

Continuous Monitoring of CHF Patients using Embedded Techniques and Android Application

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Abstract— Chronic heart failure has become one of the most common issues of our growing population and it has become the major cause for hospitalization of the patient. A current survey estimates that about 10 million cases have been hospitalized each year due to chronic heart failure in India alone. It is the leading cause for hospitalization for elderly citizens. The hospital admission caused by CHF results in large societal and economical issues. The expenditures are becoming a burden for the patient. The current health care model is mostly In-hospital based and consists of periodical visits. It is accepted that change in the vital sign often precede symptom worsening and clinical destabilization. This results in re-hospitalization. On a motive to overcome such scenario a complete and an integrated information and communication technology system is described in this paper enabling the CHF patient to collect the vital signs at home and automatically send them to the concerned physicians through mobile Android application. By this the physician monitors their patients at a distance and takes timely action in need. ECG, pulse rate, blood pressure, temperature has been measured using non invasive biomedical sensors. The microcontroller used in the proposed word is Arduino Uno. This innovative technology proves the effectiveness of the telemonitoring system from both patients and caregivers point of view.

Keywords— Arduino Uno, blood pressure, CHF, ECG, pulse rate, temperature.

I. INTRODUCTION

Chronic Heart Failure (CHF) represents one of the most relevant chronic disease in all industrialized countries, affecting approximately 15 million people in Europe and more than 5 million in the U.S., with a prevalence ranging from 1% to 2% and an incidence of 3.6 million new cases each year in Europe and 550 000 cases in U.S. It is the leading cause of hospital admission particularly for older adults reaching a prevalence of 1.3%, 1.5%, and 8.4% in 55– 64 years old, 65– 74 years, and 75 years or older segments, in intensive care units, there are provisions for continuously monitoring patients. Their heart rates, temperatures, ECG etc. are continuously monitored. But in many cases, patients get well and come back to home from hospital. But the disease may return, he may get infected with a new Disease, there may be a sudden attack that may cause his death. So in many cases, patients are released from hospital but still they are strongly advised to be under rest and observation for some period of

time. On this motive a low cost, efficient and continuous monitoring using Arduino has been developed. These include parameters like temperature sensors, blood pressure, spo2, ECG. These parameters are being continuously monitored by the hospital information system using android application.

II. OVERVIEW OF WIRELESS TECHNOLOGY

Wireless technology has reached a turning point, as vendors and researchers prepare to take it to the next level. Most industry observers agree that next-level wireless technology will offer more bandwidth, security, and reliability, making it more suitable for multimedia, e-commerce, video conferencing and other advanced applications.

Data is to be transmitted to remote location as per our projects main requirement. There are various communication technologies used for data transmission these are ZIG-BEE, BLUETOOTH, GSM, and GPRS.

ZIG-BEE is used to create personal area networks built from small, low-power digital radios. It is based on an IEEE 802.15 standard. It has Short-range wireless transfer of data at relatively low rates. It transmits data over longer distances by passing data through intermediate devices to reach more distant ones. It has Low data rate, long battery life, and secure networking applications. It's Data Rate of 250 kbit/s. but zigbee is not suitable for medical application Zig-Bee may not be suitable for transmitting vital signs, especially for emergency messages, since these messages are critical for diagnosing the illness of patients as well as providing important clues to the urgency level. Bluetooth has packet-based protocol with a master-slave structure. The Bluetooth Devices communicates with each other on a secure connection through an unlicensed short-range radio frequency. Easy discovery and setup of services between devices. Bluetooth may not be suitable for transmitting vital signs, especially for emergency messages, since these messages are critical for diagnosing. GSM Standard for mobile communication. SMS was developed as part of the GSM Communication. Useful when the mobile phone user is not expect to answer or respond immediately. By using GSM only SMS can be sent but medical data cannot be transmitted.

GPRS (General Packet Radio Service) is Based on GSM and IP. The Data Rate of GPRS is up to 40 Kbit/s. It is one of the quick and cost- effective solutions. It has 3GSM networks and services. The GPRS is useful in medical data transmission because it has direct data uploading capability to server. Interfacing GPRS modem to controller the data can be

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transmitted from patient side to server. Then the smart phone is having an application that will make that received data available globally.

III. PROPOSED TECHNOLOGY

A. Block Diagram

The proposed system consists of ECG electrodes, LM35 temperature sensor, Blood Pressure sensor and pulse rate detector. The sensors are connected as inputs to the microcontroller. The ECG signal acquired are noisy and are amplified and then given as input to microcontroller. The instrumentation amplifier AD620 was used, which has a very high CMRR (90dB) and high gain (1000). The micro controller converts analog signal to digital signal and check abnormality condition, sends the data to mobile where it is displayed through Android application. The block diagram of the proposed work is shown in the figure 1.

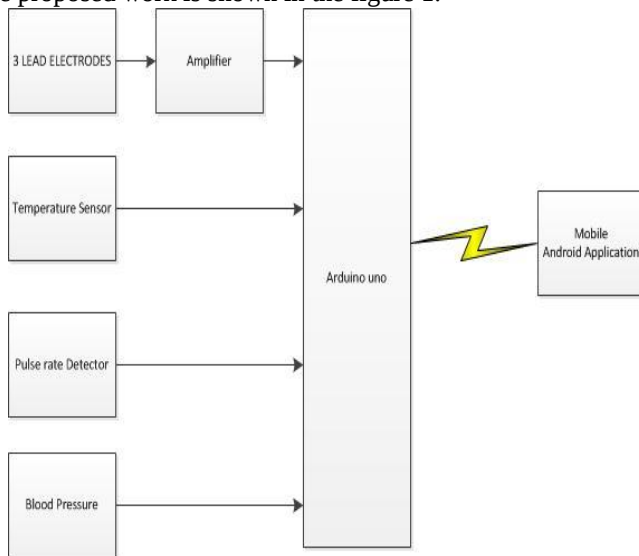


Fig 1: Block Diagram of the proposed work

B. ECG Electrodes

An ECG electrode is a device attached to the skin on certain parts of a patient's body generally the arms, legs, and chest during an electrocardiogram procedure. It detects electrical impulses produced each time the heart beats. The number and placement of electrodes on the body can vary, but the function remains the same. The electricity that an electrode detects is transmitted via this wire to a machine, which translates the electricity into wavy lines recorded on a piece of paper. The ECG records, in a great detail, are used to diagnose a very broad range of heart conditions. An ECG electrode is usually composed of a small metal plate surrounded by an adhesive pad, which is coated with a conducting gel that transmits the electrical signal.

C. The LM35 Temperature Sensor

The LM35 series are precision integrated circuit LM35 temperature sensors, whose output voltage is linearly proportional to the temperature in Celsius

(Centigrade). The LM35 sensor thus has an advantage over linear temperature sensors, calibrated in °Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. The LM35 sensor does not require any external calibration or trimming to provide typical accuracies of $\pm\frac{1}{4}^{\circ}\text{C}$ at room temperature and $\pm\frac{3}{4}^{\circ}\text{C}$ over a full -55 to $+150^{\circ}\text{C}$ temperature range. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. As it draws only $60\text{ }\mu\text{A}$ from its supply, it has very low self-heating, less than 0.1°C in still air.

D. Blood Pressure Sensor

Blood pressure sensor is a device that measures the pressure of the blood in the arteries as it is pumped around the body by the heart. When our heart beats, it contracts and pushes blood through the arteries to the rest of our body. This force creates pressure on the arteries. Blood pressure is recorded as two numbers—the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats). Some special features of blood pressure sensor includes (i) automatic measurement of systolic, diastolic and pulse, (ii) large LCD screen with LED backlight, and (ii) touch pad key. In addition a typical blood pressure sensor can store 80 measurements data with time and date.

E. Pulse rate Detector

Pulse rate of a body can be counted by change in blood flow in blood vessels. In the system the IR led and IR detector is used to fulfil the requirements of pulse rate counter. Fig 1 shows the positioning of IR LED and IR detector. Putting any finger between the gaps causes change in IR light to be received at receive. The light must pass through finger and detected at other end. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse and pulses are counted.

F. Android Application

Android SDK has been used which has been integrated with Eclipse IDE built by Oracle corporation. The Android SDK is open source tool, It is freely available on the developer website. The Eclipse program has become the most popular IDE for Android application development. Android developer site has powerful plug-in for facilitating Android development. Android applications are written in java programming language, developers are already familiar with many of the packages provided as part of android SDK, such as java, dotnet. Android development tools (ADT) plug-in for eclipse. Android application provides automated builds and application deployment to android emulators and handsets.

IV. RESULTS

The vital parameters were acquired and sent to the mobile application. The patient physical condition whether normal or abnormal are displayed through the application created.

Table1 : Normal and Abnormal values

S. No	Vital Signs	Normal Value	Abnormal Value
1	ECG-R wave Amplitude in sec	0.4-1.2 sec	Above 1.2 sec
2	Pulse Rate	60-100	Below 60
3	Blood Pressure	120/80 mmhg	140/90 mmhg
4	Body Temperature	36.8±0.5 °C	Above 38°C

V. CONCLUSION

This work presents the requirements and the realization in terms of sensing devices and sensor data signal processing to improve the provisioning of healthcare services for CHF patients. With the remote monitoring, the medical staff can realize changes in the parameters of patients without frequently visiting them and consequently they can take concerned action to prevent possible aggravations. The benefits extend beyond the early detection of clinical exacerbation to optimizing specialized resources scheduling and to reduce unnecessary travels to hospital. It reduces the Re-hospitalization rates. This system reduces costs by enabling in home monitoring of patients, eliminating the need for utilization of expensive facilities. In this proposed work vital multi parameters like ECG, pulse rate, blood pressure and temperature has been measured. The measured outputs can be visualized and are easily understandable by the physician and the patient care taker by the means of an android application.

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