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Design and Implementation of Heart Rate Monitoring and Integrated Insulin Infusion System

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Abstract- Diabetes is one of the disease which requires constant monitoring and regular intake of medications. Another critical part of this disease is that, it leads to various cardiovascular disorders. Manual calculation of insulin dosage of the patient will take time and it lacks accuracy. So, in this paper we described the design of the instrument that we intended to develop, which will be able to monitor both Blood Glucose level as well as the Heart Rate and also it continuously injects the required amount of insulin that needs to balance the level of glucose in blood. This approach is mainly introduced to provide assistance to type2 patients.

Keywords: Glucose Sensor, Heart Rate Sensor, Insulin, Blood Glucose, Diabetes.

I. INTRODUCTION

Diabetes is a disease in which blood glucose, or blood sugar levels are too high. Glucose comes from the foods we eat. Insulin is a hormone that helps the glucose get into the cells to give them energy. With type 1 diabetes, human body does not make insulin. With type 2 diabetes, the more common type, your body does not make or use insulin well. Without enough insulin, the glucose stays in blood. One can also have prediabeties. This means that blood sugar is higher than normal but not high enough to be called diabetes. Having prediabetes puts them at a higher risk of getting type 2 diabetes.

Overtime, having too much glucose in blood can cause serious problems. It can damage your eyes, kidneys, and nerves. Diabetes can also cause heart disease, stroke and even the need to remove a limb. Pregnant women can also get diabetes, called gestational diabetes.

Blood tests can show if person has diabetes. One type of test, the A1C, can also check on how patients are managing their diabetes. Exercise, weight control and sticking to your meal plan can help control blood glucose level and take medicine if prescribed.

A blood glucose test measures the amount of a sugar called glucose in a sample of blood.

Glucose is a major source of energy for most cells of the body, including brain cells. Carbohydrates are found in fruit, cereal, bread, pasta, and rice. They are quickly turned into glucose in your body. This raises your blood glucose level.

In 2013 it was estimated that over 382 million people throughout the world had diabetes (Williams's textbook of endocrinology).

Type 1 Diabetes - the body does not produce insulin. Approximately 10% of all diabetes cases are type 1.

Type 2 Diabetes - the body does not produce enough insulin for proper function. Approximately 90% of all cases of diabetes worldwide are of this type.

Gestational Diabetes - this type affects females during pregnancy.

The most common diabetes symptoms include frequent urination, intense thirst and hunger, weight gain, unusual weight loss, fatigue, cuts and bruises that do not heal, male sexual disfunction, numbness and tingling in hands and feet.

As the risk of cardiovascular disease is much higher for a diabetic patient, it is crucial to monitor blood pressure and cholesterol levels regularly. As smoking might have a serious effect on cardiovascular health, diabetics should stop smoking.

Hypoglycemia - low blood glucose - can have a bad effect on the patient. Hyperglycemia - when blood glucose is too high - can also have a bad effect on the patient.

Some of the test available now a days are, C-Peptide—Instead of checking for antibodies, this test measures how much C-peptide is in blood. Because levels of this peptide generally match insulin levels in the body, the test can indicate how much insulin your body is producing. Low levels of C-peptide and insulin usually point to type 1 diabetes.

Glutamic Acid Decarboxylase Autoantibodies (GADA or Anti-GAD) - This test looks for antibodies built against a specific enzyme in the pancreatic beta cells that produce insulin.

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Insulin Autoantibodies (IAA) - In addition to attacking beta cells, the immune system in people with type 1 diabetes also targets insulin, says Laffel. This tests looks for the antibodies targeting insulin.
Insulinoma-Associated-2 Autoantibodies (IA-2A) - This test looks for antibodies mounted against a specific enzyme in beta cells. Both the IA-2A and GADA tests are common type 1 antibody tests performed at endocrinology offices.
Islet Cell Cytoplasmic Autoantibodies (ICA) - Islet cells are clusters of cells in the pancreas that sense blood glucose levels and dole out insulin accordingly. This test looks at the reaction between islet cell antibodies from humans and a variety of islet cell proteins (including beta cells) from an animal pancreas, says Laffel. If your antibodies react with the animal islet cells, you have a marker for type 1. This is the oldest type 1 antibody test, and is not used as frequently today.
Zinc Transporter 8 (ZnT8Ab) - The newest type 1 test, this looks at antibodies targeting an enzyme that is specific to beta cells. This test may not be as readily available.

But most of these tests are not easy for patients and these are painful methods and also time consuming. So we developed a system that helps the patients to manage their diabetes by simple method.

TABLE I CONTROL COMMANDS

Commands	Description
SA, SB	Stop syringe A, Stop syringe B. Stop normal flow or flush.
DA, DB	Dispense syringe A or Dispense syringe B with pre-set flow.
FA *x*, FB *x*	Set Flow to x □l/min for syringes A and B respectively. Flow range values 1 to 200 in steps of 1/10 □l/min.

II. METHODS AND MATERIALS

A. GLUCOSE SENSOR

Blood glucose monitoring is a way of testing the concentration of glucose in the blood glycaemia. Particularly for the treatment of diabetes mellitus, a blood glucose test is performed by piercing the skin (typically, on the finger) to draw blood, and then the blood is applied 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. The test is usually referred to as capillary blood glucose.

A blood glucose meter is an electronic device for measuring the blood glucose level. A relatively small drop of blood is placed on a disposable test strip which interfaces with a digital meter. Within several seconds, the level of blood glucose will be shown on the digital display.

In each test strip, there is an enzyme called glucose oxidase. This enzyme reacts with the glucose, in the blood sample and creates an acid called gluconic acid. The gluconic acid then reacts, with another chemical in the testing strip called ferricyanide. The ferricyanide and the gluconic acid, then combines to create ferrocyanide. Once ferrocyanide has been created, the device runs an electronic current through the blood sample on the strip. This current reads the amount of ferrocyanide and determines the quantity of glucose present in the sample of blood which has been placed on the testing strip.

Fig1

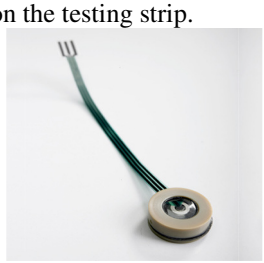

Fig2

Figure1: Image of Blood Glucose Sensor
Figure2: Image of Test strip

B. HEART REAT SENSOR

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM). It works on the principle of light modulation by blood flow through finger at each pulse. For further information please refer to its datasheet.

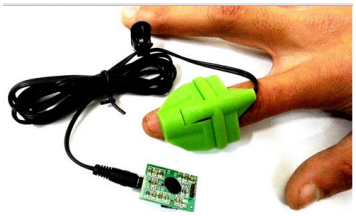

Fig3

Fig4

Figure3: Image of Heart Rate Sensor

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Figure4: Image of Strip

C. PIC CONTROLLER

In this PIC microcontroller, there are 40 pins. Out of this 40 pins, 33 pins are used for I/O operation. There are 5 ports in PIC microcontroller that is port A, port B, port C, port D, and port E. port A is 6-bit port, it is used as input or output port. Port B, port C and port D are 8 bit port. Port E is 3-bit port. The PIC microcontroller support USART, I2C and SPI protocals.PIC microcontroller consist of external oscillators like RC oscillator, crystal oscillator. In our Project, the glucose sensor output is connected to port A (4^{th}pin) in PIC microcontroller and heart rate sensor output is connected to the port A in PIC. The LCD consist of 8 data pins which is connected to port B 8 pins in PIC and also the motor driver IC is connected to port B 5^{th} pin and 7^{th} pin .

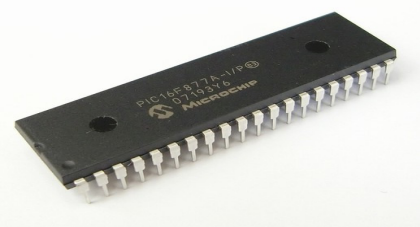

Figure5: PIC 16F877A

D. LCD DISPLAY UNIT

LCD modules are preferred over seven segment LEDs and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data are the ASCII value of the characters to be displayed on the LCD.

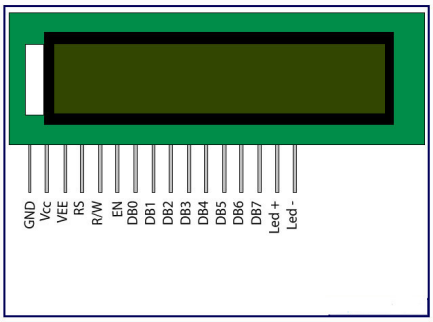

Figure6: LCD Display

E. MOTOR DRIVER CIRCUIT

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to flow in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, hence H-bridge IC are ideal for driving a DC motor.

In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller. There are two Enable pins on l293d. Pin 1 and pin 9, for used to drive the motor hence they should be connected to logic high. For driving the motor with left H-bridge it is essential to enable pin 1 and for right H-Bridge it is essential to enable pin 9. If either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It acts like a switch.

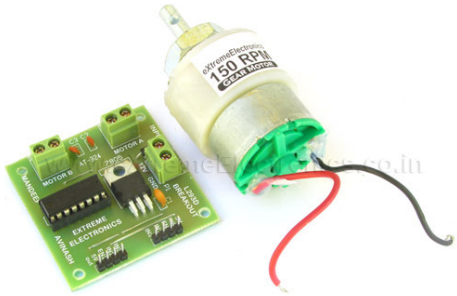

Figure7: Motor Driver Circuit

F. FLOWCHART

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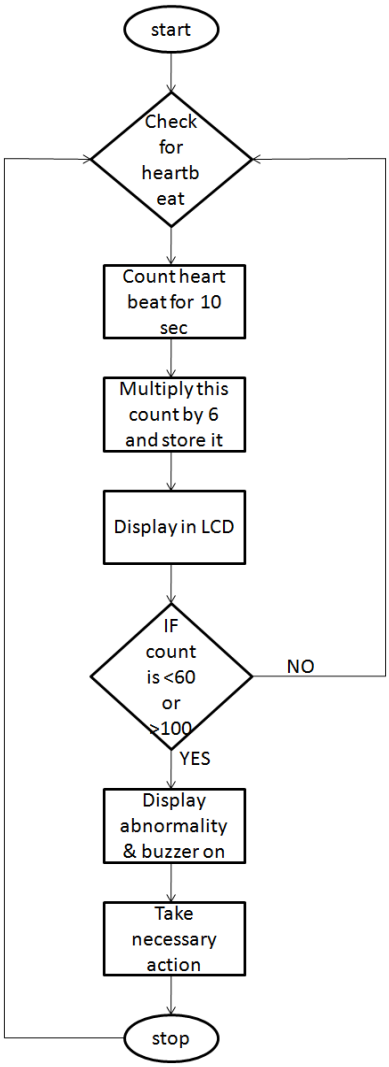

Heart Rate Flowchart

CONCLUSION

This study is to design the continuous subcutaneous insulin infusion pump with real-time continuous glucose monitoring device. The proposed system controls the insulin dosage automatically according to the real-time glucose level.
Furthermore, this system displays the heart rate, glucose value from CGM, and flow rate per minutes for further use. Overall this newly developed system compile whole real time glucose data to the end user to manage the diabetes.

REFERENCES

[1]P. Zhang, X. Zhang, J. Brown, D. Vistisen, R. Sicree, J. Shaw, G. Nichols, "Global healthcare expenditure on diabetes for 2010 and
2030," Diabetes Res. Clin. Pract., vol. 87, pp. 293–301, 2010.
[2] American Diabetes Association, "Standards of Medical Care in
Diabetes – 2014," Diabetes Care, vol. 37, pp. S14–S80, 2014.
[3] M. Shichiri, H. Kishikawa, Y.Ohkubo, N. Wake, "Long-Term Results
of the Kumamoto Study on Optimal Diabetes Control in Type 2 Diabetic Patients," Diabetes Care, vol. 23 (Suppl. 2), pp. B21̃B29,
2000.
[4] I. M. Stratton, A. I. Adler, H. A. Neil, D. R. Matthews, S. E. Manley,
C. A. Cull, D. Hadden, R. C. Turner, R. R. Holman, "Association of
glycaemia with macrovascular and microvascular complications of type
2 diabetes (UKPDS 35): prospective observational study," British Medical Journal, vol. 321, pp. 405–412, 2000.
[5] I. M. Wentholt, M. A. Vollebregt, A. A. Hart, J. B. Hoekstra, J. H. DeVries, "Comparison of a needle-type and a microdialysis continuous glucose monitor in type 1 diabetic patients," Diabetes Care, vol. 28, no.
12, pp. 2871–2876, 2005.
[6] R. Guardo, S. Trudelle, A. Adler, C. Boulay, and P. Savard, "Contactless
recording of cardiac related thoracic conductivity changes," in *Proc. IEEE Ann. Int. Conf. Eng. Med. Biol. Soc.*, Quebec, Canada, Sep. 20–24, 1995, vol. 2, pp. 1581–1582.
[7] J. Vedru and R. Gordon, "Model of an inductive sensor of cardiac activity attached to patient," *J. Phys., Conf. Ser.*, vol. 224, 2010, doi: 10.1088/1742-
6596/224/1/012010.
[8] D. Teichmann, A. Kuhn, S. Leonhardt, and M. Walter, "The MAIN shirt: A textile-integrated magnetic induction sensor array," *Sensors*, vol. 14, no. 1, pp. 1039–1056, 2014.
[9] K. Matthes, "Untersuchungen ¨uber die sauerstoffs¨attigung des menschlichen arterienblutes," *Naunyn-Schmiedebergs Archiv f¨ur Experimentelle Pathologie und Pharmakologie*, vol. 179, no. 6, pp. 698–711,
1935.
[10] K. Li and S. Warren, "A wireless reflectance pulse oximeter with digital baseline control for unfiltered photoplethysmograms," *IEEE Trans. Biomed. Circuits Syst.*, vol. 6, no. 3, pp. 269–278, Jun. 2012.

