

DESIGNING OF INSULIN PUMP

Zameera Tabassum^{#1}, Kalpana Vanjerkhede^{*2} and Channappa Bhyri^{*3}

^{#1} P.G Student, IT dept., PDA College of Engineering, Kalburgi, India.

^{*2} Prof. & head, IT dept., PDA College of Engineering, Kalburgi, India

^{*3} Prof. & P.G Co-ordinator, IT dept., PDA College of Engineering, Kalburgi, India

Abstract— Bio-Medical Instrumentation is an expanding and demanding area in which many fields are available to explore, among which diabetes is one of them. Glucose and Insulin are both interrelated terms. Glucose is a sugar which provides energy to the cells. Insulin is a hormone which supports the absorption of glucose. This paper deals with designing of insulin pump, which is used to regulate the blood glucose level in the body according to the requirement.

Insulin delivery system is a low cost, portable, automated pump which is used by diabetic patients to administer insulin as and when they require it at regular intervals. The purpose of designing an insulin pump is to deliver precise and accurate amount of insulin to the patient. Insulin pump is used to deliver extremely small volume of insulin in predefined time duration, at a constant flow rate which allows the patient to modify the amount of insulin using keypad at any time of the day. A processing module controls the position of the piston which is instructed to move in clockwise and anticlockwise direction and is attached to the syringe pump.

This paper introduces the use of low power embedded system with the help of microcontroller which gives the idea about use of embedded system in portable insulin syringe to deliver predefined dosage of insulin with the help of servo motor.

Index Terms— Diabetes, insulin, glucose, insulin pump.

I. INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder that is characterized by the disability of the body to maintain blood glucose levels within physiological ranges. Particularly, it is an autoimmune disease in which the beta cells of the pancreas are destroyed, resulting in the absence of insulin secretion. Long term complications from diabetes include heart disease, stroke, vascular disease, blindness, nerve damage, amputation and kidney disease. These long term complications are resulting in increasing disability, reduced life expectancy. When a normal human being body cannot secrete enough insulin, his/her blood glucose level rises, resulting in many adverse medical conditions. Diabetes is due to either the pancreas not producing enough insulin or the cells of the body not responding properly to the insulin produced. There are three main types of diabetes mellitus:

- Type 1 DM results from the pancreas's failure to produce enough insulin. This form was previously

referred to as "insulin-dependent diabetes mellitus" (IDDM)

- Type 2 DM begins with insulin resistance, a condition in which cells fail to respond to insulin properly. As the disease progresses a lack of insulin may also develop. This form was previously referred to as "non insulin dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes". The primary cause is excessive body weight and not enough exercise, may be treated with medications with or without insulin.
- Gestational diabetes, is the third main form and occurs when pregnant women without a previous history of diabetes develop high blood-sugar levels, usually resolves after the birth of the baby. The designing of insulin pump is mainly for Type 1 DM patients.

The objective of this paper is to deliver insulin by the syringe which is connected to the microcontroller through servo motor with low cost hardware setup.

Insulin Pumps are used to deliver very small quantities of drugs over long periods of time. They are also commonly called Syringe Pumps. Infusion is a method of delivering fluids, medication or nutrients into a patient's circulatory system, generally used intravenously, although subcutaneous, arterial and epidural infusions are occasionally used. Infusion pumps are usually used in hospitals. Infusion pumps can administer fluids in ways that would be impractically expensive or unreliable if performed manually by nursing staff. Insulin pump is one among them, any infusion pumps are used to deliver insulin.

In olden days injection pumps were used manually. It is difficult to deliver the liquid in small quantities. When it is used manually, there may be small decrement or increment in dosage. Exact value is not possible by using manual operation. So to overcome these drawbacks infusion pumps are used. A microcontroller based insulin pumps is designed and presented here.

II. RELATED WORK

The first prototype of a 'pump' that delivered glucagon as well as insulin was similar to a backpack. Rigorous clinical testing for CSII (continuous subcutaneous insulin infusion) began in the late 1970s, and by the early 1980s, CSII was being considered as a possible alternative form of insulin delivery for patients with type 1 diabetes. A new research tool has been developed to dramatically improve metabolic control in selected type 1 diabetic subjects. Later a drug driver system that can be used for continuous glucose monitoring system intended to drive a pump that will administer insulin for the purpose of combating diabetes. The idea behind the proposed system is to design an insulin pump using RTC and servo motor.

III. BLOCK DIAGRAM OF PROPOSED SYSTEM

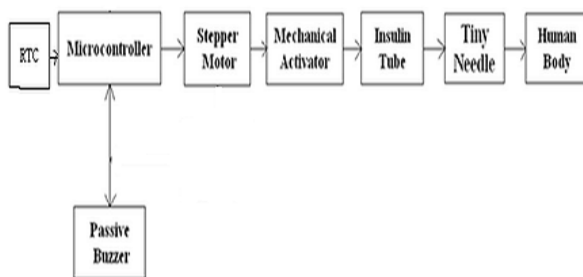


Fig 1: Block diagram of proposed system

IV. CIRCUIT DIAGRAM

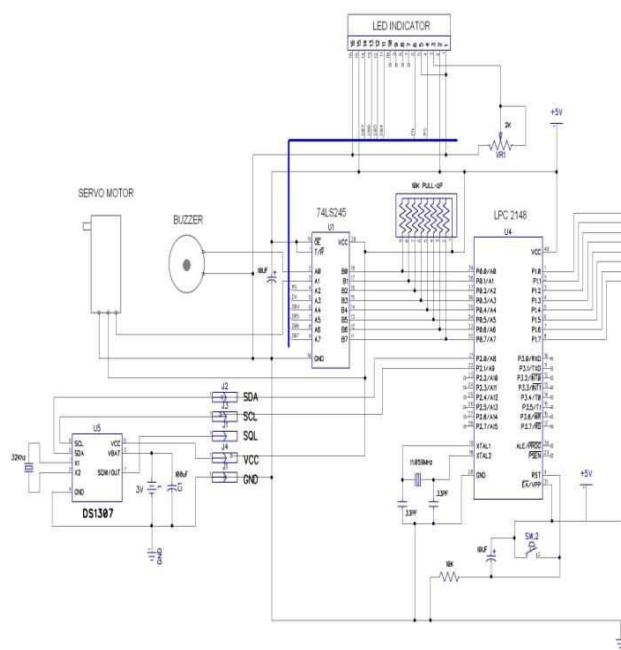


Fig 2: Circuit Diagram

V. WORKING PROCESS

An insulin pump is a device to which a syringe is fitted which is filled with a liquid, in particularly insulin. This mechanism is connected to the microcontroller through servo motor. Here servo motor is used to drive a screw, which in turn pushes the piston. Since the rate at which the insulin is injected is extremely small so, the piston is to be pushed very slowly with many rotations of the motor.

An insulin pump consists of the servo motor, syringe and a keypad. A syringe is needed to store the insulin that is to be fed to the body. Typical capacity is around 2-3 ml (200 to 300 insulin units). The syringe needs to be refilled whenever it is near empty.

First limit switch is provided to bring the piston in starting position. According to range of the medicine required we have to set the rotations of the servo motor. To inject 1ml of liquid in 1hour we have to use more time delay for moving the steps in the servo motor.

The second limit switch is used to refill the syringe whenever it is empty. The rotations of the motor are controlled by the microcontroller. The volume of the liquid is entered with the help of the keypad and it can be displayed on LCD with the help of the microcontroller and the brightness of the display is varied by potentiometer. RTC (real-time clock) block is used to store the current date and time in internal EEPROM (Electrically Erasable Programmable Read-only Memory). This allows the date and time to be stored even if the device is powered off.

The system can also drive an alarm to indicate that the liquid in the syringe is coming to the end point.

A processing module is required to control the position of the piston. The three pins of the servomotor are connected to the port 0 via pull up resistor (pin-1); Second pin is connected to port 2.0 (pin-21); third pin is connected to ground. Servo motor is instructed to move in clockwise and anticlockwise direction according to the control of the motion of the piston which is attached to the syringe pump.

When the manually entered data matches the RTC the servo motor drives the piston causing the insulin delivery via syringe.

RTC is used to maintain the current time in off line processing. The DS1307 Serial Real-Time Clock is a low power; full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially via a 2-wire, bi-directional bus, which is connected to microcontroller. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply. Counter blocks can be used with a very low frequency source clock on the order of 1Hz. This 1Hz clock can be derived from the 32.768 crystal used to drive the RTC.

Here to interface servo motor with microcontroller L293D driver is used. L293D are quadruple high-current half-H drivers which is designed to provide bidirectional drive

currents of up to 1 A at voltages from 4.5 V to 36 V.

VI. CONCLUSION

The designing of Insulin pump using microcontroller has been successfully developed, which is used to deliver precise and accurate amount of insulin to the patient to regulate the blood glucose level.

REFERENCES

- [1] Dr Arnold Kadish: "Insulin pump therapy"; acceptable alternative to injection therapy. *Postgrad Med* 99:125–132, 141–144, 1996.
- [2] Dean Kamen , "first wearable infusion pump", *The International Who's By Europa Publications*;1978.
- [3] Pickup JC "Continuous subcutaneous insulin infusion":To improve metabolic control in selected type 1 diabetic subjects. *Br Med J* 1978;1:204- 7.[PUBMED]
- [4] Arnold C. Paglinawan, "A design of a drug driver system for controlling an insulin pump and microcontroller hardware implementation using two- point calibration algorithm" ; Department of Electronics, Computer and Electrical Engineering, Mapua Institute of Technology, *IEEE International Conference 2014*.
- [5] Jameel Ahmed, Bilal A. Alvi and Khan Zeeshan Ali, "Blood Glucose-Insulin Regulation and Management System Using MATLAB/SIMULINK", 2008, *IEEE*.
- [6] Smita R. Dikondwar, "Design and Development of Insulin Delivery System Prototype", 2011, *IEEE 3rd International Conference*.
- [7] Elizabeth Cohen "Insulin Pump Therapy Less Post- Exercise Hyperglycemia than Multiple Daily Injections: An Observational Study of Physically Active Type 1 Diabetes Patients". *diabetes technology & therapeutics journal* 2013.
- [8] Mr.Rajesh R.Dodake, Dr.Prof.Mrs.S. Subbaraman, Mr.Ramchandra K. Gurav," Design and Development of Portable Insulin Syringe using Low Power Embedded Systems" 2013 *IJERT International Journal*
- [9] Engr. S. Ghufuran Khalid, M. Iqbal Bhatti and Engr. Kamram Hameed, "Advancement in Insulcagon Pump Simulating as an Artificial Pancreas for the Treatment of Diabetes", 2010, *IEEE*.
- [10] Giovanni Sparacino, Francesca Zanderigo, Stefano Corazza, Maran Alberto, Andrea Facchinetti and Claudio Cobeli, "Glucose Concentration can be Predicted Ahead in Time From Continuous Glucose Monitoring Sensor Time-Series", 2007, *IEEE*
- [11] Zhi Xu, Sheng Liu, Zlyin Gan, Bin Ma, Guojun Liu, Xinxia ghai Zhang, "An integrated intelligent insulin pump" 2006 *IEEE.7th International Conf. on Electronics Packaging Technolog*
- [12] P Srinivas; P.Durga Prasada Rao" CLOSED LOOP MODEL FOR GLUCOSE INSULIN REGULATION SYSTEM" Department of EIE,*International Journal of Instrumentation and Control Systems (IJICS)* Vol.2, No.4, October 2011.