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A HEALTH IOT FOR PATIENT MONITORING WITH BIO-SENSORS AND INTELLIGENT MEDICINE BOX

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ABSTRACT

Currently chronic diseases and number of patients are being a common concern. So hospital restructuring and thereby encouraging home healthcare is very important. An intelligent home-based Platform is proposed here, which involves bio-sensors for reading the human heart rate in digital format, an intelligent medicine box (iMedBox) with enhanced connectivity and interchange ability for the integration of devices and it is connected with a light sensor to read the variations in the medicine slots like counting the number of tablets a patient is consuming. Thus this home health IoT platform can continuously monitor the patient and can provide proper alarms and trigger a message when there is any abnormal variation in the pulse rate. The status of the patient is generated every day and is stored in the server in the encrypted format. The encryption algorithm used here is the arithmetic part of elliptial curve cryptography without generating a curve. This platform flawlessly fuse IoT devices with in-home healthcare services for an improved user experience and service efficiency. By largely using and promoting Home Health IoT the facilities and services of hospitals can be made available in our home environment itself.

INTRODUCTION

The Indian health-care system has diverse ironies. We are debatably one of the premium health care in the world, but it is not uniformly accessible to all citizens. Nowadays, global aging and the pervasiveness of chronic diseases have become a widespread distress. Majority of our citizens are uninsured Indians, many uninsurable patients are so in poor health that insurance companies refuse them completely or charge unaffordable high premiums. As a prosperous country with enormous resources, India is in an exclusive position to set an example provided that all its citizens have access to excellent health care. The present health-care problems can be solved by a new system that transforms medical care away from the hospital into a community clinic. Several countries are enduring hospital improvement by dropping the number of hospital beds and rising percentage of home healthcare. Patients and their chief care donors then utilize telemedicine above a distributed network to link to tertiary medical providers and systems worldwide. An upcoming trend in healthcare is to shift routine medical checks and other healthcare services from hospital to the home conditions.

The new wave in the era of computing will be outside the sphere of the conventional desktop. Internet of Things (IoT) is a network where many of the objects that surround us will be networked in one form or another. By using this technology the heartbeat sensors of the patient is collected through the heartbeat sensors and is fed to the computer server for further processing and encryption. The swift paced life has always taken a levy on the people. The satire is that new medicines are found for the never ending chain of diseases and often require timely medication with course therapy for curing. But the busy life agenda of the people frequently let down this procedure. Most regular reason for letdown of a method of cure is the failure of the patient to control the dosage in the exact proportion and at exact time. As per the WHO (World Health Organization), 80% of the people above the age of 60 years are prescribed with medicines that are to be consumed 2 - 4 times a day. With the increase in heart diseases and Diabetes regular medicine administration has become a requirement. But another 40-60% of patients are having the issues associated with forgetting to take medicines at prescribed time. The existing techniques in market for the reminder include a pill box with a normal alarm. But this does not help in checking, overdose and wrong dosage among the patients.

This proposed idea is a valuable solution to the medical non-compliance problem. Reducing patient's non-compliance, guarantees improved health, longer life expectancy, and better quality of life. The invention makes

use of a dispensing scheme to assist patients keep trail of their medicine consumption through a series of LED alarm indicator signals and audio alarm indicator indicators.

The structure of the current Indian health-care system can be changed from large hospitals to a distributed, networked healthcare system. This proposed idea can be delivered locally in neighborhoods and individual homes, by means of electronic technologies like telemedicine, to tie patients and primary care contributors to tertiary medical contributors. This devolution could lessen costs; it would benefit patients and providers, it would better shield the country's resources and citizens.

LITERATURE SURVEY

Alok Kulkarni, Sampada Sathe's [2] paper about healthcare internet applications, discuss about the evolution of internet, its concise discussion and applications. IoT is that network of physical objects or "things" fixed with electronics, software, sensors and connectivity to permit it to achieve higher values and facilities by exchanging data with the firm operators and other connected devices. Each objects around us are totally peculiar through its embedded computing system but is able to interoperate with the active Internet infrastructure. It includes traditional fields like Embedded Systems, Control Systems and Wireless Sensor Networks to make easy Device to Device (D2D) communication through the internet.

David Niewolny in his paper describes, 'How the Internet of Things Is Revolutionizing Healthcare' [3] is discussing about the reasons for emergence of IoT and designs of applications where IoT is used. The issue is people have only limited time, awareness and accuracy, which means they won't be able to capture data about things networked in the real world consistently. The answer is empowering devices to collect information on their own, without any human interference.

Different sensors are accessible and available in the market for providing ad ensuring home healthcare, S. Tozlu, M. Senel, W. Mao, and A. Keshavarzian in his paper Wi-Fi enabled sensors for internet of things describes a practical approach,[4] and give explanations about different sensors available. Conventionally ZigBee and other IEEE 802.15.4 based protocols have been regarded for sensor network applications because of their energy-efficient design. On the other hand, newly developed power-efficient Wi-Fi components, with proper system design and usage model is a strong contender.

The terms ubiquitous and persistent computing designates the diffusion of our everyday life with intelligent devices. Security is significant for a diversity of sensor network applications. There are a large number of security vulnerabilities in WSNs, which cause different kind of attacks. Wireless sensor networks (WSN) are delegate networks using these small and low-power sensor devices. Two types of Communications occur in sensor networks are, between end nodes, and between end node and base station Symmetric key algorithms are ideal for resource constrained environments of WSN Implementations which can only provide confidentiality. Public key cryptosystems are resource hungry but will provide a lot more features than confidentiality. Mathematical part of Elliptical Curve Cryptography (ECC) got the attention of the researchers due to its smaller key size. It guarantees practical implementation possibilities in resource constrained devices. Earlier work shows public key algorithms are best choice for use in wireless sensor networking, and that the advantage of smaller Cryptographic keys will be significant in getting better in energy conservation.

BACKGROUND AND FRAMEWORK

Nowadays, global aging and the dominance of chronic diseases have become a common concern. Many countries are undergoing hospital restructuring by dropping the number of hospital beds and rising the proportion of home healthcare .A promising trend in healthcare is to shift routine medical checks and other healthcare services from hospital (Hospital-Centric) to the home environment (Home-Centric). By doing so, first, the patients can get seamless healthcare at any time in a comfortable home environment; next, society's financial load could be greatly reduced by remote treatment; third, limited hospital resources can be released for people in call for of emergency care. In-home healthcare and services can drastically reduce the total spending on medical care or treatment. Hence, it is urgent in the near future for the healthcare industry to expand advanced and practical health linked technologies and services by leveraging information and communication technology (ICT), and relate them

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directly in the home atmosphere. In order to track the physical status of the elderly and, in the meanwhile, to keep them healthy, the following two daily tasks are essential:

1) Real-time monitoring and analyzing critical signs to early-detect or predict life-threatening difficult events;
2) Checking whether they are following their prescribed treatment, with taking their prescribed medicine on time.

However, with rapidly aging populations, these daily tasks have brought immense pressure and confronts to global healthcare systems. One review estimates that about 25% of the adult population do not hold to their prescribed medication, which may lead to poor health outcomes and increased mortality. Poor medication adherence is a major problem for both individuals and healthcare providers. Technology upgrading in healthcare facilities and services are highly desirable to meet the requirements of this giant group.

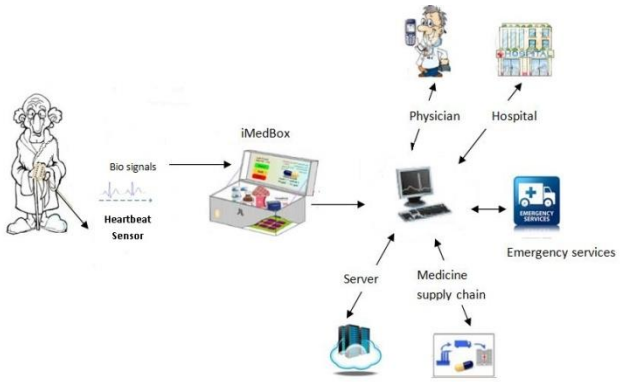

Fig: 1. Architecture of iHome Health System

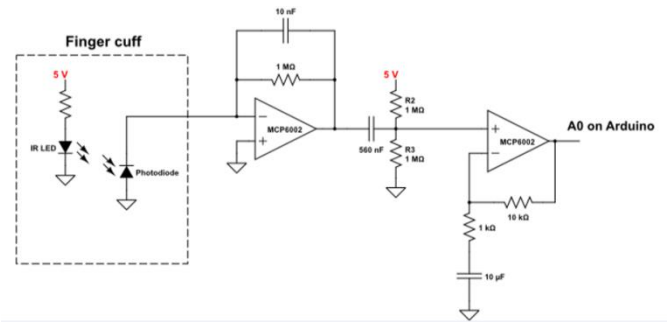

Fig: 2. Circuit Diagram of Heartbeat sensor

With the emergence of wearable trackers today, there seems to be further ways than ever before to electronically detect a heartbeat, which sports a finger cuff with an integrated IR LED and photodiode. As blood is pumped through the body, the volume of blood in farthest points fluctuates with the beating of the heart. This change in blood volume in the finger tips can be sensed by shining a light through the finger and sensing the amount of light that passes in and out of the finger using a photodiode.

"The photodiode creates a current that is converted to a voltage using a trans impedance amplifier (current-to-voltage converter). The signal is then high-pass filtered to remove the DC bias from the signal and then biased at Vdd/2 so that the wave is symmetrical about 2.5 V. Once the current produced by the photodiode is converted to a voltage by an amplifier and examined by the Arduino (while the Maker notes that any 'duino can be used, a Mega ATmega was choosed for this project). This information is then passed on to a computer via serial.

To connect a sensor or a motor to an arduino, you require to connect them to its pins. The readings from the heartbeat sensor is fed into our system and is continuosly monitored.The monitoring is done by reading these values from the .txt file and comparing the present pulse reading with the range pre-defined in the program.The

normal pulse rate is being set and any variation from this normal value will trigger a message to the respective doctor and emergency center.The message set here is "Patient pattern become changing..Please provide ambulance service", a period is set for sending the messages and the mesage will be send at these regular intervals.

CRYPTOGRAPHIC METHOD

The Cryptographic method used here is the mathematical part of elliptical curve cryptography avoiding the geometrical part, as the geometrical part is not that so relevant in this criteria. It is a public key cryptography, where each user or the device, taking part in the communication normally use a pair of keys, a public key and a private key, and a set of operations associated with the keys will be undergone to complete the cryptographic operations. Crypto Algorithm, Crypto Analysis Secure key Management, Access control Authentication and secure routing Data Aggregation will be knowing the private key while the public key is distributed to all users taking part in the communication. Public-Key cryptography systems can be used to offer secure communications above timid channels without exchanging a secret key. The most popular public-key cryptography systems currently are RSA and Elliptic Curve Cryptography (ECC).

Security is critical for a variety of sensor network applications. Main proposes of security is not message encryption but prevent from changing the contents of the message or disguising sender. It is the most important mutual authentication in order to defend from disguise of sender. For the reason of limited energy, numerous research processes have been done to capitalize on a lifetime of networks. Implementations of symmetric key algorithms are ultimate for resource controlled environments of WSN. But symmetric algorithms can only offer confidentiality. Public key cryptosystems are very much keen to resources but are capable of providing a lot more than confidentiality. ECC got the attention of the researchers due to its smaller key size. It suggests practical implementation possibilities in resource constrained devices. ECC is capable of managing and achieving authentication and key management. Currently, RSA algorithm demands a key length be not less than 1024 bits for guaranteed security and ECC with only a 160 bits modulus offers the same level of security as RSA with 1024-bit modulus. Thus, using ECC in wireless communication system is extremely recommended. The key distribution and storage problems, which are commonly faced in the secret-key settings is solved by this cryptographic conception.

Large number of sensor nodes is deployed to monitor in a vast network field, where the working conditions are most often hassling or even hostile. In view of the fact that these networks are usually deployed in remote places and left unattended, they should be encapsulated with security mechanisms which act as a shield against attacks such as node capture, physical tampering, eavesdropping, denial of service, etc. Regrettably, conventional security mechanisms with high overhead are not practicable for resource controlled sensor nodes. The researchers have proposed various security schemes which are optimized for these networks with source constraints.

Key management and Key establishment is an important issue in wireless sensor networks. There are two approaches for it - Centralized and Distributed. In the previous approach there is prior assignment of a unique key to each node and uses the base station as central source of trust while in later approach each sensor node is capable of authenticating its neighbours or a subset of them. Typical public-key protocol used in key establishment is the Diffie-Hellman method. In public-key protocols, data is encrypted with the public key and decrypted only with the private key so it is necessary to maintain both public and private keys. Key exchange problem arises in symmetric protocols because data is encrypted and decrypted with a single shared key. Secure key distribution of keys securely to communicating hosts is significant problem since pre-distributing the keys is not always possible. Asymmetric cryptosystems for constrained devices were not considered due to their extensive mathematical calculations. These calculations entail large amount of space and power resources seen widespread use is also one of the most accessible illustrations of this principle in action. An efficient key management scheme for WSN using ECC can be designed. A typical WSN can be an assuming combination of both large number of normal sensor nodes also known as cluster heads and small number of special nodes. Cluster nodes having more power computationally more capable than special nodes. Before the predistribution of the sensor nodes, key server based on ECDSA can be used to generate both public/private key pair.

However, there exist several protocols for asymmetric cryptographic algorithms for USNs. In [WKC+04] Watro et al. describe public-key based protocols for USNs. In exacting, they present authentication and key-agreement protocols based on RSA.RSA needs much longer key lengths compared to elliptic curve cryptography to achieve

the same security level .Considering the restricted amount of memory, computing power and energy of a typical 8-bit sensor node, it seems that ECC is a lot better choice for public-key cryptography than RSA.

MEDICINE BOX

The patient non-compliance is an important problem which place a prior importance to the health of millions of patients. The Medicine Box offers a solution to the patient non-compliance problem. The Smart Medicine Box keeps track the number and time of pills the patients have taken. This invention is therefore capable of improving patients' health significantly. The functionality of the Medicine Box is based on a LEDs and a microprocessor keeping track of time and the number of pills left at several time in the Medicine Box The patient' s schedule for taking his medication is also stored. The Medicine Box uses this information to assume whether the patient is complying with his treatment

The Medicine Box works in the following way:

1. The Medicine Box is filled with the prescribed medicine
2. The schedule for the medicine consumption is stored in it.
3. Each time when the patient opens the bottle,a counter counts the openings and stored.
4. Each time a pill is taken, the Medicine Box will note the decrease in the number of the pills and use this information to mark the time the pill was taken and from counting the number of times the bottle is opened, the remaining pills calculate how many pills were taken.
5. The Medicine Box can remind the patient to take his medication. Further Medicine Box can send information using indications like light and sound.

The elderly are more likely to forget to take or fail to consume the medicine as prescribed. There are conditions like , user takes a wrong medicine, takes too much or too little of a definite medicine, receives the medicine at the wrong time, or adverse drug reactions/interactions happen with the possibility of causing death. According to the severity in each case, various levels of indications should be triggered. The iMedBox executes an intellectual analysis by automatically comparing the recorded medication time with the doctor's prescription. The alarm and the medicine name with the count will first show up on the iMedBox's screen.The medication history is regularly uploaded and saved. The doctor can take it as a reference for the next prescription. By linking the wearable Bio-Patch with the iMedBox, the iHome Health-IoT system is capable of monitoring and analyzing the vital signs. The bio-sensor samples, such as ECG and body temperature, are digitized and wirelessly fed to the iMedBox, this data is stored, analysed, performs real-time signal processing and display. Based on the recorded ECG signal from sensors, the user's heart rate information can be extracted, and a heart rate variability analysis can be performed on a regularly. Once a continuous abnormal heart rate is detected, it will automatically send out a text message to the doctor and emergency center.

CONCLUSION

As an affluent country with vast resources, India is in a unique position to set an example by providing all its citizens with access to good health care. The medical, social, and financial problems facing this dilemma are solvable if the right resources are applied. Top priority must be to deliver the best health care, accessible to anyone regardless of money or connections, in a financially responsible manner. The current health-care dilemmas can be solved by a new system that shifts the clinical care from the hospital into the community clinic. An IoT-based intelligent home-centric healthcare IOT platform, which flawlessly connects smart sensors attached to human body for biological monitoring and intelligent medical packaging for daily medication management. It also offers multiple opportunities to adapt a wide variety of electronic-health applications with minimum changes. It includes the scenario of assisted living for people with physically and mentally disabled, where users can intermingle with smart objects deployed in a home environment to ensure their health and well-being. The proposed Home health system involves different aspects from the hospital, emergency center, body, and even medicine. The MedBox serves as a home healthcare station providing strong interoperability and network connectivity. The healthcare system can deliver various services, including monitoring of real-time bio-signals, alarms and medication noncompliance control. The Health system combines the health network, telemedicine, and emergency and medication management services. This helps in the swift transformation from Hospital-Centric medical treatment to Home-Centric healthcare and finally bring about ubiquitous and personalized healthcare.

The long predicted IoT revolution in healthcare is already underway. And, as new use cases are emerging, they continue to address the urgent need for affordable, accessible care. Meanwhile, the IoT will act as building blocks for automation and machine-to-machine communication. The addition of the service layer forms the complete IoT infrastructure. This is characterised by providing end-to-end processing, analysis and connectivity solutions for IoT-driven healthcare.

FUTURE WORK

The Internet of Things will change our society, and will bring seamless 'anytime, anywhere' personalized healthcare and monitoring over fast reliable and secure networks. This implies that we are approaching the end of the divide present between digital, virtual and physical worlds. Today, the most widely adapted technology for the Internet is the standard web services. Wireless identifiable embedded healthcare systems at the edge of the network should be connected to web services and make use of comparable functionalities and this will prove to be a challenge in the future for the internet. These millions of components produce, analyse, consume and process information in dissimilar healthcare environments such as hospitals, households and nursing homes as well as in the work and everyday lives of people. The Internet of Things will change our society, and will bring seamless 'anytime, anywhere' personalized healthcare and monitoring over fast reliable and secure networks. This implies that we are approaching the end of the divide present between digital, virtual and physical worlds.

Today, the most widely adapted technology for the Internet is the standard web services. Wireless identifiable embedded healthcare systems at the edge of the network need to have and utilise similar functionalities and this will prove to be a challenge in the future for the internet. Wireless sensor networks and ubiquitous networks, where the sensors will be connected and controlled by embedded systems, where services summarize the functionality and provide unified access to the functionality of the system. These billions of mechanisms produce, consume and process information in different healthcare environments such as hospitals, households and nursing homes as well as in the work and everyday lives of people.

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