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A Portable Electronic System for Health Monitoring of Elderly People

[1]KUPPAM VINEELA RANI, [2]Y. SHABEENA

[1]M.Tech., Dept:Digital Electronics & Communication Systems (DECS), Email id: kuppamvineelarani@gmail.com, Sir C.V.Raman Institute of Technology & Sciences, Tadipatri - Anantapur - Andhra Pradesh

[2]Asst. Professor, Dept:Digital Electronics & Communication Systems (DECS), Email id: cvrtecetdp@gmail.com, Sir C.V.Raman Institute of Technology & Sciences, Tadipatri - Anantapur - Andhra Pradesh

Abstract:

Elderly individuals are expanding as a rate of the populace in Ecuador and everywhere throughout the world. As per populace projections, Ecuador will have matured a 12% more than the present record by 2050. Consequently, the utilization of innovation to give remote observing and medicinal services benefits at home would decrease the popularity that healing centers right now understanding. Under these suspicions, this paper depicts the usage of a model to screen the wellbeing status of elderly individuals. The framework gathers information from various natural factors of the human body, for example, temperature, blood oxygen level, heart rate, body position, and even electrocardiogram signals. This propotype likewise utilizes portable correspondence (i.e.,GSM/GPRS) to send cautions and aggregate information at a Web server. That server may produce electronic wellbeing records keeping in mind the end goal to help far off specialists. The execution of the framework was investigated by unwavering quality, normal testing rate at every sensor, and message dormancy through the versatile system. With this proposition, we search for a huge change in the personal satisfaction of elderly individuals by averting conceivable

crises that may bring about the passing of patients.

Index Terms—e-health, wireless communications, biometric sensors.

Introduction:

Implementation of computer technology in all fields of life, is very useful either it is about crossing through the door or measuring nutrition value in a cup of tea. In computer technology, innovation is increasing day by day and improving the capabilities to overcome the problems faced by the human beings. Although it is an old story to implement IT in health care field, but still in some fields of health care, computer applications can make a difference. To improve the quality of life for heart patients by computer application is one of the most important. E-Health is valuable use of information and communications technology (ICT) to provide medical information, maintaining the patient‟s record in electronically, and support user interaction with the system. “E-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies”. E-Health also emphasizes on the use of ICT in the field of health and medical care including, electronic prescriptions, electronic health records, digital imaging and health information directed at citizens via web portals. E-Health services facilitate the easy and secure exchange of vital health data between healthcare providers, policy makers and patients.

Heart diseases are very dangerous, chronic and miserable for the life therefore some time a patient may have sudden death due to such kind of chronicle diseases. Precautionary, a patient should have some diets, exercise, medicines and visiting to the doctors for consultation but it is not easy for the old patients to move frequently to their doctors for checkup

and other precautionary measures. It is a difficult task for the doctors and care givers to handle such kind of patients because some time heart diseases become lethal. The medical staff also has to maintain the history of the patient‟s i.e. previous heart problem, abnormality of heart beats, heart attacks, diet, medicine, exercise, heart patient in the family and visit to the doctors. This information supports for optimal decision of the medical staff to safe the patient from sudden mishap. To overcome these problems in health care especially in heart department, Intelligent Decision Support System (IDSS) is a very helpful solution. Intelligent Decision Support System (IDSS) based heart monitoring system will very helpful for the both health care providers as well as for the heart patients. Due to such intelligent decision support system, heart attacks, rate of sudden death, unnecessary visits of the patients to the doctors and unnecessary expenses may also be reduced.

IDSS based system will be helpful to make quick optimal decision for providing understandable information of the patients to the doctors for necessary decision. The patients also demand such type of system which helps them to make remotely communications with health care providers due to any heart problems and reduce their continuously and unnecessary visits to the hospitals. So the system should be accessible remotely. There are many sophisticated devices for recording i.e. Medtronic Reveal Insertable Loop Recorder. These record the data of ECG for up to the time period of fourteen months. With the help this device, by doing an experiment for fainting episode, user can press the activation button with his hand. The physicians can analyze from the stored information of a specific time period to determine whether it was remove by an abnormal heart rhythm. For example, if a patient suffers due to the serious rhythm irregularity, they perform only

recording instead of real-time classification of ECGs and then the classification is performed off-line.

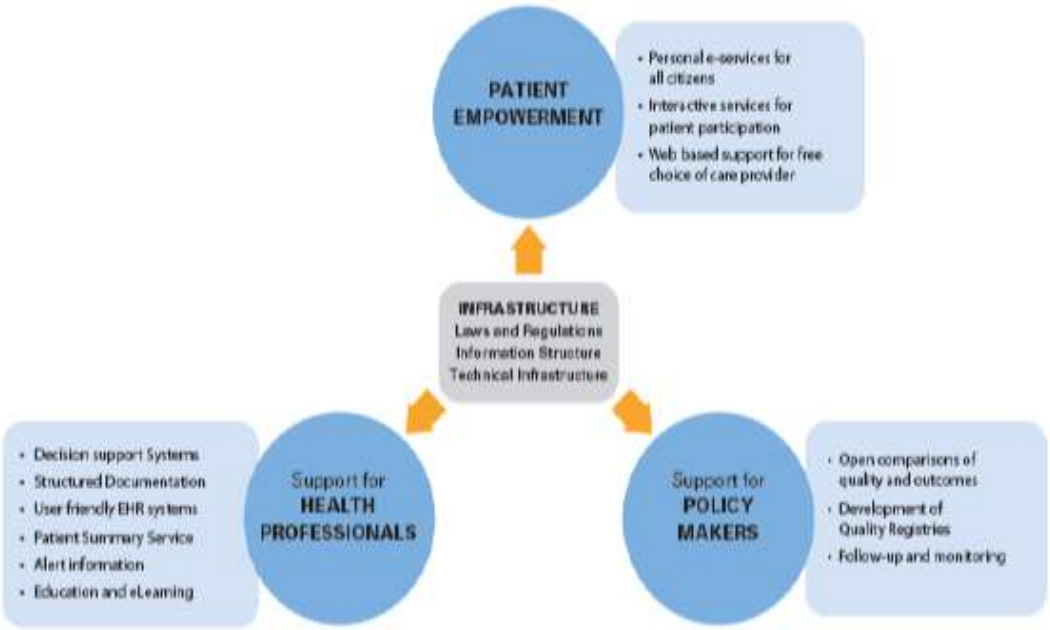

Figure 1: - Basic concept of e-Health

Health Monitoring System

Health monitoring system is used to monitor the patient activity and get the clinical information. Remote monitoring of patients at home, with the help of telecommunication and information technologies is an emerging field in healthcare. Monitoring system may include video-monitoring, telemonitoring, messaging reminder, alerts. With the help of monitoring systems, the health professional, monitor the electrocardiogram, pulse oximetry, glucose, and movement or position detectors. These technologies provide the clinical information about the patient's current condition and support the medical professional for decision making. Fast development in communication and information technology have opened a numerous of

new trends of healthcare delivery in far-flung areas. This new form of service delivery, not only provides the healthcare facility to far-away populations, but also makes it possible to monitor the health condition of elderly and chronically ill patients at their homes. Due to the alarming increase in the population suffering from chronic diseases in advance countries, that has absolutely distorted the healthcare systems in these countries. Chronic diseases should be monitored properly during all phases of the treatment.

Health monitoring systems can play an important role in improving the lives of patients, especially the weaker part of the population including disabled, elderly and chronically ill patients. Such patients may be able to get standard healthcare facility without visiting to their doctor regularly. These technologies facilitate to both patient and doctors. Doctors can save their time and focus more on priority tasks and the patient avoid making extensive visits to the doctor, especially if they live in a remote location. Moreover hospitalizations expenses decreasing due to use of the technology. In case of chronic diseases such as diabetes and heart problem in remote areas, there is acute a shortage of specialists, which is a big challenge facing by most countries in the world. The health monitoring system solves this problem and improves the overall quality of health service in remote areas. There are major two types of monitoring systems, telemonitoring and video monitoring.

Health Monitoring System for Elderly

In the most developed and developing countries, the population of elderly is increasing faster than any other segment of the population. According to WHO report the population of elderly people having age 60 or above will be double in the year 2025. Sweden is a country having the oldest population in the world after Italy, Greece, and Japan and nearly 24% of population in Sweden (about 2.2

million) were in group in population having age 60 or above in 2006. It is estimated that in 2035 the greater part of the Swedish population will be in aging group, which are unable to work. Elderly are the largest consumer of health care in Europe. They consume three times healthcare resources as compare to other age groups. There are increasing numbers of elderly people in Europe as well as in the other developed countries. From the last three decades, there has been an increased reliance on the family to provide help to their sick old relatives but now in the developed countries especially in North Western Europe, it is carried out by the state. Sweden spends a major portion of its gross domestic products (GDP) for its elderly citizens than any other country in the world.

According to the World Health Organization reports, chronic diseases, such as heart disease, stroke, cancer, chronic respiratory diseases, and diabetes, are by far the leading cause of mortality in the world, representing 60% of all deaths. The proportion of people aged over 60 years is growing faster than any other age group, because of both longer life expectancy and declining fertility rates. Coronary heart disease is the leading killer of older people; half of all heart attack victims are over 65. The large amount of patients with chronic diseases and the increasing percentage of older adults, combined with the rising cost of medical procedures, will place an enormous strain on the world's healthcare industry. More than 160, 000 Swedes are being affected by the heart failure, which is approximately 2% of the total population, in this percentage 10 to 15 % people are more than 75 year of age.

According to official statistics of Sweden regarding health and medical care, almost 72% of all deaths were in the age group of 75 years or over. The leading cause of death for both men and women was Heart diseases (circulatory system), which was the

primary cause of death among 39% of men and 41% of women by the year 2010. Cardiovascular diseases kill more people each year than any other disease. According to (W.H.O) report, the underlying cause of death in the world by the year 2008 was cardiovascular diseases, as shown in the following table.

Disease Name	Deaths in millions	% of deaths
Ischaemic heart disease	7.25	12.8%
Stroke and other cerebrovascular disease	6.15	10.8%
Lower respiratory infections	3.46	6.1%
Chronic obstructive pulmonary disease	3.28	5.8%
Diarrhoeal diseases	2.46	4.3%
HIV/AIDS	1.78	3.1%
Trachea, bronchus, lung cancers	1.39	2.4%
Tuberculosis	1.34	2.4%
Diabetes mellitus	1.26	2.2%
Road traffic accidents	1.21	2.1%

Table 1: - Cause of death in the world

Cardiovascular diseases are defined as the" disorder of the heart and blood vessels". Cardiovascular disease (CVD) includes:

- Coronary heart disease(CHD): disease of the blood vessels supplying the heart muscle;

- Cerebrovascular disease (Stroke): disease of the blood vessels supplying the brain peripheral arterial disease: disease of blood vessels supplying the arms and legs
- rheumatic heart disease: damage to the heart muscle and heart valves
- Hypertension: raised blood pressure
- Heart Failure: heart is not pumping as well as it should.
- congenital heart disease: malformations of heart structure existing at birth

The normal heart is like a strong and hard-working pump. Heart is made of muscle tissue having size little larger than a person's fist. The normal human heart is composed of four chambers, two upper chamber called atria and the lower two chambers called ventricles. There is a wall of tissue called septum between these chambers are strong, hard-working pump made of muscle tissue. The heart also contain four valves helping pumping the blood through these chambers. The blood flows by opening and closing of these valves. Each valve has a set of flaps. The blood flows only in one direction. The electrical system of the heart is also called the cardiac conduction system. The Electrical signals of heart called heartbeat (expands and contracts) control the pumping system of the heart.

Problem Definition

There are many patients, who are in chronic condition and need long-term and ongoing health care. Elderly people also prefer to stay in their own homes where they can have the right to use of public support, shopping, transportation services, social activities, and health care when they needed. They need to have medical treatment at their doors, from the doctors in case of any emergency or abnormality in the working of heart. Therefore, many elderly people wish to

remain as independent as possible in their own home for as long as possible.

It is not possible for the elderly heart patients to visit their doctor every day for regular checkup or any laboratory test. They are too weak to attend the hospital appointment regularly. On the other hand, patients have behavior to avoid from the visiting to the care provider. Sometimes there is much crowd in clinics and hospital and patient have to wait for long time of their turn, which is also problem for patients. Heart monitoring system (Holter Monitor) is used for heart patients to get heart electrical activity data for analyzing their previous condition. The heart monitoring system is attached with the patients and after few days, the patients have to go to the hospital and cardiology department, the holter monitor attached with the system to get heart electrical activity data of the patients for analyzing. Although some time heart diseases, e.g. heart attacks become very dangerous and fatal and these should be controlled immediately but through the current Holter Monitor, it takes a time to know about any abnormality in heart. Sometimes even patients can not inform to the doctors during such serious attack.

Therefore, the above mentioned challenges and problems have contributed the significant role in our research study and encourage us to do research for IDSS (Intelligent Decision Support System) based heart monitoring system to save the life of elderly heart patients from any emergency. Therefore medical resources such as budget, life and time as well can be saved and can be utilized for constructive activities. Patients may have a lot of time to spend with their relatives and friend instead of in hospital because human beings are social animal and they want to interact with each other.

METHODOLOGY:

Bluetooth Enable Holter Monitor

The Bluetooth enable Holter Monitor is not limited to just recording ECG

but also has functionality to transfer ECG data via Bluetooth simultaneously to intelligent decision support system [91].

5.3.2. Bluetooth

Bluetooth technology is a short-range wireless communications technology. This technology has vast use ranging from mobile phones and computers to medical devices and home entertainment products. The key features of Bluetooth technology are simple, secure, robust, low power, and low cost [69, 91]. In proposed system the functions of Bluetooth transfers data from holter monitor to DAM.

5.3.3. Data Acquisition Module (DAM)

The main function of DAM is to acquire patient‟s ECG data from holter monitor through Bluetooth. The ECG signal obtained by the DAM is in the range of 1 to 5mV. Due to weak voltage level of the ECG signal, there is need to amplify for analyzing purpose. DAM also performs this function. The amplified signal is then fed into the ADC circuit for A/D conversion [18]. This processed ECG data is send to computer based IDSS system.

Intelligent Decision Support System

Our proposed system is an efficient mechanism for real time alert for heart monitoring. Our proposed system helps the cardiologist to notify promptly when abnormal condition occurs. IDSS is proposed for this functionality. The proposed heart monitoring system enhances the functionality of current heart monitoring System (Holter Monitor). The heartbeat generated by heart monitored by holter monitor. These heartbeats can be sent through the wireless devices (Bluetooth) to our proposed intelligent decision support system (IDSS) via DAM. In IDSS the heartbeats analyzed and in case of abnormality and alarm is generated, which is received by Cardiologist, Nurse or Emergency depending upon the degree of abnormality.

IDSS is inherited from DSS that uses different intelligent techniques to solve the real world problems and find out the most optimal solutions. There are different kinds of multiple IDSS, which include.

- IDSS that replace the existing model
- IDSS where the functionality is added to enhance the existing model in order to make it intelligent

In the context of our research, we proposed the second model of IDSS, which enhances it functionality. It has ability to improve and increase its analytical capabilities. Normally IDSS has large number of options to analyze the problem and has to decide among the options in short time.

Decision Support System (DSS)

Decision support system is an important computer-based tool. The main purpose of DSS is to support and improve decision making. DSS support in complex problem solving mechanism and assist the human to make better decision. In health-care, such systems used to improve the quality of health-care, with the possibility of reduction of hospitalization cost without loss of quality. Successfully implemented DSS can help to diagnose the complex diseases and save the time for an optimal decision. Decision Support System is a general term, which can cover all types of systems in the field of health-care.

Architecture of IDSS

The ECG signals from holter monitor are detected by detector, and separated in to normal and abnormal heartbeats. Normal heartbeat stored in database and abnormal heartbeat stored in buffer zone for 30 second. Abnormal heartbeats are then analyzed by analyzer. Alarm generated depending upon potency of abnormality. In the architecture of the IDSS for elder heart patients, different functions of holter monitor e.g. monitoring; storing and alarm are integrated without disturbing each other. An integrated architecture is useful for the system. Therefore, the system can be efficient and consistent.

The use of intelligent decision support systems (IDSS) in holter monitor will make it more efficient and intelligent. The care giver will be able to quickly gather information and process it in various ways in order to assist the elderly heart patient in some severe situations. IDSS will also enhance the functionality of current Holter Monitor.

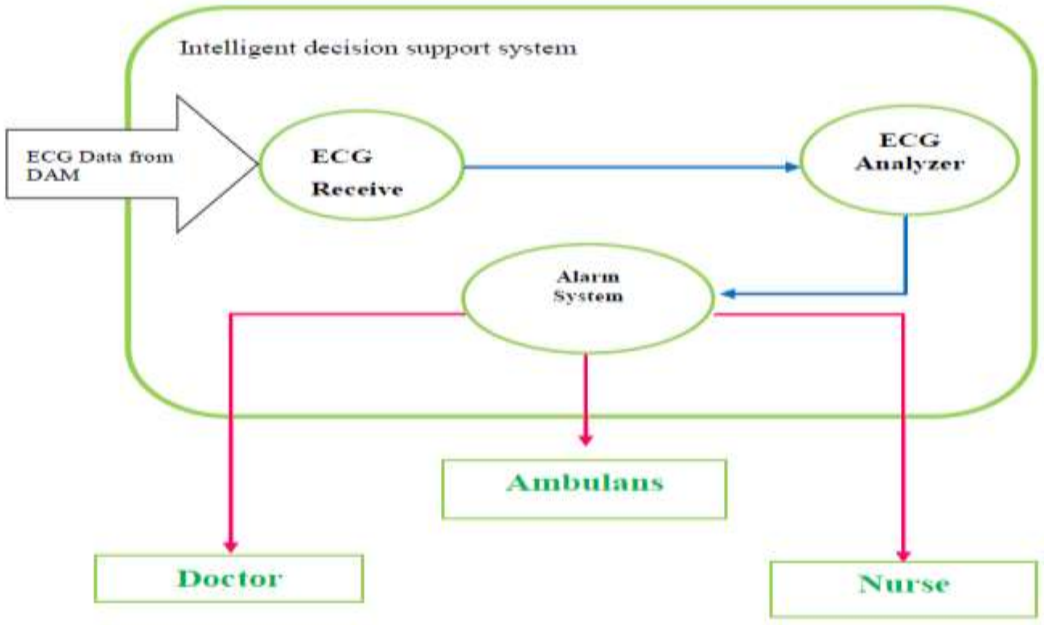

Figure 2: - Intelligent Decision Support System for Holter Monitor

The Intelligent decision support system in Holter Monitor will monitor the heart activity in case of any abnormality. It will pass an alarm to Nurse, Cardiologist or Ambulance depending upon the type of abnormality. In this way, the patient will be treated in time and will be saved from complex situation. Therefore, the system will help to save from complex condition of heart patients and reduce the treatment cost as well.

ECG Receiver

The main function of the ECG Receiver is to receive the ECG data

from DAM via wireless. After receiving the ECG data, it will be sent to the ECG analyzer for analyzing the ECG.

ECG Analyzer

The electrocardiogram (ECG) interprets the electrical activity of the heart and is the most important data to investigate heart diseases and conditions. In each ECG cycle, QRS Complex, S and T wave are the feature points with physiopathological significance. These points show the action potentials of different chambers of heart .

- P wave corresponds to the contraction of the atria
- QRS complex (composed by Q, R and S wave) corresponds to the contraction of left ventricle
- T wave corresponds to relaxation of the ventricles

Hence, it is possible to find out the heart condition and degree of disease of the patient based on the features of ECG signal. The fuzzy method is the appropriate method for classification of ECG. Hence, the fuzzy ECG classifier is used in proposed heart monitoring system. The fuzzy ECG classifier is comprised of two major function blocks, ECG Parameterizer and Fuzzy classifier. The ECG Parameterizer block is used to detect the characteristic points, including P wave, QRS Complex and T wave, of ECG signal base on the method of Wavelet Transform (WT). The derived parameters including amplitudes and durations will be sent to the second block fuzzy classifier for classification of ECG. The level of abnormality of heart will be determined. The signal depending upon the level of abnormality will be generated by alarm system.

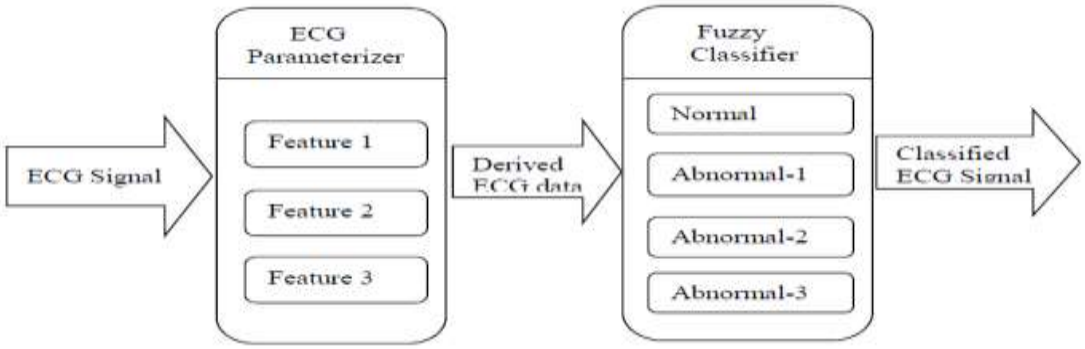

Figure 3: - ECG Analyzer

Alarm System

The main function of alarm system is to send the information of heart beat to the Doctor, Nurse or emergency staff according to level of abnormality. If abnormal heart beat found but condition is not worse than signal will be send to heart nurse to see the patient. In case of the abnormality is alarming than the signal will be sent to the doctor to see the patient. If the abnormality is worse than the alarm will be sent to ambulance to treat the patient immediately.

RESULTS

Three respondents have suggested that there should be a real time heart monitoring system to save the lives and the recording capability of the heart monitoring system should be extended. According to the respondents, heart monitoring system (Holter Monitor) gives the accurate and efficient result but it has some flaws which should be filled. They responded that in some extent the current heart monitoring system is not fully supporting in case of acute situation. It does not transfer any data or message to the medical specialist about any abnormality in a real time. The data gathered through the question expressed that the patients dont fully satisfy because it does not support in case of any emergency. The accuracy of data depends upon the daily report of activities and symptoms in detail.

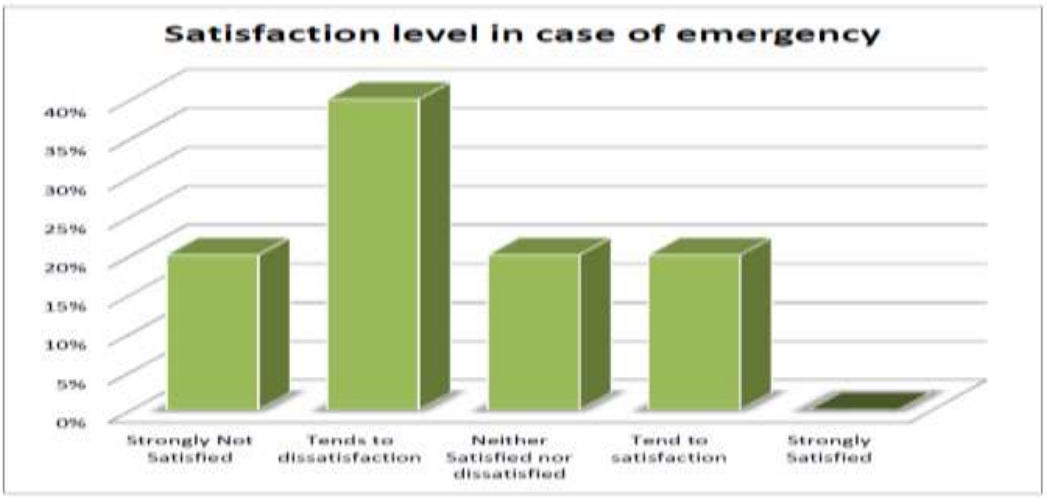

Figure 4: - Satisfaction level in case of emergency

They also gave their views about the recording period of the current heart monitoring system. It was judge in lieu of the data gathered from the survey that there exists a drawback that the current heart monitoring system has very less recording period up to 48 hours. If the holter monitor dairy sheet is not completed properly, there might be some percentage of error in analysis. So the dairy should be maintained properly. But some time patients forget to write down the symptom and time of occurrences. Suggestions from the respondents are as under.

Figure 5: - Effectiveness, while evaluating the functionality of implanted devices

In the current holter monitor, the patients have to maintain the diary sheet regarding the time and date in case of any emergency. It was asked from the patients in the survey that how much you satisfy to maintain the diary. Most of the respondents gave their views that they were not satisfied to maintain the diary because sometimes they forget to write the exact time and date.

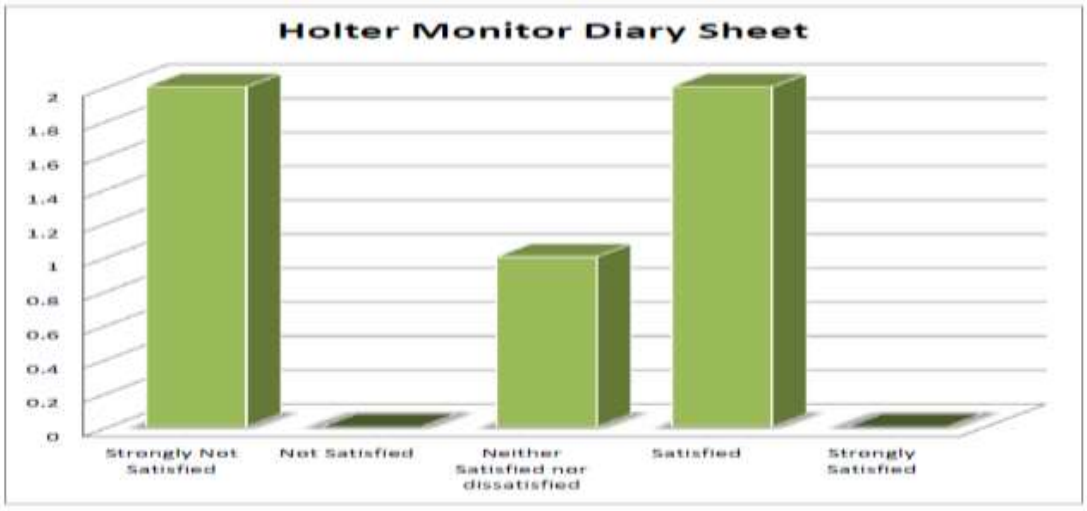

Figure 6:- Holter Monitor Diary Sheet

Discussion/Analysis

Heart disease is a major cause of death in the world, especially in elderly people. Heart diseases affect the elderly people in large scale. Heart monitoring system for elderly people is big challenge in developing and developed countries. Currently there are two broadly applicable systems for heart monitoring, ECG data recording and analysis. First, is a real-time recording of ECG during patient examination at hospital and second is a 24-48 hour ECG recording with a post analysis called Holter monitoring. The weakness of the first method is that it is not possible to have the complete diagnosis, which often requires more monitoring and recording than a single ECG recording. The inadequacy of the

second method is that it is not possible to inform concerned medical staff immediately in emergency, which sometimes can have severe consequences. Moreover, the analysis accuracy of the recorded ECG data mostly depends upon the patient diary. Our proposed system is an intelligent decision support system based heart monitoring and alarming system for elderly heart patients living alone at home. We are able to detect life-threatening heart abnormality in time. Through IDSS based proposed system, we can make contact with an ambulance, doctors, and medical staff respectively according to the condition of the heart patient. However, in normal situations, our system is capable of monitors and records the ECG data for further analysis by specialist. This analysis will be helpful to know the condition of the patient. Our focus group is elderly heart patients that have had a heart attack, or are at high risk and have sometime heart problem not clearly. We learned from discussions with cardiologists that these patients are worried that a heart attack will occur again. They are very impressed with our concept and agree with our proposed system. We have learned from discussion and survey with heart patient, that our proposed system more helpful in emergency situation and also to check the functionality of implanted devices like pacemaker. The patients are worried, that current heart monitoring system is not much effective in severe situation. They are facing problems with current heart monitoring system, when they undergo to check the functionality of pacemaker. Fuzzy based ECG classifier proposed for heart monitoring system, which is more suitable. ECG signal is very sensitive and have complex parameters, in order to analyze the ECG more accurately. In fuzzy logic, we measure the value between 0 and 1. Therefore, fuzzy based classifier, classified the ECG signal in to four

categories, Normal, abnormal-1, abnormal-2, abnormal-3.

In order to validate the concept, we have conducted the survey with heart patients from Sweden and Denmark and interviews with concerned health professional from Sweden, Denmark. The result obtained from survey with heart patients shows that, proposed system will play important role in heart monitoring field. The patients feel strongly agreed with our proposed system. We conduct interview with related health professional not only from Sweden but also from other countries for more evidence to validate our research work. There is a big scope of future work regarding our thesis. During the interviews when we described about the proposed heart monitoring system all the respondents had appreciated our effort for elderly heart patients. They encouraged us and promise to support in any kind of information related to our research in future. They said that with the existing system patients come to the doctors and then they are examine after analyzing the data received from current heart monitoring system, but due to the IDSS based system the doctors will be able to monitor the current condition of the patients even if they are at their homes. The doctor will have enough time to save the patients life in any abnormalities. Through the interviewees, it has also come to notice that the IDSS based system will help a lot to the both medical staff as well as to the heart patients. It will also be helpful to make any decision for patients health. Due to this system care providers will able to monitor the current heart condition of the patients and also the previous abnormalities which had been occurred, only by using the patients identification number or name. It will also reduce the unnecessary visits of the elderly patient to the doctors. It will more satisfy to the patients because they would be able to be helped with in short period of time, in case of emergency.

Conclusion

In this thesis, we proposed an intelligent decision support system based real-time alarm mechanism, in case of any abnormality in heart, in heart monitoring system. This will improve and enhance the functionality of current heart monitoring system. In the first step, we identified the effectiveness and shortcoming of current heart monitoring system. This was accomplished by conducting systematic literature review, surveys and interviews from heart patients and concerned health professional, from Karlskrona Sweden and Copenhagen Denmark, China and Pakistan. According to the results obtained from the surveys and interviews, there are some deficiencies in the current heart monitoring system. It is also find out, there is no any real time feedback or alarm mechanism, in case of worse condition of the elderly heart patient living alone in home. The current heart monitoring system (holter monitor) only records the ECG for 24-48 hour. It is also necessary for patient to maintaining the patient diary, in current heart monitoring system, which is problem for patient.

In the third step, based on shortcoming in current heart monitoring system, an intelligent decision support system proposed, to solve the issues in current heart monitoring system. The proposed system has capability of real time alert to health professional. The proposed heart monitoring system especially designed for elderly heart patient ling alone in home. The proposed system will also fulfill the future needs of heart monitoring.

In the last step, the proposed heart monitoring system was validated by conducting interviews from concerned health professional and survey from heart patient. We select the interviewees from different countries, Sweden, Denmark, Pakistan and China. This helps us for better validation of our proposed heart monitoring system. The result from interviewees and patients showed, the proposed system is the best option to

save the life of elderly heart patients. The proposed system will also help to reduce the hospitalization cost and will be more beneficiary in view of health professional as well as elderly patients.

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