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Design of Remote Monitoring System for the Detection of Vital Signs

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Abstract- Chronic heart failure (CHF) patients are commonly addicted to frequent hospital admissions. They should be constantly monitored for that sake they should be admitted in hospital. But frequent admissions is not that much possible for poor people. This is possible for rich ones. So to overcome this problem we go for home monitoring. The chronic heart failure patients should be monitored at home continuously when needed. By this home monitoring we can avoid frequent visits to hospital. Here we detect vital signs from patients and send to the hospital information system (HIS). The hospital information system is nothing but the centre which receives information about the patients. It can be sent from anywhere. It can be either email or online web transmission. All the parameters after being detected it are interfaced in ARM LPC2148 processor which processes the signals. ZigBee module helps in transmitting these signals to the Hospital Information System.

Keywords: Biomedical instrumentation, chronic heart failure (CHF), sensor signal processing.

I. INTRODUCTION

Chronic heart failure (CHF) is common in growing population. The heart failure patients are periodically addicted to frequent illness and hospital re-admissions. Due to this capability of sign detection will be destabilized and leads patient life at risk. To avoid this, a developed remote monitoring system is designed and transmitted to hospital via LabVIEW web publisher tool. This home monitoring device is portable. ECG, SpO2, Temperature, Weight, Blood Pressure are acquired and processed through LabVIEW. Continuous home monitoring of heart patients will lead to early detections of dangerous heart rate. Early Diagnosis of heart failure problems helps reducing the number of death.

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 3.6million 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, respectively [2].

Admission to hospital with heart failure has more than doubled in the last 20 years, and it is expected that CHF patients will double in 2030. Hospital admissions caused by CHF result in a large societal and economical issue, accounting for 2% of all hospitalizations. The CHF management accounts for 2% of the total healthcare expenditure and hospitalizations represent more than two thirds of such expenditure.

This paper represents an overview of a flexible and high configurable platform for domestic vital signs acquisition and processing, integrated with the Hospital Information System. Patients' signs, symptoms, and raised alarms can be received by healthcare providers, and aggravations can be quickly detected and acted upon. According to the analysis carried out by the clinicians, interesting vital parameters to monitor in a CHF patient are ECG, SpO2, weight, blood pressure (BP), chest impedance, respiration, and posture [1].

Heart failure is a complex clinical syndrome of symptoms and signs that suggest the efficiency of the heart as a pump is impaired. Most of the evidence on treatment is for heart failure due to LVSD. The most common cause of heart failure in the UK is coronary artery disease, and many patients have had a myocardial infarction in the past.

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All patients with chronic heart failure require monitoring. This monitoring should include:

a) A clinical assessment of functional capacity, fluid status, cardiac rhythm (minimum of examining the pulse), cognitive status and nutritional status.

b) A review of medication, including need for changes and possible side effects.

c) Serum urea, electrolytes, creatinine.

II. OVERVIEW

The monitor introduced in this project is as follows: it can continuously monitor real-time ECG, SpO2, Temperature, Weight and Blood Pressure. It displays each parameter by processing in LabVIEW software. The signal is acquired and sent to the hospital via Web publishing tool. When there is abnormality in the acquired signal, immediately doctors are informed about the patient's condition and he is treated avoiding risk stage.

III. METHODOLOGY

The remote monitoring device is specially developed for the patients who are suffering from heart ailments. Basically these patients are to be monitored continuously at home or hospital, but at hospital it will increase the expense. So to avoid this we are going for this method of detection of vital signs. Here we detect ECG, PPG, Blood Pressure, Weight and Temperature.

PARAMETERS	SAMPLING
3 Lead ECG	500 S/s/lead (12bit/S)
SpO^2	3 S/s (10 bit/S)
Blood pressure	1 S/type (32 bit int)
Weight	1 S (32 bit float)

Table 1: Parameters and sampling

A. Detailed Block diagram

a) Electrocardiogram (ECG) 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. ECG is a trans-thoracic interpretation of the electrical activity of the heart over a period of time, as detected by electrodes attached to the surface of the skin and recorded by a device external to the body. The recording produced by this noninvasive procedure is termed an electrocardiogram. 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, and the effects of drugs or devices used to regulate the heart, such as a pacemaker.

This display indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle. Usually, more than two electrodes are used, and they can be combined into a number of pairs. A 12-lead ECG is one in which 12 different electrical signals are recorded at approximately the same time and will often be used as a one-off recording of an ECG, traditionally printed out as a paper copy.

At rest, each heart muscle cell has a negative charge, called the membrane potential, across its cell membrane. The ECG device detects and amplifies the tiny electrical changes on the skin that are caused when the heart muscle depolarizes during each heartbeat.

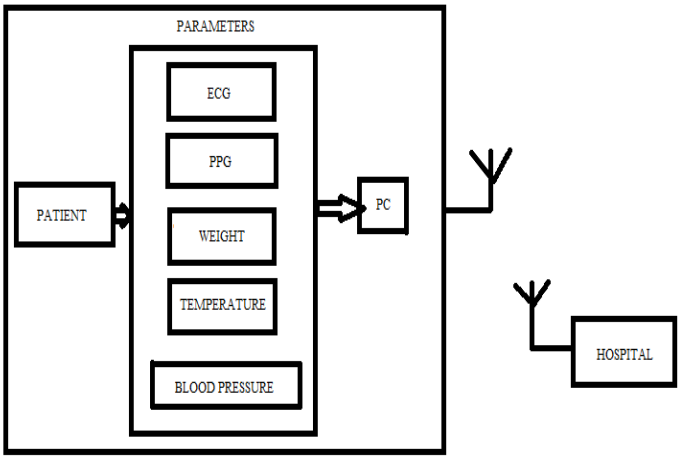

Fig. 1: Block Diagram

This is detected as tiny rises and falls in the voltage between two electrodes placed either side of the heart, which is displayed as a wavy line either on a screen or on paper.

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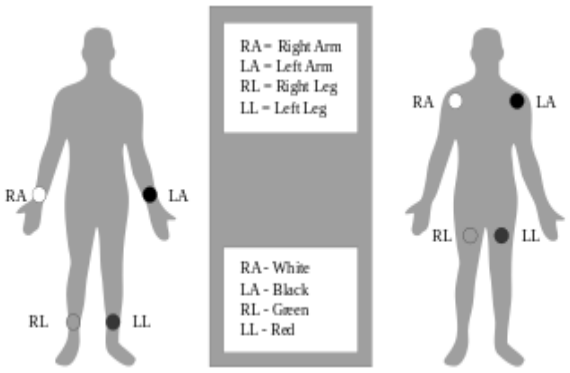

Fig. 2: ECG leads.

The output from each pair is known as a **lead**. Each lead looks at the heart from a different angle. Different types of ECGs can be referred to by the number of leads that are recorded, for example 3-lead, 5-lead, or 12-lead ECGs. Three- and 5-lead ECGs tend to be monitored continuously and viewed only on the screen of an appropriate monitoring device, for example during an operation or whilst being transported in an ambulance. There may or may not be any permanent record of a 3- or 5-lead ECG, depending on the equipment used. In this measurement system surface electrode is used to measure the ECG.

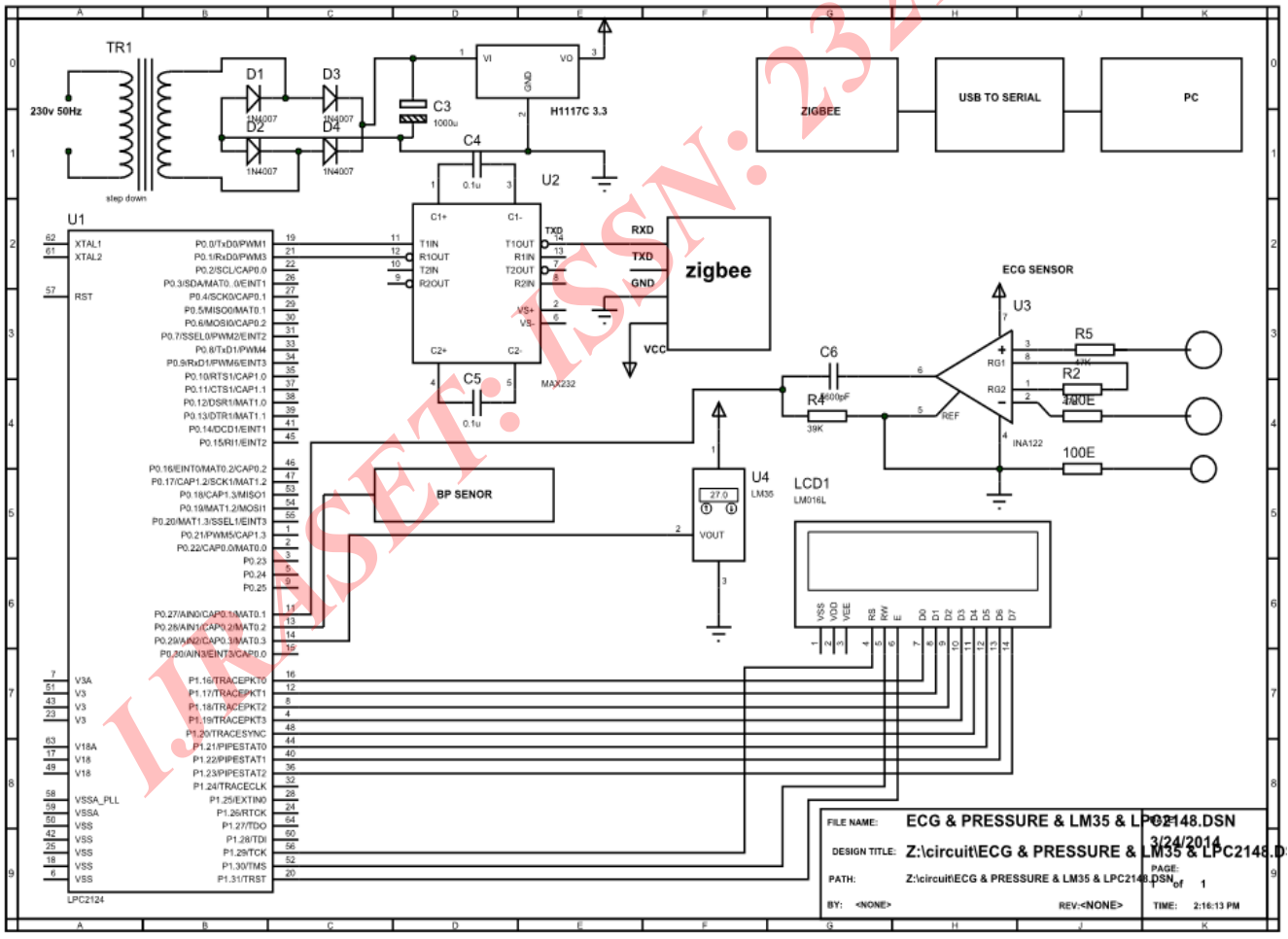

Fig. 3: Circuit diagram

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b) Blood Pressure (BP) is the pressure exerted by the blood against the walls of the arteries and veins. It varies during the heartbeat cycle and according to a person's age, health and physical condition. Blood Pressure is used to identify the blood pressure of a patient. It detects the systolic pressure and diastolic pressure. The normal blood pressure is 80/120 mmHG. Here the 80mmHG is systolic pressure and 120 mmHG is diastolic pressure. Systole is an rhythmic contraction of the heart by which the blood is driven through arteries. Diastole is relaxation and dilation of the heart chambers between contractions during which they fill with blood. The systolic pressure ranges from 70 to 90 mmHG and diastolic pressure ranges from 110 to 130 mmHG.

c) Temperature measurement is used to measure the cold and heat of a body. Thermometer is the basic instrument to measure the body temperature. That works by using the mercury. Nowadays everything has been improved and so the temperature measurement too. We use the LM35 sensor to measure the temperature of the patient. This sensor ranges from ±55 to ±110◦c.

d) Weight measurement module: The stability of body weight depends only on the energy intake and the expenditure. When energy intake exceeds the output, the excess energy is stored in the body as carbohydrates, proteins or fats and this causes a gain in body weight. When energy expenditure exceeds energy intake, body weight decreases.

e) Photoplethysmography (PPG) ensures detection of blood volume pulsations by time-resolved analysis of the tissue back-scattered or absorbed optical radiation. PPG technique has good potential for express diagnostics and early screening of cardio-vascular pathologies, as well as for self-monitoring of the vascular condition.

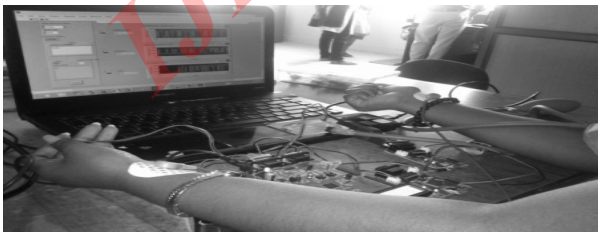

Fig. 4: Experimental Setup

The fig. 3 clearly explains the project. Transmission is made easy using ZigBee.

V. TRANSMISSION

After acquiring all the data, it is ready to be transmitted serially and continuously. Due to some circumstances we use the ZigBee for transmitting and receiving the data from patient.

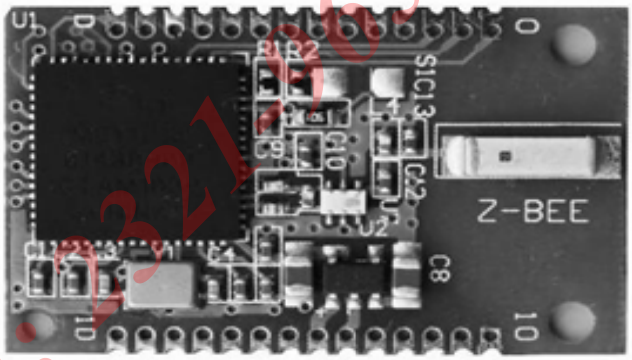

Fig. 5: ZigBee module

When compared to Bluetooth this transmitter has more advantages. Transmitting range is high in ZigBee. It covers almost more than one kilometer. The receiver end starts receiving the data serially. Finally it is displayed in LabVIEW at the receiver end.

IV. RESULTS AND DISCUSSION

The results are displayed in the PC which has LabVIEW software. We dump the program in the ARM board. The processor used is ARM LPC2148. This has an external SD memory slot available.

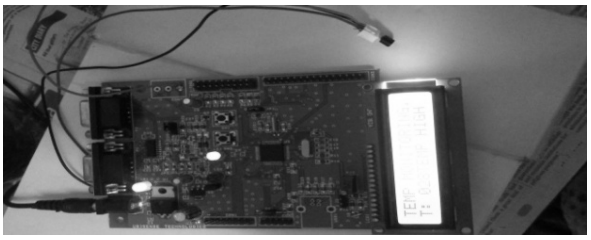

Fig. 6 ARM LPC2148 kit

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The internal memory is 842 KB. This also has USB ports and UART ports to which the ZigBee is connected.

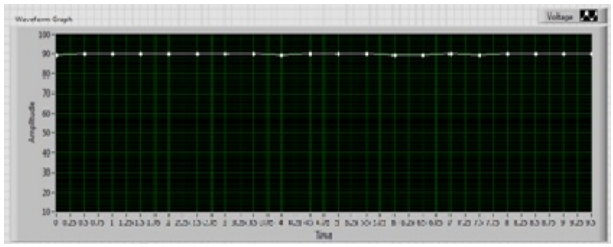

Fig 7: Temperature Waveform

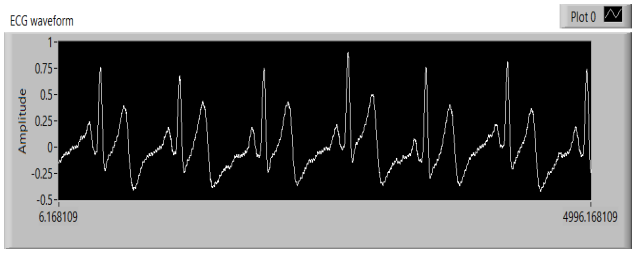

Fig 8: ECG waveform

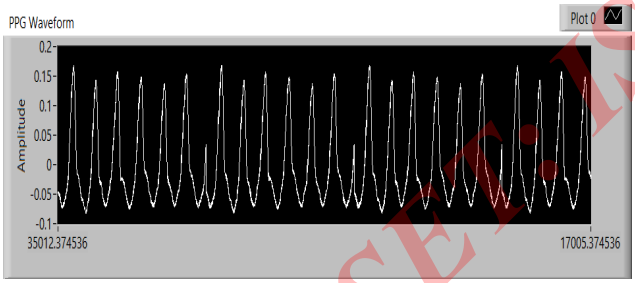

Fig 9: PPG Waveform

When the patient is tested he is monitored continuously and the data are sent to hospital immediately.

Fig 10: LCD Display of temperature measurement

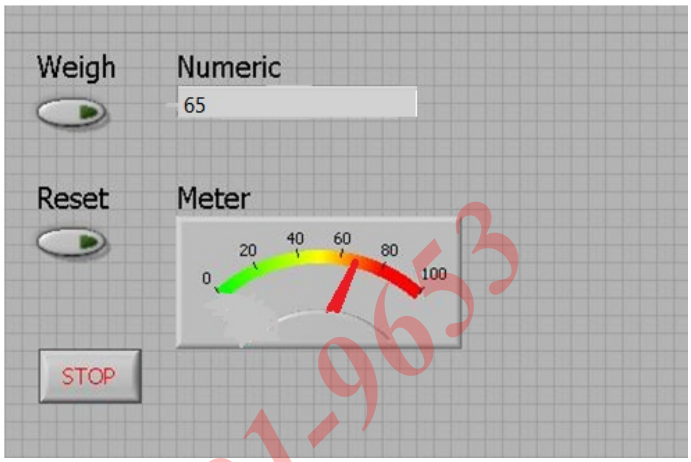

Fig 11. Weight measurement display in LabVIEW

VI. CONCLUSION AND FUTURE SCOPE

Thus the patient's data are transmitted serially and received using ZigBee module. Using LabVIEW makes the user to understand visually also. Both digital and graph readings are displayed in PC. The future scope is that we can use Wi-Fi instead of ZigBee which is faster. Another scope is that we can use WEB PUBLISHING TOOL in LabVIEW. This tool is more efficient.

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