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Remote Monitoring of Vital Signs in Chronic Heart Failure Patients

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ABSTRACT: The chronic heart failure (CHF) affects an ever-growing segment of population and it is among the major causes of hospitalization for elderly citizens. The actual out-of-hospital treatment model, based on periodic visits, has a low capability to detect signs of destabilization and leads to a high re-hospitalization rate. In this paper, a complete and integrated Information and Communication system is described to daily collect vital signs of the patients at home and automatically send them to the hospital database through GPS. This is achieved by using microcontroller along with a set of sensors which monitors the different vital signs of the patients. All signals are processed upon acquisition in order to assert if both punctual values and extracted trend lay in a safety zone established by thresholds. In case of emergency, the GPS module present in the kit will give a message or make a call to the physician and the caretaker of the patient to take necessary action. The vital signs are going to be monitored are electrocardiogram, blood pressure, temperature and spo2.

KEYWORDS: chronic heart failure (CHF), telemonitoring, vital signs, Global positioning System (GPS), electrocardiogram (ECG), spo2, physician, and caretaker.

I. INTRODUCTION

In medical field continuous patient monitoring is an important task at the hospital and patients home also. Particularly CHRONIC HEART FAILURE (CHF) patients need an intensive care and continuous monitoring to avoid Heart attack which leads to death, in hospital and home. The objective of this paper is to continuous monitoring of ECG signal and some other vital signs of Chronic Heart Failure patients from their home to avoid re-hospitalization and increase patient satisfactions. It is achieved by a minimum set of vital signs threshold values are fed in the microcontroller to monitoring the vital signs measured through a pool of wireless, non-invasive biomedical sensors .The Physicians monitor their patients at distance and take timely actions in case of emergency. In this paper introduction is given in the section 1, section 2 gives overview of the telemonitoring system, and vital signs descriptions which related to this paper. Section 3 gives a detailed description of the circuits of this paper. Section 4 gives the results and discussions of this paper. Finally, section 5 concludes the thesis.

II. SYSTEM OVERVIEW

The main objective of this paper is to continuously monitor the CHF patient's body vital signs using out-of hospital treatment model. A minimum set of vital parameters has been identified, consisting of electrocardiogram, SpO_2, blood pressure, and weight, measured through a pool of wireless, non-invasive biomedical sensors. A microcontroller with sensor interfacing has been also developed.

Sensor data acquisition and signal processing are in charge of an additional device. All signals are processed upon acquisition in order to assert if both punctual values and extracted trends lay in a safety zone established by thresholds. Per-patient personalized thresholds, required measurements and transmission policy are allowed. The proposed telemedicine platform represents a valid support to early detect the alterations in vital signs that precede the acute syndromes, allowing early home interventions thus reducing the number of subsequent hospitalizations. The normal and abnormal values of vital signs are tabulated for references.

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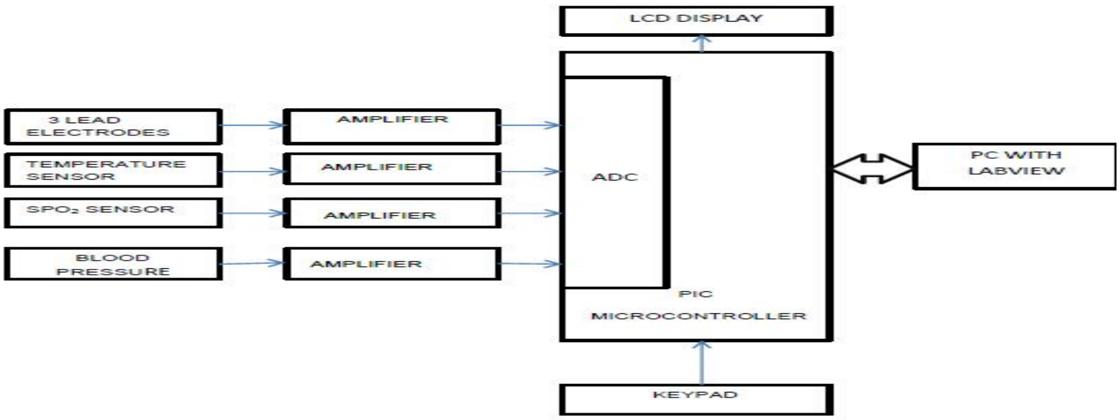

Fig. 1 Block diagram

Table I

Normal and Abnormal Values of Vital Signs.

Sl.no	Vital Signs	Normal Value	Abnormal Value
1	ECG-R wave Amplitude in sec	0.4-1.2 sec	Above 1.2 sec
2	Saturation Of Peripheral Oxygen (Spo_2)	90-100	Below 90
3	Blood Pressure	120/80mmhg	140/90mmhg
4	Body Temperature	36.8±0.5 °C	Above 38°C

III. DESCRIPTION OF CIRCUITS AND SENSORS

A. ECG CIRCUIT DESCRIPTION

In this circuit there are three electrodes is used to measure the ECG waves in which two electrodes is fixed with left and right hand another one electrode is fixed in the left leg which acts as reference ground electrode. Electrode 1 and Electrode 2 pick up the ECG waves from the both hands. Then the ECG waves are given to instrumentation amplifier section.

The instrumentation amplifier is constructed by the TL072 operational amplifier. The TL072 are high speed J-FET input dual operational amplifier incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset current and low offset voltage temperature coefficient.

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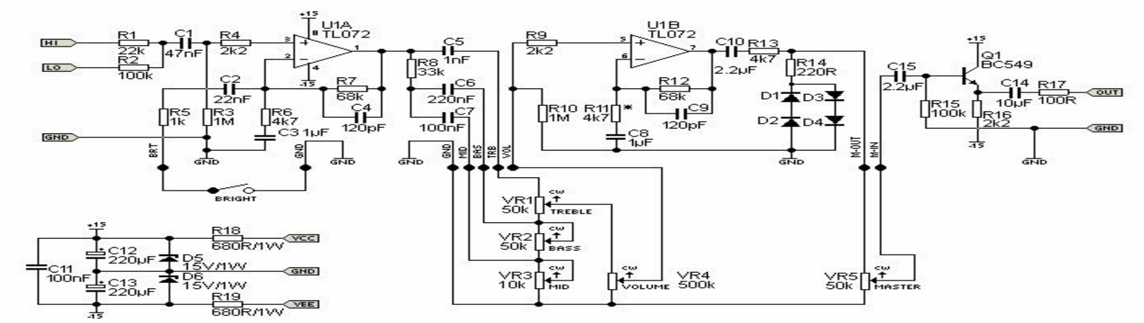

Fig. 2 ECG circuit

The instrumentation amplifier amplifies the differential signal from the both electrode. This amplified ECG waves contains the line frequency, high frequency and low frequency noise signals. So the ECG wave is fed to filter section. The filter section consists of high pass filter and low pass filter which is used to remove the high frequency and low frequency noise signal. After the filtration the ECG wave is given to pulse width modulation unit. In this section the ECG waves convert to pulse format in order to perform the isolation. The isolation is constructing by the opto coupler. The isolation is necessary to isolate the human body and monitoring equipment such as CRO, PC etc.

B.PRESSURE MONITORING

The pressure is measured by diaphragm which is one type of transducer. When pressure is applied, the diaphragm is moving in the forward side. The diaphragm moving is depends on the pressure. So it generates the voltage pulse depends on the movement of diaphragm. The voltage pulses are in the range of millivolt. Hence the voltage pulse is given to Instrumentation amplifier section in order to amplify the signals.

The important features of instrumentation amplifier are high gain accuracy, high CMRR, low output impedance. Here the instrumentation amplifier is constructed by TL 074 operational amplifier. The TL 074 is the dual operational amplifier that is two operational amplifiers is fabricated in single chip. Here the instrumentation amplifier acts as differential instrumentation amplifier. The diaphragm transducer terminals are connected to A1 and A2 amplifier of the differential instrumentation amplifier.

The difference of the varying voltage signals from the transducer is amplified by the instrumentation amplifier. The A4 amplifier is used for zero adjustment. When there is no pressure the diaphragm may be sliding in the forward or reverse side. Due to that instrumentation amplifier delivered some voltage at the output. To avoid this problem A4 amplifier is used for zero adjustment. Hence when there is no pressure the output is zero.

The A5 amplifier acts as gain amplifier in which variable resistors is connected as feedback resistor. By adjusting the feedback resistor we can vary the gain of the output signal. Then the final gain adjusted signal is amplified by the

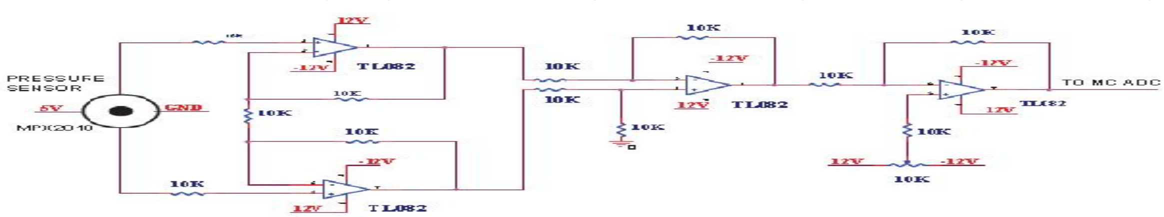

Fig.3 Pressure circuit

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C.SATURATION OF PERIPHERAL OXYGEN (Spo$_2$) CIRCUIT DESCRIPTION

The ADG1636 is a monolithic CMOS device containing two independently selectable single-pole/double-throw (SPDT) switches. An EN input is used to enable or disable the device. When disabled, all channels are switched off. Each switch conducts equally well in both directions when on and has an input signal range that extends to the supplies. In the off condition, signal levels up to the supplies are blocked. Both switches exhibit break-before-make switching action for use in multiplexer applications.The CMOS construction ensures ultralow power dissipation, making the parts ideally suited for portable and battery-powered instruments.

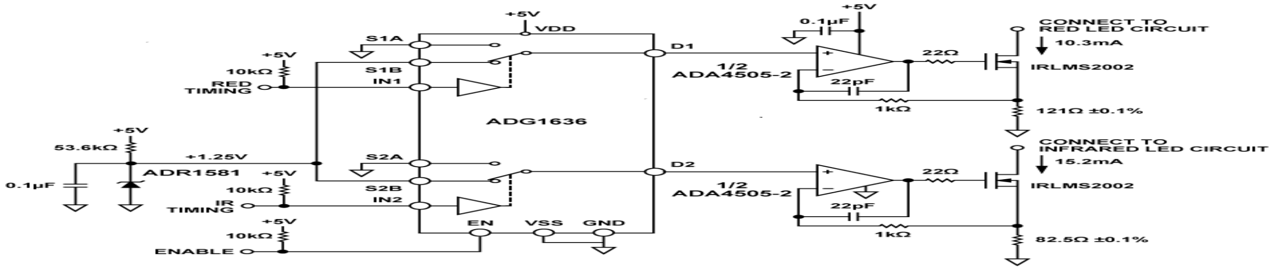

Fig .4 SPO2 circuit

The measurement starts when the MCU generates a PWM signal that varies the LED intensity. Because every person has a different finger size and skin color, the LED needs to be calibrated to acquire an accurate signal. LED calibration is performed by taking the LED filtered baseline and using an algorithm described in the Software model which changes the PWM duty cycle value to adjust the LED intensity for every kind of user.

The signal passes through a current to the voltage converter where it is filtered, amplified, and converted into a voltage. The signal is now multiplexed to its respective filter and amplification stage, depending on whether it is Red or infrared LED. At this stage, the signal is treated and most of the noise is removed. The signal is also amplified in order to be detected easily by the MCU ADC.

D. TEMPERATURE SENSING

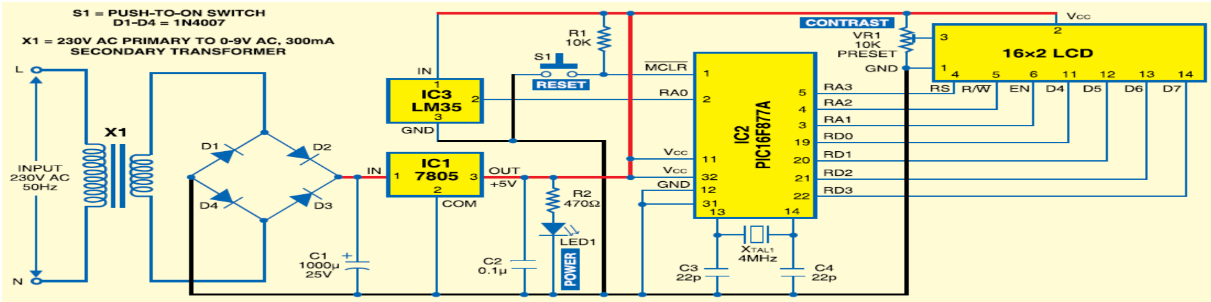

Fig.5 Temperature circuit

The circuit mainly consists of the LM35 temperature sensor, PIC16F877A microcontroller and HD44780 controller based 16×2 LCD. The output of the sensor is fed to the internal ADC of the microcontroller. Pin 2 of the microcontroller (RA0/AN0) is channel-1 of the internal ADC. The analogue voltage output of the sensor is converted into its equivalent digital value by the ADC and then its equivalent degree Celsius value is calculated by the software. The calculated temperature value is displayed on the LCD.

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LM35 is a precision integrated-circuit centigrade temperature sensor whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in degree Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. For each degree Celsius change in temperature, the sensor output changes by 10 mV.

E.GSM CIRCUIT

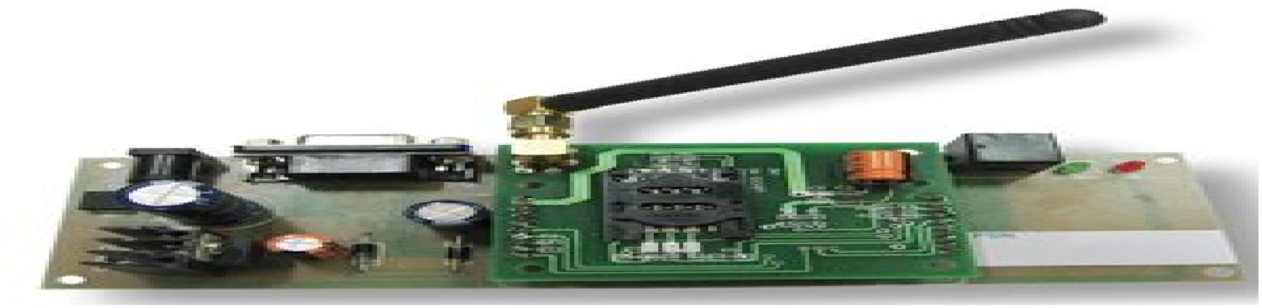

Fig.6 GSM circuit

GSM module is used to establish communication between a computer anda GSM system using RS-232 cable for transmitting and receiving information about the vital signs. In case of emergency, the GPS module present in the kit will give a message or make a call to the physician and the caretaker of the patient to take necessary action.

IV. RESULTS AND DISCUSSIONS

In the analysis of the vital signs of human body is monitored by the designed kit is calculated and transferred to the Pc with lab view to visualize the vital signs changes in the physician's desktop. It helps the patient to be with confidence and satisfaction and the physician's to monitor their patients continuously from their work space.

It reduces the Re-hospitalization rates. Physicians reported that the use of this platform does not load up in a significant way their regular activity, but represents a valid means to control at distance the evolution of the followed patients thanks to the high quality of acquired signals and alarm detection capability.

In the previous literature some of vital signs are measured manually and entered in the Pc from the patient home. But in this proposed method all the vital signs are monitored with the help of sensors and simply transferred to the hospital database for analysis.

This architecture differs from the previous ones. In the earlier work, only ECG and SpO2 were included which again are less than the minimum required by clinicians for clinical monitoring of patient with CHF. Additionally the user interface running on PC is not suitable for elderly people. All the previous solutions do not include advanced signal processing functions in the home gateway for early warning of the remote system. But in this proposed system (i.e., 3-lead ECG, BP, SPO_2 in basic configuration) and flexibility, through the OP, to meet the individuality of the end users. The quality and the reliability of acquired signals and generate alarms, the robustness of data transmission, and the system effectiveness from the medical perspective was evaluated as a key point of system functionalities with regular monitoring methods. The outputs can be visualized and are easily understand -able by the physician and the patient care taker as shown in the output figures.

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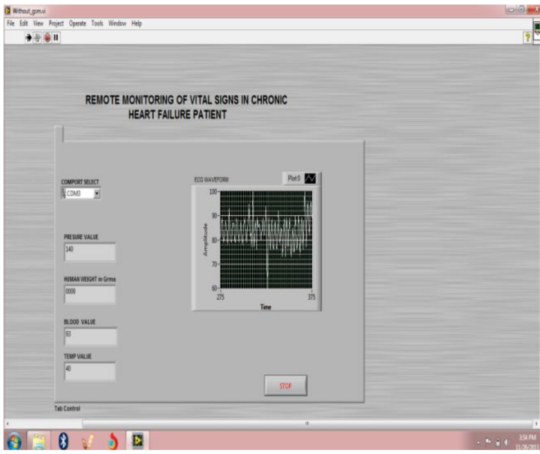

Fig. 7 Output on desktop

Fig. 8 Output on kit.

V. CONCLUSION

In this paper, the requirements and the realization in terms of sensing devices and sensor data signal processing of a complete and integrated ICT platform to improve the provisioning of healthcare services for CHF patients. The H@H system proposes an innovative home care model in order to support in integrated and coordinated fashion the whole process of the patient treatment, connecting in-hospital care with out of-hospital follow up. Sensor data acquisition and signal processing are in charge of an additional device. All signals are processed upon acquisition in order to assert if both punctual values and extracted trends lay in a safety zone established by thresholds. Per-patient personalized thresholds, required measurements and transmission policy are allowed. The proposed telemedicine platform represents a valid support to early detect the alterations in vital signs that precede the acute syndromes, allowing early home interventions thus reducing the number of subsequent hospitalizations.

The benefits extend beyond the early detection of clinical exacerbation to optimizing specialized resources scheduling and to reduce unnecessary travels to hospital. The system definition was completely driven by the end-users resulting in a platform particularly effective and practical with respect to other telemonitoring trials.one more advantage in proposed system is the measured parameters are visible and easily understand by the patient's caretaker also. The processed data's of the vital signs and some other vital signs are added for processing, and the processed data's are transmitted to the hospital database for analysis using GSM.

REFERENCES

[1] Luca Fanucci, Member, IEEE, Sergio Saponara, Member, IEEE, Tony Bacchillone, MassimilianoDonati, PierluigiBarba, Isabel Sánchez-Tato, and Cristina Carmona 2013 IEEE transactions "Sensing Devices and Sensor Signal Processing for Remote Monitoring of Vital Signs in CHF Patients'', pp. 553-569.

[2] P. Jiapu and W. J. Tompkins, Mar. 1985 "A real-time QRS detection algorithm", IEEE Trans. Biomed. Eng., vol. BME-32, no. 3, pp. 230–236.

[3] J. Allen, Mar 2007, "Photoplethysmography and its application in clinical physiological measurement," Physiol. Meas., vol. 28, no. 3, pp. R1–R39.

[4] Bajo.J.Tapia, D.I.Abraham, A, Mar 2010, "Using Heterogeneous Wireless Sensor Networks in a Telemonitoring System for Healthcare", pp. 234 - 240.

[5] JakubParak, Jan Dvorak, MatousPokorny and Jan Havlik, 2012,"Modular development telemonitoring system", 35th International Conference Telecommunications and Signal Processing, p. 494-498. ISBN 978-1-4673-1118-2.

[6] B.-K.Miller and W.MacCaull, Nov. 2009, "Toward web-based careflow management systems," J. Emerg. Technol. Web Intell., vol. 1, no. 2, pp. 137–145.

[7] A. L. Goldberger, L. A. Amaral et al, Nov. 2000, "PhysioBank, PhysioToolkit, and PhysioNet: Components of a new research resource for complex physiologic signals," Circulation, vol. 101, no. 23, pp. 215–220.

[8] S. Saponara, M. Donati, T.Bacchillone, L.Fanucci, I.Sanchez-Tato,C. Carmona, and P. Barba, 2012 "Remote monitoring of vital signs in patients with chronic heart failure: Sensor devices and data analysis perspective," in Proc. IEEE Sens. Symp. Appl, pp. 1–6.

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[9] T. Bacchillone, M. Donati, S. Saponara, and L. Fanucci, 2011, "A flexible home gateway system for telecare of patients affected by chronic heart failure," in Proc. IEEE Int. Symp. Med. Inf. Commun. Technol., pp. 139–142.

[10] Insight Telehealth Syst., Phoenixville, PA. [Online]. Available: http://www.itsmyhealthyheart.com