AN INVESTIGATION ON MONITORING CARDIAC ACTIVITIES USING MICROCONTROLLER

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ABSTRACT

This paper describes the development of a heart rate monitor system based on a microcontroller using fingertip sensor. The paper explains how a single-chip microcontroller can be used to analyze heart beat rate signals in real-time. The hardware and software design are oriented towards a single-chip microcontroller-based system, hence minimizing the size. Heart rate of the subject is measured from the finger using optical sensors and the rate is then averaged and displayed on a text based LCD. It allows patients to measure their own vital signs, such as heart rate and temperature, and provide the health .care professionals with the facility to remotely monitor the patient's vital signs quickly and easily. The gadget would then activate a GSM modem (SIM based) and also a GPS (global positioning system). An onscreen display will start scrolling the person's name, address and contact details so that people who try to help such a person get the complete information from the device.

I. INTRODUCTION

Heart rate measurement is one of the very important parameters of the human cardiovascular system. The heart rate of a healthy adult at rest is around 72 beats per minute (bpm). Athletes normally have lower heart rates than less active people. Babies have a much higher heart rate at around 120 bpm, while older children have heart rates at around 90 bpm. The heart rate rises gradually during exercises and returns slowly to the rest value after exercise. The rate when the pulse returns to normal is an indication of the fitness of the person. Lower than normal heart rates are usually an indication of a condition known as bradycardia, while higher than normal heart rates are known as tachycardia. More sophisticated methods to measure the heart rate utilize electronic techniques. Electro-cardiogram (ECG) is one of frequently used and accurate methods for measuring the heart rate. ECG is an expensive device and its use for the measurement of the heart rate only is not economical. Low-cost devices in the form of wrist watches are also available for the instantaneous measurement of the heart rate. Such devices can give accurate measurements but their cost is usually in excess of several hundred dollars, making them uneconomical. Most hospitals and clinics in the UK use integrated devices designed to measure the heart rate, blood pressure, and temperature of the subject [1-9].

Although such devices are useful, their cost is usually high and beyond the reach of individuals. This paper describes the design of a very low-cost device which measures the heart rate of the subject by clipping sensors on one of the fingers and then displaying the result on a text based LCD. The device has the advantage that it is microcontroller based and thus can be programmed to display various quantities, such as the average, maximum and minimum rates over a period of time and so on.

II. SYSTEM DESIGN

The patient (client) and the health care professional (server) can be located anywhere in the globe where there is GSM (cellular) network coverage. The patient's Heart Rate and temperature, and other vital signs if desired, can be acquired by the patient himself under follow up scenario for example, or the patient can be assisted by a family member or a health care professional in more serious cases depending on the particular patient's case [10-17]. The signal acquisition process is performed by attaching the Heart Rate electrodes and the temperature sensor to the patient's body at designated places as is normally done in a typical similar set-up.

The client unit communicates with the mobile phone via a GSM modem connection, which can be established through a UART. The mobile phone in- turn submits a series of SMS messages that contains the acquired data to the cellular network by communicating with the serving cellular base station. When the SMS messages reach their destination mobile phone (or PDA), they are either downloaded via and RS232 connection by a special software running on a laptop, or they can be imported by a mobile application running on the phone [18-27]. The microcontroller acquires the amplified and conditioned signals, and then performs the interface with the mobile phone using the supported standard AT commands.

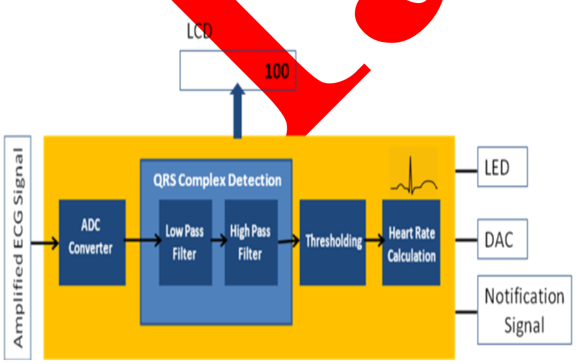

Figure 1: General articulation

III. HEARTRATE SENSORS

The device consists of an infrared transmitter LED and an infrared sensor photo-transistor. The transmitter-sensor pair is clipped on one of the fingers of the subject .The LED emits infrared light to the finger of the subject [28-32]. The photo-transistor detects this light beam and measures the change of blood volume through the finger artery. This signal, which is in the form of pulses is then amplified and filtered suitably and is fed to a low-cost microcontroller for analysis and display. The microcontroller counts the number of pulses over a fixed time interval and thus obtains the heart rate of the subject. Several such readings are obtained over a known period of time and the results are averaged to give a more accurate reading of the heart rate. The calculated heart rate is displayed on an LCD in beats-per-minute in the following format: Rate = nnn bpmw where nnn is an integer between 1 and 999.

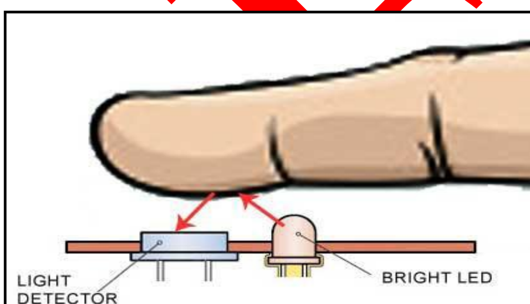

Figure 2: Sensing devices

A. PIC 16F877

The PIC 16F877 is an 8-bit microcontroller, which has an on-chip eight channel 10-bit Analog-to-Digital Converter (ADC).First we detect fall down using accelerometer and fed to the I2C ports. The amplified and conditioned Heart Rate signal is fed to input port RB0 (INT) of the microcontroller. Also, upon command, the microcontroller reads the temperature sample stored in the RAM of the LM35 through the ADC port RA0. It is then converted and stored in the PIC16F877 memory as two 8-bit unsigned integers (0-255). After completion of signals acquisition, the microcontroller constructs the SMS messages and packs the data samples in these messages to the desired length, then communicates with the mobile phone using at-commands on its GSM modem port to send the message(s). A complete system can therefore be built using one MCU chip and a few I/O devices such as a keypad, display and other interfacing circuits. Most of the pins are for input and output, and arranged as 5 ports: PORTA (5pins), PORTB (8pins), PORTC (8pins), PORTD (8pins) and PORTE (3 pins), total of 32 I/O pins

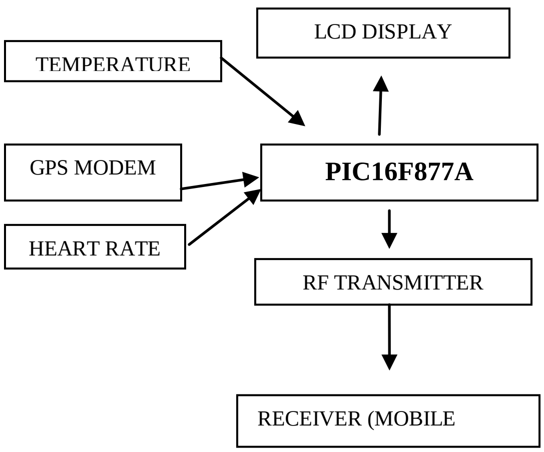

Figure 3: Block diagram

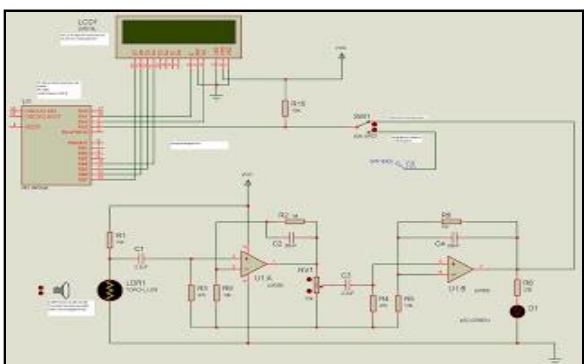

Figure 4: heart rate displayed in LCD

B. GPS SENSOR

This is a high gain GPS Receiver (5V Serial) with 4pin. Receiver is made with third generation POT (Patch Antenna on Top) GPS module. The built in 3V3 to 5V level convertor enable us to interface with normal 5V Microcontrollers. The 4 Pins are 5V, TX, RX, and GND. Yes, there is no setting required, just plug in to the power (5v), your data (NMEA 0183) is ready at TX pin! This is a standalone 5V GPS Module and requires no external components .It is built with internal RTC Back up battery. It can be directly connected to Microcontroller's UART. With the use high gain GPS engine providing a solution that high position and speed accuracy performances as well as high sensitivity and tracking capabilities in urban conditions & provides standard NMEA0183 strings in "raw" mode for any microcontroller. The module provides current time, date, latitude, longitude, speed, altitude and travel

C. GSM/GPRS MODEM

GSM/GPRS Modem-TTL (5V is built with Tri-band GSM/GPRS engine, works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz It is very compact in size and easy to use as plug in module. The Modem is coming with 5V TTL interface, which allows you to connect directly to 5V microcontroller. The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS TTL Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS as well as DATA transfer application in M2M interface. You need only two wires (Tx, Rx) except Power supply to interface with microcontroller. Using this modem, you can send SMS, data and read SMS through simple AT command .Inbuilt Powerful TCP/IP protocol stack for internet data transfer over GPRS. Input Voltage: 9-12VDC.

D. BODY TEMPERATURE SENSOR

We used a special rapid, low-cost, integrated-circuit temperature sensors. 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 ±¼°C at room temperature and ±¾°C over a full -55 to +150°C temperature range. It can be Operates from 4 to 30 volts. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range. We interface the temperature sensor to the PIC16F877A microcontroller using the ADC port on the microcontroller [4].

E. AT COMMANDS:

The AT commands are standard control tools based on GSM to establish communication with the mobile GSM phone or modem. The commands set consist of strings, which will enable the exchange of serial data, according to certain syntax rules, between the mobile and the microcontroller at the client unit, and the laptop or PC at the server. A graphical LCD can be used to display a graph of the change of heart rate over time. Sound can be added to the device so that a sound is output each time a pulse is received. The maximum and minimum heart rates over a period of time can be displayed. Serial output can be attached to the device so that the heart rates can be sent to a PC for further online or offline analysis.

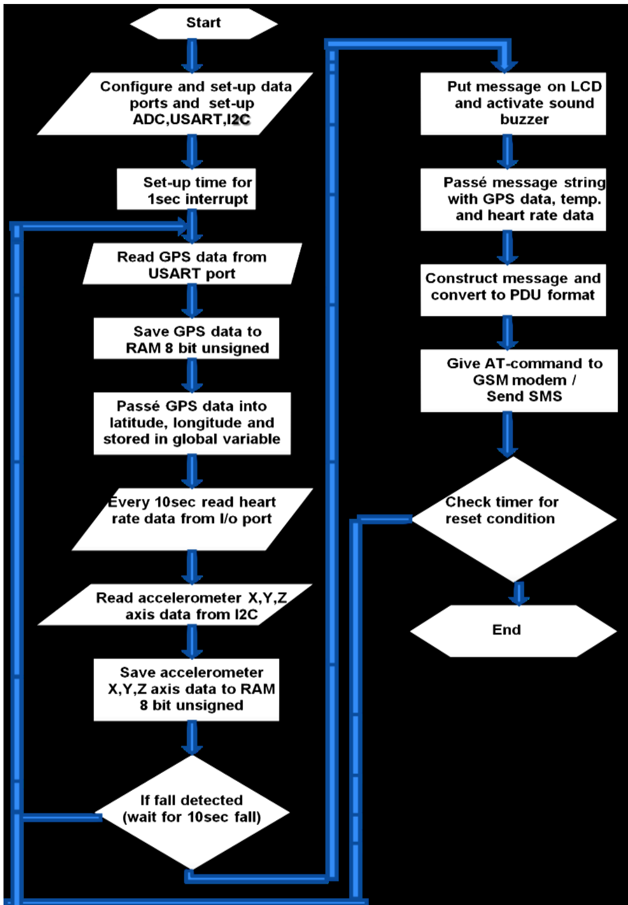

Figure 5: Flowchart of the model

F. SERVER UNIT:

The platform or Operating System (OS) used to run the application software at receiving device will influence the choice of the preferred programming language used in implementing the software. The smart-phone we have used was the Motorola mobile phone. Capturing the data through SMS message(s) decoding them, and extracting the user data part. The software decodes each SMS and extracts the time and date, originating mobile number, and the transmitted patient's temperature and Heart Rate samples in the payload. The software converts the data in the message from binary to ASCII and displays the contents of the message. The first three digits represent body temperature (were obtained from two bytes) with an implicit decimal point after the first two digits from the left. Each Heart Rate sample can take a value between 0 and 255 as a maximum since we originally used eight bit accuracy in our ADC Also, the application software has a menu button, which allows for plotting the Heart Rate sample points and displaying the Body temperature reading contained in the selected SMS message from the list.

IV. CONCLUSION

The design of a low-cost microcontroller based device for measuring the heart pulse rate has been described. The device has the advantage that it can be used by non-professional people at home to measure the heart rate easily and safely. A low cost mobile patient monitoring system that utilizes Short Messaging Service (SMS) was designed, developed, and tested. An Infrared temperature sensor was integrated with a three lead Heart Rate monitor (client unit) on a cellular (mobile) phone platform, which can be considered as a real time transmission mode. Application software is required at the receiving mobile device (consultation unit) to decode the signal SMS messages and plot the Heart Rate and display the body temperature. The new system has a significantly reduced size and weight, which improves its versatility and mobility. Besides, SMS can be the most suitable, if not the only, method of data transmission in emergency situations in remote area where broadband data communications (like GPRS, EDGE … etc.) are not available. In future work more powerful transmitters with higher range will be used and the flexibility to use the internet to send the data to the receiving site will be fully explored.

REFERENCES

[1] S. Edwards., "Heart rate Monitor Book", Leisure systems international, Dec. 1993.

[2] Microchip web site: http://microchip.com

[3] A. R. Houghton and D. Gray., "making sense of the ECG", Hodder Arnold Publishing 2003.

[4] http://www.heartratemonitor.co.uk

[5] Hamid Ali Abed Al-Asadi, "Temperature dependence of the lasing characteristics of vertical cavity surface emitting lasers," Engineering Journal of Technology University, Vol. 145, 1994.

[6] Boselin Prabhu S.R. and Sophia S., "Environmental monitoring and greenhouse control by distributed sensor Network", International Journal of Advanced Networking and Applications, 5(5), 2014.

[7] Boselin Prabhu S.R. and Sophia S., "Greenhouse control using wireless sensor network", Scholars Journal of Engineering and Technology, 2(4), 2014.

[8] Hamid Ali Abed Al-Asadi, "Temperature dependence of the noise characteristics of Multiisection semiconductor lasers," Science Journal, vol. 7, No. 3, 2001.

[9] Hamid Ali Abed Al-Asadi, "Linewidth characteristics of vertical cavity surface emitting lasers due to external optical feedback," Science Journal, vol. 8, 2001.

[10] Boselin Prabhu S.R. and Sophia S., 'Modern cluster integration of advanced weapon system and wireless sensor based combat system', Scholars Journal of Engineering and Technology, 2(6A), 2014.

[11] Boselin Prabhu S.R. and Sophia S., 'A review of efficient information delivery and clustering for drip irrigation management using WSN', International Journal of Computer Science and Business Informatics, 14(3), 2014.

[12] Hamid Ali Abed Al-Asadi, "Linewidth characteristics of vertical cavity surface emitting lasers due to external optical feedback," Science Journal, vol. 8, 2002.

[13] Hamid Ali Abed Al-Asadi, "Theoretical investigation of spectral linewidth properties of double fused 1.3 um MQW-VCA in reflection and transition modes," Tikrit Journal for Pure Science, vol. 8, No. 2, 2002.

[14] Boselin Prabhu S.R. and Sophia S., 'Mobility assisted dynamic routing for mobile wireless sensor networks', International Journal of Advanced Information Technology, 3(3), 2013.

[15] Boselin Prabhu S.R. and Sophia S., 'A review of energy efficient clustering algorithm for connecting wireless sensor network fields', International Journal of Engineering Research and Technology, 2(4), 2013.

[16] Hamid Ali Abed Al-Asadi, "Vertical cavity amplifiers and its cavity length dependence the saturation power and quantum efficiency," Tikrit Journal of Pure Science, vol. 9, No. 2, 2003.

[17] Hamid Ali Abed Al-Asadi, "Effects of pump recycling technique on stimulated Brillouin scattering threshold: A theoretical model," Optics. Express, Vol. 18, No. 21, pp. 22339-22347 Impact factor: 3.88, 2010.

[18] Boselin Prabhu S.R. and Sophia S., 'Variable power energy efficient clustering for wireless sensor networks', Australian Journal of Basic and Applied Sciences, 7(7), 2013.

[19] Boselin Prabhu S.R. and Sophia S., 'Capacity based clustering model for dense wireless sensor networks', International Journal of Computer Science and Business Informatics, 5(1), 2013.

[20] Hamid Ali Abed Al-Asadi, "Brillouin Linewidth Characterization in Single Mode Large Effective Area Fiber through the Co-Pumped Technique," International Journal of Electronics, Computer and Communications Technologies (IJECCT), Vol. 1(1), pp. 16-20, 2010.

[21] Boselin Prabhu S.R. and Sophia S., 'An integrated distributed clustering algorithm for dense WSNs', International Journal of Computer Science and Business Informatics, 8(1), 2013.

[22] Boselin Prabhu S.R. and Sophia S., 'A research on decentralized clustering algorithms for dense wireless sensor networks', International Journal of Computer Applications, 57(20), 2012.

[23] Hamid Ali Abed Al-Asadi, "Analytical study of nonlinear phase shift through stimulated Brillouin scattering in single mode fibre with pump power recycling technique,", Volume 13 Number 10, Journal of Optics. Impact factor: 1.99, 2011.

[24] Hamid Ali Abed Al-Asadi , "Architectural Analysis of Multi-Agents Educational Model in Web-Learning Environments," Journal of Emerging Trends in Computing and Information Sciences, Vol. 3, No. 6, June 2012.

[25] Boselin Prabhu S.R. and Sophia S., 'Hierarchical distributed clustering algorithm for energy efficient wireless sensor networks', International Journal of Research in Information Technology, 1(12), 2013.

[26] Boselin Prabhu S.R. and Sophia S., 'Real-world applications of distributed clustering mechanism in dense wireless sensor networks', International Journal of Computing Communications and Networking, 2(4), 2013.

[27] Haitao, Z, Shiwei, Z &Wenshao, B 2014, 'A clustering routing protocol for energy balance of wireless sensor network based on simulated annealing and genetic algorithm', International Journal of Hybrid Information Technology, vol. 7, no. 2, pp. 71-82.

[28] Han, L 2010, 'LEACH-HPR: An energy efficient routing algorithm for heterogeneous WSN', Proceedings of the IEEE International Conference on Intelligent Computing and Intelligent Systems, pp. 507-511.

[29] Heinzelman, WB, Chandrakasan, AP &Balakrishnan, H 2002, 'Application specific protocol architecture for wireless microsensor networks', IEEE Transactions on Wireless Communications, vol. 1, no. 4, pp. 660-670.

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[30] Hill, J 2000, 'System architecture directions for networked sensors', Proceedings of the 9th International Conference on Architectural Support for Programming Languages and Operating Systems, pp. 93-104.

[31] Hossein, J 2013, 'An introduction to various basic concepts of clustering techniques on wireless sensor networks', International journal of Mobile Network Communications and Telematics, vol. 3, no. 1, pp. 01-17.

[32] Huifang, C, Hiroshi, M, Yoshitsugu, O, Tomohiro, K & Tadanori, M 2007, 'Adaptive data aggregation for clustered wireless sensor networks', Proceedings of the Ubiquitous Intelligence and Computing, pp. 475-484.