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WIRELESS BODY AREA NETWORK (WBAN) FOR HEALTH MONITORING SYSTEM USING SENSORS AND ANDROID APPLICATION

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Abstract:

Body area network (BAN) is an affirmating technology for real-time monitoring of physiological parameters of the patients. Tele medical system is provided when wireless technology is combined with body area network. When the Wireless Body Area Network (WBAN) comes in contact with the Android based smart phones gives a latest technology and is easy to use. The telemedical systems measures and evaluate the parameters such as heart rate, temperature, accelerometer and level. WBAN along with the use of the sensors, localization of patient, stores the data, analysis and representation on the smart phone, transmission of the data and emergency communication with the one who enrolled email address at the setting activity and a clinical server can perform the operation using this system. The Bluetooth based sensor nodes takes the parameters of patients then perform signal processing and data analysis, data recording and send results to the coordinator node.

Key Words: WBAN, Wi-Fi & GSM

1. Introduction:

Due to changes in technology, a continuous evolution is occurring in industries such as medical services, industrial manufacturing, and comfort services. In these industries, technological advances must be monitored to support decisions or actions that could benefit the processes supporting the industry. In medical services, researchers are developing tele-operated robots, prostheses, and smart monitoring systems to benefit services such as medical interventions, medical studies, and medical care. In public health institutions (PHIs) in some countries, the excessive number of hospitalized patients cared for by the nursing staff represents a problem. The nurses invest substantial amounts of time updating information about each patient's health by measuring values such as body temperature, heart rate, and glucose levels.

A smart monitoring system could measure the patients' progress in real time, providing continuous feedback on the improvement in the health of patients who have undergone treatment. Additionally, nurses and doctors could save valuable response time with real-time notifications. Integrating intelligent monitoring systems could improve care by providing the nurses with efficient documentation and timely access to information.

The remote monitoring of vital signs could be useful in overcrowded PHIs, especially for the continuous monitoring of patients in the emergency department or of unattended patients when there is concern that the condition of a patient in the waiting area could deteriorate suddenly without being observed. WSNs are being used to provide feedback during the monitoring process. WSNs can be used to support intelligent decisions, and moreover, these networks can provide data from many process points, providing an overall view of conditions.

2. Related Works:

This paper describes the development of a remote monitoring system for ECG signals. The system provides remote monitoring of several patients wearing a portable device equipped with ZigBee/IEEE RF module connective based on wireless sensor networks. We have designed to record on-line database, server computer used to analyze ECG signals and detect serious heart anomalies in time sent alarm to authorized medical staffs or physician through telecommunication network. The system has a decision support on web based methods that can detect with high precision. Then the ECG signals are sent by a patient's equipped through wireless to the server of the ECG receiver used in hospital. The physicians can have an easy access to that patient's information and ECG with software on PDA, and in the web browser on PDA or PC computer [1].

In recent years, smart-devices became very popular among people of all ages around the world. Very important is especially their usage in health applications. Special Body Area Network (BAN) for the stress monitoring is currently being developed within the authors' department. Android-based smart phone is employed as the main control unit of the sensor network built on the star architecture. Since the power consumption of the smart-phone as well as of the single sensor node is one of the key limitations of the network, special attention has to be given on it. In this article, energy requirements necessary for the data transmission among the network is analysed in detail. For this purpose, communication solution based on 2.4 GHz proprietary RF transceiver is implemented [4].

A system allowing to use a patient's mobile phone or PDA for storing of biomedical data, which then, during medical consultation or intervention may be used by the medical staff. The presented solution is aimed on providing both: reliable protection to sensitive patient's data, and easy access to information for authorized medical staff. In the presented system, data are stored in an encrypted form, and the encryption key is available only for authorized persons. The central authentication server verifies the current access rights of the person trying to obtain the information, before providing him or her with the key needed to access the patient's data. The key provided by the server is valid only for the particular device, which minimizes the risk of its misuse. For rare situations when no connection to the authentication server is available (e.g. intervention in the mountains or rural area), system assures an additional "emergency" method to access the encryption key in controlled, registered way [5].

A wearable device for monitoring multiple physiological signals (polysomnograph) usually includes multiple wires connecting sensors and the monitoring device. In order to integrate information from intelligent sensors, all devices must be connected to a Personal Area Network (PAN). This system organization is unsuitable for longer and continuous monitoring, particularly during the normal activity. For instance, monitoring of athletes and computer assisted rehabilitation commonly involve unwieldy wires to arms and legs that restrain normal activity. A wireless PAN of intelligent sensors as a system architecture of choice, and present a new design of wireless personal area network with physiological sensors for medical applications. Intelligent wireless sensors perform data acquisition and limited processing. Individual sensors monitor specific physiological signals (such as EEG, ECG, GSR, etc.) and communicate with each other and the personal server. Existing growth of wireless infrastructure will allow a range of new telemedical applications that will significantly improve the quality of health care [7].

Continuous monitoring and analysis of vital parameters like SO2, heart frequency, breathing frequency is important for the prevention and management of cardiac heart failure. The cardiac sentinel allows continuous monitoring and recording of these parameters and automatic transmission of the collected data to the clinical server via an inbuilt GSM modem [8].

A body area networks (BAN) can provide a wide range of applications in primary for medical healthcare such as telemetering vital sign, telecontrolling medical equipment, and in addition for non-medical service such as entertainment. To harmonize with the strong demands from both medical healthcare societies and ICT industries, a standardization committee referred to as IEEE 802.15.6 was formally set up in December 2007. The objective of 15.6 is to define new physical (PHY) and media access control (MAC) layers for wireless BAN (WBAN). This paper introduces a trend of R&D for WBAN and an overview of standardization in IEEE802.15.6. Some critical and future works are suggested. A BAN must be a major successful system to achieve both ubiquitous medical service to solve medical crisis and global business to create a new market in medical ICT [9].

Cardiovascular disease (CVD) is the single leading cause of global mortality and is projected to remain so. Cardiac arrhythmia is a very common type of CVD and may indicate an increased risk of stroke or sudden cardiac death. The ECG is the most widely adopted clinical tool to diagnose and assess the risk of arrhythmia. ECGs measure and display the electrical activity of the heart from the body surface. During patients' hospital visits, however, arrhythmias may not be detected on standard resting ECG machines, since the condition may not be present at that moment in time. While Holter-based portable monitoring solutions offer 24-48 h ECG recording, they lack the capability of providing any real-time feedback for the thousands of heart beats they record, which must be tediously analyzed offline. In this paper, we seek to unite the portability of Holter monitors and the real-time processing capability of state-of-the-art resting ECG machines to provide an assistive diagnosis solution using smartphones. Specifically, we developed two smartphone-based wearable CVD-detection platforms capable of performing real-time ECG acquisition and display, feature extraction, and beat classification. Furthermore, the same statistical summaries available on resting ECG machines are provided [10].

3. Existing System:

The existing system has a wearable sensor node with solar energy harvesting and BLE transmission to implement an autonomous WBAN. The solar energy harvester is controlled by an output based MPPT technique to extract the maximum power from a flexible solar panel. The sensor node is integrated with an onboard accelerometer, temperature sensor and a plug-in PPG sensor on a flexible solar panel. Multiple nodes can be deployed on different positions of the body to measure the temperature distribution of the body. The node can also measure the heartbeat and detect the fall of the subject. All the data from the sensor nodes and fall notification will be transmitted to a web-based smartphone application through a commercial BLE module. When the sensor node is set to an appropriate wake-sleep mode, the 24 hours operation of the sensor node powered by the solar energy harvester is achieved and verified by experiments.

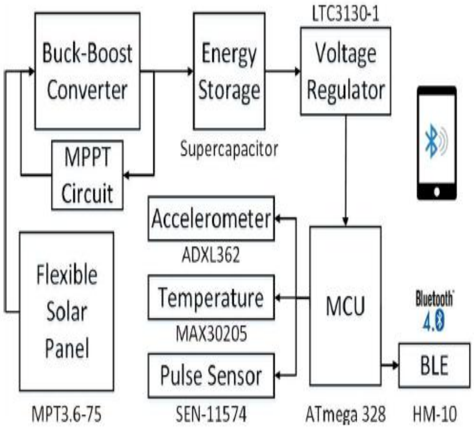

Figure 3.1: Flexible wearable sensor node with energy harvesting

4. Proposed System:

4.1 Basic System:

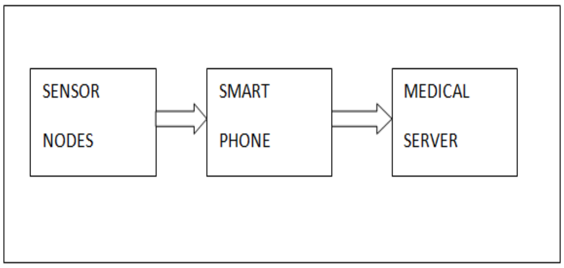

Figure 4.1: Basic System

The basic system consists of the following three parts:-

- ✓ Sensor nodes
- ✓ Smart phone
- ✓ Medical server

Figure 4.1 shows the structure of the basic system. It consists of three steps which include sensor nodes which will sense the various physiological parameters and performs the operation of primary data processing along with physiological signal processing in microcontroller. Data representation, data filtering, graphical user interface, data synchronization will be done in smart phone whereas the data processing along with data base management and data storage will be followed at the medical server. The above figure shows the three most important steps that are involved in the whole system.

4.2 Block Diagram:

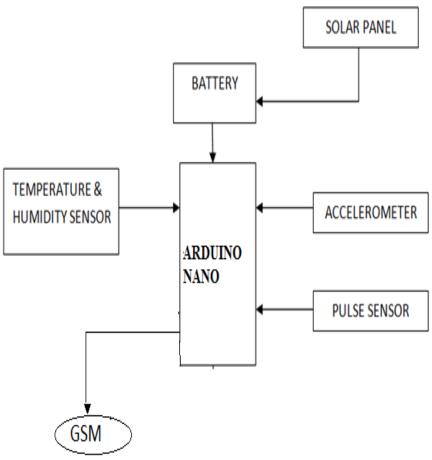

Figure 4.2: Block Diagram of the Proposed System

There are two different designs of a (Wireless) Body Area Network connected to an Android smart phone with the Real- Time system features several capabilities: Data acquisition in the (W) BAN plus the use of the smart phone sensors, patient localization, data storage, analysis and visualization on the smart phone, data transmission and emergency communication with first responders and a clinical server. In the based approach smart and energy efficient sensor nodes acquire physiological parameters, perform signal processing and data analysis and transmit measurement values to a coordinator node. In the second design sensors are connected via cable to an embedded system.

In figure 4.2 the block diagram consists of the sensors that are applied to the patient's body which are then given to the A to D Converter since the data acquired are in the analog form which is applied to the microcontroller. From microcontroller the data is sent to the android smart phone via Bluetooth which is then transmitted to the server via Wifi. If the patient's condition leads to the critical state an alert alarm is also provided in the system.

Basically the various physiological parameters of the patient are measured using various parameters. Here instead of Zigbee / IEEE 802.15.4 the communication between the primary node and smart phone will be done using Bluetooth also the communication between the smart phone and the server computer will be done using WI-FI. Along with this the project will be extended with data mining i.e. the last history records of the patients will be stored in the server computer so that it will be easy for the doctor to treat the present patient by using the last data.

4.3 Alert System: The alert system is been formed here for handling the emergency situation. A threshold value is been set in the setting of the system. Whenever the sensors readings are above the threshold value, the system automatically starts the alert system in order to provide the proper medical care to the patients. The alert system consists of the two types of alerts such as SMS alert and email alert. If no response obtains from the patient's is recorded then automatically the alert propagation starts.

- ✓ **SMS Alert:** Whenever any abnormalities is detected the APP will initiate an alert SMS (message) to primary contact save in the settings activity. The primary number is been entered at the window of the android application.
- ✓ **Email Alert:** The alert email is been send immediately after the alert SMS send by the system. For sending the email alert an internet connection is necessary to the android smart phone. The email is sent to the primary contact person whose email id is filled in the setting activity of android application.

Figure 4.1: Prototype Model

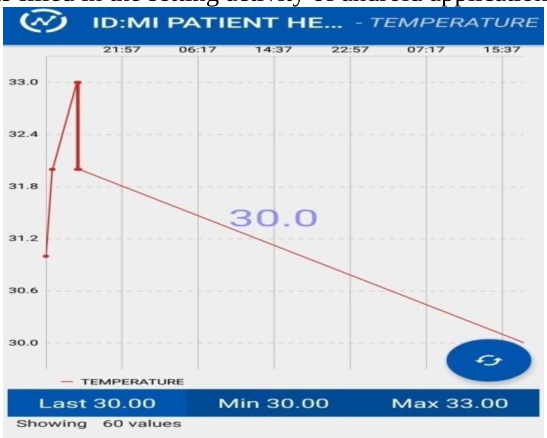

Figure 4.2: Screenshot of temperature of the subject

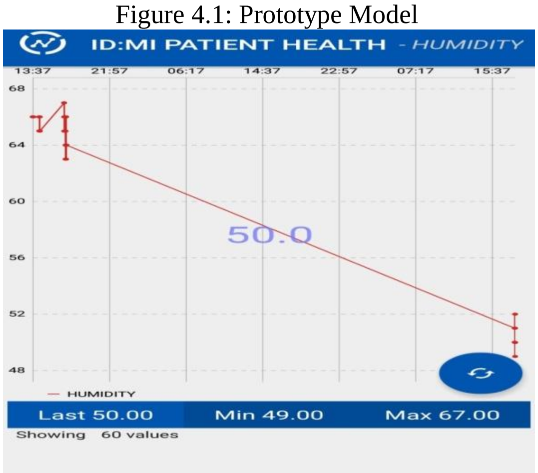

Figure 4.3: Screenshot of humidity value

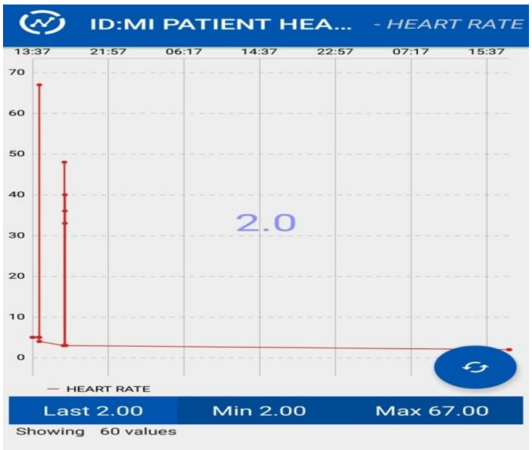

Figure 4.4: Screenshot of heart rate of the subject

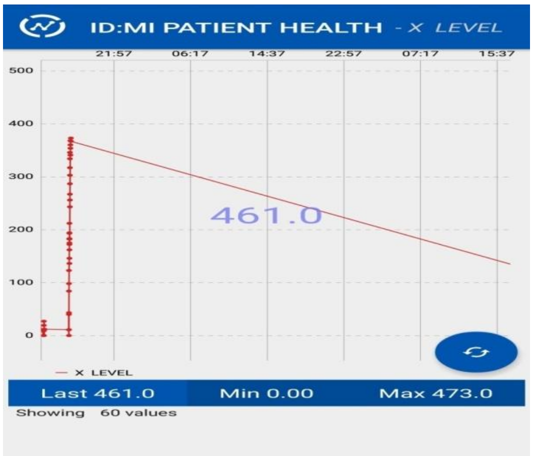

Figure 4.5: Screenshot of x-level of the patient measured by accerelometer

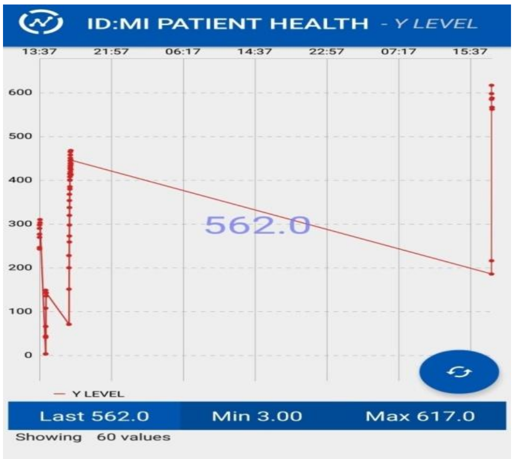

Figure 4.6: Screenshot of y-level of the patient measured by accerelometer

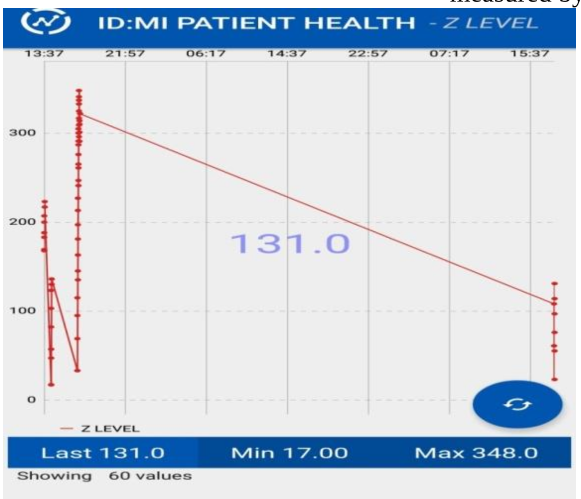

Figure 4.7: Screenshot of z-level of the patient measured by accerelometer

5. Conclusion:

Body area network (BAN) plays an important role in supporting a wide range of medical applications with BAN devices that operates in the whole vicinity. Reliability, functionality and range are enough to obtain the best results. The combination of the WBAN with an Android smartphone offers a large functionality. Vital parameters can be stored, analyzed and visualized with GUIs designed for the end-user. Due to fears with respect to transmission power of wireless systems the upcoming standard IEEE 802.15.6 will be considered for future designs. In future a special application can be designed especially for the medical representative so that if he is out of hospital he can receive the latest updates of the patients and he can provide first aid from anywhere. Certification according to medical safety standards is currently impossible due to the different components used, e.g. the Android operating system.

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