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WIRELESS PATIENT HEALTH MONITORING SYSTEM

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Abstract- In most hospitals and clinics patient waiting times are continuously increasing due to a shortage of trained physicians. Wireless Doc is a device that integrates an Electrocardiogram (ECG), (EEG) and BP together for further medical examination. Wireless Doc aims at a faster and an efficient way for providing this information to assist a physician in acquiring an accurate diagnosis sooner thereby reducing patient wait times in emergency. The Electroencephalography (EEG) is used in the evaluation of brain disorders. Most commonly it is used to show the type and location of the activity in the brain during a seizure. It also is used to evaluate people who are having problems associated with brain function. The Electrocardiogram (ECG) aims to measure the cardiac rhythm and rate of a patient. It ensures that the QRS complex is intact for the diagnosis of cardiac arrhythmias. The ECG system is used to detect Respiratory Sinus Arrhythmia (RSA). Design considerations that need to be taken into account when designing an ECG, EEG and BP are discussed. By using the electrodes attached to the patient from which the electrical activity of the heart and brain are acquired, amplified, filtered and sent wirelessly through Zigbee networks to a base station for post processing.

Keywords: Blood Pressure, Database, ECG, EEG, Zigbee

I. INTRODUCTION

In today's world, a major challenge that every country faces is healthcare. In emergency cases we need to begin to look at ways of easing the workload on current healthcare professionals so that they can take on more patients and need less time to diagnosis. This is where advancements in biomedical technology come into play. There are certain basic physiological signals or vital parameters such as the electrical activity of the heart, temperature, the blood pressure, EEG and the blood oxygen concentration which can be measured to provide a holistic view of a patients' health. It is necessary to measure and analyze various vital body parameters in case of a medical emergency. In this paper we put forth a method to measure vital parameters (BP, EEG and ECG) and transmit this information wirelessly from a remote location to a hospital. These parameters play a key role in estimating the patient condition.

II. DESIGN OBJECTIVE

In case of medical emergencies such as accidents, cardiac arrest or brain attacks monitoring of patients body parameters known as patients vital signs is essential to estimate the condition of the patient. In such cases all the parameters monitoring should be embedded into a single device to ensure portability and ease of use. The vital parameters to be monitored are body

temperature, Blood Pressure, ECG and EEG. The device is also to be used for regular monitoring of patient even at home on a regular basis and log in the details into a date base. A Software along with the database should provide information regarding the concerned problem and treatment for that based on the combination of various vital parameters recorded from the patient. Prime aim of our work is to integrate all the parameters monitoring into a single system and thereby making it portable and cheap. Easy ways to sense the parameters from human body have been formulated. The characteristics of the device so developed should be portable, light weight, Low cost, reliable, sensitive, ease of use and safety.

III. BLOCK DIAGRAM

In this section we will look at the challenges that need to be accomplished in order to create a working Wireless Doc. This section will include an overview of the ECG and EEG. It will introduce theoretical developments that are essential for understanding the design. The block diagram shown in the figure 1 basically consists of three blocks: Sensing block consists of ECG amplifier, EEG amplifier and electrodes. Communication block consists of ZIGBEE transmitter and receiver. Database is designed using Microsoft access and Html. The stimuli from the patient are sensed by the sensing block and the responses are calculated and respective values are generated, which is transmitted by the

communication block which consists of Zigbee modules. This data is sent to the server.

Fig 1: Block diagram of Wireless Doc

A. ECG Measurement System

An electrocardiograph (ECG) is non invasive technique that utilizes electrodes placed on the skin to capture the electrical activity of the heart. The electrodes on different sides of the heart measure different parts of the heart muscle in between the electrodes. The ECG measures the overall resultant electrical vector from the contraction of the heart muscle cells. By exploiting the ECG's ability to measure the electrical signal between a given pair of electrodes a physician is able to diagnose the any abnormalities that may exist in that portion of the heart [1]. A clinical ECG consists of 10 electrodes which translate to 12 leads or 12 different views of the heart but this is extremely time consuming and involves the use of gels and pastes that require skin preparation in the thoracic region. Given the fact that there are long wires used in clinical ECGs a patient's mobility is severely restricted which results in patient discomfort. This project has been designed so as to allow any patient to administer portions of the ECG test themselves thereby reducing the work load on healthcare professionals. All this is accomplished by reducing the number of electrodes required to perform an ECG this results in only one view of the heart instead of the 12 different views in clinical ECGs. The purpose of this system is to only provide preliminary diagnosis this is sufficient. The electrodes in this project provide cardiac rate and rhythm which are adequate for a general diagnosis on the health of the heart.

The ECG measurement system shown in the figure 2 comprises of four stages. The first stage consist of a transducer

—AgCl electrode, which convert ECG into electrical voltage in the range of 1 mV ~ 5 mV. The second stage is an instrumentation amplifier having a very high CMRR and high gain. An opto-coupler to isolate the Instrumentation amplifier and output is used in third stage. Final stage is implemented by cascading a low-pass filter and a high pass filter.

Fig 2: Simplified ECG recording system

B. EEG Measurement System

An EEG is non invasive technique that utilizes electrodes placed on the scalp to capture the electrical activity of the brain. Each electrode is connected to one input of a differential amplifier. A common system reference electrode is connected to the other input of each differential amplifier. These amplifiers amplify the voltage to about 60–100 dB. The amplified signal is digitized via an analog-to-digital converter, after being passed through an anti-aliasing filter.

During the recording, a series of activation procedures may be used. These procedures may induce normal or abnormal EEG activity that might not otherwise be seen. These procedures include hyperventilation, photonic stimulation, eye closure, mental activity, sleep and sleep deprivation. During epilepsy monitoring, a patient's typical seizure medications may be withdrawn.

Wave Patterns

Mental position of patient can be decided depend upon the type of wave patterns obtained [2] [3].

1) Delta: Delta is the frequency range up to 4 Hz as shown in fig 3. It tends to be the highest in amplitude and the slowest waves. It is seen normally in adults in slow wave sleep, normally in babies. It may occur focally with sub-cortical lesions and in general distribution with diffuse lesions, metabolic encephalopathy hydrocephalus or deep midline lesions. It is usually most prominent frontally in adults and posterior in children.

Fig 3: Delta wave pattern

2) Theta: Theta is in frequency range from 4 Hz to 7 Hz. It is seen normally in young children, seen in drowsiness or arousal in older children and adults and also seen in meditation. Excess theta for age represents abnormal activity. It can be seen as a focal disturbance in focal sub-cortical lesions; it can be seen in generalized distribution in diffuse disorder or metabolic encephalopathy or deep midline disorders or some instances of hydrocephalus. On the contrary this range has been associated with reports of relaxed,

meditative, and creative states. Figure 4 shows theta wave pattern.

Fig 4: Theta wave pattern

3) Alpha: Alpha is the frequency range from 8 Hz to 12 Hz. This was the "posterior basic rhythm" seen in the posterior regions of the head on both sides, higher in amplitude on the dominant side. It emerges with closing of the eyes and with relaxation, and attenuates with eye opening or mental exertion. This rhythm is actually slower than 8 Hz in young children.

Fig 5: Alpha wave pattern.

4) Beta: Beta is the frequency range from 12 Hz to about 30 Hz. It is seen usually on both sides in symmetrical distribution and is most evident frontally. Beta wave pattern is shown in Fig 6. Beta activity is closely linked to motor behavior and is generally attenuated during active movements. Low amplitude beta with multiple and varying frequencies is often associated with active, busy or anxious thinking and active concentration. Rhythmic beta with a dominant set of frequencies is associated with various pathologies and drug effects, especially benzodiazepines. It may be absent or reduced in areas of cortical damage. It is the dominant rhythm in patients who are alert or anxious or who have their eyes open.

Fig 6: Beta wave pattern

5) Gamma: Gamma is the frequency range approximately 30–100 Hz. Gamma rhythms shown in fig 7 are thought to represent binding of different populations of neurons together into a network for the purpose of carrying out a certain cognitive or motor function.

Fig 7: Gamma wave pattern

6) MU: Mu ranges 8–13 Hz and partly overlaps with

other frequencies. It reflects the synchronous firing of motor neurons in rest state. Mu suppression is thought to reflect motor mirror neuron systems, because when an action is observed, the pattern extinguishes, possibly because of the normal neuronal system and the mirror neuron system "go out of sync", and interfere with each

Fig 8: ECG output on CRO interfaced PC monitor

Fig 9: EEG output on CRO interfaced PC monitor

Fig 10: Wireless Doc- Development kit

D. BP Measurement System

1) Photoplethysmography:

Plethysmograph is an instrument used to detect the arterial pulse and pulse pressure waveform and respond to a change in the volume of blood as a measure of blood pressure. It is a method for the

detection of volume changes due to blood flow. It applied the method of reflection and transmitting of light as shown in fig 8. In transmittance method, a light emitting diode (LED) transmits light through the finger tip of the subject's finger, reflecting and scattering the light to a photoresistor. While in reflection method, a photoresistor is placed adjacent to the LED to determine the quantity of light reflected by the blood saturation of the capillaries. The electrical signal from the photo detector is related to blood volume changes in tissue. This signal provides a means of determining properties of the vascular tree during the cardiac cycle and changes with aging and disease. The shape of the pulse wave varied according to the thickness of the blood vessel and also the contractility of the heart wall. Fig 12 shows the general shape of peripheral pulse wave.

Fig 11: The light emitted from IR LED and detected by the photosensor.

Fig 12: Photoplethysmograph signal

2) PPG Circuit Instrumentation

The input receiver circuit contains of infrared LED and receiver photodiode acted as sensory part of PPG. The infrared light will be emitted into the skin and reflected while the receiver photodiode detects the reflected light and transforms the light in a current form. The current will be converted to voltage through transimpedance amplifier. The transimpedance amplifier strong negative feedback decreases its susceptibility to component variation and improves the dynamic range over the voltage amplifier converter by the ratio of the open-loop gain to the closed-loop gain.

IV. DATA ACQUISITION PROCEDURES

The constructed ECG and PPG circuit along with an automatic blood pressure monitor was used to take the measurement of PWTT and SBP of subjects as shown in fig 14. The cuff of automatic blood pressure monitor was wrapped around subject left arm while the electrodes of ECG was attached at the right arm and left arm of the subject as

Fig 13: BP measurement system

their right hand pointing finger was placed at the photoplethysmograph sensor to obtain the measurement of SBP and PWTT simultaneously. The measurement of SBP was taken from the automatic blood pressure monitor whilst the PWTT measurement taken by using the oscilloscope. The data acquisition procedures is experimented. Fifteen measurements of PWTT and SBP from two subjects were obtained as shown in fig 14, during relax condition, exercise condition and recovery condition. SBP is calculated from differential mathematical equation shown in table 1.

Fig 14: Graph of SBP vs PWTT

TABLE 1: SBP CALCULATED FROM DIFFERENT MATHEMATICAL EQUATION

Experiment	Mathematical equation	Calculated SBP(mmHg)	Difference (mmHg)
1	$Y = -0.347x + 208.5$	111	1

V. HARDWARE & SOFTWARE

A. HARDWARE

The Hardware design phase consists of critical design of power supply, Micro-controller circuit and LCD interface. The power supply circuit has to provide a 5V regulated power to the micro controller for its operation. Important components used for designing consists of microcontroller as a processor, Zigbee modules for data transmission, Analog to Digital converter and LCD for display.

B. SOFTWARE

Any microprocessor and microcontroller system requires associated software along with the hardware for the system to work. The software is developed using Kiel –C, Micro Soft Visual Video and MatLab is used. The developed software is cross compiled. The final compiled program generates the machine code, and the code is then dumped into the microcontroller through development tool. The free GNU AVR GCC development tool and compiler is used for developing and compiling the code written in Programmer's Notepad. The AVR Studio is used to download code to the microcontroller. Together with this the programmer AVR JTAG is used for debugging [4].

C. DATABASE BLOCK

The software apparatus used for the data base are MICROSOFT Visual Studio 2008, MS Access, MAT lab and HTML. The codes written in visual studio are used to acquire data and are run in this application the results are stored in a MS Access document and this data is sent into the web using HTML. The output wave forms for the given values are shown using a MAT LAB program.

VI. SIMULATION MODEL

Every patient is identified by a unique ID number. The measured vital parameters of the patient for further diagnosis are stored in the personal computer.

The doctor can login into the system to view the patient condition and can comment on the health hazards. The HTML pages screenshots fig 15 & 16 shows the measured parameter loaded into the database. The pages so created have many advantages: Virtual treatment of doctors is possible Self diagnosis at home is possible which can be preloaded in the database by certified doctors, since the use of the database and software is done more effectively and user friendly. Emergency conditions like in ambulances. Time is saved, rather than analyzing the patient in the hospital and waiting for the result, instant analysis and diagnosis can be done. As data is directly transferred into the computer, doctor and patients can monitor the parameters frequently, the analysis becomes easier.

7. CONCLUSION

The Wireless Doc system has achieved the objectives that were laid out at the beginning of the project. BP being a continuous measurement, it is not measured at the location of emergency in mobile vehicles like Ambulances. Medical parameters, monitoring system has been designed, which can take the values of EEG and ECG of a person and amplify them to the required level for wireless transmission. The data can be transmitted through Zigbee from transmitter to receiver using the other modules as nodes. This data is sent to the PC which stores the values in the database, in the server which provides diagnosis given by specialist doctors which is preloaded. Hence this provides self medication safely as the device is virtually guided by the doctor. In emergency cases and to the places where doctor is out of reach this device is very much useful.

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Fig 15: Log in Page and registration Page

Fig 16: Measured Values stored in database