Non-Invasive Blood Glucose, Blood Pressure, Heart Rate and Body Temperature Monitoring Device

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Abstract -The race for the next generation of painless and reliable glucose& BP monitoring for patients is on. As technology advances, both diagnostic techniques and equipment improve. 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 4 important medical parameters, which are glucose, blood pressure, heart rate and body temperature. However, all these techniques are non-invasive meaning the usage doesn't depend on taking out blood from the body but uses sensors to compute all the 4 parameters. The device is also capable of sending all the computed data to the doctor via SMS using SIM900 communication module.

Keywords*: Glucose, Blood pressure, Heart rate, Body temperature, Non-invasive*

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I. INTRODUCTION

Diabetes has become a modern, mostly common disease and more than 150 million people are suffering from it all around the world. In order to avoid complication, the tight blood glucose level control is very essential[1] Today, the most popular method for the measurement of the blood glucose is invasive method in which most of these involve drawing blood through a small pinprick and placing a drop on a test strip. This is risk of infection, costly and discomfort for the patients. To reduce all these problem we implement non-invasive method for blood glucose measurement which is painless, low cost, safe, highly accurate and comfortable for the patients.

Blood pressure refers to the variations in the heart beat or heart rate. Blood pressure measurementgives the information about heart and also gives the information about various important organs like kidneys, liver, brain etc. Therefore, accurate BP measurement is a major task that is examined for every individual. [2] We propose an electronic system to perform a non-invasive measurement of the blood pressure based on the Oscillometric method and able to evaluate both the systolic and diastolic blood pressure values.

Heart rate is the number of heart beats per unit of time which is generally expressed in beats per minute (bpm). Heart rate and body temperature are very important parameters that are routinely measured whenever a patient arrives in a hospital which makes heartbeat one of the very significant property of cardiovascular system. [3]

II. METHODOLOGY

There are different methodologies exist for the measurement of blood glucose and blood pressure.

A. Methods for measurement of blood glucose:

1) Near infrared spectroscopy (NIR):

The light concentrated on the body is partially absorbed and scattered, due to its interaction with the chemical components within the tissue. Glucose concentration could be predicted by variations of light intensity both transmitted through a glucose containing tissue and reflected by the tissue itself [8]. Advantage is High accuracy. Measuring signal has high energy compared with MIR spectroscopy [18].

2) Raman spectroscopy:

It *is* based on the use of a laser light to induce oscillation and rotation in molecules& resultant emission of scattered light influenced by this molecule vibration, which depends on the concentration of the glucose molecule. Advantage:Fixed wavelength lasers at relatively low cost can be used. The limitations are associated to instability of

the laser wavelength and intensity, and long spectral acquisition times [5].

3) *Fluorescent spectroscopy*:

This technique tests the fluorescence from the sample. It was also proved that fluorescence intensity was based upon glucose concentration in the solution. Advantage:Light in the visible spectrum can be used and more decent for studying fluorescence of tissues. Limitations**:** In tissues, the use of ultraviolet light could lead to strong scattering phenomena, in addition to fluorescence [5].

4) Mid-infrared spectroscopy:

It *is* based on light in the 2500–10,000nm spectrums. The physical principle is same to that of NIR. When compared to NIR, however, due to the higher wavelengths, Mid-infrared exhibits decreased scattering phenomena, and increased absorption. Advantage of Mid-infrared compared to NIR is that the Mid-infrared bands produced by glucose, as well as other compounds, are sharper than those of NIR, which are often broad and weak. Limitation is poor penetration.

B. Methods for measurement of blood pressure

1) Palpatory Method:

Pump up the cuff rapidly to 70 mmHg, and increase by 10 mm Hg increments while palpating the radial pulse. Note the level of pressure at which the pulse disappears and subsequently reappears during downfall will be systolic blood pressure.When the cuff is contracted, there is a palpable pulse inthe wrist. In this method, blood pressure can be measured in noisy environment too and Technique does not need much equipment.

2) Auscultatory Method:

Pulse waves that travels through the brachial artery, generate Korotkoff sounds. There are 5 different phases in the Korotkoff sounds, which define SP and DP. Also with this method, several measurements should be done. The frequency range is 20-300 Hz and the accuracy is +/- 2mmHg (SP) and +/- 4mmHg (DP). Auscultatory technique is easy and doesn't need much equipment. The auscultatory method used for measuring blood pressure require an operator behind the same patient.

3) Ultrasonic Method:

A transcutaneous (through the skin) Doppler sensor is applied here. The motion of blood-vessel walls in various states of occlusion is measured. The frequency difference between transmitted (8 MHz) and received signal is 40-500 Hz and it is proportional to velocities of the wall motion and the blood. The vessel opens and closes with each heartbeat when DP < P < SP cuff.As the cuff pressure is increased, the time between opening and closing decreases until they coincide. (*Systolic pressure)*Again as the cuff pressure is decreased, the time between opening and closing increases until they coincide. (*Diastolic pressure)*

4) Tonometry Method:

A sensor arrayis used here, because at least one of the pressure sensors must lay directly above the artery. Linear array of pressure sensors is pressed against a superficial artery, which is supported from below by a bone (radial artery). The pressure is increased continuously and the measurements are made when the artery is half collapsed. When the blood vessel is partly collapsed, the surrounding pressure equals the artery pressure. The hold-down pressure varies between individuals and therefore a 'calibration' must be done.

5) Oscillometric Method:

The blood pressure measurement using oscillometric devices works similar like the auscultatory method. Instead of recording the readings acoustically the oscillometric method records and evaluates the oscillations of the arteries. The intra-arterial pulsation is transmitted via cuff to transducer. The arterial pressure oscillations (which can be detected throughout the measurement i.e. when P > SP and P < DP) are superimposed on the cuff pressure. SP and DPare predicted from the amplitudes of the oscillation. The cuff pressure is contracted either linearly or stepwise.

III. METHODOLOGY OF IMPLEMENTATION

Poor penetration is the main drawback of MIR. Other limitations, as with NIR, include problems with confounding factors, such as water content in blood. Photonic sensing can suffer from strong scattering phenomena, especially in fluorescence technology. Moreover, there are limitations, such as short lifetimes and biocompatibility, which need to be dealt with possibly through the use of colorimetric assays. The main limitations of Raman spectroscopy are instability of the laser wavelength and intensity, and long spectral acquisition times. In addition, as the power of the light source must be kept low to prevent injury, the signal-to-noise ratio is significantly reduced. Moreover, as with NIR spectroscopy, interference from other compounds remains a problem.

Hence in our project we preferred NIR spectroscopy for glucose measurement which has high accuracy & Measuring signal has high energy.

In Palpatory Method,only the systolic pressure can be measured (not DP) and the technique does not give accurate results for infants and Hypertensive patients. In Auscultatory Method, Auscultatory technique cannot be

used in noisy environment. A mechanical error might be introduced into the system e.g. mercury leakage, air leakage, obstruction in the cuff etc. In ultrasonic method, Subject's movements change the path from sensor to vessel. In Tonometry Method,The wrist movement and tendons result in measurement inaccuracies and technique is highly costly. In the recent years, oscillometric methods have become popular for their simplicity of use and reliability. BP can be measured reliably even in the case of hypertension. Hence in our project, we preferred osillometric method for non-invasive blood pressure measurement.

As shown in Fig.1 the system and controller to be powered on, the blood pressure module to start measuring blood pressure by operating control button, the controller to read the blood pressure value and send to PC via serial communication module. Again operating key control button heart rate & body temperature values are read by controller & sent it to PC.

Glucose module operates on scattering theory of light. Here, light is passes through figure tip & glucose concentration in blood get measured& send to PC.Using GSM module values of sugar, blood pressure, heart rate & body temperature sent to doctor through SMS.

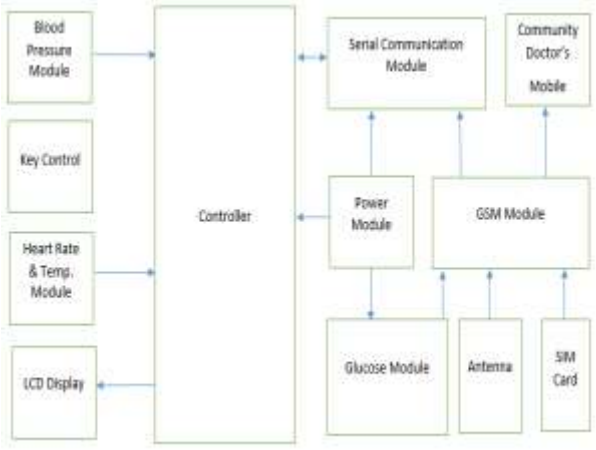

Figure 1.Block diagram of proposed system

A. ALGORITHMS

B. System algorithms are as given below,

1) For LPC2148 Controller
a) Initialize LCD
b) Initialize ADC
c) Input Temperature
d) Input Heart Rate
e) Display on LCD
f) Send serially to MATLAB based module

2) For Blood Pressure Module
a) Take pressure input
b) Convert to digital
c) Send serially to MATLAB

3) For Sugar Module
a) Take image
b) Take red component
c) Calculate Gray Threshold
d) Convert to practical value using multiplying factor

4) For MATLAB Module
a) Collect all data
b) Form message string
c) Initiate GSM module
d) Send SMS

IV. RESULTS

Figure 2. Heart rate & Body Temperature displayed on LCD Display

Figure 3. Values of Sugar, Heart rate, Temperature & Blood pressure on MATLAB

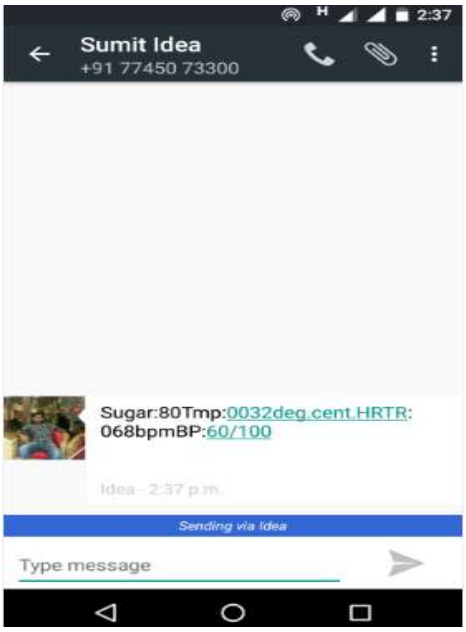

Figure 4.Screenshot of SMS on doctor's mobile

V. CONCLUSIONS

In this paper, we have shown the implemented approach of non-invasive glucose measurement using NIR spectroscopy. We measure blood pressure non-invasively using oscillometric method. Also we measure heart rate & body temperature. These 4 parameters real time values sent to doctor via SMS.

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