International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

Heart rate measurement with photoplethysmography through SCADA

M.A. Khadar Baba[1]; Narla Akhil[2]; N. Navya Sree[3]& N. Alluraiah[4]

[12,3,4] ECE Department, Guru Nanak Institutions Technical Campus, Hyderabad, Telangana, India.
Email: narlaakhil@gmail.com, abdul2805@gmail.com

Abstract: *This paper describes the development of a heart rate monitor system based on a Arduino UNO. It offers the advantage of portability over tape-based recording systems. This paper explains how a Arduino UNO can be used to analyze heart beat rate signals in real-time. In addition, it allows doctors to get the heart beat rate file of the patient by email every twenty-four hours. It can also be used to control patients or athletic person over a long period. The system reads, stores and analyses the heart beat rate signals repetitively in real-time. The hardware and software design are oriented towards a Arduino UNO system, hence minimizing the size. It then processes on real-time the information to determine some heart diseases.*

Key Words: Heart Beat Rate, SCADA, PID controllers, Photo plethysmography.

I. INTRODUCTION

This concept "Heart Rate Measurement with Photoplethysmography through SCADA" can be used in hospitals and also for patients who can be under continuous monitoring while traveling from place to place. Since the system is continuously monitoring the patient and in case of any abnormal in the heart beat rate of the patient the system will immediately message to the concerned doctors and relatives about the condition of the patient and abnormal details. To perform these operations the system uses heart beat sensor, Bluetooth module, and to control all these devices the heart of the system Arduino Uno ATMEGA328p is used. Some severe diseases and disorders e.g. heart failure needs close and continual monitoring procedure after diagnosis, in order to prevent mortality or further damage as secondary to the mentioned diseases or disorders. Monitoring these types of patients, usually, occur at hospitals or healthcare centers. Heart arrhythmias for instance, in many cases, need continual long-term monitoring. However, the patients are often too early released, owing to need of hospital bed for another patient on the waiting list, who needs to be hospitalized immediately. In transmitter circuit the Heat Beat is measured by LED and LDR, and then it is applied to the microcontroller. The Microcontroller maintains the records of the measured readings. It compares the measured heart beat with the normal readings and verifies whether it is within the normal range or not. If it is normal, then it sends the message as normal otherwise it sends abnormal to the specified mobile number. The time specified for sending message is given by the user. The heart beat wave will be displayed in the SCADA Screen.

Technological innovations in the field of disease prevention and maintenance of patient health have enabled the evolution of fields such as monitoring systems. Heart rate is a very vital health parameter that is directly related to the soundness of the human cardiovascular system. Heart rate is the number of times the heart beats per minute, reflects different physiological conditions such as biological workload, stress at work and concentration on tasks, drowsiness and the active state of the autonomic nervous system. It can be measured either by the ECG waveform or by sensing the pulse - the rhythmic expansion and contraction of an artery as blood is forced through it by the regular contractions of the heart. The pulse can be felt from those areas where the artery is close to the skin. This paper describes a technique of measuring the heart rate through a fingertip and Arduino. It is based on the principal of photoplethysmography (PPG) which is non-invasive method of measuring the variation in blood volume in tissue using a light source and detector. While the heart is beating, it is actually pumping blood throughout the body, and that makes the blood volume inside the finger artery to change too. This fluctuation of blood can be detected through an optical sensing mechanism placed around the fingertip. The signal can be amplified and is sent to Arduino with the help of serial port communication. With the help of processing software heart rate monitoring and counting is performed. HEART RATE MONITORING SYSTEM as a reference this paper has been implemented.

II. SYSTEM DESCRIPTION

Embedded systems are one of the emerging technologies which are touching every nook and corner of the mind. "It is impossible to live without these embedded gadgets"- says ELECTRONICS magazine. From the above statement, the liveliness of embedded system can be understood. Data communications is one of the most rapidly growing commercial market areas today,

especially "wireless communications" [5]. In the past few years, wireless data communications have grown from an obscure and expensive curiosity into a practical and affordable communication and networking technology. The convenience of wireless is very appealing as not to deal with running cables to and from devices in order to interconnect them, and wireless devices can be.

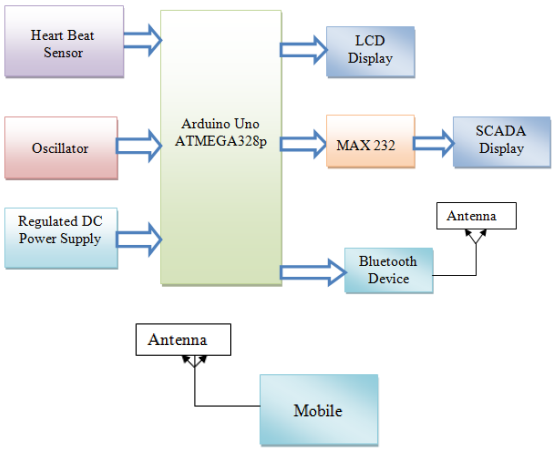

Fig.1 Block Diagram

moved to any location within the transmission range, while still being able to communicate and broadcast data. Due to this, it is expected that wireless data communications will become even more popular and more extensively used in the medical field. Currently the most popular method of wireless communications is radio frequency transmission. As these devices have a very low power consumption and power output, perhaps more importantly devices can achieve good data transmission rates.

III. IMPLEMENTATION

Hardware:

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate [3]. It works on the principle of light modulation by blood flow through finger at each pulse. The Arduino Uno used is ATmega328P operates at 16 MHz at 5V D.C. Arduino Uno controls all the operation. The Arduino Uno obtains the input from the heart beat sensors and monitors the heart beat rate[8].

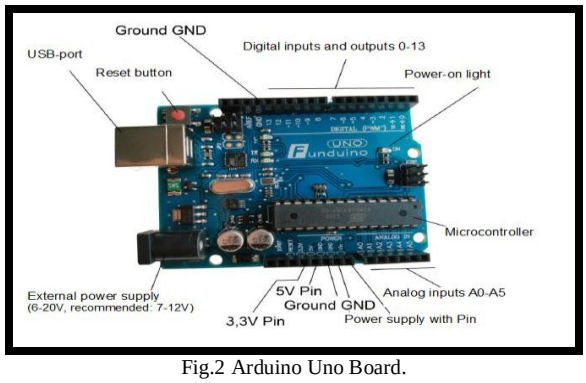

Fig.2 Arduino Uno Board.

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

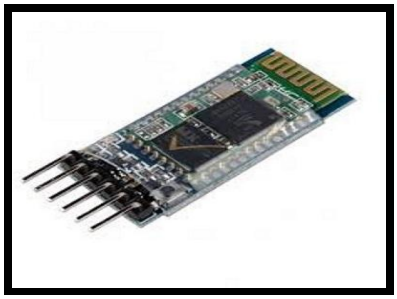

Fig.3 Bluetooth Module HC-05

.

The Heart Beat Sensor provides a simple way to study the heart's function. This sensor monitors the flow of blood through Finger. As the heart forces blood through the blood vessels in the Finger, the amount of blood in the Finger changes with time[9]. The sensor shines a light lobe (small High Bright LED) through the ear and measures the light that is transmitted to LDR. The signal is amplified, inverted and filtered, in the Circuit. The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator using four capacitors to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments Lin ASIC™ library. Outputs are protected against shorts to ground.

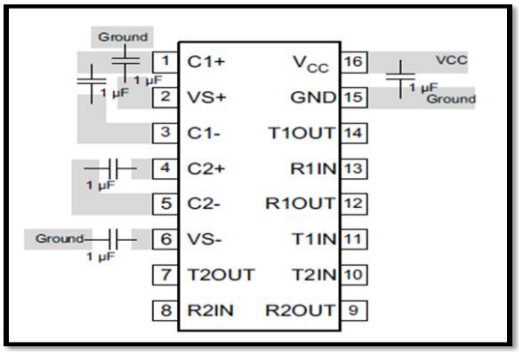

Fig.4 MAX 232 Pin Diagram.

Mainly this section is used to convert any obstacle or we can say that to count a pulse and to convert it into the form of voltage. An IR LED, also known as IR transmitter, is a special purpose LED that transmits infrared rays in the range of 760 nm wavelength. Such LEDs are usually made of gallium arsenide or aluminum gallium arsenide. They, along with IR receivers, are commonly used as sensors. The appearance is same as a common LED. Since the human eye cannot see the infrared radiations, it is not possible for a person to identify whether the IR LED is working or not, unlike a common LED. To overcome this problem, the camera on a cell phone can be used. The camera can show us the IR rays being emanated from the IR LED in a circuit. Infrared (IR) radiation is part of the electromagnetic spectrum which includes radio waves, microwaves, visible light, and ultraviolet light, as well as gamma rays and X-rays.

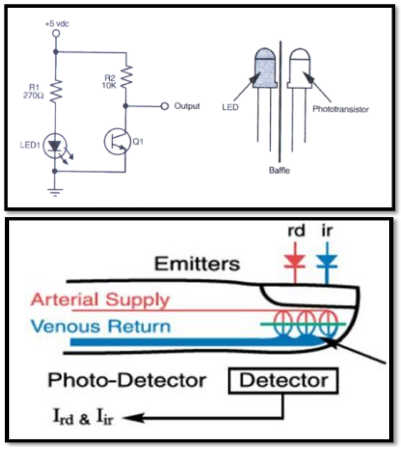

Fig.5 IR Sensor.

Software:

Arduino Software:

The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions. An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program.

Fig.6 Arduino Uno IDE.

Integrated Development Environment (IDE):
We can use the Arduino IDE on our computer (picture following) to create, open, and change sketches (Arduino calls programs "sketches". We will use the two words interchangeably in this book.). Sketches define what the board will do. You can either use the buttons along the top of the IDE or the menu items [2].

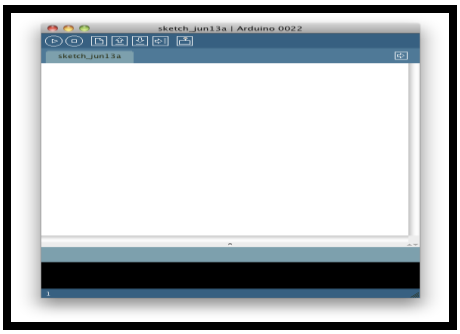

Fig.7 Arduino IDE on our computer screen.

Connect your Arduino to the computer with the USB cable. You do not need the battery for now. The green PWR LED will light. In the editing window that comes up, enter the following program, paying attention to where semi-colons appear at the end of command lines.

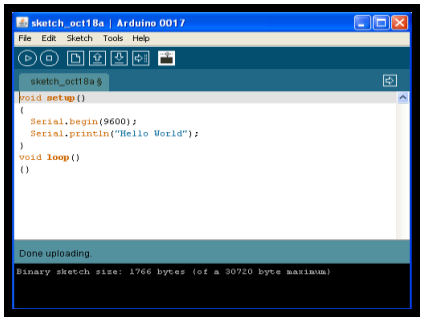

Fig.8 Program on Arduino IDE**.**

Click the Upload button  or Ctrl-U to compile the program and load on the Arduino board.

Click the Serial Monitor button  .

Introduction to SCADA:

SCADA (Supervisory Control and Data Acquisition) is a system for remote monitoring and Control that operates with coded signals over communication channels (using typically one communication channel per remote station). The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions. It is a type of industrial control system (ICS). Industrial control systems are computer based systems that monitor and control industrial processes that exist in the physical world. A SCADA system refer to a system consisting of a number of remote terminal units (or RTUs) collecting field data connected back to a master station via a communications system. The master station displays the acquired data and also allows the operator to perform remote control tasks. The accurate and timely data (normally real-time) allows for optimization of the operation of the plant and process. A further benefit is more efficient, reliable and most importantly, safer operations. This all results in a lower cost of operation compared to earlier non-automated systems. A successful SCADA installation depends on utilizing proven and reliable technology, with adequate and comprehensive training of all personnel in the operation of the system. There is a history of unsuccessful SCADA systems – contributing factors to these systems includes inadequate integration of the various components of the system, unnecessary complexity in the system, unreliable hardware and unproven software. Today hardware reliability is less of a problem, but the increasing software complexity is producing new challenges. It should be noted in passing that many operators judge a SCADA system not only by the smooth performance of the RTUs, communication links and the master station (all falling under the umbrella of SCADA system) but also the field devices (both transducers and control devices). The field devices however fall outside the scope of SCADA in this manual and will not be discussed further.

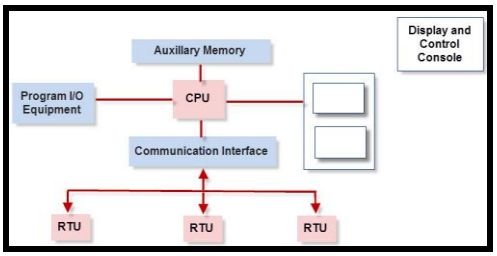

Fig.9 Block diagram of SCADA

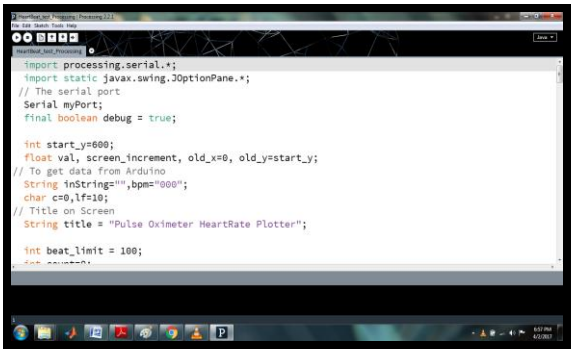

Fig.10 Program on SCADA

IV.**STEPS OF EXECUTION**

Algorithm:

- Connect the circuit to the supply with the help of adapter and press the switch near to the DC Jack.
- Connect the USB serial Interfacing cable to the Personal computer and select the driver in the device drivers of the computer as shown below.

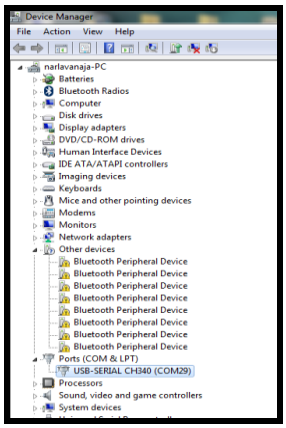

Fig.11 Serial Interfacing in PC.

- Select the USB-SERIAL CH340 (COM29).Then press OK.

- Now Place the clip on your Finger in such a way that two IR sensors should placed above the nail of your finger.
- Now pair your Andriod Mobile with the Bluetooth module(HC-05) through Arduino SMS application.Which is available in the Play store of Google.
- Open the SCADA Software and run the program on the PC.
- Then press the Pulse counting Switch to Count the number of Pulses.
- After 1 minute the pulse reading will be displayed and the SCADA Screen and on the LCD display.
- If the number of beats of the person is less than the threshold the SMS will be sends to the respective mobile number of the Doctor through the Arduino SMS application from your mobile. Otherwise it sends the normal message stating that the beats are normal.

V. RESULTS &ANALYSIS

Experimental Kit:

The experimental kit of "Heart Rate Measurement with Photoplethysmography through SCADA" is depicted below. LCD to display predefined messages that were written the program. Moreover, it contains Photo plethysmography Sensor ,Bluetooth Module etc.

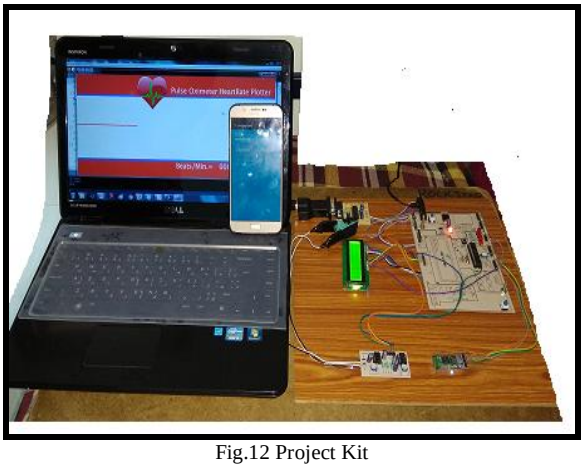

Fig.12 Project Kit

Results:

Welcome message and device numbers are displayed on LCD device once the kit is switched ON.

Fig.13 Welcome message on LCD.

Now Place the Photoplethysmography sensor clip on your Finger in such a way that two IR sensors should placed above the nail of your finger as shown in figure below.

Fig.14 Photoplethysmography sensor clip

Open the SCADA Software and run the program on the PC. The output will be displayed on the Screen.

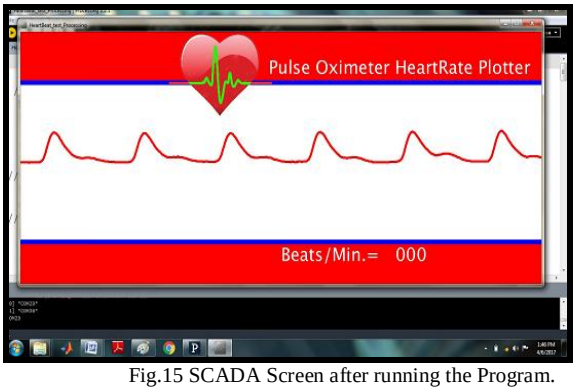

Fig.15 SCADA Screen after running the Program.

SMS will be sent after the count of the pulses through Android SMS application.

VI. CONCLUSION

Finally, by this We conclude that Cardiovascular disease is one of the major causes of untimely deaths in world, heart beat readings are by far the only viable diagnostic tool that could promote early detection of

cardiac events. Wireless and mobile technologies are key components that would help enable patients suffering from chronic heart diseases to live in their own homes and lead their normal life, while at the same time being monitored for any cardiac events. This will not only serve to reduce the burden on the resources of the healthcare center but would also improve the quality of healthcare sector.

REFERENCES

[1] Matina Kiourexidou , Konstantinos Natsis , Panagiotis Bamidis , Nikos Antonopoulos , Efthymia Papathanasiou , Markos Sgantzos , Andreas Veglis "Augmented Reality for the Study of Human Heart Anatomy" International Journal of Electronics Communication and Computer Engineering 2015..

[2] Souvik Das "The Development of a Microcontroller Based Low Cost Heart Rate Counter for Health Care Systems" International Journal of Engineering Trends and Technology- Volume4Issue2- 2013.

[3] Embedded Lab. Introducing Easy Pulse: A DIY photoplethysmographic sensor for measuring heart rate. http://embedded-lab.com/blog/?p=5508, 2012.

[4] Sankar Kumar S, Gayathri N , Nivedhitha D , Priyanka A S "A Cost effective Arduino Module for Bedridden patient's Respiratory Monitor and Control" International Journal of advanced research trends in engineering and technology (IJARTET) VOL. II, SPECIAL ISSUE XXI, MARCH 2015.

[5] Ch.Sandeep Kumar Subudhi,'Intelligent Wireless Patient Monitoring and Tracking System (Using Sensor Network and Wireless Communication)",2014.

[6] Bhagya Lakshmi.J.M1 Hariharan.R2 Udaya Sri.C3 Nandhini Devi.P4 Sowmiya.N "Heart Beat Detector using Infrared Pulse Sensor" IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 09, 2015.

[7] Nazmus Saquib, Md. Tarikul Islam Papon, Ishtiyaque Ahmad, and Ashikur Rahman "Measurement of Heart Rate Using Photoplethysmography" .

[8] Embedded Lab. PC-based heart rate monitor using Arduino and Easy Pulse sensor. http://embedded-lab.com/blog/?p=7485, 2013.

[9] Ufoaroh S.U , Oranugo C.O, Uchechukwu M.E "Heartbeat monitoring &alert system using GSM technology" International Journal of Engineering Research and General Science Volume 3, Issue 4, July- August, 2015.

[10] Hashem et al., ―Design and Development of a Heart Rate Measuring Device using Fingertip‖, IEEE International Conference on Computer and Communication Engineering (ICCCE), ISBN: 978-1- 4244-6235-3, 2010.

[11] Sagar C. Chhatrala, 2Mitul R. Khandhedia" Ubiquitous Physiological Monitoring of SPO2& Heart Rate" International Journal for Research in Technological Studies Vol. 1, Issue 2, January 2014.