demand. Continuous monitoring is performed when intensive monitoring is needed for patientsIt performs basic data analysis and aggregation, generating alarm signals, making the data available to the entities subscribed to be notified (e.g., patient), or pushing the data (along with the location of the patient) out to the cloud for further analysis and sharing by healthcare professionals. In order to manage bandwidth and energy consumption, a fuzzy-based data fusion technique that distinguishes and aggregates only the true values of the sensed data is used. This method decreases the processing and transmission of the sensed data as well as removes redundant data, thus minimizing energy depletion while prolonging the network lifetime. In addition to transferring data from the sensors to the cloud, the personal server can possibly receive a request for specific data from cloud applications or an end user.

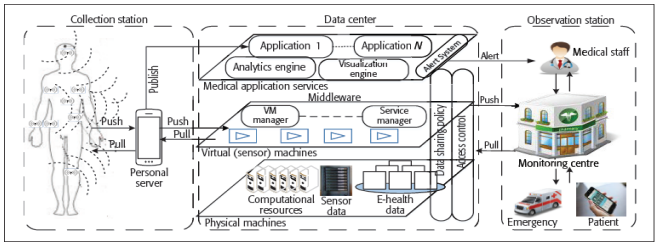


Figure shows the IOT and cloud based architecture. The observation station is where data-driven clinical observation and intervention take place. At this tier, entities such as healthcare professionals (e.g., doctors), emergency response services, medical research centres, and patients have the cloud also hosts the middleware system, virtual sensors, and application services that allow medical staff to analyze and visualize patients' data as well as to identify and raise alerts when events requiring urgent intervention are observed . The monitoring center involves the participation of many healthcare actors, including doctors, patients, and nursing staff, in clinical observation, patient diagnosis, and intervention processes. Thus, all access requests for patient

data are managed by the monitoring center. Any authorized user wanting to access the sensor data can do so by issuing a data request to the cloud through the monitoring center. If the requested data is available in the sensor data storage, the data will be returned to the user.

IV. PROPOSED SYSTEM

UPHM framework is proposed for continuous monitoring of patients health. The sensors collect the data and send it to the personal server. Data is stored in the data center and retrieved whenever needed.The patient health is monitored continuously and the database is maintained. The objective is to integrate IOT and cloud technologies and to provide a data monitored continuously to both data center and observation server simultaneously and to provide an alert system and data retrieval capability whenever needed.In this system, PIC microcontroller is used to control the operation of the system. Temperature sensor, pressure sensor, bio-potential electrode sensor are used to measure the health status.LCD display is used to display the measurements of sensors.Proteus software is used to analyse and display the readings taken.Java Script is used to create a webpage for storing and displaying the database using IoT. UPHM framework is proposed for patient monitoring which integrates IoT and cloud technology.

A. Proteus

Proteus PIC Bundle is the complete solution for developing, testing and virtually prototyping the embedded system designs.The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

B. MPLAB Setup

MPLAB is Microchips Integrated Development Environment. It can be download directly from Microchips MLAPB Site. If you are usingCCS' C-Compiler, make sure to run their MPLAB integration tool, otherwise the PIC Compiler will not work. The MPLAB integration tool for MPLAB version 6.xx will work for MPLAB v. 7.00. After the installation you will find the highlighted tool suite (under Project select Set Language Tool Locations). Make sure not to use CCS C Compiler or will get 'BUILD FAILED' after compiling and downloading the HEX file will not work.)

C. Aurdino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

D.Python

Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language. It was created by Guido van Rossum during 1985- 1990. Like Perl, Python source code is also available under the GNU General Public License(GPL).Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntacticalconstructions than other languages.

E. JavaScript

JavaScript is a dynamic computer programming language. It is lightweight and most commonly used as a part of web pages, whose implementations allow client-side script to interact with the user and make dynamic pages. It is an interpreted programming language with object-oriented capabilities. JavaScript was first known as LiveScript, but Netscape changed its name to JavaScript, possibly because of the excitement being generated by Java. JavaScript made its first appearance in Netscape 2.0 in 1995 with the name LiveScript. The general-purpose core of the language has been embedded in Netscape, Internet Explorer, and other web browsers.

F. .Node-Red

Node-Red is a flow-based developmental tool for wiring together hardware devices, APIs and online services as part of IoT. JavaScript cam be created within the editor using rich text editor. Basic node types are inject, debug, template.

G. Raspberry Pi

Layers of Abstraction-In a sense all a computer can do is store 0s and 1s, move them around, and add. Yet the computers of today (software and hardware) are incredibly complex. This complexity is managed by using layers of abstraction. General Purpose Computing-The components of a Raspberry Pi are similar to those you will find in any modern device (phone, tablet, laptop, desktop...).Tthe concepts that can be translated to all other devices and operating systems. Android, iOs, Windows, Mac OSX, and the various Linux.

H. Temperature sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.

I.ECG Sensor

The electrocardiogram (ECG or EKG) is a diagnostic tool that is routinely used to assess the electrical and muscular functions of the heart. The electrocardiogram (ECG) has grown to be one of the most commonly used medical tests in modern medicine. Nervous stimuli and muscle contractions can be detected by measuring the ionic current flow in the body. This is accomplished using a bio-potential electrode .

J.Vibration detector

The sensor for vibration detection is a vibration detector (or shock sensor), the detector must have a mechanical displacement to generate the alarm signal; vibration detection equipment is not only best suitable for file cabinets, vaults, strong rooms, safes and Automated Teller Machines (ATM), confidential protection special objects, but also suitable for other systems in combination, to prevent intruders break in from wall. There are two major detection methods for vibration detector; the one is mechanical detection, it works as a ON/OFF switch using the mechanical movement of metal contact, the other is acoustic sound detection.

K. LCD Display

There are many display devices used by the hobbyists. LCD displays are one of the most sophisticated display devices used by them. Once you learn how to interface it, it will be the easiest and very reliable output device used by you! More, for micro controller based project, not every time any debugger can be used. So LCD displays can be used to test the outputs. Most of the LCD Displays available in the market are 16X2 (That means, the LCD displays are capable of displaying 2 lines each having 16 Characters a), 20X4 LCD Displays (4 lines, 20 characters). It has 14 pins as shown in fig.4.5. It uses 8lines for parallel data plus 3 control signals, 2 connections to power, onemore for contrast adjustment and two connections for LED back light.

L. Aurdino UNO

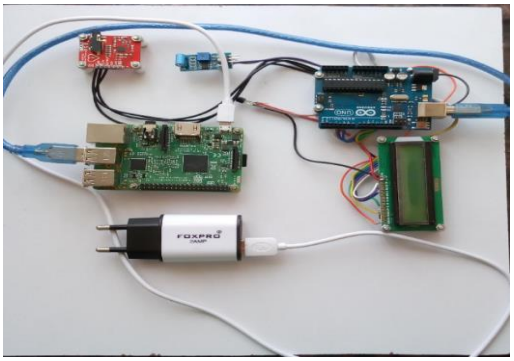
Arduino Uno is a microcontroller board based on the atmega328p.It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 mhz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.You can tinker with your UNO without worring too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

M. Power supply

A power supply is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others**.**The transformer steps up or steps down the input line voltage and isolates the power supply from the power line. The RECTIFIER section converts the alternating current input signal to a pulsating direct current. However, as you proceed in this chapter you will learn that pulsating dc is not desirable. For this reason a FILTER section is used to convert pulsating dc to a purer, more desirable form of dc voltage. The REGULATOR, maintains the output of the power supply at a constant level in spite of large changes in load current or input line voltages.

V. IMPLEMENTATION

Health is one of the prime factors for every individual. In the implementation of the patient health monitoring system, the system consists of a wearable sensors like ECG sensor, Temperature sensor, vibration sensor. The Figure represents the hardware of the developed system.



This patient health monitoring system provides the detection of diseases at an early stage and proper medication is provided. To monitor the patient's body parameters the sensors have adhered to them. Every patient has a setup with the desired patient health monitoring system. All the sensors are interfaced to the Raspberry Pi 3. The temperature sensor LM 35 is used to measure the patient's body temperature and collect the data and transfer it to the Raspberry Pi 3. The patient's temperature parameters are continuously updated with the help of central server Raspberry Pi 3 to the database on the web server and the doctor can monitor the temperature of the patient's body in the web page. The temperature parameters of the body must be within some preferred limit. If the logged value is not in the favorable range, then the doctor will be notified in the form of email.

The vibration sensor is used to detect the motion of the patient where they can be monitored continuously. It is interfaced with Raspberry Pi 3 and the status of patient is monitored continuously and updated to the server.

ECG sensor AD8232 is a little chip to measure the electrical activity of heart and charted as electrocardiogram. Electrocardiography is used to diagnose heart conditions. An ECG sensor with disposable electrodes is used to detect every heartbeat. The electrodes of ECG sensor will convert heartbeat into electrical signals. This sensor is provided with 3 pins and connected by a cable with 30 inches in length. The pins are attached on left arm, right arm, right leg. The corresponding waveform is obtained and from the R-R peaks of QRS complex, heart rate variability is calculated that makes the heartbeat. The measured value is updated in the server. HRV is one of the indicators of the state of patient health and fitness, recovery and readiness. Higher the HRV rate is indicator of better health.

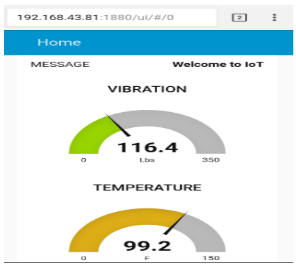
The aurdino UNO R3 is used mainly for two purposes:

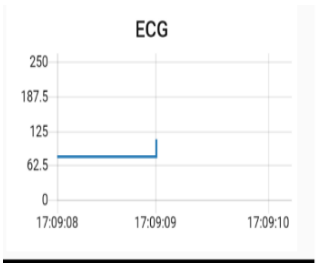
1.Conversion of analog signal measured from the sensor into digital data to update the data into server using Raspberry Pi.

2.Amplification of 3.3v to 5v which is required for display for the measured value.

VI. RESULT AND DISCUSSION

The patient health is monitored continuously using sensors. The data is sensed and stored in cloud for future retrieval. The data is monitored continuously and immediate alert is sent to the doctor in case of emergency. The patient is monitored continuously and the display of measured data is as shown in the figure 6.2. The measured data are uploaded in the server and it can be retrieved. The web page displaying the updated data measured is shown in the figure. Thus in case of any emergency, email will be sent to the respective doctors, relatives and voice message is also provided during the monitoring of patients.





VII. CONCLUSION

The system that integrates the capabilities of the IoT and cloud technologies for remote monitoring of patient's health status is proposed for monitoring patient health.The healthcare spending challenges by substantially reducing inefficiency and waste as well as enabling patients to stay in their own homes and get the same or better care is achieved.The patient can be monitored continuously .The data can be sent continuously for both the observation center and cloud storage . The database of patient is stored in the cloud automatically. The data can be retrieved whenever needed and provides an alerting system in case of emergency.

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