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An Efficient Human Health Telemonitoring System

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ABSTRACT: In case of critically ill patient, it requires monitoring the patient in hospital for 24*7 bases so in order to overcome this problem, a system is designed with wireless physiological monitoring system. This paper is focused on monitoring of remote patients, after he/she is discharged from hospital. The PIC microcontroller based patient monitoring system offers a reliable, energy efficient and remote patient monitoring system using appropriate sensors and also the system able to send parameters of patient in real time. It enables the doctors to monitor patient's parameters such as blood pressure, SpO_2 and ECG in real time. Here the parameters of the patient are measured continuously and transmitted to authorized doctor through internet. Also the above parameters can be displayed as GUI using LabVIEW in patient side. This helps the patient to aware on their own health. Then the three parameters are provided dynamically to a web page in real time to be viewed by an authorized doctor, if anyone of the vital parameter goes out of normal range then an alert message as SMS is sent to the patient from the doctor side.

KEYWORDS: PIC microcontroller, blood pressure, $SpO_{2,}$ ECG**,** LabVIEW, GSM, SMS.

I.INTRODUCTION

The modern visionary of healthcare industry is to provide better health care to people anytime and anywhere in the world in a more economic and patient friendly manner. Therefore for increasing the patient care efficacy, there arises a need to improve the patient monitoring devices and make them more reliable. The medical world today faces two basic problems when it comes to patient monitoring, first is the need of healthcare providers present at the bedside of the patient and second the patient is restricted to bed and wired to large machines. In order to achieve better patient care, the above cited problems have to be solved. As the bioinstrumentation, computers and telecommunications technologies are advancing, it has become feasible to design a home based vital sign Tele-Monitoring system to acquire record, display and transmit the physiological signal from the human body to any location is shown in the figure.1 below.

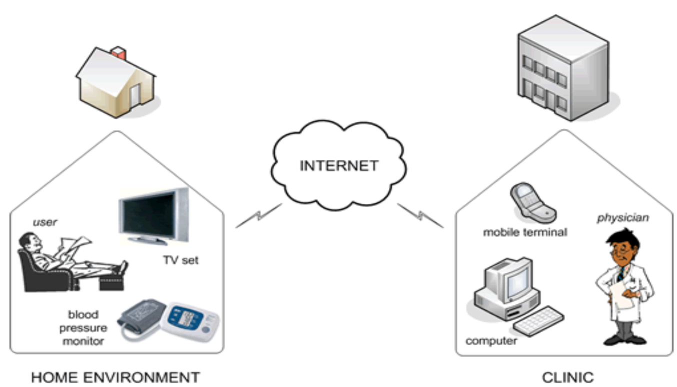

Figure.1 Basic Tele-monitoring system

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The need for real time notification of vital signs of patient to the doctor is of prime importance, thus the need of active database system arises and that is integrated with patient monitoring device. The importance of Patient Monitoring System (PMS) in medical treatment is very high; therefore in recent days in medical field introducing centralized PMS. In centralized PMS all patient monitors are connected with a single server based PMS. For a more efficient patient care by the caregivers, the PMS must be incorporated with smart alarm systems. Thus the new PMS with intelligent alarm system has significantly improved sensitivity of monitoring and also demonstrated the feasibility of real time learning at the bedside. In order to alert the patient caregivers about the vital signs of patient these alarm systems are characterized based on the signal characteristics such as for ECG, attributes like R-R interval, peak detection and for other parameters their normal range sets the alarm system. The computer-based PMS can help improve the patient's awareness and understanding of his or her disease, thus the efficacy of treatment can be increased by displaying them in a graphical user interface and also sending the clinically useful data on a personalized website[1]. The alert message is generated by the system in two ways, first on the doctor's mobile about the vital signs of the patient and second by an email notification.

II. SYSTEM ARCHITECTURE IN PERSONAL HEALTH TELE-MONITORING

The aging of population gives rise to chronic diseases in daily. Health monitoring has become more significant in modern medical field. In recent years, the home Tele care system (HTS) has been employed in personalized examination by miniaturization and portable auxiliary .The bio-medical signals are self-examined and transmission between the person and medical centre over the internet is expected to play a more prominent role in HTS .An interactive intelligent health care and monitoring system (IIHMS)[2] is to enhance the portability and increase the popularization of HTS. IIHMS aims to monitor patients especially those with cardiovascular disease, at any time and place. Figure.2 below illustrates the scenarios of IIHMS heterogeneous networks with including a body area network.

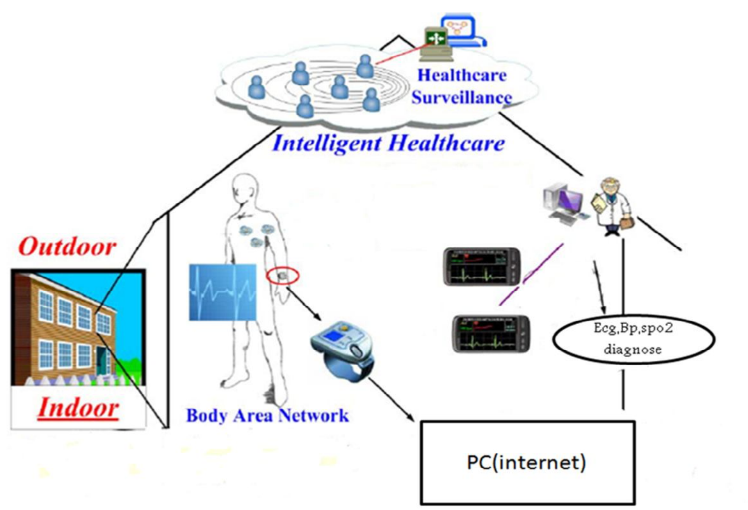

Figure.2 IIHMS heterogeneous network

ECG/EKG is used to measure the heart's electrical conduction system. It picks up electrical impulses generated by the polarization and depolarization of cardiac tissue and translates into a waveform. The waveform is then used to measure the rate and regularity of heartbeats, as well as the size and position of the chambers, the presence of any damage to the heart[3]. Pulse oximeter is the non-invasive method for monitoring a patient's Oxygen saturation. Blood pressure monitoring represent the measure blood pressure in an artery and it uses oscillometric method of monitoring and that device has a pressure sensor for sensing arterial wall vibrations. Here the microcontroller used is PIC 16F877 operate under low power consumption with small pin count.

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III. BLOCK DIAGRAM OF TELE-MONITORING SYSTEM

The proposed system has been designed to take several inputs to measure physiological parameters of human such as ECG, Blood Pressure and Pulse Oximeter[4]. The inputs from the sensors are integrated and processed. This measured value has been sent to the hospital through their webpage. The history of the individual patient has been maintained by the hospital. The vital -sign parameters of the patient is provided dynamically to a web page to be viewed by an authorized doctor .An alert SMS will be sent to the patient indicating message received, status of normal and abnormal condition of the patient. In the transmitter side the data's are collected from the sensors and are processed by the controller and digital data's from controller is transmitted through the Website to the receiver unit. The uploaded data of the patient is monitored by the doctor. Using GSM, an alert message is sent to mobile to indicate the patient's present health status. The transmitter and receiver block diagram is shown the figure.3&4 below.

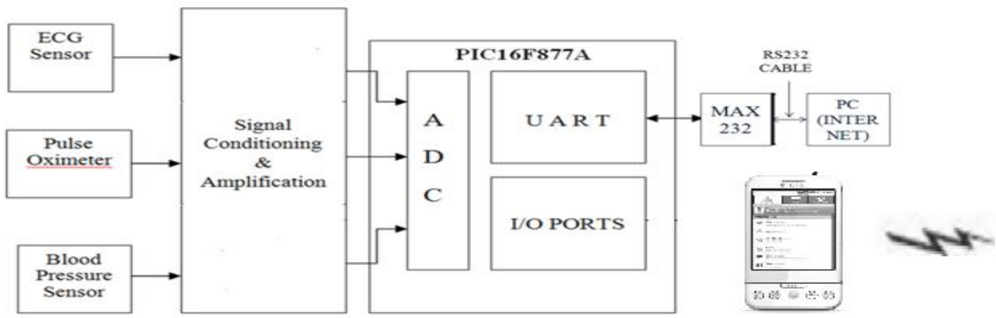

Figure.3 Patient side transmitter section

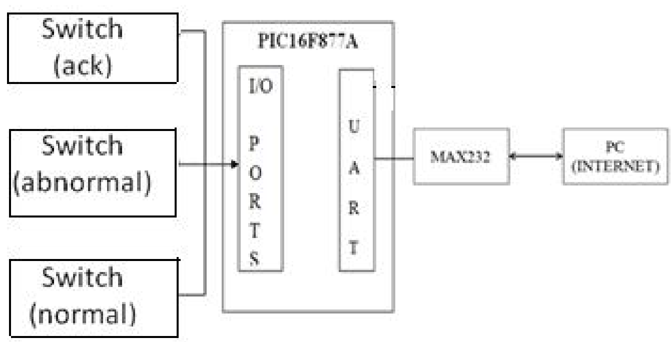

Figure.4 Doctor side receiver section

IV. MODULES USED IN TELE-MONITORING SYSTEM

A. Signal Conditioning and power supply unit

The outputs obtained from sensors which is having low amplitude signal, so that signal conditioners circuit is used to amplify the signals to the requirements of the receiver (circuit or equipment). Power supply is designed to convert the voltage AC mains electricity to a suitable low voltage DC supply for electronic circuits and other devices.

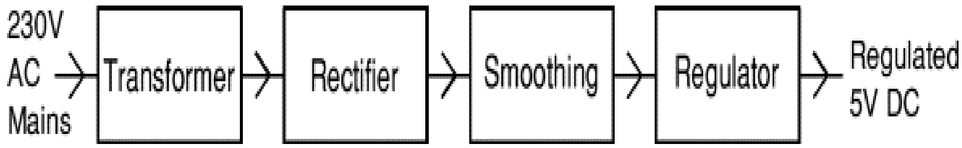

Figure.5 Block diagram of regulated power supply system

Transformer that steps down 230V AC mains to low voltage AC, Rectifier used to convert AC to DC voltage, but the DC that contains ripple. So smoothing is performed to smooth the DC from varying greatly to a small ripple and the regulator which eliminates ripple by setting DC output to a fixed voltage.

B. Microcontroller

Peripheral Interface Controller (PIC) is a family of microcontrollers introduced by Microchip Technology[5]. PIC microcontroller (16F877A) has attractive features and they are suitable for a wide range of applications. PIC microcontrollers are RISC processors and uses Harvard architecture. PIC 16F877 is a family of CMOS 8-bit flash controllers. Apart from the flash program memory there is a data EEPROM. A RISC instruction set includes fewer and simpler instructions with hardwired control, simpler processor pipeline and a large number of registers. An inbuilt ADC is used to convert the analog signal output from signal conditioner to digital. On chip UART transmits the signal from controller to PC via RS232 cable. MAX232 integrated circuit is used to convert TTL logic to RS232 logic when controller transmits the data and vice versa operation during reception.

C. SENSORS USED

ECG Sensor: The three electrodes with their leads are placed on the appropriate locations of the patient. The ECG signals detected from the subject are of very low amplitude and it is amplified by the instrumentation amplifier with sufficient gain. ECG sensor board consists of ECG electrodes and signal amplifying circuits. The task is to acquire the data (heart signal) from the human body, amplify and filter the signal before it is sent to its destination. Microcontroller circuit receives the acquired data in analog form and then converts it to digital signals with 8 bit resolution and a sampling rate of 500 Hz before sending it to the personal computer (PC). The sensor gathers useful patient ECG data and these signals have to be amplified due to the reason that signals acquired from human body are generally weak, ranging from 0.5 mV to 5.0 mV. The amplified signals are then filtered for noise removal.

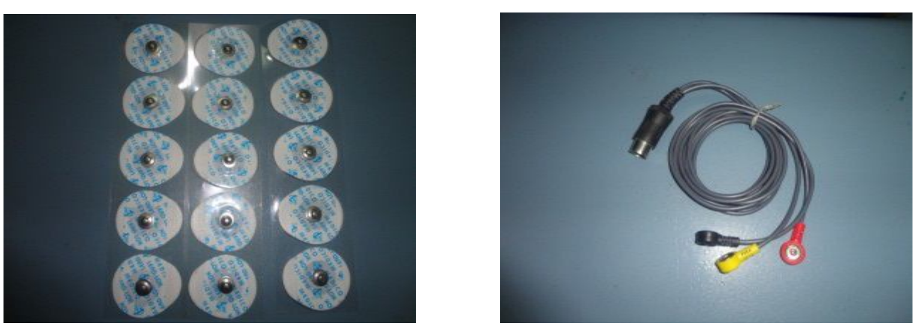

Figure.6 ECG Electrodes and Leads

BP Sensor: The blood pressure sensing system reads the cuff pressure and extracts the pulses for analysis and determination of systolic and diastolic pressure. This design uses a 50 kPa integrated pressure sensor yielding a pressure range of 0 mm Hg to 300 mm Hg. Oscillometric method is employed by the majority of automated non invasive devices[6]. A limb and its vasculature are compressed by an encircling, inflatable compression cuff. The blood pressure reading for systolic and diastolic blood pressure values are read at the parameter identification point. The simplified measurement principle of the oscillometric method is a measurement of the amplitude of pressure change in the cuff as the cuff is inflated from above the systolic pressure. The amplitude suddenly grows larger as the pulse

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breaks through the occlusion. This is very close to systolic pressure. As the cuff pressure is further reduced, the pulsation increase in amplitude reaches a maximum and then diminishes rapidly. The index of diastolic pressure is taken where this rapid transition begins. Therefore, the systolic blood pressure (SBP) and diastolic blood pressure (DBP) are obtained by identifying the region where there is a rapid increase then decrease in the amplitude of the pulses respectively. Mean arterial pressure (MAP) is located at the point of maximum oscillation.

Figure.7 Pictorial view of Pulse Oximeter and BP sensor.

Pulse Oximeter Sensor: Pulse Oximetry is the non-invasive measurement of the oxygen saturation (SpO2). Oxygen saturation is defined as the measurement of the amount of oxygen dissolved in blood, based on the detection of Hemoglobin and Deoxyhemoglobin. Two different light wavelengths are used to measure the actual difference in the absorption spectra of HbO_2 and Hb. The bloodstream is affected by the concentration of HbO2 and Hb, and their absorption coefficients are measured using two wavelengths 660 nm (red light spectra) and 940 nm (infrared light spectra). Deoxygenated and oxygenated haemoglobin absorb different wavelengths. Deoxygenated haemoglobin (Hb) has a higher absorption at 660 nm and oxygenated haemoglobin (HbO_2) has a higher absorption at 940 nm Oxygen saturation, which is often referred to as SaO_2 or SpO_2, is defined as the ratio of oxyhaemoglobin (HbO2) to the total concentration of haemoglobin present in the blood (i.e., oxyhaemoglobin + reduced haemoglobin):

$$SaO_2 = \frac{[HbO_2]}{[\text{Total haemoglobin}]}$$

Arterial SaO_2 is a parameter measured with oximetry and is normally expressed as a percentage. Under normal physiological conditions arterial blood is 97% saturated, whilst venous blood is 75% saturated. The acquired signal from sensor is amplified and sent to the Microcontroller. The digitally converted signal is transmitted to PC and it is displayed graphically in Lab View. The sensed data is uploaded in the particular hospital website and system generated mail and at the same time SMS will be sent to the patient about normal/abnormal condition of health parameters.

LabVIEW: The LabVIEW software is used as the integrating platform for acquiring the physiological signals, processing and transmitting the physiological data as it is an excellent graphical programming environment to develop sophisticated measurement, test, and control systems using intuitive graphical icons and wires that resemble a flowchart[7]. The software also includes number of advanced mathematics blocks for functions such as integration, filter and other specialized capabilities.

V. RESULT AND DISCUSSION

The complete hardware circuit diagram for patient side and doctor side is shown in the figure.7&8 below. The embedded C programming is used to program the PIC microcontroller. A sample result is displayed in the LabVIEW software is shown in the figure.9 below.

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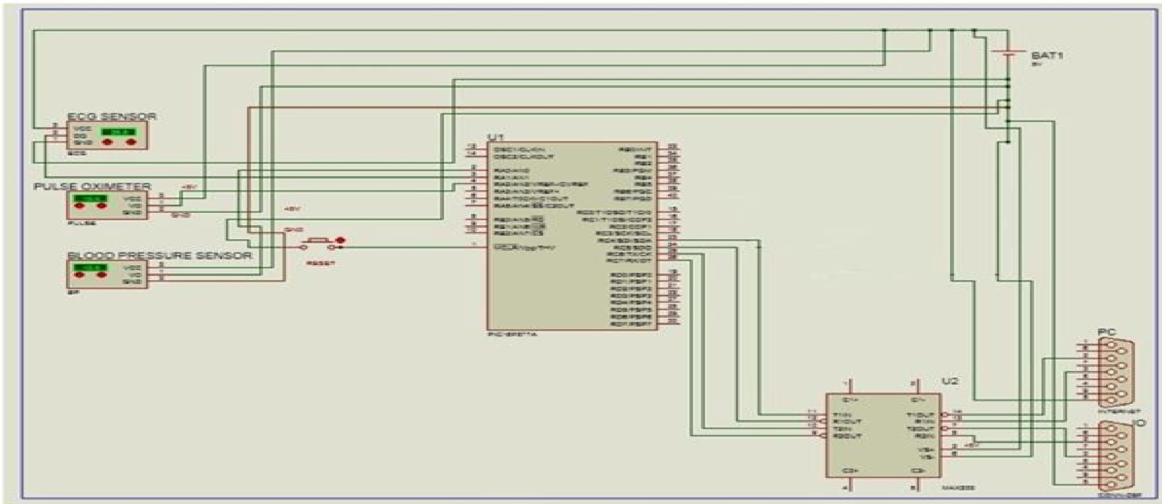

Figure.8 Hardware circuit diagram of patient section.

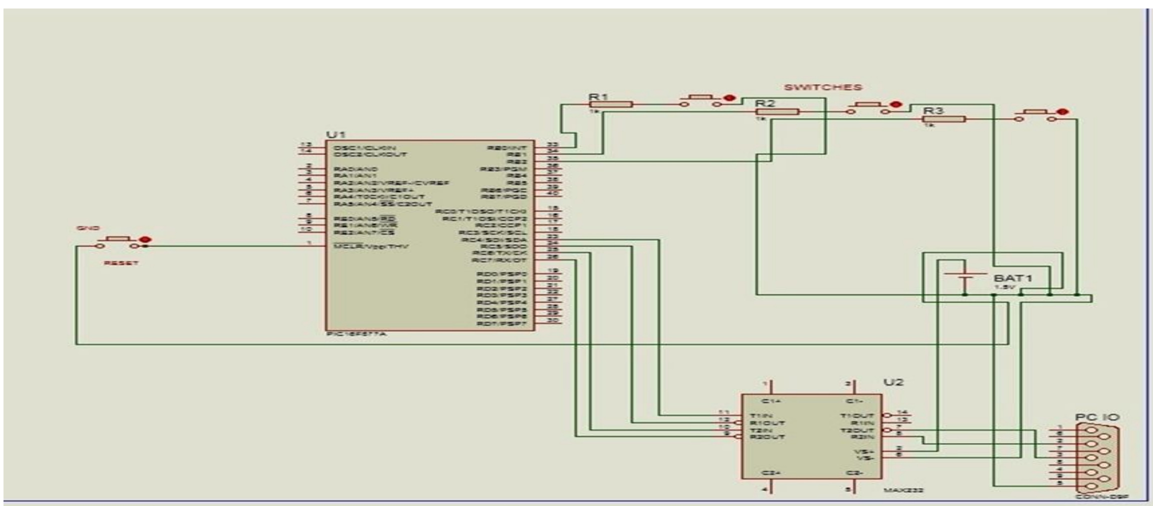

Figure.9 Hardware circuit diagram of Doctor section.

Figure.10 Graphical display of parameter values using LABVIEW

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VI. CONCLUSION

This proposed system helps the doctors to keep an eye on the heath condition of the patient on 24*7 bases and provide proper treatment at the correct time when the patient goes to abnormal condition. The inputs from the sensors are integrated and processed. The history of the individual patient has been maintained by the hospital. The vital-sign parameters of the patient are provided dynamically to a web page to be viewed by an authorized doctor. An alert SMS will be sent to the patient, indicating message received status of normal or abnormal condition of the patient. Totally this device helps the patient to check their health regularly without going to hospital and saves the patient life in emergency condition.

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