International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Volume 7, Issue 03 (March 2020) www.ijirae.com
Special Issue – 6th International National Level Conference- "MEEMIC-2020"

NON INVASIVE BLOOD GLUCOSE LEVEL MEASUREMENT USING LORAWAN

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Manuscript History
Number: **IJIRAE/RS/Vol.07/Issue03/Special Issue/01.MRAESCE10083**
Received: 15, February 2020
Final Correction: 27, February 2020
Final Accepted: 10, March 2020
Published: **14, March 2020**
Editor: Dr.A.Arul Lawrence selvakumar, Chief Editor, IJIRAE, AM Publications, India

Abstract: Diabetes is one of the most commonly found health ailment globally. Early detection of Diabetes aids in better diagnosis & treatment. With this consideration, Real-time Continuous monitoring of the blood glucose level is highly desirable. A number of invasive and non- invasive techniques have been proposed in past. In this paper, we propose a unique Real time Invasive Blood Glucose Monitoring system. Our work is based on PIC16 microcontroller. We have also included a GSM SIM 900a for transmitting the Blood Glucose Level data to a Personal Computer used to record the readings and also to the doctor's mobile. We have used MPLAB IDE 8.92 for generating the binary files and Ki-Cad for PCB design.
Keywords: Diabetes, Glucose Meter, PIC controller, SIM900a, MPLAB, Embedded applications

INTRODUCTION

The area of research in biomedical signal processing is rapidly growing in recent decades. Research for design of bio-medical systems which can generate health alerts for critical ailments like Diabetes is one of the major thrust areas for research in this direction [4]. Energy transport in human body is affected by a complex endocrine system involving blood-glucose interaction mechanism. Due to this, Blood glucose system is considered to be one of the critically important systems in human body. Pancreas controls glucose concentration in blood through release of the insulin. Disruption in this bio-chemical mechanism leads to a Clinical condition called Diabetes mellitus. The fasting blood glucose level should be 70mg/dL and after meals it should be 140mg/dL. Any prolonged increase to these values may be cause for threat to life of the individual [10].

In recent decades, the number of patients suffering from Diabetes Mellitus is increasing at an alarming rate, mostly due Lack of exercise, bad food habits and Lazy life-style. Additionally, women might suffer from diabetes during pregnancy (called gestational diabetes). It is expected that the number of patients suffering from diabetes will grow exponentially to 70 million people worldwide by 2070 [1] [2]. Understanding the criticality of this health ailment, it would be desirable to have a system which performs continuous real-time monitoring of blood glucose levels. The patients as well as doctor would be able to keep track of variation in blood glucose levels. The advantage is that the patient can regulate his food habits and also, the doctor would be able to suggest better diagnostics [5]. We propose a novel Wireless Blood Glucose Monitoring system which consists of a GSM 900a Module. The patient can record the Blood Glucose measurement using the sensor strips. The GSM module sends SMS about the blood glucose level of the patient as when desired by the doctor. The last updated reading is sent to the doctor. Section II highlights details of the proposed system. Section III, IV, V and Section VI deal with work- flow, Results, conclusion and Identification of future scope in this direction.

PROPOSED SYSTEM

The schematic of the proposed system is as shown in Figure 1. The PIC16f1829 forms the heart of the Blood Glucose Monitoring System. It has been interfaced with a Blood Glucose sensor (which is available in form of Strips in market), and a GSM module. The GSM module has been used to wirelessly transmit the present Blood Glucose level along with time of capture of Blood glucose data.

A. Microcontroller

We have used low cost, 8 bit PIC16 microcontroller in this work, with small operating range i.e. 1.8 to 5.5 volts. This supports various data communication interfaces including UART, A/E/USART, SPI, I2C MSSP (SPI/I2C). It has an internal 10 bit 12 channels ADC. 32 MHz internal oscillator is also present in the controller with frequencies ranges of 31 kHz to 32 MHz, which is software selected [6] [11]. We have used UART of the microcontroller for communicating with GSM module [9]. We have used internal ADC for blood sensor interfacing and conditioning. We use software selection of frequency.

B. GSM module

GSM 900a is dual Band 900/1800MHz GPRS Class B GSM module. It is based on SIMCOM enhanced. AT Commands. The operating voltage is 3.1 to V. It supports both Text mode and PDU mode. We send the data in Text format [7] [12].

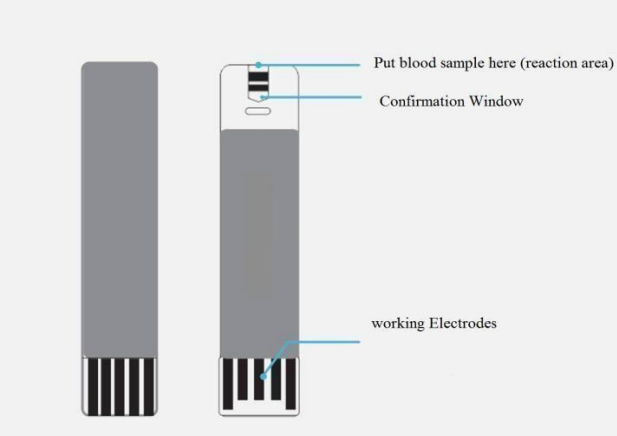


Figure 1: Blood glucose test strip

A. Blood Glucose Sensor

Blood glucose sensor is invasive type blood glucose strips. The model of invasive type blood test strip is show in Figure 1. This is invasive type of blood glucose sensor because blood sample is to be put on the strips for calculation of the blood sugar reading. For sample to be put, blood should be taken out by pricking the finger and put on the strip such a way that it covers the confirmation window. It works on the electrochemistry principle. Blood sample is to be taken in the reaction area on the blood strips. In the reaction area the blood gets oxidised and gives gluconic acid [8]. The amount of the current that has been produced in the electrodes depends upon the concentration of the gluconic acid produced during the oxidation reaction of the blood sample.

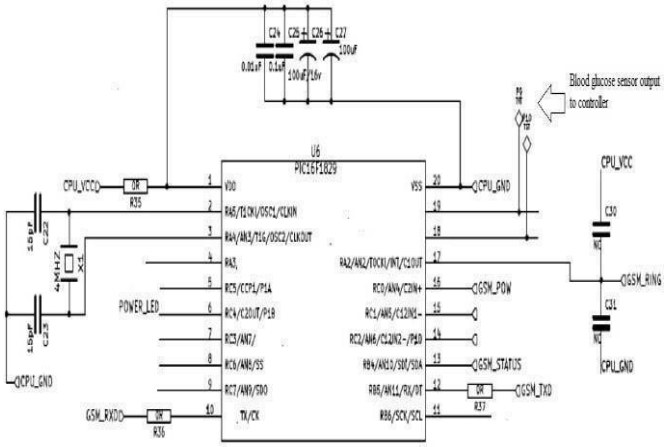


Figure 2: Schematic of Proposed Blood Glucose Monitoring System

Then this produced current will be converted to voltage and amplified and then converted to respective blood glucose value by the microcontroller. The connections of the microcontrollers are shown in Figure 2. Input is taken from pin 18, 19 and is converted to digital form by internal 10 bit ADC so it has 1024 levels between lowest level '0' volts to highest level '5' volts. The digitized value is converted to respective blood glucose value by the controller. AT commands are sent to the GSM to make it responds and the information values are sent to the phone bye SMS. Figure 3 shows the experimental setup of the implemented system. A PCB, on which the microcontroller and GSM is mounted. A SIM port holding the SIM card to connect to the respective network. In this way the whole system on integrated on PCB.

WORKING

The biomedical signals, from the finger, are extracted by the blood glucose sensor which is then amplified and filtered in the signal conditioning stage. After the signal is filtered then the ADC converts the analog signals to corresponding digital values to be given to the microcontroller. The microcontroller then accepts the values and the blood glucose values and the same values are provided to GSM module which transmits them via SMS to doctor's mobile, so that accessible by the doctors. So a continuous monitoring of a person's blood glucose can be done and frequently visits a doctor for the glucose testing can be altered. This flow has been explained in Figure 4.

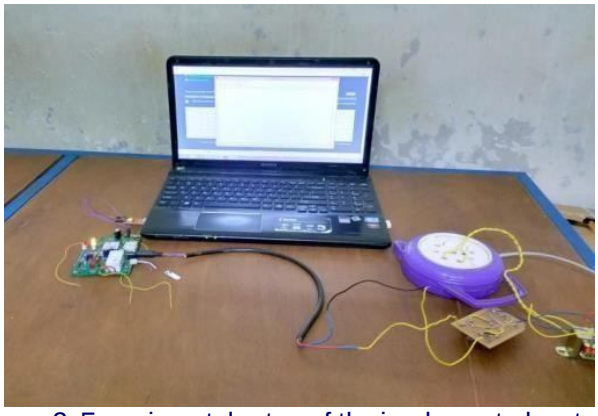
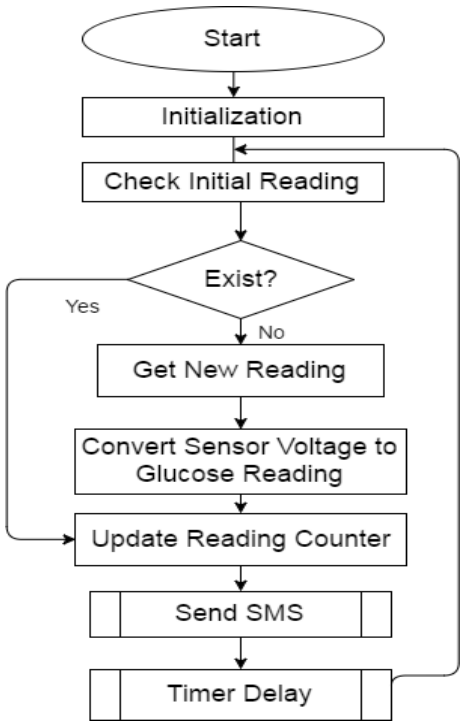


Figure 3: Experimental setup of the implemented system



RESULTS

We have conducted the experimentation on five subjects at Sanjeevani Pathology Lab, Kothrud, Pune. We have compared the readings of the test performed by Pathology experts and those generated by our proposed system. All the readings are taken before meal i.e. in fasting state. These are highlighted in Table I.

Observed Value	Actual Value	(As per pathological report)
Subject 1 87 mg/dl	78 mg/dl	9
Subject 2 88 mg/dl	75 mg/dl	13
Subject 3 98 mg/dl	86 mg/dl	12
Subject 4 89 mg/dl	80 mg/dl	9
Subject 5 93 mg/dl	82 mg/dl	11

Table 1: Observed readings on different subjects

GSM is initialized by sending a message to the respective number. A message has been received regarding the initialization of the GSM module. After taking the Blood Glucose reading the message has been sent to the mobile number displaying the current reading of the glucose value. The same is depicted in Figure 5, is the screen shot of the message displaying the current glucose reading.

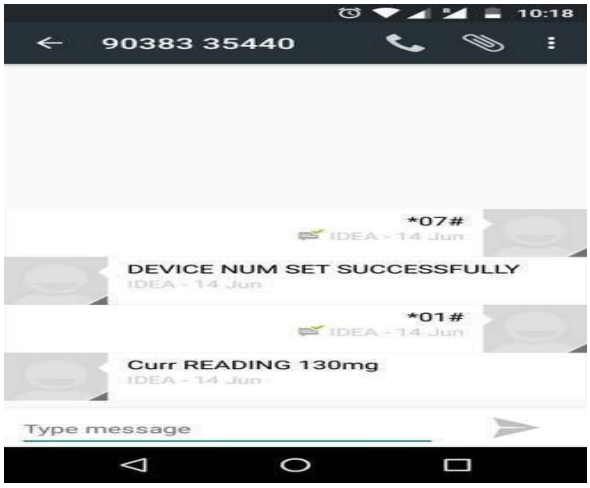


Figure 4: Screenshot of the SMS received by GSM

CONCLUSION

In this paper, we discussed our efforts towards design of a simple Real- time wireless blood glucose monitoring system which is useful for a diabetic for continuous monitoring of his/her health in home environment. Our proposed system helps one to cut short the regular visits to the doctors for a check-up, as they obtained information from the sensors can be transmitted to the server. Doctors can monitor patient's health without meeting him personally and on the basis of regular readings of the system; a better treatment can be provided to the diabetic.

FUTURE SCOPE

1. The blood glucose reading can be sent over cloud so that it can be accessed from any location acrossglobe.
2. The accuracy of the Blood Glucose Reading needs to be improvised. Also, size of the Device should be made more compact.

Non-invasive technique should be implemented. In invasive technique, the user has to prick his/her finger for every reading to be taken which can be painful and there may be chances of infection if the sample is taken from same area from the figure. Non-invasive technique provides user to just place the finger over sensor and the values are achieved at the output of the sensor. In this way, it can avoid the pricking of body parts for blood sample which is absolutely painless. But design of sensor for extracting the glucose value without the blood involvement is a challenging issue.

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