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SMART GSM-BASED GLUCOSE METER

Win Adiyansyah Indra[1], Fikarwin Zuska[2] and Adi Saptari[3]
[1]Microwave Research Group (MRG), Centre for Telecommunication Research and Innovation (CeTRI), Fakulti Teknologi Kejuruteraan Elektrik and Elektronik (FTKEE), Universiti Teknikal Malaysia Melaka (UTeM), Melaka, Malaysia
[2]Department of Anthropology, Faculty of Social Science and Politics, University of Sumatera Utara, Indonesia
[3]Department of Industrial Engineering, President University, Bekasi, Indonesia
E-Mail: adiyansyah@utem.edu.my

ABSTRACT

This paper developed GSM-Based Smart Glucose Meter, a portable and mobile device to measure level of glucose in blood that effect our health in general. Eco-friendly technology brings advance to this new era of technology. Blood glucose care is one element in the care blood glucose levels at home. Diabetes is increasing now that this will delay the process of examination of the patient in hospital. For the elderly have to wait too long for their turn. Those who are suffering from diabetes, consists than about the elderly, therefore, this project are designed to facilitate the patient's health, going to hospital if necessary, since the patient will always checking glucose levels from time to time. Then a project designed to help patients control or determine the level of blood glucose at home and that information will be sent to the person responsible in a distance for diabetics using the GSM module to the mobile phone via SMS. Arduino board is used to measure blood glucose levels. This prototype is designed to be user friendly it can carry anywhere.

Keywords: glucose, GSM, arduino.

INTRODUCTION

The world today is much dangerous disease in itself, diabetes is a dangerous disease. Diabetes require regular treatment phase by the experts. Of the observations that have been made, the statistics diabetes worldwide is increasing year by year. The percentage derived from the observations that have been made, the elderly, which recorded the highest percentage of diabetes. Consequently, much of the equipment is designed to check blood sugar levels to their own knowledge and if the results are not satisfactory, the patient will go on referring doctors or people who are more expert on this disease. Therefore to make it easier for patient glucose care created. This paper will be specially developed for all, regardless of the community, especially to those suffering from diabetes. As used in hospital the same system can be used for a person who is not under the continuous observation of doctor, can check people vital signs using the sensors in this project if sensors output starts fluctuating above normal rate hence through GSM (Global System for Mobile Communication)network sends an indication to doctor's mobile immediately.

The topic suggests that a blood glucose meter combine with wireless device. The glucose care designed to facilitate the people and it is able to transmit the results of blood sugar levels to relate person. The ardiuno as a tool for testing blood sugar levels using a glucose sensor. When the results of the inspection blood sugar levels by glucose care, are obtained the test results then will be sent to relate person by using GSM. Today, diabetes is often associated with the elderly it may cause problems to the patient for the shuttle to the hospital every week or every month, sometimes the patient takes a long time to wait for their turn to check the level of their diabetes. Of the observations that have been made, a project to make it easier for diabetics to be created, thereby the patient will not be shuttles to the hospital again, the patient will check their own levels of diabetes and the decision will be sent to a doctor or a person related to them for further action.

Nowadays many gadget glucose meter is used manually and variety of glucose level monitoring equipment and a variety of brands. In this situation for diabetic or normal person would checks blood sugar levels alone or involving doctors using the tools available in the market. Lack of monitoring glucose levels available are not able to send test results to a particular person. Thus, this project will become one of the project can help people for their convenience to diabetics checks blood sugar level at home and facilitate all parties, and especially for those who work away from the family, with the creation of glucose care, family member or doctor can monitor the patient's progress from time to time, even over long distances. With a combination of glucose care and GSM, it can send the results to a specific person and action will be taken immediately.

The main objective of this project is to develop a glucose care to be implemented for monitor diabetics at home. To achieve the project objectives, the scope of this project is to build a system that will function properly based on the objective and to solve problem faced as much as it can. The scope of this project is to build a glucose care using GSM. There are two part of the project, the first part is hardware and the second part is software. The first part is hardware it consists of glucose sensor, arduino module, GSM (Global System for Mobile Communication). The cellular should be used with GSM module to display a message from glucose care. The second part is software it consists of coding for microcontroller are using an arduino module and GSM module. The processing is done by the microcontroller and the level glucose will be display on the LCD at arduino module. The Strips for blood sugar checks can only be used once per test.

BLOOD GLUCOSE TEST DEVICE

Diabetes is a metabolic illness in which a person had high blood sugar levels. It is caused by insufficient released of insulin by the pancreas or the cells are not reacting to the insulin generated. Generated high blood sugar symptoms common for the patient, to polyuria (pass urine frequently), polydipsia (increases thirsty) and polyphagia (increase hungry). Among Symptoms that can arise when a person had high blood sugar levels. These symptoms are caused by one's own biology. There are three types of diabetes, the first type of diabetes is most dangerous when the body fails to produce enough insulin, and it is caused by beta cells in the pancreas that produce was destroyed by the immune system. When the disease has been confirmed, the patient must take insulin injections or use an insulin pump. The disease usually starts from childhood or adolescence.

It is the second kind of situation [1] "resulting from impaired insulin utilization coupled with the body"s inability to compensate with increased insulin production "or in other terms is that when cells do not respond to insulin. This type usually strikes adults people and obese people. The third kind of is diabetes during pregnancy. It is caused by high glucose in the blood when a woman is pregnant. According to [2] Hyperglycemia and Hypoglycemia refer to medical conditions that exhibit abnormally high or low blood glucose/sugar levels. Diabetes is a condition in which the pancreas of the body ceases to produce insulin, which controls blood glucose levels. The causes of diabetes in humans are not yet fully understood, but the widely accepted hypothesis is that it may be genetic and may be caused by a high sugar intake as part of a daily meal serving. By following [3] once diabetes is diagnosed, the blood sugar level needs to be continuously monitored in order to facilitate medicinal insulin intake. Patients with hyperglycemia, in which continuously high blood glucose levels are exhibited, may require continuous blood glucose monitoring. This will require a continuous supply of blood from the patient as current measurement devices invasively monitor sugar levels, which sometimes leads to other complications such as hemorrhaging, blood loss, and other irritable conditions. Non-invasive techniques resolve blood requirement issues. This article explores and implements a non-invasive approach to blood glucose monitoring.

Blood sugar levels has three categories which hypoglycemia (low blood sugar), blood glucose levels are normal and hyperglycemia (high blood sugar levels). Measurement of blood glucose levels 70mg / dl to 100mg / dl for children and 70mg / dl to 150mg / dl for adults. When the level of glucose in the blood ascending until 150mg / dl it is called hyperglycemias and when glucose levels below 70mg / dl it is called hypoglycemia. To ensure that good health is very important to control the level of glucose in the blood. Based on the observations that have been made, the cause of diabetes is dependent on a person's lifestyle regardless of age. Hence, health care is very important to avoid health complications will arise. Glucose meter is a medical device for measuring the level of glucose concentration in the blood of patients. It is a tool for home glucose monitoring for people with diabetes or hypoglycemia. The use of glucose meters, it requires a drop of blood obtained from puncture the skin with a scalpel and the blood will be put on the meter test strips to determine the level of glucose in the blood. On-screen meter will display the level of glucose in mg / dl or mmol / l. Watches or blood glucose meter has been recognized as Gluco Watch. This clock can measure the level of glucose in the blood over time that has been set within 24 hours and if the Gluco Watch, it is not necessary to remove the blood by puncture the skin with a scalpel. The use of electric Gluco Watch present to take up glucose and will switch to this auto sensor. Auto sensor specially created to respond due to electric shock.

Continuous glucose monitoring (CGM) system used to check the glucose level using a small sensor on the surface of the skin patch. The sensor affixed for days, weeks or months should be replaced with a new sensor. Transmitter sends glucose information related to the use of radio waves from wireless sensors to monitor pager like. However CGM has confirmed the weakness of it is not accurate and reliable as a standard blood glucose meter, for a follow-up inspection of the parties involved, the patient has to verify in advance by using a glucose meter. Test strip is a tool to check the concentration of glucose in the blood, the blood obtained from puncture the skin with a scalpel, and blood will be placed on the test strip, glucose oxidase as the chemicals will produce gluconic acid that will react with blood. Terminal exists at the end of the test strip aims to measure electric current between the terminals. Test results will be displayed.

WIRELESS SENSOR NETWORK

According to [4] this paper presents a mobile phone SMS-based system for self-management of diabetes. The system is designed to be a long term health for patients with diabetes. It allows the patients to get connected to their physician constantly. Through the exchange of SMS massage the patients sent their insulin measurements, insulin intake and the other data to the physician making continuous health monitoring possible. Based on the data sent, return SMS massage can be sent to motivate patients or to remind them of activities such as exercise and health care appointments.

[5] with advancements in Sensor Technology, the Wireless Sensor networks offer attractive solutions to many problems in process monitoring systems. The WSN has abundant applications in continuous or discrete monitoring systems irrespective of the field.

The Biocompatible wearable sensors allow vast amounts of data to be collected and mined for clinical trials, reducing the cost and inconvenience of regular visits to the physician. Implying this concept, our project is used to track diabetes using a wireless sensor network as an implant to continuously monitor the patient’s blood glucose level. The sensor implanted in the body identifies the level of glucose in blood. The level thus measured needs to be monitored. The most conveniently used method to monitor the implant would be to use a detector

to telemeter the collected sugar concentration to an external receiver [6].

In the case of our project, we aim to replace the detector by transmitting the monitored data as a message to the patient's cell phone itself. This is a simple and an efficient way to make the process less strain full for the patient and also relatively cheaper. Thus the sensor can effectively monitor the glucose level and can also send a notification message to the patient, thereby reducing the need of tedious physical processes by the use of smart futuristic technology.

According to [7], Mobile phone technology has advanced in recent years. Many innovative applications with mobile phones were implemented apart from the conventional voice data transfer. Short Message Service (SMS) originally developed for sending status information by the service providers has found numerous applications recently including business transactions. This paper describes, a prototype of a wireless health monitoring system capable of sending SMS related to the health status of the patient developed using Arduino and GSM technology. It is a combination of ubiquitous computing with mobile health technology to monitor the well being of patients.

The arduino analyses the data in real-time and determines whether the person needs external help. It interfaces with medical devices and offer suggestions based on the readings. When anomalies are detected or a threshold is reached, the monitoring system automatically transmits the information to the doctor's hand phone on the mobile network as a SMS message via a GSM and in case of critical conditions it automatically gives SMS or call to the ambulance. It mainly focuses to improve the health of people, reduce in Hospitalization and Assistant Cost and could ease the burden on the health-care system.

[8] present disclosure relates to a blood sugar meter system with a wireless communication module, and more particularly, to a time synchronization method between a blood sugar meter system with a wireless communication module synchronization with a cellular network such as a global system for mobile communication (GSM) network and the cellular network. the present innovation provide a blood sugar meter system with a wireless communication module applying a time synchronization scheme including, a global system for mobile communication (GSM) network transmitting network identity and time zone (NITZ) information. And a blood sugar meter metering user's blood sugar data, wherein the blood sugar meter synchronization with an internal time of the metered data and transmits the metered blood sugar data to a server connected to the GSM network.

GSM (global system for mobile communication) is a wireless system that functions using a wireless network. GSM is used in a variety of time division multiple access (TDMA) and most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM requires a Sim card to function. GSM can use various types of Sim cards of prepaid or postpaid, however, 3G Sim card or 128k Sim card, can not be used for GSM as it has compatibility issues with Wavecom GSM modem and frequency used by GSM is 850MHz, 900MHz, 1800MHz and 1900MHz. It is suitable for SMS as well as data transfer application in the mobile phone to mobile phone interface.

METHODOLOGY

The GSM modules are used as a communication device by using SMS among patients with a particular person. It will send any information related to the blood glucose level to a specific person. Therefore, the GSM module has a SIM card that allows information to be sent to mobile phones. The information will be sent include the patient's blood glucose levels. Arduino Uno using ATmega328 microcontroller to be programmed to check blood glucose levels, it will classify blood glucose levels in value form in unit mg/dL. This microcontroller was chosen because it is suitable for this project and it has a 12digital port to test strip connector and GSM module pins and it is easily to programmable.

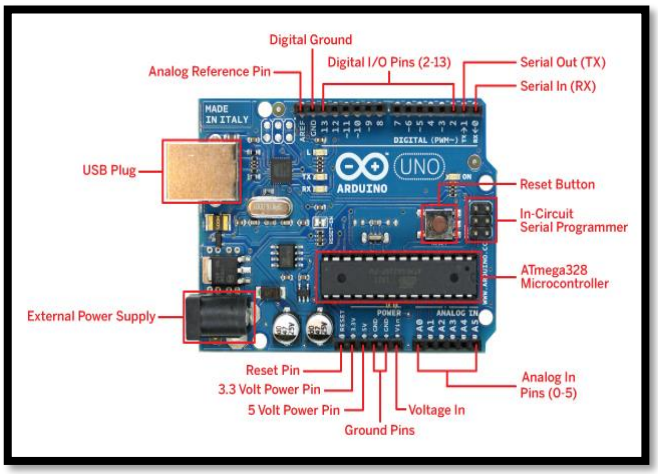

Figure-1. Arduino Uno.

LCD keypad shield specially designed for arduino board, it is also not necessary in soldering to fit the arduino board. LCD keypad shield has six (6) button, such as select, left, right, up, down and reset buttons. all these buttons has its own task in accordance with the programing was added to arduino. Pin 4 to pin 9 of the main Arduino board is used to control the LCD display, while pin 8 and pin 9 are used for the Register Select (RS) and Enable pin. LCD keypad shield is to key in the height and weight and so on will display the glucose level and insulin as needed. Figure 1 show the schematic diagrams of the push buttons and the LCD screen.

The IR detection circuit consists of a transmitter circuit and a receiver circuit, with both transmitter and receiver positioned side by side and points to a reflective surface. Both transmitter and receiver operate at 5V and are powered by the Arduino microcontroller. The transmitter (LED850) is a High Speed Infrared Emitting Diode. The receiver circuit consists of a photodiode, a noise filter and an operational amplifier. A low pass filter is connected to the voltage source to reduce the noise

frequency from the source. The OPF470 photodiode is suitable to be used with the transmitter as it has a wavelength sensitivity which is within 800 nm - 900 nm [9]. The photodiode is used to measure continuous wave fiber light source and converts the optical power received from the transmitter to an electrical current value. In this project, the electrical current is converted into voltage by placing a load resistor (RL) at the anode. The value of the output voltage depends on the intensity of the infrared signal it receives, which is between 0 V to 5 V. Since the output voltages from the photodiode are usually less than 1 V, an operational amplifier is used to amplify the output signal [10].

The main focus of the software development is the microcontroller. The Arduino Uno is a microcontroller board based on Atmega328 and has 14 digital input and output pins. It can be powered by a (5 V-12 V) battery or by simply connecting it to a computer with a universal serial bus (USB). The Arduino Uno is used as the controller for the device as it is an open source which is easy to code and upload to the input/output (I/O) board. The open source Arduino code is known as integrated development environment (IDE).

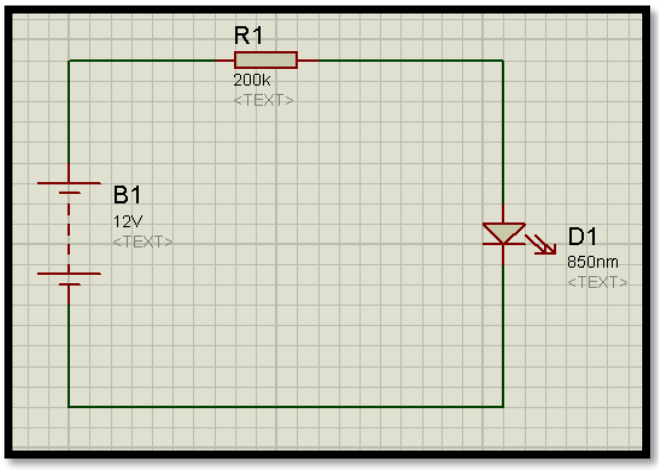

Figure-2. Transmitter circuit.

The microcontroller supplies voltages to bias both transmitter, as shown in Figure-2, and photodiode. The output of the photodiode and amplifier are connected to the analogue pin of the microcontroller.

RESULTS AND DISCUSSIONS

The Figure-3 below shows a prototype that has been designed for Blood Glucose Test Device via GSM.

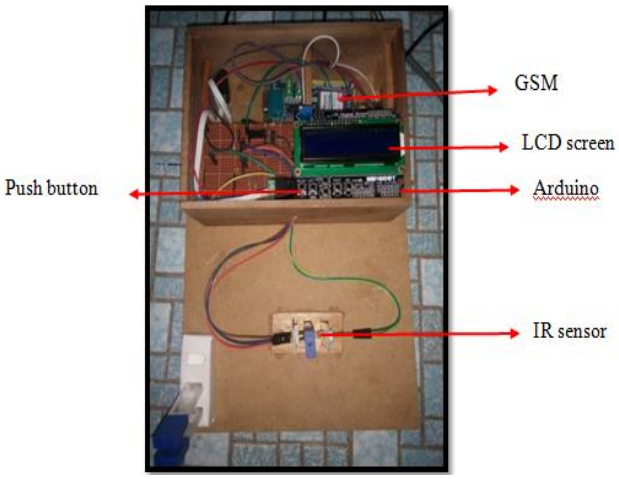

Figure-3. Portable prototype of glucose tester.

The device is developed using a near infrared sensor with a peak wavelength of 850 nm and Arduino Uno as a microcontroller. It was found that NIR with the higher wavelength (2050 nm) was able to penetrate deeper into the body tissue. However, too high of observance may cause other substances in the blood to interfere with the infrared signal. Besides that, inadequate power source from the microcontroller might be one of the reasons of the some measurement errors (Sia, 2010).The main components in this project are Arduino UNO module, IR LED, photodiode, GSM and LCD keypad shield. ATmega328 microcontroller is microcontrollers that work in the Arduno UNO module. The microcontroller act as interface between LCD keypad shield, GSM, and sensor. For checking the blood glucose using the light source with is IR LED and photodiode. To check blood glucose using a light source it requires a high wavelength as a transmitter, in this project as a transmission medium IR LED and photodiode as the receiver. This project uses a wavelength transmitter is relatively low, so readings are obtained when the inspection inaccurate.

GSM SIM900 is used in this project to communicate with microcontroller using serial communication. GSM interfacing with microcontroller for SMS control of several applications. The GSM is connected at pins 2 and pins 3 which is an output port. The GSM is used to transmit the glucose level to the user. The software is written in Arduino language which compiled, debugged and tested. The signal from the Arduino also to the GSM according to the software code dumped in the Arduino.

Several functions had been used in the Arduino programming language in order to build the blood glucose test device. Void setup () was a function used to run once at the start of a program that can initialize setting. This function defined the variable used either it is input or output. Void loop () also was used in the coding program. This function used to call repeatedly until the board power off. It does not precisely what its name suggests and loops consecutively, allowing the program to change and respond. Function “if” and “while” is used in the void loop

to declare the action need to be taken in the decision mode. The device requires the user to key in their height and weight using the push button as shown in Figure-3. Once the height and weight are keyed-in, the BMI for the user will calculated and shown on the LCD screen. To proceed to the next process, the user will need to press the SELECT button. At this stage, the sensor will start too active and a "READY" message will be displayed on the screen as in step 6. Once the glucose concentration is measured, the device will calculate the required insulin dose corresponding to the BMI and display the measured glucose concentration in mg/dL and insulin dose needed in Units as shown in the last step. After that, when the user press the SELECT button, the result will be send automatically to the related person by using SMS. The user can repeat the measurement by pressing the RESET button. The working displays on the LCD screen are shown in the steps below;

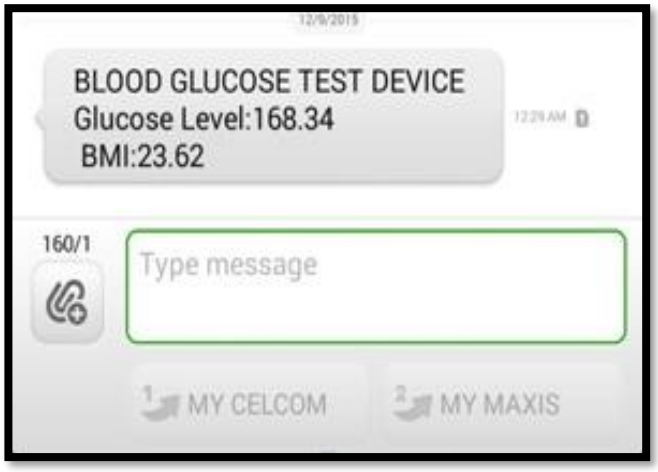

Figure-4. Result of glucose level receive via SMS.

CONCLUSIONS

The project was successfully implemented and the device was able to detect different glucose concentration and determine the required insulin dose for different BMI. The detection sensor was developed using a infrared sensor with a peak wavelength of 850 nm and photodiode (OPF470). The Arduino Uno microcontroller was used to control the operation of the system.

Glucose test device projects act as a tool to monitor the level of glucose in a person's blood continuously, this project has a LCD keypad shield allows users key in their height and weight to calculate BMI and subsequent glucose level display will appear on the LCD and it is able to send glucose results level to the specific person using the GSM and results was sent in the form of SMS, usually the project for the use of parents that their child stay away from them. Therefore, this project provides facilities being on both sides, especially parents who live far away from their children, so their children can monitor glucose parent and can take appropriate action.

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