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A STUDY ON REDESIGNING MODERN HEALTH CARE USING INTERNET OF THINGS

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Abstract

In today's fast world owing to advancement in medical technology, health care has become one of the most striking application areas for the Internet of Things (IoT). There is a huge competition in building up high-speed health care services. The IoT has the prospective to offer many medical applications such as remote health monitoring, elder care, and chronic diseases especially heart disease monitoring and emergency support for the needy people. The study suggests a system that will improve the performance of health care even in the rural areas. Tracking patient's location, sensing parameters like blood pressure, glucose, breathing rate and automatic data collection and analysis of the data will take the IoT to the next level of health care applications. State-of-the-art IoT health care system built with Decision Support System (DSS) will definitely help the patients and doctors in critical conditions. Proposed work targets Ischemic Heart Disease (IHD) with IoT application.

Keywords:

Health care, Internet of Things (IoT), Decision support system(DSS), Ischemic Heart Disease(IHD).

1. INTRODUCTION

The Internet of Things (IoT) is a term which means connect everyone, everything, every service, every network any time and any place. Modern health care is one of the most important application of IoT[1]. The IoT has the prospective to offer many medical applications such as remote health monitoring, elder care, and chronic diseases especially heart disease monitoring and emergency support for the needy people.

Figure 1: Health care trends with IoT[2]

Personalization of health care and connectivity with doctors and hospitals is the latest trend in health care. IoT supports this trend by connecting every thing all time and in all places including remote areas. Medical devices like personal home-use diagnostic devices and imaging devices that are used by mobile health workers are one of the key technology components [3].

Connected health care technology will help in reducing the occurrence of chronic diseases like heart disease and diabetes by continuous monitoring of patients by doctors, with data analytics using decision support system. IoT based connected health care system sets up an environment where vital parameters are sensed by devices like sensors, transmitted through a gateway, stored in a cloud where aggregation and analysis of data happens with appropriate decision support system. Figure 1 gives an overview about health care trends with IoT.

Further in this paper, section 2 provides Literature available in health care and IoT, section 3 discusses example use cases, section 4 provides details about data analytic techniques section 5 discusses proposed work and section 6 concludes the paper.

2. LITERATURE ON HEALTH CARE AND IOT

Suriya Begum and Venugopal [4] have discussed about the importance of monitoring the health of patients on daily basis. An effective modernized health care system is required to keep every individual healthy [5]. In their paper they have discussed about implementation of wireless health monitoring system. The components used were ECG electrodes, LM35 temperature sensor, blood pressure sensor, Microsoft pro tablet and blood glucose sensor. IoT helps in tracking the patient health parameters, connects with doctor and keep track of patient records in detail through the use of sensors, detectors, actuators etc.[6]. Yvette et al. has discussed about Ubiquitous health care system where people need not visit hospital to monitor their health. It promises accuracy and availability of medical treatment online [7]. The main parts of U-Health care system are

Body area network which has sensors attached to the body to capture body bio signals, body temperature, pulse etc.

Intelligent Medical Server which has analytics module to determine if the patient is in critical condition or not.

Hospital system where nurses/doctors will take corrective actions based on patient report. Such systems not only help patients, but also health care professionals from moving from one place to another. When a patient in in unstable state, the sensors will warn practitioners/ nurse remotely in order to help them [8].

Punit Gupta et al.[9] has suggested Internet of Things Analytics (IoT A) to handle large collection of data generated and analyze them effectively. They have proposed a intelligent, robust health care management system to monitor the patient effectively and automatically. The status information is collected through systems automatically. Blood pressure, heart rate, and ECG are the parameters collected and sent as an emergency alert to medical practitioner with revised status and complete patient information. It uses smart sensors generating raw data collected from each sensor, send it to a database server where the data is analyzed statistically and maintained to be used by the medical team. Maintenance of a database server is necessary to keep an eye of previous record of the patient for a better and improved examination. Cooey [10] uses Bluetooth to log in medical data of patients. The system gives alerts on health risks to patients. It connects with pharma, labs, doctors and teleconsulting. It has Smart Blood Pressure Monitor, Glucometer and Body Analyzer. It has a personalized health care monitoring system. Cooey smart sevices help chronic patients to survive. Microsoft Health Vault [11] assists the patient to collect, store, utilize and share health information. All health records can be maintained at one place and is available online. Especially during medical emergencies it helps to keep track of all the details. Data is recorded once, and used with new data to get frequent updates about health.. It has multiple application connectivity to share the information with everyone. Key Characteristics:

Updated medication

Updated readings of blood pressure, glucose level, weight from home

History of health details

HealthVault to store, organize and share the data with Doctor.

This provides easy information to healthcare consultants for advising the user on proper health management. Dashboard of Weight management guides the user to have fitness watching the weight, daily diet, physical activity and tracking the progress always.

USE CASES ON HEALTH CARE AND IOT

The IoT is a boon to the society in terms of 3 D's namely Disease, Data, Devices [12,13]. Here, the authors have mentioned that most IoT-enabled devices are wearables like activity monitors and devices like digital scales and thermometers and an application to track results. IoT applications promise to improve and personalize patient healthcare by making everything automatic. The interactions with patients are periodic. In the United States, everyday behaviors causes conditions causing about 40 percent of premature deaths [14]. If the digitally collected patient data are reliable then, IoT applications can critically improve personalized health care [15]. Remote patient monitoring will save up to $36 billion globally in the next five years [16]. Specifically, home monitoring has the possibility to decrease the incidence of death and hospitalization occurred by falls [17,18]. IoT-based home monitoring devices can reduce costs, improving outcomes by preventing falls. This is by predicting the likelihood of a fall with data acquisition and decision support system by observing movements and pressure distribution [19].

Use case :- Care at Home Current status:

Elderly individuals who are at risk of health are placed in the full-time care of relatives, nurses or old age homes.

Use of IoT:

Detecting slips [20].

Checking if an individual took his/ her medicine[21] Other use cases of Iot include

Care for the kids

Chronic disease management

Personal health and fitness management

Short term care planning to give medicines by keeping reminders

DATA ANALYTIC TECHNIQUES

Wu, et al. [22] have proposed a combination of decision support system with computer based data mining techniques to reduce the medical errors, improve patient's safety, reduce the unwanted practices and increase patients' true positive and true negative outcome. El Ouardighi et al.[23] proposed a feature selection method based on Wilk's Lambda criterion. It is a statistical method used in discriminant analysis. Correlation based feature selection is used by Umut and Fikret[24] for

Arrhythmia classification. 22 attributes were selected giving good accuracy with different classifiers like Bayes classifier, Support Vector Machines, Neural Networks (MLP), C4.5 Decision tree classifiers. Agarwal and Srikant [25] have dealt with this issue in depth and proposed a new approach that adopts subset lattice search space, using structural properties of frequent itemsets to assist fast detection. Association algorithms find interrelationships between data and reveal this relationship in the form of rules. The efficiency of them is one of the key distinguisher in the midst of different algorithms. Several algorithms build a database of rules, confidence factors and support to facilitate querying. (For example, "illustrate all associations where computer is the consequent, with a confidence factor of over 90% with a support of 80% or more"). According to Borgelt and Kruse [26], Association analysis is a powerful method to generate association rules for market basket analysis to understand the customer's behaviors while shopping. In data mining, classification is one of the important problems. As stated by Xu-min liu et al.[27], in a given database, each record with a class label, a classifier produces a concise and meaningful description of each class that can be used to classify subsequent records. Han and Kamber [28], explain the rule-based classification approach as follows. A better way to represent information is by using Rules. Rule induction is a process for obtaining a set of rules to classify cases. IF-THEN rules are used in rule-based classifier system. The rules can be generated either from decision or from training data using sequential covering algorithm. Though decision trees produce a set of rules, rule induction methods produce a set of independent rules that do not essentially form a tree. Latha and Subramanian [29] have proposed an innovative approach based on Coactive Neuro-Fuzzy Inference System (CANFIS) to predict heart disease. The presence of the disease is diagnosed by the CANFIS model. Ganji and Abadeh[30], have used Ant Colony Optimization (ACO) to extract a set of rules for diagnosis of diabetes. It extracts fuzzy If-Then rules for diagnosis. P.RInnocent et.al.[31] have experimented with fuzzy neural networks. Experience acquired using fuzzy neural networks is modelled and used in the improvement of classification accuracy.

Many hybrid techniques with data analytics were proposed and implemented. Ahmad et al. [32] has implemented a hybrid combination of Artificial Neural networks (ANN) and Genetic algorithm. Babita Pandey and Ravi Bhushan Mishra [33] have made a literature survey of all hybrid methods available for intelligent computing in medical planning, diagnosis and treatment. Xu and Li [34] confirmed that Intelligent Information Processing is a field of research for the past 10 to 15 years. To address the problems and to focus on this esearch area, an International conference on Intelligent Information Processing was held at Beijing in 2006. Many research works presented in the conference dealt with Genetic Algorithm, Fuzzy logic and Case based reasoning.

Companies are investing more money for retrieving intelligent information from a large collection of data. Tang et al. [35] have discussed about intelligent processing of medical images by having a prior knowledge about the medical domain for analysis. According to their papers, Knowledge-Based Systems (KBS) consist of Rule-Based Reasoning (RBR), Case-Based Reasoning (CBR), Model-Based
Reasoning (MBR), Intelligent Computing Method (ICM) encompasses Genetic Algorithm (GA), Artificial Neural Networks (ANN), Fuzzy Logic (FL) and others. The hybrid methods such as CBR-RBR, CBR-MBR and RBR-CBR-MBR, ANN-GA, Fuzzy-ANN, Fuzzy-GA and Fuzzy-ANN-GA,RBR-ANN, CBR-ANN, RBR-CBR-ANN, Fuzzy-RBR, Fuzzy-CBR and Fuzzy-CBR-ANN are very useful.

Neural networks are nonparametric, robust, and exhibit good learning and generalization abilities in data-rich environments. Genetic algorithms present competent search algorithms to choose a model, from mixed media data, based on several preference criterion/objective function. Rough sets are rightly used for handling various types of uncertainty in data. Sivagaminathan et al. [36] have described a hybrid method to select a subset of features. Variables contributing for noise and strongly correlated with a selected variable are removed. Combination of Ant Colony Optimization and Neural Networks is used as a hybrid technique.

5. PROPOSED WORK

Ischemic Heart Disease(IHD) is a chronic disease which is topping the death reason in counties like hidia[37]. Sudden death occurs when some of the health parameters are not regularly monitored. This work focuses on regular monitoring of parameters of individuals especially in rural areas where there is acute shortage of doctors especially cardiologists. The figure 2 below gives the framework of the system[38]

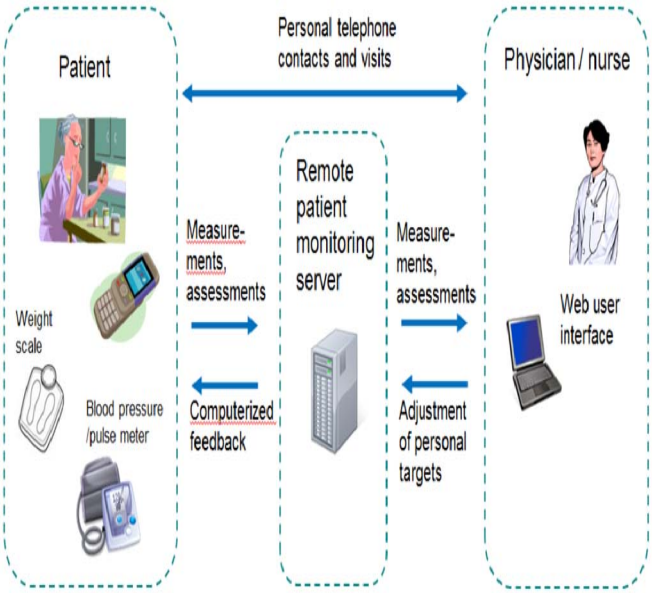

Figure 2: Continuous Monitoring of patients with chronic disease.

The attributes to be collected from patients in three stages are listed in the following tables Table 1, 2 and 3. These attributes are finalized in discussion with Madras Medical College. A mobile application is used to upload all the measurements

Table 1: Stage 1 of data for IHD

Stage 1						
1.Age	2. Sex	3.Menopause	4.Height	5. Weight	6.Body Mass Index	7.Waist Measure

Table 2: Stage 2 – Co Morbid Factors of IHD

Stage 2				
Co-Morbid Factors				
8. SBP	9. DBP	10. Diabetes	11. Cholesterol	12. Thyroid

Table 3: Stage 3 of data of IHD

Stage 3				
13.Personal habits Y[1] / N [0]	14.Family history Y[1] / N [0]	15.Genetic factors Y[1] / N [0]	16. Type A personality Y[1] / N [0]	17. Sleeping disturbance Y[1] / N [0]

Type 4 : Risk of IHD

Absolute Risk of IHD			
No Risk	Low Risk	Medium Risk	High Risk

A software mobile application is proposed to get the parameters listed in Stage 1, 2 and 3. In rural areas, Primary Health Care centers(PHC) generally help people for basic medical issues. In this work we propose to take the measurements with the help of supporting staff present there. The patients will be advised to report the measurements once a week. Parameters like age need to be orally asked to patients parameters like Systolic blood pressure (SBP) can be measured with Pressure measuring machine. Initially, based on the parameters collected risk of the patient is classified by experts, based on their experience. To make the system critical, it is suggested to have minimum three expert opinions. In case of contradiction, the class label value is the maximum This data collected along with the class label will be analyzed by decision support system and in case of critical cases (High risk), doctors and ambulance services will be informed to support the patient immediately. Patients with low risk and medium risk will be advised to visit doctors, take medications with diet recommendations. If recommendations are not followed reminder/warning messages will be given to the patient and the relative(s). Based on the recommendation, few of the stage 1, 2 and 3 parameters need to be collected on every visit (weekly/ monthly). Few parameters may be static and automatically updated(like age). The proposed system will reduce the number of sudden death of patients due to IHD especially in rural areas as continuously health parameters are monitored.

6. CHALLENGES

This work to implement in rural India is a big challenge due to following reasons

People have to report to PHC weekly (or at least monthly).

Cost of Equipments. Approximately 23,236 health care centers are there in India [39].

Approximate cost		
Weighing machine	:	Rs. 3000/-
Height measuring machine	:	Rs. 3000/-
Pressure machine	:	Rs. 1500/-
Diabetes measuring machine	:	Rs. 1000/-
Cholesterol measuring machine	:	Rs. 3000/-
Thyroid checking machine	:	Rs. 5000/-
Total approximate cost (Minimum)	:	Rs. 16500/-

In a single PHC, at least two sets of equipments are to be kept(one for male and other for female).

Ability to manage all devices

Data analytics for doctors and patients

Device maintenance

Security of data in cloud

7. CONCLUSION

The paper has given the latest developments in redesigning healthcare using IoT. Further the paper proposes a system for reducing the death ratio due to IHD especially in rural areas. Further in non critical cases, medicines can also be delivered to the rural address if pharmaceutical companies are connected with IoT with the prescription of Medical practitioners. As a result a set of recommendations to maintain the health of a individual in terms of advice on exercise, scheduling tasks daily, relaxation methods like hearing music, laughing loud, viewing comedy shows, watching movies etc. will bring a transformation in health care domain. But while redesigning the health care systems with IoT especially in rural India there are challenges as mentioned in section 6. But overcoming the challenges will lead us to build a healthy India

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