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An Overview on a Low Power Telemedicine System

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***Abstract*—** The design of portable systems for remote monitoring of cardiac activity is one of the most important fields in telemedicine and telecare. Telemedicine system is an effective outcome of it and has become essential to the people especially living in rural, tribal as well as in the interior parts of the country and even in the world. Patient with acute heart complexity (might require regular checkups) are benefited with these systems. In this direction the lot of research has carried out to develop the wireless patient monitoring based on various communication protocols such as Bluetooth, Zig-Bee, mobile communication system, RFID WLAN systems, satellite system, GPS systems. In this paper an effort has been made to bring all such telemedicine systems together so that based on this review more effective low power telemedicine system can be developed which will serve the society better.

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I. INTRODUCTION

The term telemedicine stands for the use of communications and information technologies for the delivery of clinical care [1]. Telemedicine can be roughly broken into three main categories: Store and forward, remote monitoring, and interactive services. In the store and forward approach, the data (images, biosignals) captured from the patient are transmitted to the doctor at his convenience on a request basis for assessment offline. Online storage of medical records and their access by the medical personnel can be placed in the same category. In the remote monitoring approach, a patient is continuously monitored using various technological devices. This method is primarily used for monitoring patients with chronic diseases or specific conditions, such as heart disease, diabetes mellitus, and asthma or as a cost effective replacement for the intensive care units (ICUs) used after operations. The interactive telemedicine concept, on the other hand, includes several interactions between patient and doctor including phone conservations, online communications, and online diagnosis. Many activities such as physical examination, psychiatric evaluations and ophthalmology assessments can be conducted with interactive telemedicine. According to the user surveys, the store and forward, and remote monitoring telemedicine services have been found acceptable and even preferable since they ease the burden and costs of the frequent office visits [2].

The recent communication technology has proven its utility in telemedicine and telecare. Wireless sensor network (WSN) are becoming increasingly important for monitoring patients in the clinical setting and at home, thereby providing more comforts for the patient regarding reduced cost and more flexibility. The main components of a communication set up are sensing nodes and transmission technology in order to transport data among network nodes. Wi-Fi, Bluetooth, GSM, GPRS, Zig-Bee, RFID Wireless LAN, mobile IP, Satellite and 3G system standards etc. are the most popular available transmission technologies. [3].

In this paper various wireless telemedicine systems has been considered for the discussion along with their features as well as improvement scopes based on which a low cost, low power system can be suggested.

II. LITERATURE REVIEW

There are various wireless biomedical monitoring systems to capture physiological signals, which incorporates sensor network, data acquisition systems, display, communication networks etc. Main objective of such systems is to transfer live data via mobile phone networks with varying reception and quality of service and implementation of adaptive system behaviour for medical devices and equipment at the patient's home [7]. Primary task of the device is to gather all information from the medical devices via Bluetooth, USB or WiFi or other interfacing techniques.

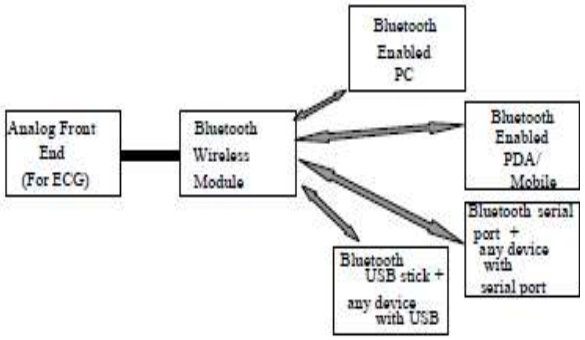

Figure 1. Block diagram of wireless physiological monitoring system

As mentioned in the paper, "**An Application of Embedded System in Telemedicine Using Arm-7**"by Mr. Prafulla P. Chaudhari, Mr. Dhiraj G. Agrawal and Mr. Mandar M. Kulkarni published in "International Journal of Innovations in Engineering and Technology (IJIET)"The system shown above in figure 1 is the advanced ECG monitoring system designed to monitor a very important parameter i.e. ECG and comprises of Analod to Digital convertor(ADC), Bluetooth as a wireless communication Protocol, ARM 7 as a microcontroller and PDAs. The complete assembly is Blue-tooth based in order to reduce power requirement, to make it cost effective with less complexity. The used wireless communication Protocol supports point to point and point to multipoint data transfer with a range of 10-100m. As it is not limited to line of sight communication and supports 723.2

kbits, which is adequate for most of the medical parameter data transmission. Figure 1 shows the block diagram of wireless physiological monitoring system [6].

Figure 2 shows, multi signal sensing system [6]. The main module is interfaced with the sensing module and the output module. The user can select different function modules according to their own needs. The data from various sensing need can be transmitted serially depending upon the user's need. Meanwhile, some other functional modules can be expanded depending on market demands, for example, the photoelectric communication module, fetal heart rate monitoring. The design structure is convenient not only to use but also to update. [6,7]

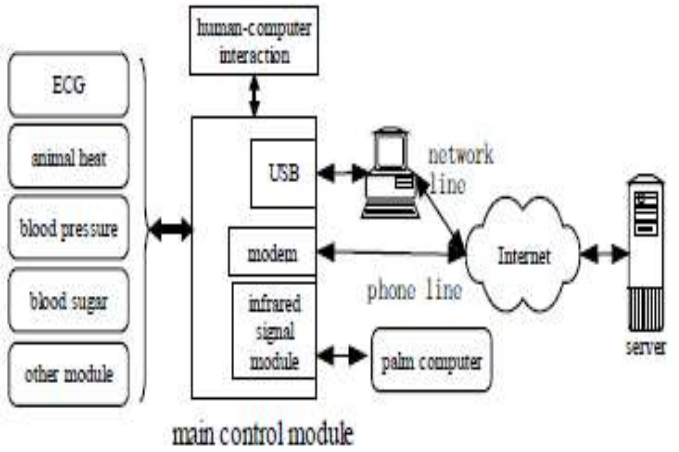

Figure 2. Embedded data acquisition system module

The main control module may use any microcontroller for data processing. Communication with functional modules, data storage, data transmission is achieved through this etc. Through controlling the main functional module, the user may operate the functional module as well as other system functions and the data will be saved in the main control module. The controller module can then send data to the server or communicate with palm computer through infrared modules in the form of wire dialers or PC linked with internet through USB interface. This three data transmission mode can satisfy the requirements of the majority of the user [6,7].

As mentioned in [3], system architecture of telemedicine system, figure 3, describes the overall system architecture of mobile telemedicine system. It depicts that, the system comprises of a telemedicine unit and base unit. The telemedicine is responsible for collecting and transmitting biological signals and still images of the patients to the base unit (or doctor's location). At base unit user can monitor biological signals or still images coming from the telemedicine unit, thus keeping a continuous online communication with patient location. When the base unit is located in the hospitals (especially in emergency handling or in home telecare), a hospital data base unit can be integrated in the system in order to record information concerning the cases handled. The doctors can retrieve medical history when required.

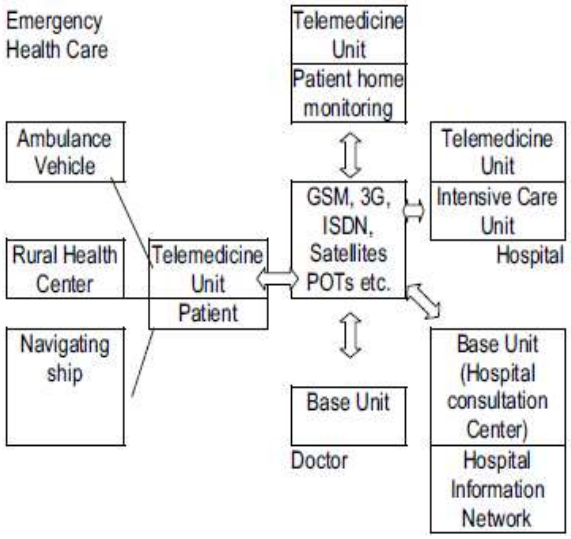

Figure 3. System architecture of telemedicine system

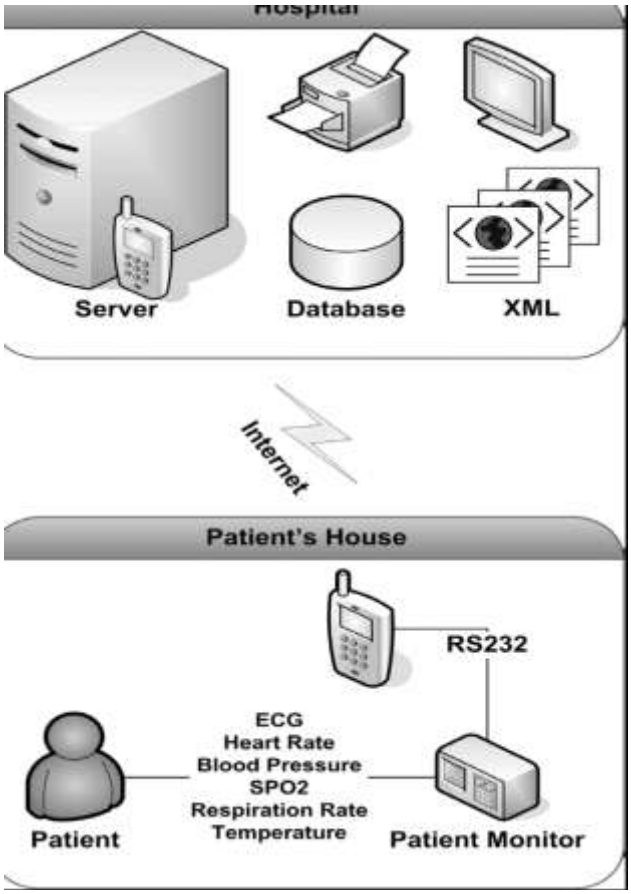

Figure 4. Mobile telemedicine system

As shown in figure 4 of telemedicine system on mobile uses the communication protocol that runs on the mobile phone. It is implemented using JAVA Mobile information Device Profile which provides provides the core application functionality required by mobile applications.[17]. The body parameters or the related signals are first converted in packets

and then uploaded to the server using TCP/IP and/or UDP protocols. The server kept in hospital stores data in a properly coded database. Then, the respective team of health supervisors monitor the patients using this database. Also, signals can be exported to XML files or printed.[7,17]

III. PROBLEMS ASSOCIATED WITH EXISTING TELEMEDICINE SYSTEMS

As shown in figure1 (Block diagram of wireless physiological monitoring system). Bluetooth is a recommended protocol for transmission, but range and communication interferences related with the biomedical crucial signals is an important limitation of the system. In addition for the application like home monitoring and continuous monitoring of the patient where the probability of introduction of noise is higher along with latency and fidelity issues of wireless transmission; and also to get clinical grade accuracy, a novel algorithm is required for wireless data transmission to reduce higher frequency noise and which can work in any patient position and with any sampling rate without affecting the original biomedical signals.

As shown in figure 2 (Embedded data acquisition system module), major issue to be considered is regarding choice of processor with respect to the power consumption ,circuit complexity , low cost , size and multi functionality. As shown in figure 3, (system architecture of telemedicine system), there are some limitations to existing wireless technologies for health that mostly depend on GPRS technologies. Some of these issues like lack of flexible and integral telemedical linkage between various mobile telecommunication systems, high link cost, especially between global mobile services, wireless transmission data rates especially for 2.5 G and 3G services.

As per figure 4 (Mobile telemedicine system) the patients data is first collected, converted into the appropriate packets and then transmitted or uploaded on to the server. This indicates that the data is not transmitted on real time basis as well as the modification is still required that the medical examiner should be in touch with the patient with acute dieses even though the doctor is either out of the hospital or out of station.

IV. POSSIBLE MODIFICATIONS IN THE EXISTING SYSTEMS

For the design of an efficient wireless telemedicine system it is obvious to use the optimum hardware design so as to make the system more portable and handy for the patient. In addition to this the wireless connectivity of the system with either computer or the mobile should be quiet strong and uninterrupted. Side by side the complete system should consume less power and fast in a speed with highest accuracy. For the Development of wearable patient monitoring system it is essential to connect the data acquisition system (containing all the body sensors connected to it the) to the control unit wirelessly. For this the latest wireless communication protocols like Bluetooth, Zig-Bee etc can be used in a efficient way. The telemedicine systems considered here for the discussion require some or the other modification so that an efficient low power wireless telemedicine system can be developed to serve the society better especially the people living in interior part of the world can be benefitted more with this.

V. VARIOUS COMMUNICATION TOOLS

To meet the above proposed requirement the various communication tools can be used as per the requirement to the different applications. Some of such communication tools are mentioned below.

Network Simulator(NS2)

A network simulator is a technique of implementing the network on the computer. Through this the behavior of the network is calculated either by network entities interconnection using mathematical formulas, or by capturing and playing back observations from a production network.

"The Network Simulator provides an integrated, versatile, easy-to-use GUI-based network designer tool to design and simulate a network with SNMP, TL1, TFTP, FTP, Telnet and Cisco IOS device."

Network simulator allows the researchers to test the scenarios that are difficult or expensive to simulate in real world. It particularly useful to test new networking protocols or to changes the existing protocols in a controlled and reproducible environment. One can design different network topologies using various types of nodes (hosts, hubs, bridges, routers and mobile units etc.) [10]

Some of the network simulator are OPNET, NS2, NS3, NetSim, OMNeT++, REAL, J-Sim and QualNet.
we studied on some stimulators .

NS2 (Network Simulator version2): NS2 is a discrete event simulator targeted at networking research. It provides support for simulation of TCP, routing, and multicast protocols over all networks (wired and wireless).

NS3 (Network Simulator version3): NS3 is also an open sourced discrete-event network simulator which targets primarily for research and educational use. NS3 is licensed under the GNU GPLv2 license, and is available for research and development.

OPNET (Optimized Network Engineering Tools): It is extensive and powerful simulation software with wide variety of possibilities to simulate entire heterogeneous networks with various protocols

NETSIM (Network Based Environment for Modelling and Simulation): It is an application that simulates Cisco Systems networking hardware and software and is designed to aid the user in learning the Cisco IOS command structure.

OMNET++ (Optical Micro-Networks Plus Plus): It is a powerful, modular, component-based C++ simulation library and framework, primarily for building network simulators.

JSIM (Java-based simulation): For building quantitative numeric models and analyzing them with respect to experimental reference data Java-based simulation system is used.[10,11]

VI. STUDY OF SENSOR NETWORK AND SIGNAL CONDITION SCHEMES

Wireless LANs and protocols

Operation over WLAN

The biomedical signals can be collected with a general network model for the remote patient monitoring service is shown in Fig. 5 (a). Two entities in this network are the an Electronic Health service provider (e.g. hospital, or healthcare center) and the network service provider Monitored biological signal data from the patients is provided through a radio and core access network obtained by the network service provider to the Electronic -Health service provider.

Patient living in interior places and mobile patients can connect to either a WLAN or the WMAN. Figure 5 (b), shows wireless access to WMAN and WLAN are available while WLAN access is available only in some locations and WMAN access is available in all locations of a service area.

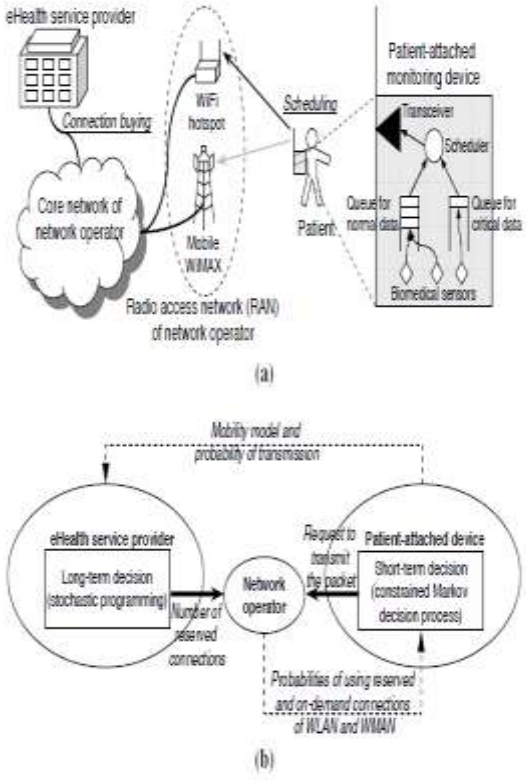

Figure 5. (a) Architecture of remot patient monitoting system and (b) decision of ehealth services provider and patient-attaced device [2].

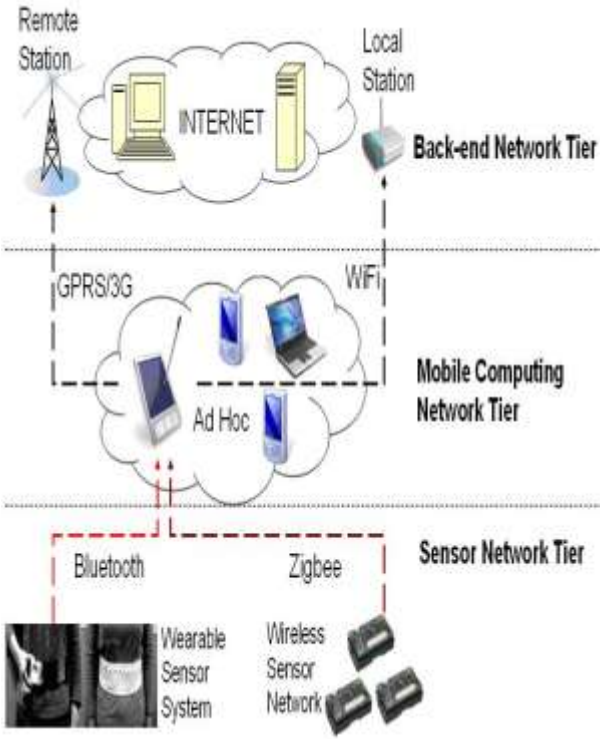

Figure 6. Healthcare system Hierarchical Network Architecture in wireless sensor networks [1]

VII. CONCLUSION AND MODIFICATIONS PROPOSED

Wireless telemedicine system is the primary requirement for the people suffering from the acute diseases and living far away from the health care centers. For such people who cannot afford long stay in the hospital for their treatment surely can be benefitted with the telemedicine systems proposed. The researchers are taking interest in using wireless and mobile technologies in patient monitoring systems in hospitals and nursing homes. However, there has not been much work in determining the requirements of patient monitoring and satisfying these requirements using wireless networks. In this paper, various wireless telemedicine systems have been studied and based on the problems associated with them some possible modifications including latest software tools as well as communication protocols have been suggested for more efficient (with respect to speed, accuracy, secrecy, power consumption as well as cost) system.

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