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Micro Flow rate Infusion Pump Prototype

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Abstract - Since manual method of micro or nano flow-rate of liquid handling is inaccurate and tedious job, The automated micro flow-rate liquid delivery system is best suitable. This paper presents the development of practical approaches to liquid-delivery system for micro flow-rate with accuracy and precision. The experimental and results demonstrate that the liquid-delivery system is capable of generating accurate and condition-independent micro- and nano-flowrate. Liquid delivery can be used in medical Infusions such as in anesthesia, diabetes mellitus[1][2] (Juveniles,Type1 and Type2)and in several applications where extremely small volume of liquid in predefined time duration, at a constant flow rate is required , therefore the system find its use in research and development related to biomedical ,biotechnology, bioengineering, chemical laboratories and analytical instruments.

Keywords- Electronic Instrumentation, Syringe Pump, Mini stepper motor, Flow rate regulation.

I. INTRODUCTION

Micro and nano[1] flowrate delivery systems has been known as important biomedical device as it has many potential applications in different areas of medicine and biotechnology. The micro flowrate pumping allows accurate drug delivery with respect to time for different therapeutics such as the continuous[2] and discontinuous type liquid delivery.

II. FLOW-RATE DELIVERY SYSTEM

1. Flowrate measurement.
2. Delay time of a delivery stroke due to liquid compressibility.
3. Theoretical and practical approaches of micro-flow liquid-delivery system.
4. Conditions-independent flow-rate accuracy and gradient profiles.

III. MICRO FLOW LIQUID PUMPING SYSTEM

The block schematic consists of three major components: A syringe[13] reciprocating piston pump,linear actuator of stepper motor with instrumentation system for flow-rate regulation. The overall function of the system appears simple. As shown in Fig.1, the controller, [5]which controls the flow-rate through the linear actuator and piston to deliver micro or nano liters of liquid.

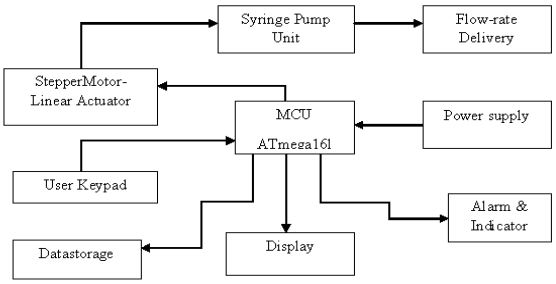

Fig1. Block Schematic of Micro Flow-rate pumping system.

IV. INFUSION SYSTEM OPERATIONS

1. Automatic Flow-rate Control.
2. Flow-ate Delivery Range : 0.35µl/Min to 500µl/Min (0.035U-50U).
3. Insulin Level & Battery Level Indication and Alarm.
4. User Keypad for Entering the Insulin Rate Value from Menu selection with Up –Down & Ok Keys.
5. Operation of start and stop and reset.
6. Operation of alarms and indication.
7. Low level of reservoir indication.

8. User Interface with keypad and LCD display.
9. keypad (UP, DOWN, OK and Menu) to set desirable Flow-rate.

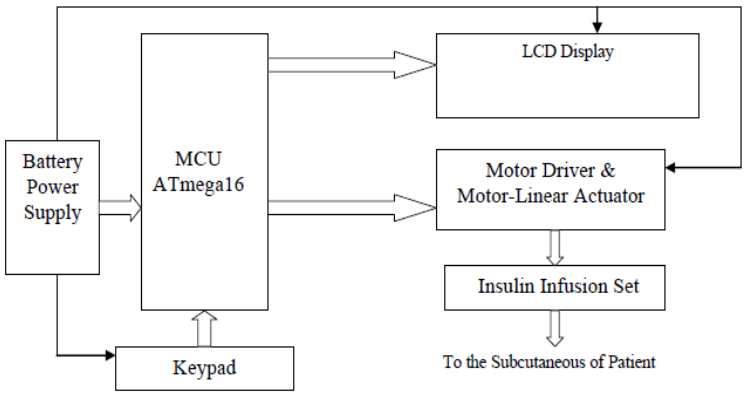

Fig.2 Block diag.of embedded controller for insulin delivery system

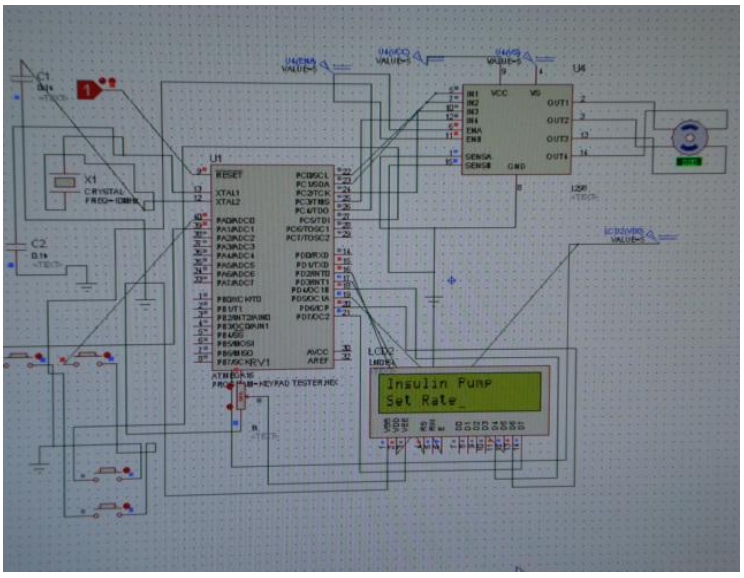

Fig.2 Block diag.of embedded system for insulin delivery system

The controller must ensure that the system strictly obeys the medical rules and guarantees the safety of patient. To develop an insulin delivery system with high assurance of its reliability and safety for commercial standards and use, the work followed using International Electron Technology Commission (IEC) in the European Standard (IEC 61508) to apply a formal method for the development.

V. Experimental And Results

The tests are performed for liquid delivery for different flow-rates, the delivered flow rate is measured by micro and nano liter syringe. For various number of steps the observations are noted, which renders to determine the accuracy, repeatability and span of operation of the infusion pump.

VI. Results

a. The delivery of liquid in vertical position of setup is averaged from tests observations is 0.209µl = 0.0209Units.
b. The Resolution is 0.025µl = 0.0025Units.
c. The test shows Accuracy of about +- 0.01%.
d. The Repeatability of the test is very good for (alternate or continuous) forward and reverse step cycles with different time delays.
e. The system has wide span of operation which is 0.209 µl- 209µl(0.0209U-20.9U), comparatively system offers very high span.
f. During experimentation of liquid delivery tests -The linear actuator of mini stepper motor performance is exemplary, as no vibrations and noise or friction due to rotor movement is observed. It shows smooth operation for the entire tests with no back inertia of actuator.

Fig.3. Micro flow rate Infusion Pumping system

Fig.4. Micro flow rate Infusion Pump Unit

VII. CONCLUSION

a. Micro / Nano flow-rate delivery (0.035U/step).
b. Low Cost System.
   Automatic and Accurate
   Other micro-fluidic application of Insulin delivery system.
c. Insulin Delivery Pump (CSII) system best suited for severe diabetes (Type1and Type2) patients to be used continuously as life saving device[11].
d. Infusion Pumps play vital role in Medical Institutions and Hospitals as life saving instruments for the medicine delivery[12].
e. In Research and Development related to Biotechnology, Bioengineering and Chemical Laboratories for applications such as study of chemical reaction, Synthesis etc.
f. Infusion Pumps are also used in many analytical instruments such as particle analysers, liquid chromatographs etc.

VIII. FUTURE SCOPE

System developed here, represent the basic model of 'micro flow rate Infusion prototype'. The hardware and software features may be modified. Developed system can be deployed with biosensor for advanced control strategies like Model based predictive control [6] to improve accuracy and complete[10] automation of system. Telemetry can be the best suited for wireless advanced control of infusion pump.

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