A Conceptual System on Ubiquitous Cardiovascular Health-Care System (UCHS)

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***Abstract*— In a cardio center, heart-care monitoring system, it is essential to continually monitor the patient's physiological parameters such as heart patient parameters like heart rate and blood pressure to control their health conditions on an immediate basis. In this research work, a Ubiquitous Cardiovascular Health-Care System (UCHS) model is proposed that focuses the collaboration and mobility features in the proportion of working inside and outside of the hospital to interact with each other. The research study presents a model of a wearable UCHS, using an Electrocardiogram (ECG) and oxygen saturation (SpO2) sensors. The model suggests an uninterruptible healthcare system based on the ubiquitous wearable system being used to control cardiac issues to access, updated patient medical records anytime and anywhere. The physiological measurements of ECG data and other body activities data are transmitted for remote monitoring to the doctor's ubiquitous wearable device through the base station, based on the ad-hoc network using IEEE 802.15.4 and to hospital main-server.**

***Index Terms*— Electrocardiogram (ECG), Wireless Electrocardiogram (WECG), Sensor System, Cardio-Healthcare. Ubiquitous Cardiovascular Healthcare System (UCHS).**

I. INTRODUCTION

An early stage of heart-care system can address and prevent the diseases at the earliest possible moment, rather than a late disease model where the emphasis is mainly on diagnosis and treatment. Due to the aging population, the health-care and the delivery of health services today experience new challenges. A person who aims a prolonged life with the preserved quality of life is always ready to actively participate in his own health management. This paper has been focused over the Information Technology (IT) side of Cardiovascular Department of Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan, in order to, study its existing Cardiovascular System and to update it into the Ubiquitous Cardiovascular Healthcare System (UCHS).

The existing Electrocardiogram (ECG) heart monitoring system and corresponding equipment are installed in the facility, to provide minute-to-minute patient's heart activity over the little-screen display, visible in very limited jurisdiction such as emergency cardiac department, besides, in case of external caretaking they refer to the printed ECG reports due to non-availability of remote access of the ECG [1].

This kind of manual cardiac systems mainly used for diagnostic and information delivery of heart patients. In case of an emergency it does not provide an automated minute-to-minute update of heart activity, which enables the doctors to take immediate measures to control the critical situation to save valuable lives. The manual system does not even provide portability and mobility of information, of a huge number of serious heart patients to busy or patrolling doctors inside and outside the emergency cardiac ward.

The doctors, in traditional way, rush to the serious patient for taking-care and treatment or they eventually call the staff for health care instructions on the basis of printed ECG reports. But, what about the treatment of the emergency condition i.e., where, the overall action is to be required in minutes or seconds. What for the important steps or actions which are required to be taken by the surgeon only. How the healthcare takers will face this challenging situation. [2].

The issue is not limited up-to-the cardiac patients, yet the other patients of several diseases are also doubted about suffering a heart problem. What about this condition, how the specialists will face the other department's patients from the remote area, not limited to the other departments of the same hospital, but, the problem can arise in the nearby areas or the surrounding areas of the hospitals. Also, we can say that the heart seriousness can happen in other hospitals in the area, where, there is no such emergency ward for immediate treatment. How the issue can be resolved in providing the treatment on an immediate basis [3]. The answer behind the observations can be realized and seen as per our government strength / vision by providing strong and serious policy about taking the steps for providing a number of Cardio Emergency Wards in every nearby hospital, with the provision of modern facilities to face any unpleasant and serious conditions of heart patients.

This article is based on the mobile computing environment, because the author knows that the heart-care medical system everywhere deals dynamically with changing contexts. Our technologies are a quick and timely solution to the health problems of Cardio JPMC, as well as communicating with the external environment for the exchange of health information. The author plans to design more complex scenarios for more comprehensive tests and assessments of this system. The purpose of this study is to moderate the manual heart section of JPMC, to improve the care level of serious heart patients, and to conduct rapid computer procedures through which the system can inform the professionals.

II. LITERATURE REVIEW

The ubiquitous computing in digitalized health process is frequently declared in the situation of improving health-care with its pledge of better patient care and lower costs. Indeed, ubiquitous systems are the foundation stone of telemedicine, ambient assisted living and vital signs monitoring which according to technology forecasts will be common lifestyle elements in the future society. The ubiquitous technology has also been used to handle heart diseases and wireless ECG

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system. This paper presents an overall architecture for Ubiquitous Cardiovascular Healthcare System (UCHS) wherein its key technologies such as wearable devices and ubiquitous services equipped with seamless interaction across ECG to act as a bridge between the ECG, wearable devices and external sources. Ubiquitous smart services with its portability and mobility provide the opportunity to control serious heart condition anytime at inside or from outside the emergency jurisdiction.

The particular area where the research study is focused is the Cardiology Department of JPMC, Karachi. The aim of this study is to update its existing Cardiovascular System into UCHC system on the basis of technological base of current ECG system and its usability within the computing and information sharing level. The Cardiology Department of JPMC, having the traditional but improved ECG system deployed, wherein the patients rush in an emergency from all around the city. The Cardiology Department is the only place where serious heart patients are brought in by the peoples of the different localities. There are various reasons that peoples rush to JMPC in an urgent situation first and foremost, it is a government institute i.e., has nominal charges, and secondly it is an oldest and prestigious, govt. cardiology institute of Karachi [4].

JPMC is pioneer and founder institute of heart disease cure and control in Karachi, running since last 30 years. The JPMC's Cardiology Department has been well-furnished time-by-time and is equipped with modern technological ECG system, which is working in a superb way. The field of medicine has been getting advances through implementing broad and modest IT infrastructure, its products and services. With the fast pace of technology the vast field of IT yet has been expanding day-by-day. Any hospital or medical center, using traditional systems, as the new advancement came in the market, will have to systematically implement it into itself. The medical field is one of the mandatory stockholders of society life, which has been day by day getting strong with the modest and IT based architecture. There has been a vast improvement in ECG systems which were nothing more than just a reading display in the past [5]. In the second phase with the advent of fast computing equipment and improved software capability, the ECG became improved with timely, fast and more accurate health readings including blood pressure. In the third phase, the current era, which is equipped with the wireless network based smart and portable technology, the health readings are becoming more easy to get, handy to have, fast to receive and very common to everyone everywhere.

A Dutch scientist Willem Einthoven discovered in the 20th century that the heart emits electrical currents during a heartbeat and also developed the ECG as a tool to look at the electrical conduction of the heart. Each heartbeat begins with one tiny area of the heart muscle depolarizing. When this happens the electrical depolarization that triggers the muscle cell to contract quickly spreads to the next cell, and so on until the entire heart muscles contracts. Electrocardiography is a measurement over time of the net electrical activity of the heart muscle. It is measured in several directions simultaneously, and by interpreting the electrical currents of the heart throughout a series of heartbeats, from several angles [5]. This prospected vision is strongly supported by different Information Society Technologies (IST) programs, which in the recent years set a special focus on early sickness revealing and support non-invasive healthiness monitoring systems with flexible access for everybody, at any time and any location. The IST approach is vital within the domain of cardiac-care, where the ischemic heart disease is confidential worldwide to be the first cause leading to death and is among top six causes of burden of disease. This theory plans to donate to the early detection of cardiac ischemic happenings by putting in practice Decision Support Systems (DSS) based on ubiquitous computing, which offers people with an intelligent and self-adaptive support.

The subsequent topics are dedicated to general idea i.e., the medical surroundings, the available and applicable ECG recording, processing techniques and to introduce current results of related research studies. Ischemia is a medical situation where a blood flow limitation takes place, usually due to different aspects related to blood vessels like the surface of blood vessel are damaged or the dysfunction of the insufficiently irrigated body tissue. Cardiac Ischemia is caused by the insufficiency of blood flow and so the lack of oxygen supply to the heart muscle [6]. It has been observed that Cardiac Ischemia caused by the Coronary Artery Disease (CAD) which is the most common type of heart disease, which happens when the blood vessel (which supply blood to the heart muscle) become toughened and narrowed due to the build-up of a material called plaque on their inner walls. Besides, atherosclerosis or the plaque, which increases inside of coronary arteries and starts blocking the blood flow i.e., reducing the much-needed oxygen supply to the heart muscle.

A time comes when CAD will weaken the heart muscles and contributes to heart failure, which may commonly happen in a heart attack. Angina is a medical term for a chest pain, which occurs when the heart muscle receiving not-sufficient oxygen and produces a byproduct called lactic acid that builds up in the muscle and causes the pain. Such pain is typically described by a bunch of indications, such as a pressure, heaviness, discomfort, fullness, burning sensation, and aching or sore feeling in chest, so worrying that an acute infarction diagnosis and thus an early treatment is required. The overall above hazard position becomes life threatening if the brain, the heart or lungs are affected. That is exactly how a heart attack happens [6], [7].

It has been observed due to the perturbing statistic that 60% of peoples, who suffered a stroke or become dependent on others to help out with their everyday living, indicated prevention as a high priority strategy. The peoples fallen in such situations and became patients would have immense chances to endure only and only when the health care steps or medication would be delivered on an emergency basis.

The research reveals the precautionary points i.e., how quickly such steps are taken to save the life of a patient. The goal of health and especially ubiquitous Health (u-Health) is to furnish citizens with more proficient and approachable gear, that would assist the professionals to take steps in an urgent situation and assist patients themselves to continually carry out the basic health care steps in order to reduce the time of travel and diagnosis and give the opportunity of immediate treatment. The peoples having severe pain and abnormalities

of heart rhythm are supposed to rush to the nearest heart care hospital (cardiology emergency departments), wherein the situations are diagnosed with three principal tools; the history of the event, the 12-lead ECG and cardiac enzymes and other serum markers of myocardial injury [8]. Amongst these tools only ECG is taken which is suitable to maintain the regular self-care routine performance, as it is a non-obtrusive source of instant and objective information. The continuous changeable recording of ECG contains significant diagnostic information about the activity of the heart and so a signal analysis can provide an evaluation that supports the decision making [9].

As the wireless ECG has become in use, with the help of ubiquitous system installed at patients bad, would assist doctors or caring staff and will provide immediate and timely information to alert them for any unfavorable situation, over their wearable devices anywhere through the universal wireless network and anytime, in order to enabling them to take immediate steps to control the situation and pass the instructions apart from the different location or from the outside of the emergency department or hospital jurisdiction. The ubiquitous wearable devices will provide the staff with continuous updates even in a normal situation or the calm position of the patient [10]. The core objective of this research work is to support the success of this challenging techniques and enhancing traditional ECG system into u-Health in order to meet the emergency department's requirements. The Wireless Electrocardiogram (WECG) system was designed in order to improve the patient's safety and to provide better outcomes for the patient and their lower costs for rounds of hospitals. The installed system collects its patient ECG information through wireless equipment installed over the body of the patient and transmits it between the patient and the doctors through a universal wireless link that is compatible with many ECG devices. The benefits stated in the above technique and other patient care activities such as rush to the hospital timely and other hospital and bed acquisitions can be done more quickly and safely [11].

The aim of the research work is to add the new artificial intelligence based technological trends in the overall field of health, its caring centers and hospitals, for this reason, it was observed in the whole field of health and found heart domain is fit for this research study, in order to sustain the connectivity of the devices with the human body for extracting the results based on the changeable situations of the different parts of body i.e., ECG and blood pressure. Such instruments utilized the chips, connected with the human body, can make it happen and give the results-oriented measurements of heart and blood pressure [12]. In this regard, various sources were found and deep studies were conducted in such domain. After selecting the suitability of the research study, in the sphere of heart care, concerned with ECG system, it makes sense, to deploy the ubiquity in the selected domain of heart-care. Wherein, as per the question is concerned i.e., to set-up seem-less technology or the ubiquitous computing, to work as a bridge between the heart-care center, patient and/or doctor, to initiate the rapid heart-care actions. Apart from the traditional ECG system, limited up to the small area or patient's room based little screen information delivery system or the hardcopy reports based system, the modern e-ECG system can work in some broad and smart sense. In general, the smart e-ECG is not limited in working as comparable to the traditional ECG [13], [14].

The proposed system can be shifted to work for everywhere and anytime communicating via wireless media, web-based alarming gateways, and intelligent analysis for auto-generating diagnosis reports and to store ECG timely changeable reports/data. The main thing of the ECG system amongst the others can be the real-time diagnosis informers, which with the help of it, detects the different time positions and diagnosis situations to be reported [15].

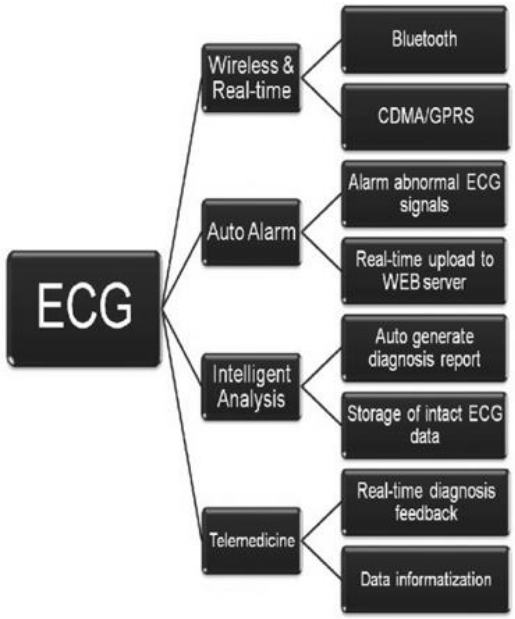

Fig. 1: Structure of ECG

The above figure i.e., Fig. 1, shows the framework of the ECG model, which is helpful for doctors, and also gives patient treatment relaxation. This model is capable of controlling serious cardiac patients within an emergency premise in a minute and changing the position is the state-of-the-art in context-aware technology. This system gives doctors and other related staff the opportunity to receive the patient's latest information and heart position via a mobile device with a system installed in it.

III. METHODOLOGY

The context-aware wearable device needs to have at least two principal elements; the intelligent agent (monitor), which might be sold as a separate device, might be embedded into a wallet, a mobile phone, a watch, or even installed into an ordinary personal computer and serves for signal recording, storing, processing and analysis. A sensor system must be reliably and conveniently placed on an individual at an appropriate location by a non-specialist citizen himself, in order to capture the heart's electrical signal.

The proposed model for controlling minute to the minute changeable position of serious cardiac patients within an emergency premise is state-of-the-art in the field of context-aware technology, which provides the opportunity to the doctors and other relating staff to receive latest information

and heart position of the patient through a mobile device with a system installed in it. The doctors would be able to view the updates of all the patients within the same device and would be able to give the instructions back in reply to the system to control the developing situation i.e., decrease the drip speed or stop the drip or injection etc., and will also able to circulate the instruction to the concerned staff to look after physically to the patient.

A. The Ubiquity of the System

The system of proposed model enabling the doctors to carry the mobile system along with them while patrolling inside or outside the emergency jurisdiction in or outside the hospitals. The hardware device and system would also be able to contain a record of the patients till days until the normalization of the heart condition or the releasing of the patient toward the room. The system would also be able to deliver the information to the main screen so that all the corresponding staff may watch it in order to take immediate action over the pertaining heart patient for delivering him relief. The proposed study is based upon the context-aware technology, with its ubiquity and seamless features, provides the information delivery over mobility and portability stages anywhere and anytime. The wearable ubiquitous healthcare monitoring system allows physiological data to be transmitted in wireless sensor network using IEEE 802.15.4 from on-body wearable sensor devices to a base station which is connected to a server PC. The physiological data can be displayed and stored in the server PC continuously. The physiological measurements of ECG data and other body odd activities data are transmitted for remote monitoring to the doctor's ubiquitous wearable device through the base station using an ad-hoc network using IEEE 802.15.4 and to hospital main server.

Fig. 2: Wireless Sensor Network (WSN) Management System

The above figure i.e., Fig. 2, shows the Wireless Sensor Network (WSN) management system. This system is very important and provides support to IEEE WSN i.e., it helps to create the healthcare system, which is based on the ubiquitous wearable system, being used to control cardiac issues to access, updated patient medical records easily. WSN is also an important support for quick correspondence of ECG and wearable systems.

B. Quick Correspondence between ECG and Wearable

The inner communication of the systems is based on the ad-hoc network, wherein all the devices would communicate with each other freely, and if any device wants to join, will requires permission from the server. Furthermore, it is very important to implement the ad-hoc network inside the hospital because it is mandatory that the patient's bed is movable and the ECG system must be battery workable and work independently, also the battery needs to be rechargeable. The patient may visit the operation theater or laboratory, in this sense, the ad-hoc network will connect the system everywhere and the overall working of the ubiquitous services will be available anywhere and uninterrupted.

Fig. 3: Model Frame of Health Care System

The above figure i.e., Fig. 3 shows the model frame of health care system. The author mentions the criteria of model i.e., all devices are connected to each other and create a bridge to check the ubiquitous wearable system and control cardiac issues with the help of this model framework.

IV. CONCLUSION

Sharing timely health information under a secured and authorized environment imposes an important technical challenge for realizing pervasive healthcare. Traditional rule engine does not deal with dynamic access control in a mobile computing environment. In this research, the author explored the idea of a UCHS, to deal with dynamically changing contexts. Techniques were employed, for quick and timely resolution of the health issues of Cardiology Department of JPMC and showed therein that how the systems can also be connected with the external environment to share the health information. The author decides the plan to design more complex scenarios to conduct more comprehensive tests and evaluation of the system. In general, the rule of thumb is that, the more the participants are involved, the more complicated interactions will be. The aim of this research plan is to moderate the existing manual Cardiology Department of JPMC for the betterment of the care of the serious heart patients, to make a quick computing based procedures through which the system may be able to inform the professionals and to assist them resolve queries of patients anytime and anywhere. For this plan, the author used the ubiquitous computing techniques, wherein the context showed the patient condition and the reaction based on the dynamically changing context.

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