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Automatic Blood Glucose Regulator

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ABSTRACT
Diabetes is the most common metabolic disease in the world in which Blood Glucose levels in the human body remain high for a prolonged period that will lead to death when there is no proper health care. For diabetic patients Blood Glucose levels must be regulated properly in order to manage their health properly. To check Blood Glucose levels diabetic patients perform a capillary test at least three times per day. This Blood Glucose monitoring technique is an invasive procedure, where the blood samples are collected through finger prick this makes the process painful with the risk of infection. To overcome this, an Automatic Blood Glucose Regulator is developed for the critical Diabetic patients. In this automatic regulator the Blood Glucose levels are continuously monitored with non invasive risk free procedure and in case of high Blood Glucose level the insulin will be automatically injected into the patient body by using insulin injector. In addition, a SMS message about a patient. Blood Glucose level will also be sent to the corresponding caretaker and the same will be stored in the cloud for future reference.
Keywords—Diabetes, Blood Glucose regulator, Insulin Injector.

1. INTRODUCTION

Diabetes is a metabolic disorder that is characterized by high blood glucose level in the human body, which is due to the insufficient or ineffective insulin secretion. It leads to blindness, renal failure, amputation, heart attacks and stroke. It is the third leading cause of death in many developed countries. It is estimated that in 2010 there were globally 285 million people (approximately 6.4% of the adult population) suffering from this disease. The health scientists say that diabetes will be the 7th leading cause of death in the coming decade with more than 400 million people affected with diabetes all over the world. Diabetes is the common name for diabetes mellitus. It is a silent killer disease. The blood sugar level becomes abnormal for a prolonged period. Abnormal glucose conditions such as hyperglycemia and hypoglycemia are very dangerous for the health of both diabetic and non-diabetic people. The glucose concentration in blood has an important role in personal health condition. Hyperglycemia brings diabetes which leads to pancreatic function failure, immunity reduction etc. Hypoglycemia creates health complications such as confusion, anxiety, even coma if not treated on time. Diabetes can be categorized into three. The type 1 diabetes appears during childhood or in adolescence. In this condition the pancreas will be unable to produce insulin, which may due to some genetic reason. The type 2 diabetes is commonly seen in adults. In this type the pancreas produces insulin, but the amount produced may not be sufficient or the body will become resistant to it. The main reason behind this is obesity. Type 2 diabetes is usually referred as a lifestyle disease. The third type is gestational diabetes, which is triggered by pregnancy. This type of diabetes usually resolves itself after pregnancy. The most common type is type 2 diabetes. Middle age and older adults are at the risk of developing this type. People at lower risk can manage their sugar level by diet and exercise. For a healthy individual the sugar level falls between 4 to 5.4milli mol/L when fasting and 7.8milli mol/L after having food. Diabetes can also be treated with various medications. The medicines help the body to use insulin efficiently. If oral medication is not effectively reducing

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the sugar level, the patients eventually need to take insulin injections. It has been observed that 2-5 weeks of intensive insulin therapy can induce remission in type 2 patients. But type 2 diabetes is a progressive disease. After 10-15 years the patients compulsorily need insulin and the dosage depends on the level of sugar. People suffering with diabetes no matter what type, should be followed by a doctor lifelong. Self testing of the same is very important for managing the treatment plan and avoiding the complications. The diabetes patients require taking blood by the finger prick method which does not monitor the levels continuously. Varieties of electronic equipment are available in the market to get the glucose measurement in a drop of blood which has the disadvantage of pain and inconvenience for the patient. The frequency of testing depends upon the type and severity of diabetes. Patients may need to take the test multiple times a day. It is very difficult for a chronic diabetes patient to take blood samples many times a day. Moreover, continuously pricking the finger and taking the sample will lead to anemia and after some years of this practice, the patient will be unable to get a single drop of blood from the fingertip. However new technologies are coming up that do not require finger pricking and achieves what is referred to as non-invasive glucose monitoring. Such techniques reduce the difficulties related to diabetes and allow the patient an alternative painless and reliable measurement. We propose a non-invasive glucose measuring system that can detect and display the sugar level of the patient in mg/dL. This system utilizes the scattering property of near infrared (NIR) light when it passes through the blood. Diabetes mellitus occurs from insulin resistance and relative insulin deficiency [2], [3]. Diabetes can cause many serious secondary health issues such as blindness, stroke, kidney failure, Ulcers, Infections, obesity and blood vessels damage Diabetes is curable when it is diagnosed before reaching the danger zone; otherwise it becomes a serious issue. To keep this disease at control level continuous monitoring of the blood glucose level is required. In a normal case, a person requires diabetes maintenance and needs to be treated with one injection of insulin in the morning. But for critically ill diabetic patients Blood glucose levels are much affected due to their medication effects, so the control of Blood Glucose level for these patients is more complicated and the regular monitoring of patients plays a vital role automated blood glucose regulator is aimed to serve as a crucial one.

2. Automatic Blood Glucose Regulator

The Blood Glucose levels of critical ill diabetic patients can be controlled using Automatic Blood Glucose Regulator. This scheme contains a LASER sensor for Non invasive Blood Glucose measurement and an Automatic insulin injector

2.1 Non Invasive Procedure:

In the conventional method the Blood Glucose cannot be measured continuously and it has a high risk of infection. So this method is not applicable for critically ill patients as they require continuous monitoring. To overcome these problems non invasive methods emerged, here the blood glucose level is continuously monitored and regulated.

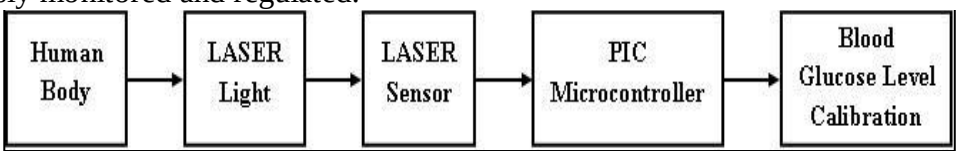

Fig. 1. Block Diagram of Non Invasive Method

In this non-invasive procedure adopted, the Red LASER (RL) is made to pass through the human finger for a few seconds. The LASER light is being absorbed by the glucose in dermis fluid, remaining light gets refracted and it is collected by the LASER sensor. The refracted light captured by the LASER sensor is converted into corresponding voltage value. The analog voltage which is given as input to PIC microcontroller

2.2 PIC Microcontroller

In this work PIC16F877A is used. The main advantage of this microcontroller is it can be write-erased as much as possible because it uses FLASH memory technology. The operating voltage is between 4.2 volts to 5.5 volts. It has 8 channels of 10 bit A/D converter. The analog voltage from

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the LASER sensor is given as input to the Microcontroller, which converts it to the corresponding digital value. The voltage processed by the PIC Microcontroller is calibrated to an equivalent level of blood glucose level and it is displayed on the LCD screen.

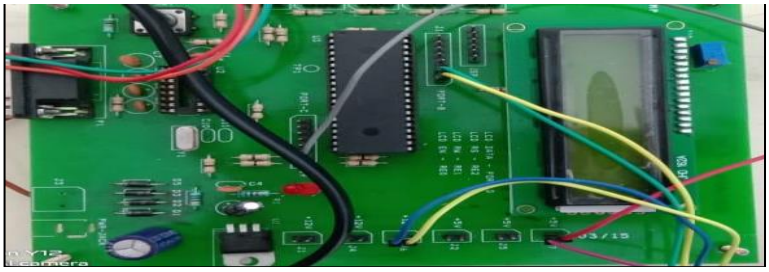

Fig. 2. PIC16F877A

2.3 UART

UART is used for transferring data serially to PC and Zigbee. Transmitting and Receiving UARTs must be set for the same bit speed, character length, parity and stop bits for proper operation. The data transmitted will be in binary form .The data transmitted is in two states, they are MARK and SPACE state. MARK state when the bit is 1 and the SPACE state when the bit is 0. The data transmission starts with the start bit (positive voltage) following it the data will be transmitted serially, it is followed by stop bit (negative voltage) this cycle continues till the data are completely transmitted.

2.4 Zigbee

Fig. 3. Zigbee Module

Zigbee module is used to create PAN (Personal Account Number). Zigbee is a low data rate supporting wireless networking standard, which is basically used for two way communication between sensors and control systems. It is a short range communication standard like Wi-Fi, covering a range of 10 to 100 meters with low power consumption.

2.5 Insulin Injector

Insulin control units consist of servo motors, pairs of gears and injection when the glucose level in the critically ill patient gets high, the insulin control unit injects the insulin automatically to the patient.

Fig. 4. Insulin injector

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2.6 CLOUD and GSM

The blood glucose values will be continuously stored in the cloud platform using Zigbee and SMS will be sent to the caretaker of the patient using GSM.

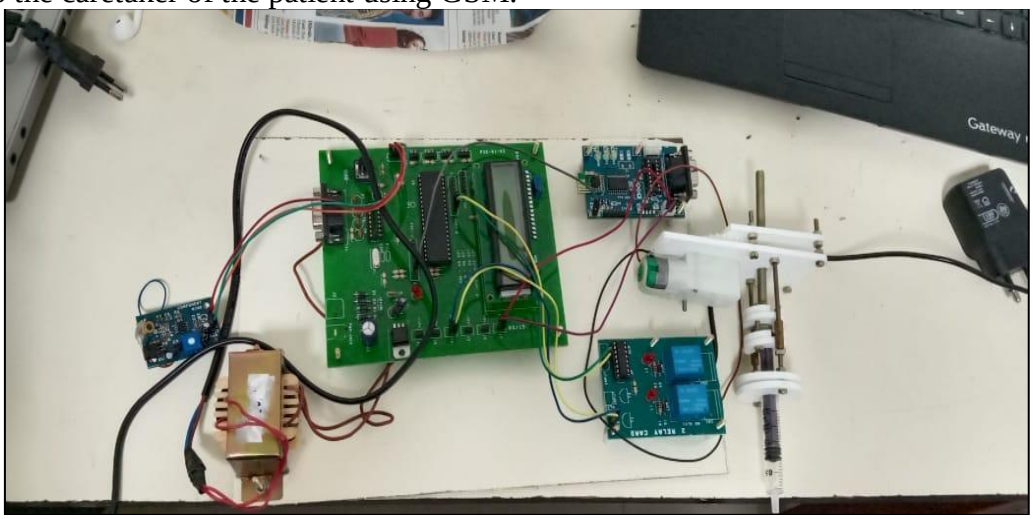

Fig. 5. Automatic Blood Glucose Regulator

The normal blood glucose level of a person is 70 to 130 mg/dL. But for the critically ill patient, the blood glucose level gets increased as the metabolic activities slow down. For such patients the blood glucose must be continuously monitored and regulated. This approach contributes to improving the quality of life of elderly patients who, due to their condition, are unable to attend appointments in a hospital continuous glucose monitoring improves metabolic control of the patient and provides a better profile of the glucose variations throughout the entire day In this project we continuously monitor and regulate the blood glucose level when the blood glucose level goes high by automatically injecting insulin to the patient.

CONCLUSION

To make the existing system more reliable, more data needs to be collected and analyzed. This improvement is necessary to make the patient feel more comfortable with the treatment for their recovery. A prediction model can be created and by training the dataset, the accuracy of glucose value can be increased more. The system can be enhanced by adding some other parameters like blood potassium level, Hemoglobin level, respiratory rate etc., to make the system a multi-monitoring system.

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