International Journal of Electrical and Electronics Engineers
Vol. No. 8, Issue No. 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321-2045

# CLOUD BASED HEART RATE, BLOOD PRESSURE AND NON-INVASIVE GLUCOSE MONITORING DEVICE

**Shashanka Venkataramanan[1], Divyata Kamble[2], Aditi Bairolu[3], Akash Singh[4], Prof. Rama Rao[5]**

[1,2,3,4,5]*Department of Electronics and Telecommunication, Vidyalankar Institute of Technology, (India)*

## ABSTRACT

*Advancements in medical device technology have allowed physicians to treat their patients better, saving lives and promoting continuous improvements in the quality of life for billions of people around the globe. This paper also aims to develop the device mostly but not limiting to the rural population of the country who hardly have access to good physicians for diagnosis and make it cost efficient. This paper first examines the various available technologies and then states our idea behind implementing a device capable of measuring 3 important medical parameters, which are heart rate, blood pressure and glucose content in the blood. However, all these techniques are noninvasive meaning the usage doesn't depend on taking out blood from the body but uses sensors to compute all the 3 parameters. The device is also capable of sending all the computed data to the cloud for authentic, meticulous, fast and reliable diagnosis by doctors.*

***Keywords: Blood Pressure, Heart Rate, Non-Invasive Glucose Measurement, Cloud Based, IBM Watson IOT Platform.***

## I. INTRODUCTION

Day to day medical diagnosis requires the use of measuring 3 important values which are heart rate, blood pressure and glucose content in the body. The use of analog devices has made it precipitous for people making them visit medical centre's on daily basis involving money and time where glucose measurements have involved pricking methods invoking pain. This project aims to solve these problems by developing low cost equipment which measures heart rate, blood pressure and glucose by non-invasive techniques. The data will be then uploaded on cloud where medical consultants can view and suggest necessary medication at the earliest. Noninvasive methods of monitoring blood glucose level are more superior to the current invasive method. Nowadays, a portable and non-invasive glucose meter is highly demanded by the society. There are many approaches on designing non-invasive glucose meter.Towards this one of the designs is by using near infrared method using finger probe and it is safe as there is no direct electrical contact between the patient and the device. The concentration of glucose in the blood is calculated based on the scattering and absorption of light through the blood. The level of the concentration, heart rate and blood pressure is displayed on the LCD and simultaneously uploaded on Cloud.

## II. MOTIVATION

Rural women in the country usually aren't under the comfort of good doctors and need to go visit doctors far away from their homes for decent and regular diagnosis. Traveling at the time of emergency like sudden rise in BP or glucose leading to unconsciousness etc. may prove to be fatal. Also money involved in consulting doctors is usually on higher end due to which affording becomes a problem. With the advancement of Integrated circuit technology, the ability to scale down various sensors is in the rise. To develop a compact system, which has the ability to measure all these parameters and then upload the data on the cloud, is what is the aim of this paper. The availability of various sensors at micro level, such as pulse sensor SEN 11574, pressure sensor BMP 180 or MP3V5050 and IR sensors have helped develop and design mechanisms which facilitates the design of an extremely compact system integrated with a module such as Raspberry Pi or similar, enabled with Wi-Fi module such that all data can be processed and transferred to remote host or uploaded on the cloud with ease.With each of these monitoring devices individually available in the market, this paper seeks to conglomerate all these mechanisms into a single device for ease of utilization. The increase in IoT based devices and techniques also brings about the motivation for this project.

## III. RELATED WORK

### A. Heart Rate

Heart rate is the speed of the heartbeat measured by the number of contractions of the heart per minute (bpm). The heart rate can vary according to the body's physical needs, including the need to absorb oxygen and excrete carbon dioxide [2]. The normal resting adult human heart rate range from 60– 100 bpm.

### B. Blood Pressure

This is based on the principle of photo plethysmography (PPG) which is a non-invasive method of measuring the variation in blood volume in tissues using a light source and a detector. The TCRT1000 reflective optical sensor is used for photo plethysmography. The use of TCRT100 simplifies the build process of the sensor part of the project as both the infrared light emitter diode and the detector are arranged side by side in a leaded package [8], thus blocking the surrounding ambient light, which could otherwise affect the sensor performance. its output is a digital pulse which is synchronous with the heartbeat. The output pulse can be fed to either an ADC channel or a digital input pin of a microcontroller for further processing and retrieving the heart rate in beats per minute (BPM). Your blood pressure rises with each heartbeat and falls when your heart relaxes between beats. While BP can change from minute to minute with changes in posture, exercise, stress or sleep, it should normally be less than 120/80 mm Hg (less than 120 systolic AND less than 80 diastolic) for an adult age 20 or over. The oscillometric method takes advantage of the pressure pulsations taken during measurements. An

International Journal of Electrical and Electronics Engineers
Vol. No. 8, Issue No. 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321-2045

occluding cuff is placed on the left arm and is connected to an air pump and a pressure sensor. Cuff is inflated until a pressure greater than the typical systolic value is reached, then the cuff is slowly deflated [7].

As the cuff deflates, when systolic pressure value approaches, pulsations start to appear. These pulsations represent the pressure changes due to heart ventricle contraction and can be used to calculate the heartbeat rate. Pulsations grow in amplitude until mean arterial pressure (MAP) is reached, then decrease until they disappear. Oscillatory method determines the MAP by taking the cuff pressure when the pulse with the largest amplitude appears. Systolic and diastolic values are calculated using algorithms that vary among different medical equipment developers. The sensor used is MP3V5050 series piezo-resistive transducer which is a monolithic silicon pressure sensor designed for a wide range of applications.

**Table 1comparative Study of Various Available Method For Blood Pressure Measurement**

| Parameters | Idea I [11] | Idea II [7] | Idea III [9] |
|---|---|---|---|
| Method | Piezoelectricity | Oscillometric method | Hall effect |
| Tested on human | Not specified | More than 20 | 13 |
| Body site | Wrist | Arm | Wrist |
| Sensor | Piezoelectric transducer | MPX2050 pressure transducer | Hall device |
| Accuracy | Not specified | Quite accurate if the cuff is worn properly | Value of the standard deviation is close to the limit on the International BP Standard |
| Error | Not specified | Failed 2 times out of 10 tries | Standard deviation for<br>SBP = 8.3<br>DBP = 4.9 |
| Advantage | Portable<br>Cuff less | Portable | Portable<br>Cuff less |

International Journal of Electrical and Electronics Engineers
Vol. No. 8, Issue No. 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321-2045

| | | | |
|---|---|---|---|
| Disadvantage | Tension of the watch band must then be adjusted to provide an optimum contact pressure | Device fails to obtain the desired data, especially if the user does not stay still or does not wear the cuff properly<br><br>Determining the diastolic pressure is quite difficult and ambiguous since the voltage threshold varies from person to person | Amount of electrical power provided by a lithium battery is less than 1.65 W after wearing the pulsimeter<br><br>This device is able to save the values of high/low BP measurements for 1 h, if the battery is 100% recharged |

### C. Non-Invasive Glucose Measurement

Blood glucose monitoring is a way of testing the concentration of glucose in the blood (glycaemia). Particularly important in the care of diabetes mellitus, a blood glucose test is performed by piercing the skin (typically, on the finger) to draw blood, then applying the blood to a chemically active disposable 'test-strip'. Different manufacturers use different technology, but most systems measure an electrical characteristic, and use this to determine the glucose level in the blood [4]. The test is usually referred to as capillary blood glucose. Two medical conditions exist when there is increase or decrease in blood glucose level: Hyperglycemia (increase in glucose level) and Hypoglycemia (decrease in glucose level). Referring to the research done in this field, IR spectrophotometry or spectroscopy (which is analysis of attenuation of electromagnetic radiation by chemical compounds for different frequencies) that is done in range between 800nm and 4000nm. There are three groups of glucose spectral absorption lines out of which 1000nm and 2000nm range is strongly attenuated by human skin while the accurate results are observed in wavelengths 1408nm, 1536nm, 1688nm and 1925nm. This leads us to NIR spectroscopy that is, Near Infrared region [6]. A polynomial will be generated after continuous iteration depending on different values of glucose level at different times of a day. The current analysis generates 50%-60% accuracy. These approaches need to recalibrate the device thus changing the algorithm often.

International Journal of Electrical and Electronics Engineers
Vol. No. 8, Issue No. 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321-2045

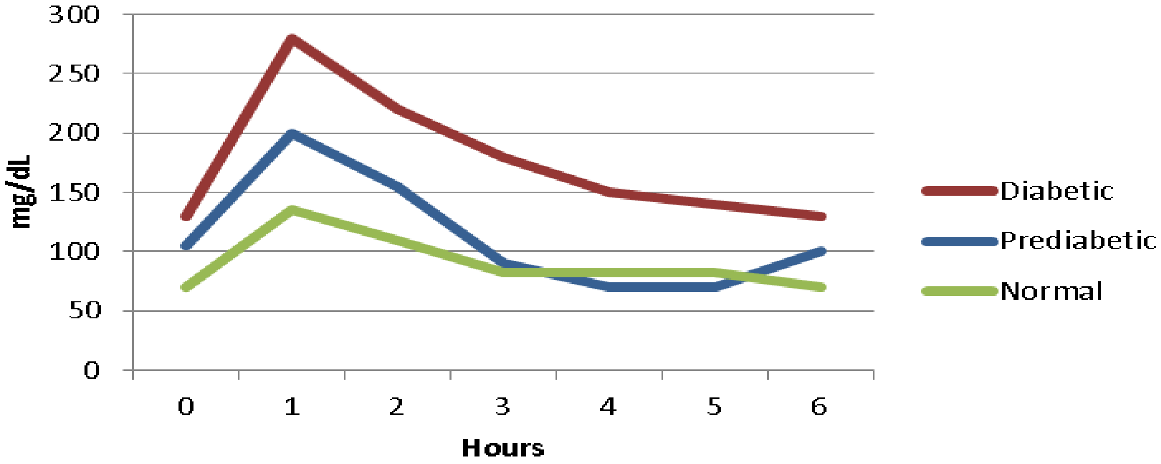


**Fig 1. Graph showing glucose content for 3 classes of people [6]**

**TABLE II**

**Comparative Study of Various Non-Invasive Glucose Measurement Techniques**

| Parameter | Idea 1 [6] | Idea 2 [5] | Idea 3 [4] |
|---|---|---|---|
| Method | NIR | NIR | NIR |
| Tested on human blood | Yes | Yes | No |
| Age group | 18-55 | 18-65 | Not tested |
| Accuracy | 70% | 80-90% | High |
| Detects hypo/hyperglycaemia | No | Yes | Yes |
| Mg/dl | 67-80 | 80-120 | 0-720 |

| | | | |
|---|---|---|---|
| Wavelength | 950nm | 790-1050nm | 1450nm |
| Body site | Finger | Wrist | Finger |
| Gain | 28.3 dB | N/A | N/A |
| Error percentage | Less than 3% | Less than idea 1 | Less than idea 1 |
| Limitations | 1. Idea has been implemented only on 6 individuals 2. Does not detect hyper and hypoglycaemia diabetic condition. 3.Detects only normal glucose level<br>4.Less accurate | 1.Experimented on 9 individuals only<br>2.System not robust<br>3.Requires recursive adjustments | 1. Experimented only on glucose samples with changing concentration<br>2. System is robust when not tested on human body but considering blood samples only in test tubes |

## IV. METHODOLOGY

The hardware setup consists of a Raspberry pi 2 B model consisting of 900 MHz quad-core ARM cortex A7 processor and 1 GB RAM. The Operating system used is Raspbian on top of Ubuntu 14.04. The model of Raspberry pi was chosen based on the availability and is subject to change in due course based on the availability of a cheaper development board. The main idea is to integrate the necessary sensors similar to the one used by previously, into one single unit which will be a wrist band. The sensor data is then processedusing suitable algorithms and then wirelessly transmitted to the webserver via the development board which could be accessed by doctors for consultancy.

International Journal of Electrical and Electronics Engineers
Vol. No. 8, Issue No. 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321-2045

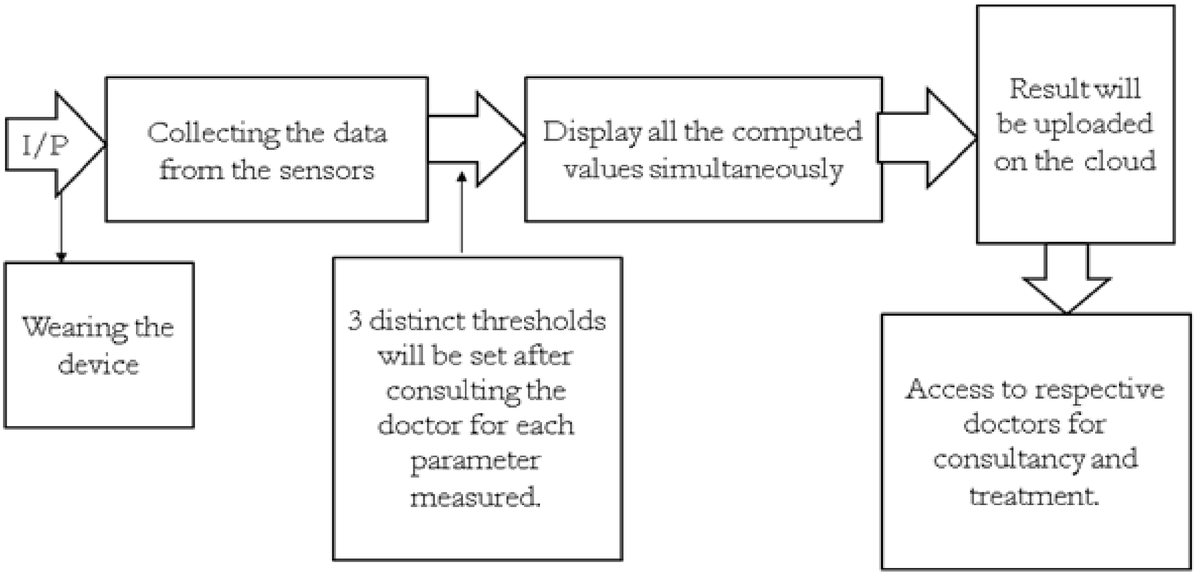


**Fig 2. Block diagram of the approach to develop the monitoring device**

## V. CONCLUSION

This paper is based on the literature survey that we've done and based on it, designed the flow of algorithm and block diagram as shown in Fig.2, to implement all these individually implemented methodologies and combining them into one single device and integrating it with cloud. The cloud which will be used to upload all these data will be IBM Watson IoT platform since it is reliable and easy to access compared to other available IoT cloud platforms. Also the APIs are very well documented for easy use.

## VI. ACKNOWLEDGEMENT

We wish to express our sincere gratitude towards IFUNA for giving us this opportunity for presenting our idea in the presence of the esteemed guests. We extend our gratitude towards Dr. Rama Rao for his guidance and support throughout this paper. We are obliged to express our sincere gratefulness towards Miss. Komal Lawand for sharing her own ideas. At the end we thank our college, Vidyalankar Institute of Technology for their continuous guidance and assistance.

## REFERENCES

[1]. Hiroshi Koizumi, Shinji Mino, Shoichi Hayashida, Kimihisa Aihara, Junichi Shimada, Yuji Uneshi, A novel blood pressure monitoring device for Ubiquitous Healthcare services, 29th Annual international conference of IEEE engineering in medicine and Biology society, 2007.

[2]. http://embedded-lab.com/blog/introducing-easy-pulse-a-diy-photoplethysmographic-sensor-for-measuring-heart-rate/

[3]. http://www.nxp.com/files/32bit/doc/app_note/AN4328.pdf?tid=AMdlDR

[4]. Christopher Dale Chua, Ian Mikhael Gonzales, Enrique Manzano, Maria Carla Manzano, Design and Fabrication of a Non-Invasive Blood Glucometer Using Paired Photo-Emitter and Detector Near-Infrared LEDs, DLSU research congress 2014, 2014.

[5]. Tomasz Kossowski, Rsyzard Stasinski IR attenuation measurement for non-invasive glucose level analysis, 23rd International conference on Signals, systems and Image processing, 2016

[6]. Komal Lawand, Mahesh Parihar, Shital N.Patil, Design and Development of Infrared LED Based Non Invasive Blood Glucometer, IEEE INDICON 2015

[7]. https://people.ece.cornell.edu/land/courses/ece4760/FinalProjects/s2005/ww56_ws62/Final%20Project%20Web/#AA

[8]. [8] http://e-radionica.com/productdata/Pressure_Sensor.pdf

[9]. Article on Measurement of Blood Pressure Using an Arterial Pulsimeter Equipped with a Hall Device, Sensors 2011, ISSN 1424-8220

[10]. D Chandana, B. Hema Latha, A Tele-Medicine system for Measuring heart rate, Blood pressure and drug level detection, IJEDR 2014.

[11]. http://www.google.com/patents/US4331154