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Design and Implementation of a Patient Monitor via the Internet

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Annotation: The summary of this work is the research that was conducted to assist the doctor and nurse in order to help them follow up on the patient’s condition and vital activities, where the doctor or nurse can monitor and follow up on the patient without the need to go to the patient. Patient health monitoring system using ESP8266 and Arduino: With the existence of emerging industries arising from modern industries in the field of food industries. Implementation of previous actions platform more than other things in this project. ThingSpeak is an open source Internet of Things (IoT) implementation and API that sends data from the Internet over the Internet or over a local area network. The following computer can read the pulse rate and measure the ambient temperature thermometer. Continuously monitors pulse rate and ambient temperature. It runs the Arduino Sketch software that performs the various tasks of the project such as reading the sensor data and converting it to the IoT platform and the pulse width and temperature measured on the character LCD. Health monitoring is the main problem in today's world. Due to the lack of proper health monitoring, the patient has serious health problems. There are a lot of IoT devices to monitor patient health online. Health experts are also making use of these smart devices to monitor their patients. With so many new startups in the field of healthcare technology, the Internet of Things is rapidly revolutionizing the healthcare industry. Here in this project, we will create an IoT based health monitoring system that records patient's heart rate, body temperature and also sends an email/SMS alert when these readings exceed critical values. Pulse rate and body temperature readings are recorded in Thing Speak and Google Sheets so that the patient's health can be monitored from anywhere in the world via the Internet. A panic note will also be attached so that the patient can press it in emergency situations to send email/SMS to their relatives.

1. Introduction

The importance of hospital users to monitor health care of elderly patients and the necessary devices for patient monitoring are discussed as the contents of the proposed open patient monitoring network. Considering the necessity of patient support by opening the monitored data distributed in the network, the architecture of the open autonomous distributed patient monitoring network is described. A newly developed open autonomous distributed ECG monitoring network is presented as a model of the proposed network.

Alteration of the society structure by the progress of super-aging has become a serious problem in the welfare of developed countries. Recent advance of telecommunication technology makes it possible for elderly persons to enjoy their living in the original places, at their homes or hospitals, free from the restricted institutes. On the other hand, the homes of the elderly persons and small city hospitals have not enough facilities and medical staffs to support the treatment of the patients completely. Coming and going to hospital periodically is left to them under the free circumstances of living. For the health care of the elderly persons, especially in hospitals, it is important for the hospital users to monitor the patient’s health. To monitor the health care of the housed patients from nurse rooms, local area networks, such as ECG monitoring networks connected to a computer, are often used. However, the LANs used in limited areas and there are some places where the ECG monitors cannot be setup. There were not enough systems for patient monitoring and it is difficult for the patients to move due to the restriction of LANs. On the other hand, the internet becomes popular and it is possible to such place. [1][2][3]

1.1. Background and Motivation

This thesis introduces a patient monitor, a server, and an application which can work through the internet. The monitor measures blood pressure (BP), heart rate (HR), temperature, and body position, and then sends data to the server using the internet transmission for storage and processing. The server will then forward the measurements to the application that can be operated by a healthcare provider. The application will show the received measurements and if necessary an alarm will be sent to the healthcare provider. Since different types of measurements are obtained, different types of alarm notifications are generated. Additionally, the system has an infrastructure for communication among the patient, the hospital, and the ambulance. Modes of measurement are planned as real-time measurement and monitoring, as well as alarm measurement in the patient monitor [4]. In long-term monitoring, the readings need to be compressed due to limited memory in the mobile-care unit. The development of an efficient algorithm for ECG compression is a challenging problem. The reliability of the ECG is an important issue. False alarms should be minimized, while detection delay is also critical.

A new approach to QRS finding using a time convolution technique for ECG segmentation, feature extraction and monitoring is presented, benefiting from both time and frequency domain observations. Consideration is given to the choice of basis functions – to provide clinically informative indices while also ensuring tractable processing requirements. The basis space is defined as a ‘dictionary' consisting of scaled and dilated Daubechies wavelets. These functions are convolved with the ECG, returning a time-convoluted signal. On statistical analysis of the time-convolved signal, a parameter set is extracted for analysis in case of eclampsia. These indices acted as a basis for comparison with those obtained using the currently accepted approach and it was determined that important clinical information was undetected. Therefore, in comparison to the state-of-the-art time domain implementation, the time convolution technique was able to provide more comprehensive information. [5][6][7]

1.2. Objectives and Scope

In this senior design project, the design and implementation of a remote monitoring system will be explored. One of the purposes for this system will be to allow health care professionals to monitor a patient's physical condition in real time. A market analysis will be performed to find the best currently available technology to implement patient monitors. Two different methods for the implementation of this device will be explored and considered. In addition to the patient monitor, the project will consider the most advantageous implementation of a modem device. A possible simple and inexpensive method, as well as a more complex method will be discussed.

The scope of the senior design project is to provide information on the implementation of a remote health monitoring system. Current health monitoring devices and technology are analyzed to determine the best design for a remote patient monitor. To this end, a proof-of-concept patient monitor was constructed. It has three sensors that allow measurement and monitoring of the user's Electrocardiogram (EKG), skin temperature, and voltage level of the power supply. The sensors connect to a microcontroller board. This board is then connected to a prototype board which can accumulate and buffer the data from the sensors. It is on this prototype board that an embedded system was interfaced. The embedded system is capable of sending the data wirelessly to a receiving computer. This receiving computer stores the data and can display it through a graphical interface that runs on the Linux operating system [8].

2. Literature Review

Through early trace analysis, it is demonstrated that alarms such as over-sampling and automatic disconnection can enhance sensing reliability substantially, with minimum manual intervention. In the past several years, a number of exciting medical systems have been developed in support of elderly care, disaster recovery, and patient monitoring. A major focus of these projects is to monitor patients either after they leave the hospital or when they are waiting in a space not designed for monitoring. An important part of these systems is a network of wireless sensor nodes that monitor patients. The monitoring of vital signs is a basic function supported by all these systems. Due to unique requirements and constraints in monitoring patients in general units, several different design decisions were made [9]. The overall design of a patient monitoring system for general hospital units is described. The system is a network consisting of multiple types of sensor nodes that monitor a diverse set of vital signs. Data measured by sensor nodes are transmitted to a base station via short-range radio. The information is then made available to hospital information systems through a middleware application. The sensor nodes and base stations are powered by an AC power supply. Data is transmitted to the base station using Bluetooth radios. In terms of networking, there are no routing issues: all of the sensor nodes are in a single hop range of the base station. Some existing systems support peer-to-peer or publish/subscribe communication. In contrast, a simpler network architecture is opted for in which 'mote' nodes forward the data to a single base station [4].

2.1. Overview of Patient Monitoring Systems

The patient monitor system uses the existing medical and computer technologies to monitor various physiological parameters of the patient over the internet. Each sensor is interfaced with a micro-controller and the micro-controller is connected to personal computer via the standard serial data communication ports. The software is developed in the Microsoft Visual C++ 6.0 to display the patient data and control the system operations. Since the monitoring software is developed as the EXE file it can run only with the Windows 9x/2000/XP operating systems. The physiological parameters considered for the monitoring are blood pressure, body temperature, ECG, response of the skin to stress. The implementations of these are shown separately [4].

Patient monitoring is a routine and frequent task in medical diagnosis and treatment for the patients of cardiovascular diseases. Cardiac patients are sometimes not able to reach the hospital in short time, and some are unable to make it to the hospital. There are many cases where patients need immediate medical attention but cannot get it in time just because they are far away from a medical center or the equipment to monitor their vital signs are not available at home. But quick treatment in many situations can save lives and/or increase the probability of the patient recovering. More than 13 million people suffer a heart attack and 7.4 million people die of it worldwide every year. As a remedy, a quite few number of reasonably successful telemedicine patient monitoring systems have been developed which for instance: heartbeat and blood pressure monitoring of elderly patients who are living alone; ECG monitoring through telephone line; fetal heart rate monitoring from the patient’s home and telemedicine systems for the battle fields. However, these systems are generally heavily area restricted, require a telephone line or need potentially a nurse on each house visit. Often the data rate and the amount of data that can be sent per transmission are limited.

2.2. Internet of Things (IoT) in Healthcare

Healthcare, a fundamental need of people, ensuring recovery and resistance to diseases; has been in high demand today with the increase in the world population. To meet these demands, advances are made in medicine as well as in the healthcare industry day by day. Monitoring systems, which are required to exhibit living and vital signs of patients with different health conditions, are included on a hospital and home scale. Many in-hospital and home devices such as ECG monitors, thermometers, etc., are used to monitor the vital signs of the patient. Health facilities are also managed through the patient’s surrounding environment. A healthy environment is required for the maintenance of health facilities. For example, the room should have adequate ventilation, a normal temperature, and gas must be at a normal level. Monitoring the patient environment is required to ensure the quality of the health facilities. Considering many rooms, such as hospital wards having critical patients, monitoring of the environment is difficult. A monitoring system is therefore needed that monitors the health of the patient and its surroundings from a remote monitoring center. Smart Healthcare monitoring systems refer to wireless monitoring systems that can monitor health systems and patients. Additionally, hospital and home devices will be accessible via the internet to the user. The main purpose of this monitoring system is to monitor the health of the patient and its surroundings. Patient vital signs (body temperature, heart rate) and room conditions (temperature, carbon monoxide gas, indoor air quality) need to be monitored. The current condition of the patient environment is then sent to the remote monitoring center via the internet. The patient’s real-time health conditions are then analyzed by the nurse or assistant doctor. If the patient’s health condition below the normal range is monitored, the nurse will make a call to the staff on duty in the ward for a response to the patient. This remote monitoring system is very useful for critical patient ward care [10].

3. System Architecture

Telemedicine is the focus of a number of promising and rapidly emerging research projects and has a tight link to telecommunication and networking areas. Telemedicine projects are under way in a variety of applications in telepathology, teleradiology, remote consultation, telesurgery, telediagnosis, telemonitoring or telemanagement, mainly from a consultation service or a second opinion service. The exchange of patient medical data involves the knowledge and expertise of the actors taking part in this process, patients for transmitting their own everyday measurements, caregivers, and the computer system for acquiring and transforming these data to a useful format. The computing system should include three blocks: the client software and hardware blocks for acquisition, preprocessing, and transmission, the communication blocks (network and security protocols for data exchange), and the server software and hardware blocks comprising databases (for storing the medical data forming the patients' longitudinal records), statistics and human–computer interaction applications (for real-time and offline processing of raw data generating valuable patient information), and third party consulting applications or applications for monitoring the processing flow of the life-stream patient medical data, because of ethical and medical safety reasons [4].

3.1. Hardware Components

It consists of several hardware components like ECG acquisition node, Temperature Sensor, Body Sensor Hammer and Remote Sensor Hammer. The patient is connected to ECG acquisition node which captures the ECG signals. ECG signal acquired from the electrodes and it is amplified using amplifier, which gain of 1000, low input bias current, very low offset and filter with cutoff frequency 150Hz. This block has ECG amplifier AC front end circuit. The wireless sensor module consists of a 16 bit MSP430G2553 micro controller and a zigbee module along with this instrumentation amplifier [11]. The MSP430G2553 contain inbuilt temperature sensor whose output voltage is linearly proportional to the Celsius temperature. The body temperature information is also transferred to local sensor network server by using the in-built sensor and zigbee module. Patient can also wear temperature sensor which measure the skin temperature of the body; this tool will also transfer the information to LSN server where the information is computationally analyzed using temperature changing algorithm.

At the LSN server sensor contains the signal fired in xml format. This signal contains samples of the ECG, temperature, and timestamp of the patient. After receiving signal the ECG samples are checksum verified, timestamp samples are then analyzed know the time interval for which patient is monitored. After that sample is interpolated to get the equally spaced samples. After that temperature samples are decoded to get the actual data. Temperature is monitored for +- 1 minute. Temperature algorithm then analyze the information temperature periodically increases and decreases. This increases and decreases are calculated w.r.t the base temperature which is initial temperature of patient. Any variation of the 0.5 degrees Celsius is considered as fever. All the processed information is stored in the file which again shared to the clinician in coded form [12].

3.2. Software Components

The device's design consists of both hardware and software components. The transducer subsystem is in control of measuring the following parameters: body temperature, heart rate, and monitoring system design of a MD. The above measured parameters are constantly displayed on a LCD and alter with an initial trigger value. The trigger is followed by a beeping action with an additional LED indication so the caregivers are alarmed about specific situations without any need of looking at the display. Furthermore, both the warning beeper and LED keep active until the acknowledgment button is pressed by the caregiver. There is a 3-axis accelerometer use to detect a sudden fall. The necessary action is taken with the help patient that's reflected in stable and smooth reading on the acknowledgment button and once two readings are averaged out, sending the feedback to the patient system by rotating the dc motor back at the beginning indicating the finalization of the particular cycle. The remote patient monitoring system for emergency situations is designed to continuously monitor the patient health measures such as the ECG, pulse rate, temperature, and oxygen levels residing remotely with the patient and alerts the family members through SMS on the occurrence of an emergency. The proposed system abridges the gap between the patient, his/her family and the medical practitioners effectiveness. Patient follow-up can be done successfully even in this enduring pandemic situation and minimize close contact between doctors and patients. For remote monitoring, the proposed system uses Zigbee technology for RF communication between the transmitter and receiver. Zigbee communication modules are attached to the patient's remote monitoring system and the caregiver's personal ID module, respectively, for remote monitoring to fulfill the expectation of physical distancing. The proposed patient monitoring system ensures safety by providing isolation signaling to prevent any further infection of medical staff. [13][14][15]

4. Communication Protocols

The monitoring of patients via the Internet, e-mails, etc., using real-time data, raises many ethical issues including the problem of secure communications. Discussion of the applicability of conventional encryption systems leads to the proposal of a system that imposes very low implementation costs on the sender and moderate costs on the recipient; estimates of the transmission times needed are given to show how these rise only reasonably for encryption strengths needed as technology advances. The substance of the discussions is preceded by a review of the ethical and technical issues surrounding telemedicine in general and electronic patient monitoring in particular [16].

Telemedicine is a rapidly expanding field of healthcare, made practicable by recent technological advancements such as improved Internet bandwidth and the proliferation of sensors and devices. A variety of telemedical practices are either currently in use or likely to be in the near future: one example being the use of video-conferencing for consultation by therapists or specialists with a patient or primary care physician. A less invasive technique is the remote monitoring of physiological variables such as heart rate or blood sugar levels: this would require data to be communicated over long distances. Classification of telemedical practices is proposed, and the widespread deployment of such systems is considered. It is noted that transmitting data over long distances exposes it to eavesdropping, and that this is generally considered an invasion of privacy. This has raised serious ethical concerns over the use of these technologies, particularly in the monitoring of people in their own homes. One solution is the use of a secure transmission system [17].

4.1. TCP/IP Protocol Suite

The TCP/IP network protocol was developed to link government research facilities and has since evolved into the de facto standard for interconnecting global academic, economic, industrial and military systems. At the architecture level TCP/IP consists of five layered protocols, though all but the two lowest and highest layers are generally bundled and taken together as a single layer, hence four-layer architecture. At the lowest level is the link layer with high-speed physical WAN interfaces like ISDN, T1, T3, and mobile phone technology. These WAN interfaces are packet-switched and deregulated to allow mixing of data or voice on the same link, as well as transparency of protocols. Next is the network layer using the User Datagram Protocol for error-checking datagrams to be sent across the network link. Above this is the transport layer, for creating point-to-point communication and the Internet Protocol for connectionless routing beneath the transport layer. Lastly, at the top is the application layer running above the transport layer and encompasses a wide variety of software including sendmail, email, ftp, ping, and telnet.

Drafts of design forms and protocols reviews were available for public comment, input, and scrutiny prior to implementation, which encouraged widespread adoption and interoperability. The interaction design for the remote maintenance system was accomplished using a protocol stack comprising a server and client with appropriate modem/s and physical interface/s utilizing the protocol for data transfer. The protocol in turn used another protocol.

4.2. MQTT Protocol

A number of sensor systems have already been proposed for evaluation of patient health conditions, usually for telemedical purposes. But these systems differ in terms of deployment, standards, and ease-of-use, and do not necessarily satisfy the requirements of the physicians. The main goal of this work is therefore to develop a patient monitor that can be accessed by a physician to provide new ways of patient monitoring and health care service provision.

The system architecture is designed and the board-level implementation of the wearable patient monitoring unit is also presented. For access, it is assumed that there are several patients, each wearing a portable patient monitor and that there are several physicians who could access the patient monitors of the patients to make a diagnosis. On the one hand, this paper aims to provide a design review for a portable health monitoring device that might be useful for application developers, healthcare professionals, and patients. On the other hand, access to the device is discussed. Prior to the synaptic link, first a connection to a relay station needs to be set up which serves as wireless access on the one hand, and the other way through the Internet. The protocol tends to be the one that best handles many-to-many communication configurable in a publication/subscription manner. For testing purposes, the configuration was approached in this way. After a successful connection being available, a doctor could control his/her patient over the Internet. The doctor can make queries about the health of the patient or modify the monitoring tasks. Furthermore, the doctor could be notified in a real-time manner about unexpected incidents involving the patient. Any transaction is safely carried out due to security concerns.

5.5. Data Security and Privacy

Monitoring patient conditions via a network-enabled telemedicine system can be accomplished more conveniently than doing so in hospitals. The patient information collected from a network-enabled patient monitor will be forwarded to the remote server in real time through the hospital’s intranet or the internet. The medical personnel can monitor the patient’s condition by logging on to the server from anywhere. This does have great commercial potential, yet such a remote real-time application must adequately address the issue of security. Because the patient information is sensitive, its transmission must be secure. Even so, a patient’s private information is still being stored and processed away from the patient in hospital or a remote computer server. In an open network environment, duplicate attacks can be performed on the communication, server, computer, and sensors. With the increasing connection of the instruments to interact with people through the data, the need to ensure the data security and privacy has been raised [18]. A network system that has the ability to protect data such as sensor medical data because of its placement is needed to monitor the activity of human body health wirelessly and store it in the monitoring station in real-time. Data that is stored must be guaranteed safety, confidentiality, and integrity. Not only a simple access that must be done, but also first must seek information about the required protocol. There are several researches that can guarantee the security of medical data transmission, including the encryption of safety data during transmission by the use of the AES, DES, and RSA development of the framework, as well as a security system for medical data processes by performing hashing and coding, or guarantee the compatibility of medical data encryption to be sent to other monitoring tools using the scrambling method. Patient health and activities data are forwarded onto the cloud servers, where recognition and examination are carried out. The outcomes of the review are accessible to doctors and health advisors on behalf of the customer or their treatment [19].

5.1. Encryption and Authentication Techniques

The Patient Monitor system is designed to allow physicians to access health parameters of their patients through the Internet. It has been developed an Oximeter measuring four vital signals that communicates through an embedded web server. This server is connected to a gateway through a serial port; the gateway forwards the data to the patient monitor. The data is sent in ancient Serbian cyrillic, which is encoded in Unicode format.

There are a number of security and privacy issues associated with the management of data, and of these, the most important is communications security. A brief history of this particular subject is presented, and an approach to unified communications security, to fortify the information while it is stored, in transit and in use, through the Internet, is suggested. The portable oximeter communicates with the gateway through a USB connection, and the gateway sends the data to the server. As the security of that transmission might be questioned, different techniques are planned to counter the effects of eavesdropping and corruption of the information during its transfer. The encryption and the verification of a transmitted message are done. All the message strings formatted on one side are encrypted with the public key, Base64 encoded and then sent. The encrypted message passes through the gateway to the standalone system. The server side program will Base64 decode the incoming string, decrypt it with the private key and verify the checksum value. Unencrypted data could eavesdrop between two elements in transit. The third party could alter the data that is not verified. In addition to all the above-mentioned measures taken to protect the data before and during the transmission between the oximeter and the internet server, further protection is required. Ideally, the information should be invulnerable in all its states: in use, in motion and at rest. In order to protect the medical staff's data on the internet server itself, the communicating entities will use encryption and certificates [20]. A digital certificate is a small file that contains an individual's name, a copy of its public key, a serial number, a copy of its certificate-holder's public key, an expiration date, a digital signature of the certificate-issuing authority, indicating CA's identity and the certificate's status. This file guarantees that the public key belongs to the particular person or a system. The medical staff data is contained in a .NET serialized string. Prior to this procedure, the byte stream is encrypted. The encryption technique for this purpose is AES.

5.2. HIPAA Compliance

HIPAA Compliance: The Health Insurance Portability and Accountability Act was adopted to address many shortcomings found within healthcare. Industries completely unrelated to healthcare are affected by security breaches or corrective dichotomies. This act seeks to create a secure infrastructure utilizing technology that is transparent to practitioners. Subsequently, any mention within this discussion to “practitioners” should be interpreted as hospital practitioners, laboratorians, billing staff, registration staff, employees in any healthcare facility, practitioners of any medical field, and emergency services. The responsibilities of practitioners are reduced to two categories: Learn and integrate. This research and physical prototype falls under the category of technology that is transparent to practitioners, as it pertains to neither the terminal interface nor the cloud. Vulnerabilities addressed by this research aim to cover technical security aspects within healthcare facilities software, hardware, and data transmission that may be exploited by practitioners, resulting in an enormous amount of damage akin to what may be brought about by malware. This can include minor repercussions, like a practitioner inadvertently configuring a software terminal to be used in a manner that affects a patient’s visit duration, all the way up to extreme repercussions, as would be the case for allowing an RKE to self-destruct. Either of these consequences is likely to result in devastating lawsuits, loss of jobs, and the closing of facilities.

6. User Interface Design

The patient monitor user interface may be accessed by the hospital departments where the chosen signals of a patient will be monitored. Check-in and check-out patient procedures must be automated by contacts to database technology. Additionally, the hospitals must log-off when the user finishes use of the patient monitor. In the end, companies which are producing medical electrophysiological therapeutic devices will be able to remotely access medical data. User Interface Design: The ECG, EMG and T (°C) signals must be displayed separately when the graphical output is performed. The medical data is always displayed on the top of the screen. It selects and displays the chosen signal, chose it in the blue color, when remaining unselected patient's signals are shown in the red color. The sample rate is indicated for every chosen modality in Hz. [21]. Real-time patient monitor must show the live values of ECG, EMG, and T. The red straight line is described by the 99 % significant threshold on the ECG signal. Chosen 1-3 pace intervals (P.I., in red color) are printed with the ellipse. User-friendly software for the PIC24 real-time patient monitor was designed and implemented to be employed as the human ECG, EMG, and T (%) monitor via internet by EMG physicians. The GUI was written in the Delphi programming language using Emotiv development environment [22].

6.1. Dashboard Layout

As can be seen from the image shown in this section before, here is a dashboard layout. This dashboard layout is created by using jasper soft and connected this layout to the restful server each client may access thronging an internet browser. In the dashboard, there are thirteen components used to display information over the patient who will be monitoring. The first component is the display of the patient's photo and the name just below the photo. The name and the photo of the patient here are coming from the data stored in the database, this data is taken through the data source. The second component is to display a label with the value of pressure data, the value of this pressure data is also getting from database and it is come from the data source.

The patient monitor via the internet is the system of monitoring the patient seen by others via the internet. It can help health workers to keep an eye to the patient when they are doing another job. In this Dashboard Layout, some information presented to inform the conditions of the patient. The information about the patient in the dashboard layout include the value of pressure data, value of temperature data, status of lights 1 data, status of lights 2 data, value of blood glucose data, the position of the bed of the patient, the position of the heart rate sensor of the patient, the position of the oxygen sensor of the patient, and also the condition of the patient whether they are sleeping or waking up. defend on the patient activity this information will change. The patient activity retrieved from the database, all information on the dashboard is getting from the Mysql database server, it is stored over the data source. But to display the data to the client-side is set on the restful server, this restful server connects the data source with the jasper soft data, jasper soft data is can display information thronging the internet [23].

6.2. Alerts and Notifications

Dialogue with sensors is essential in order to set monitoring threshold and reporting intervals for each monitored parameter. It is possible to set these parameters by accessing the Monitor section of the user interface. The latest user settings are transferred to biosensors through the Client in the following transient interval between each value report. Since the client application has three independent background processes, each of them sends different user settings one by one. The Client, thus, allows setting up different acquisition schedules and reporting intervals for each biosensor, for a total of 6. The server-client communication protocol implements a messages handling system also on the Client side, making the interaction between the internet and tablet server easy. The server 'asks' for the value of a certain parameter from the Client platform through the internet. Depending on which monitored parameter the server is interested in, the Client platform replies with the corresponding value. Each event is recorded and displayed on a LoggerBox on both systems showing Client or Server label depending on the message origin. Internet messages in both server and client systems allow the platform on which the application runs to read the address and/or the content of the message. The communication between the Server Platform and the internet is achieved by means of a post office. Messages are sent to the server simply by addressing the IP number and waiting for an answer. With this method, the server can easily interrogate thousands of monitors all around the world.

7. Implementation Details

Home medical monitoring systems have allowed care providers to reduce their patient load, and thus reduce queues and waiting times [8]. This is due in part to the fact that fewer people must travel to a central location to have their vitals recorded. In accordance with the previous observation, the focus of this paper is the design and implementation of a proof-of-concept, portable medical monitor that is able to transfer medical data wirelessly. The device is equipped with a colorful and touch-sensitive display with a basic user interface. The display and interface together provide advanced graphical and sound feedback to the user. The device is fully portable, weighing less than two pounds. Along with the display and medical monitoring hardware, the device is also a fully functional touchpad web browser and e-mail client. A 10.4” TFT display was chosen as the device’s display and input method. The display had a preferred resolution of 1024 by 768 pixels, translucent keyboard, and a touchpad that supported an average display resolution. The thought was that this option was a cheap and compact that could easily be integrated with the other components. However, it quickly became apparent that there was a limited selection. In fact, only 4.4” or 10.4” display with a 640 by 480 resolution, were available new for less than $500 at this time. With a prominent standard of 800 by 600, the 640 by 480 displays were already difficult to find. Ultimately, a 10.4” 640 by 480 touchscreen display was found for approximately $525. The resolution on this display, however, did not yield the display quality desired by the device. The current display mode on the device is increased to 800 by 600. As per the manufacturer’s warning, 800 by 600 operating modes may cause serious damage to the touchscreen due to the unknown nature of the modification.

7.1. Sensor Integration

The overall growth of the Internet of Things has resulted in the integration of WSN and IoT, which makes life more comfortable by connecting domestic appliances to the net. IoT is an innovative system that enables smart objects to communicate with each other and access data over the net to make well-informed, perceptible and continuously connected environments. There is a growing interest in merging WSN and IoT technologies together, in order to design smart services [24]. Here, a design and production of a patient monitoring system in which a Raspberry pie is used as a base station for the patient vital detection system is presented.

Implementation of the patient monitor can be divided into 2 parts, i.e., sensor integration to acquire the patient’s body vital signals through the internet, and display in a web-based GUI system. Vital signals include the patient’s body temperature, heart rate, and pulse rate. Several types of sensors are used, such as the Ultrasonic sensor for patient body temperature sensors, heart rate sensors detected by pulse sensors, and a supply patient monitor sensor. The ultra-sonic sensor works to calculate the temperature of the human body at a distance of one place and displays it in ° C on the fixed patient thus facilitating the automatic temperature calculation process. The pulse sensor consists of a light-emitting diode and a photo diode that ensures the pulse and heart rate of any part of a human body for a long time. The patient is fed from a peril stand and for this purpose, an invention is made of sensor software such way in which the Buzer will give an alert signal to notify the end of the bag.

7.2. Cloud Connectivity

the cloud and through a VPN tunnel to the hospital’s LAN. At the end, the ECG signal is displayed on a computer in the hospital [25]. There are two problems with implementing this design: a) ECG data are sensitive and should be sent encrypted over a VPN, but there is a significant complexity in managing a VPN tunnel, designing the right routing, and organizing public key cryptography; b) providing each doctor in developing countries rural and developing areas with VPN-compliant displays is an impractical assumption. The present challenge is to design and simulate a simple and effective Wi-Fi-based communication infrastructure between a rural family doctor’s practice, typically a basic rural facility with low technical expertise, and a small PatMon device worn by the rural patient, who needs to perform a remote ECG test. The doctor’s display is a cheap Android smartphone. The Wi-Fi infrastructure is based on cloud services. The challenge is to design and simulate a small and effective communication infrastructure connecting the patient’s device with the doctor’s display in a secure, confidential, and simple way. Several doctors and patients can be easily added to the service, scaling the infrastructure. Design uses open source devices, ensuring reproducibility of the implementation. Industrial devices would be much less accessible and leave a large gray area in the experiment’s outcomes; thus, the equipment for design has been selected from widely available open source devices. The Sadeghian Hilare and DePellegrin are both integrated in a case containing the Blynk ES8266 board. The top side is the screen of the smartphone on which the received ECG signal is displayed. The entire case is plugged to a common home plug connected to the internet. The equipment on both sides of the modelisation is widely and legally available for purchase.

8. Testing and Validation

A prototype implementation of a patient monitoring system over the Internet is presented. This system allows monitoring of a patient's critical physiological parameters, such as heart rate, blood pressure, and temperature, from anywhere at any time. The proposed patient monitor system consists of a wearable health parameter measurement unit and a remote monitoring unit with an embedded Web server. A health parameter measurement unit can measure many important health parameters of an individual, including ECG, temperature, blood pressure, and weight. The PC97.22 standard also defines the minimum requirements of PC-based patient monitor systems. This proposal mainly implements the monitoring framework, but it will also fully meet PC97.22's requirements [9]. The remote monitoring unit can collect health parameters measured by the health parameter measurement unit and forward them via the Internet to the other notebook computer installed with the Web browser. The monitoring Web page is implemented using HTML with some features such as server-push opportunities. The patient monitoring system utilizes the mobile Internet and is quite compact so that patients can easily carry it while on the move.

Psycostress is the physiological disruption caused to an individual when he performs the mental activities while on post-operative care and during any critical care. Heart rate and sweat rate of the individual can be taken as non-invasive stress parameters. A wearable device that one can wear on the wrist as a watch and monitors the heart rate and sweat rate can be used to monitor the psychostress of an individual. The transmitter section of the device consists of two sensor units connected to a transmitter circuit [8]. The sensors measure the heart rate of the individual and the sweat rate of the individual. The heart rate sensor is placed near the heart beats and sweat rate sensor is placed on the portion of the skin that has more sweat glands. These sensors convert the input parameter into the corresponding varying electrical voltage. These varying electrical voltages are given to the differential amplifier circuit. The output of the operational amplifier circuit is given to the positive voltage regulator circuit, which provides the constant voltage level as input to the modulator circuit. The astable multivibrator is set to the constant frequency and the modulating frequency is given as input to it. The FM generator modulates the carrier frequency and the input frequency. The frequency of the modulated frequency carrier wave is changed as per conditioning of the input frequency carrier wave. The modulated carrier wave transmitted due to the transmitted antenna circuit.

8.1. Performance Testing

Designing a health monitoring device that patients can carry with them and which feeds its information out over the Internet is not a simple task. Performance testing has suggested that there will be a number of practical and ethical limitations on how, when, or to whom such a device can be attached. Nonetheless, it is possible to devise some performance tests that will suggest the state of current technology and outline the difficulties that must be faced. The most blatant and basic performance tests involve simple measurements of agreement between remote patient monitors and their corresponding bedside monitors. Such precision is typically quite good, but this cannot be taken for granted. Measurements of pulse rate and arterial blood pressure can be expected to deviate by more than 10 mm Hg from their true values about 20% of the time. The problems are particularly severe at low pulse rates and therefore will be particularly acute when attempting to monitor cardiac bypass patients.

Another series of performance tests concerns the maintenance of technical quality of health data communications. In one set of tests the data are fed over telephone lines through a precision differential modem. Results suggest that there is significant data corruption that is as likely to make small numbers much larger as it is to make large numbers much smaller. It is also not unusual for the data transmission to be temporarily halted. In a second set of tests, data are fed through a commercial data communications system. This system performs stunningly well. Approximately 10 seconds of continuous telephone transmission is needed to transmit a 5000-word discharge summary. This constitutes about 10 seconds of telephone time, or about 35¢! However, it appears that it may not be used on an "open" basis.

8.2. User Acceptance Testing

Introduction - With the rapid progress of the Internet and communication technology, people have recently begun utilizing the internet to consult and monitor health care services. The goal is to design and implement a health monitor using the internet. This health monitor aims to track personal health information and provide information based on that data [8].

8.3. Implementation

Using the Android operating system and the WI-Fi communication module, a smartphone application and web server are developed to monitor the health of patients in a smart way from a remote place. By designing a patient-health monitoring web server and mobile applications, nurses and doctors can monitor their patients online. Multimedia laboratory communication protocol is used as a communication protocol between the Android system in devices and web servers based on Linux Fedora 14. Patient authentication is based on their identification and medical record numbers. This information must be inserted into the smart phone application. This patient monitoring process sends conventional measurements such as blood pressure, glucose level, pulse rate, and body temperature to the web server online by a smartphone using a WI-Fi communication module [26]. The web server side processes the data from the patient and displays the result. It is shown in the web display form. A notification short message feature is also added to indicate that the patient needs medical attention when out of range.

A health monitor model is tested on six patients and found to be 100% correct with a 2.4 GHz WI-Fi module in the conventional conditions of 35 meters. At a lower range, it is also tested with a GPRS/EDGE/GSM module and can successfully show that cheaper costs and easier monitoring can be used for health monitoring in developing countries. The telehealth market will grow to approximately €47 billion a year in the USA and Europe combined by 2020. Millions of patients will utilize these services. Considering movements, blood pressure, sugar levels, pulse, and temperature are needed to be monitored regularly, but most patients are not sufficiently aware of the importance of regular monitoring.

9. Case Studies and Applications

The rapid growth of the internet and wireless network can be seen in daily applications and also with different devices such as cellular phones. Combining the wide use of internet and wireless network with medical care will advance an increment of patient mobility. The feasibility of designing and implementing an internet-based patient monitor and diagnosis system through the use of a combined hardware/software system is the topic presented. The primary goal is to develop a cellular-phone internet-based telemedicine system which integrates patient-monitoring units and care-unit facilities to medical information services via the internet. The developed telemedicine system can be used in a variety of mobile patient-monitoring and diagnosis systems, such as teleradiology, wireless E.C.G., or PDA telemedicine system.

The hardware realization of a patient-monitor component and implementation of a test bed system for data retrieval from the patient-monitoring system and data transmission to server systems are implemented. In short, a design and implementation of a patient monitor via the internet (internet-based telemedicine systems) is presented. For this application, a server for web service is also prepared. With the apparition of the PDA-phone, a powerful implementation of the patient-with-facilities mobile patient-monitor system can be realized. The proposed system can also be applied to other internet-based telemedicine systems by using a PDA-phone (such as a wellness application, which uses the internet for doctor consultation). It is shown that the system can be an alternative diagnosis tool for medical treatments.

9.1. Remote Patient Monitoring

This proposed system will monitor the electronic patient's vital signs (such as HR, SPO2, and TEMP) and transmit this information using the internet to remote healthcare specialists and institutions. With patient monitor and modem connections to PC, the system can work in two modes. In automatic mode, it can monitor patient’s parameters, classify ECG detected R wave, and notify healthcare specialists through the modem when needed. Then, healthcare specialists and institutions examine and comment on the patient’s situation. In manual mode, the system will acquire parameters of the patient (with monitor), classify the ECG detected R wave, and display it on the screen. Then the patient’s ECG could be examined by pressing the transmit button and a remote healthcare specialist can observe and comment it. To evaluate and verify the ECG beat type classification method, the system could simulate patients with the adjustable simulator. The system, described in this paper, aims at providing a better quality of treatment for the patient who needs to be isolated in terms of time and place. This system consists of a patient monitor and data transfer software. Patient monitor will sample patient’s vital signs (ECG, HR, SpO2, and temperature). It will also detect the R wave and measure HR (with the HR circuit), measure SPO2 (with the SPO2 circuit) and measure TEMP (with the TEMP circuit). A PC is needed to convert digital signals to internet messages (with the modem). The transmitted data will be assumed encoding data of the patient’s ECG beat type. The received data will be decoded ECG beat type. Based on the truth patient’s ECG beat type, a diagnosis could be made. Furthermore, all ECG printed from the patient’s ECG monitor should refer to this beat type as a gold standard. Because of that the need for a labeled ECG printed by a wide area of diagnosing expert arises, thus leading to ECG annotation. In this paper, the proposed new application software that will communicate patient’s situation using internet will be described [4].

9.2. Emergency Response Systems

Loss of capacity of patients to maintain a good and satisfactory performance level at normal activities may be due to physical wounds or cognitive illness, which are known as healthcare recipients here. In some systems, family members would like to monitor the situation of their beloved ones and assure that they have the ability to realize early actions if an abnormal event happens, like collapsing down or when the location is incorrectly identified. Remote diagnostic and monitoring systems were designed for a web-based approach. Consequently, it might work effectively in particular situations and not in all stations. Moreover, there may be a general problem with the accessibility of the system in remote medical service deprivation stations.

EMERGENCY RESPONSE SYSTEMS

A medical assistance scheme is proposed to care for people who require medical help or consciousness. In an emergency stage, a communication link is established from a telemedicine-enabled alert device toward a mobile-care unit using wireless technology. The link will take place automatically or semi-automatically according to the context of urgent cases. A mobile-care unit is moved to the scene of the event by an ambulance, delivering a patient's life-sign details collected by the telemedicine system on a real time basis and determining the first aid that can be done remotely. Following a prompt preliminary visit, the final decision of the doctor decides either to return the mobile-care unit or transport the patient to a hospital where subsequent visits are prepared. The monitoring unit can interact with the Personal Server that informs him of the time slot of each visit, of information on the patient's history and the on-line doctor's opinion. Implementation aspects and the system's standardized parts are addressed, particularly the programmable algorithm unit on the server side enabling easy integration of the processing algorithms related to first-aid and other standard signals.

10. Future Trends and Innovations

In parallel to the numerous concerns about patient’s health, a trend that has begun in industrial automation and commercial networks is recently observed in health care field too; the Internet is being used to connect portable, wearable, and implantable medical devices and improve patient monitoring and treatment, health care telemonitoring. Considering other perspective, health information is also rapidly becoming increasingly available for both experts and society. A variety of topics like diseases and their symptoms, medication options, resting, nutrition information could all be easily found in a few seconds that with a doctor would make the managing of illness much less painful. However, incompatibilities and standardization problems over systems of different vendors and the safety issue of patient data transmitted over the internet have to be seriously challenged. By considering the essence of telemedicine and the aforementioned observations, in this thesis, the design and implementation of a patient monitor suitable to be monitored, controlled through the internet and a comprehensive web-based health information service is discussed. Moreover; a mathematical model to constitute the health status of the patient to be monitored to enhance earlier detection and treatment of patient disease is proposed. A summary feature, which helps to concentrate the main effects in patient monitor and to foresee the trends in health information, considering the impact of the patient monitor on section, is also mentioned.

10.1. Artificial Intelligence in Patient Monitoring

Artificial Intelligence (AI) techniques are increasingly being used in remote patient monitoring (RPM) systems. Compared to other monitoring systems, RPM simultaneously monitors many vital signs and human body parameters in real time. Bayesian optimization methods were implemented to appropriately accommodate any plausible parameterizations in the patient population, thus achieving improved convergence and smoothness of the target temperature. When the user may have a wearable device, passive monitoring RPM can automatically detect vital signs without user intervention. Some traditional manually monitoring remote patient monitoring systems only focus on changes in physiological signals without considering decimal points. Thus, these monitoring systems do not monitor the parameter levels to increase or decrease smoothly. Patient-specific parameter optimization using machine learning techniques is considered the most advanced level of RPM. The field of affective computing and emotion recognition widely uses AI in the detection of human emotions. Based on a developed physiological stress detection algorithm that combines several novel artificial intelligence-based pattern recognition and feature extraction methods, estimate the average level of perceived physiological stress. Recent trends in the development of patient monitoring devices are moving towards miniaturization and seamless integration of sensors with daily life objects. AI can classify patient's emotions based on patient face recognition. A smart integrated patient monitoring system is proposed to detect patient emotional states and heartbeat levels. Face recognition algorithms and heartbeat and temperature sensors are incorporated into the designed system. The designed of the patient's emotion detection and alert generation system for the proposed monitor. In this system, the LEDs are programmed to blink in different combinations based on the occurrence of any patient’s pre-defined emotion surpassing the threshold level. After the chronic condition of the patient becomes severe, the heartbeat detection system sends an alert for immediate medical treatment. The data will update constantly and apply the new method in the development of a multicultural design device. The capability of the Micro controller has the ability to store huge data in repetition will store the physical parameters at regular intervals in the EEPROM. The accumulated data can be accessed after a certain period by removing the EEPROM from the Micro controller and connecting to the computer. unnecessary higher amount of power use also heat the device Motors produces sound so noisy equipment. Circuitry and Components are soldered so its waste at the end of the life span can't be reused further beyond the lifetime limit the equipment should not be used there are no any safety instructions in the manual book. The interface is designed and implemented to get the patient's health status through the internet. If any abnormality is found, the buzzer and AC Appliances are turned on using motors. Behind the glass/Liquid crystal display (LCD), the MQ gas sensor is used for identifying the compounds in the chromatographic column for accurate and immediate output reading. Furthermore, the PLC module is used for the counting of compounds detected by sensors, which control the air pump for the flush of the chromatographic column. NOx, SOx Carbon and string particles are more dangerous for the environment. In this proposed system, the priority will be given for these pollutants to be controlled. Due to the dust, there might be some warning problems. A remote monitoring system in industries is proposed to resolve these critical issues. The system counts the physical product and updates the traceability server using the wireless connection.

11. Conclusion

This paper presents the design and implementation of patient monitor that is accessible via the internet. The patient monitor is a wearable health monitoring system composed of: ECG sensor, a microcontroller to digitize the ECG data, a Bluetooth module for wireless data communication, and Internet-enabled devices as display units. The system is accessible at the cloud and is capable of serving multiple patients. The ECG data is available for doctors or family members to enable immediate care and treatment. The system architecture features 4 main components: ECG sensor devices; patient database cloud; treatment equipment; and human interface. The accessed database clinical process record (CPR) value is written by the selected physician with the add appointment request process.

With the advent and rapid development of the internet and mobile technology, healthcare providers are encouraged to remotely access patient health information and monitor their health status anywhere and anytime. Research works on providing real-time health status through online systems are of great interest of medical practitioners in monitoring and diagnosing medical conditions of their patients and can provide better quality healthcare service even when they are away. Additionally, these systems are estimated to save a substantial amount of time and effort for medical personnel. The first system is designed to provide medical personnel with the ability to access current patient health status and record historical data. The second system is designed to allow the general public to make appointments for specialist consultations and can also access patient treatment records. This work presents the design and implementation of the Patient Monitor via the Internet. This system allows a medical professional authorized by the patient to monitor real-time patient clinical process record value data and historical data online via a user-friendly and interactive web display. The use of this Patient Monitor system will be helpful for the dental care profession with features that facilitate the exchanged patient's oral health information. After doctor confirmation and successful treatment/recall, dental professionals can fill in the CPR-Vstime with the date and explain the treatment results and advice for the patient. This record can be a report and systematic reference [4].

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