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Smart Drip Infusion Monitoring System and Electronic Valve System with Quantitative Control Using IoT

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***Abstract*—** In health care system environment use of IOT technologies bring convenience to both doctors and patients. This work proposes a method for drip infusion monitoring system. The system is designed to work in two modes viz Manual mode and Auto mode. The patient's heart beat and body temperature are obtained using sensors. Based on these readings the flow rate of the glucose is determined by the doctor or nurse. While the glucose is being given to t he patient, it should be carefully monitored so that the glucose bag does not become empty. This is very much essential to prevent reverse blood flow. In this project the reverse blood flow is prevented using solenoid valve with quantitative control. The salient features of this project includes: Drip bottle weight monitoring using a load cell , Flow control using a electronic valve, Patient Monitoring using Sensors and Automation of Drip Process.

Keywords: Drip infusion, Health monitoring, Quantitative control, IOT.

I. INTRODUCTION

In order to achieve the function of the quantitative control in a variety of flow systems, a new type of electronic valve with quantitative control is designed. The valve collects flow pulse signal from the impeller Hall flow sensor. Micro controller chip is used to calculate the flow value and cumulate the total value. It`s also used to control relay in order to real-time control solenoid valve. Electronic valves have been widely used in production and daily life. Now electronic valves are moving towards four directions of streamlining, intelligent, generalization and customization. Except for switch function of basic solenoid valve, dedicated solenoid valves also have some kind of special function or apply to some special occasions, such as gas solenoid valves, steam solenoid valves, oil solenoid valves, refrigeration solenoid valves, high temperature solenoid valves and explosion-proof solenoid valves and so on.

In this paper we are interfacing a load sensor to the ARM micro controller, this load sensor will sense the weight of the chemicals and displayed it on the LCD display. In the next stage we are giving a flow input in ml/sec, in one second a particular quantity of chemical should go to the outlet this will be controlled by a solenoid valve. This can be implemented in automatic flow control of glucose in hospital, in physical vapour deposition, in chemical supply control of plants which grows in water (hydroponics). The Drip bottle weight is measured using an electronic load cell and information about it will be sent to IoT server of the Hospital.

But here for demonstration purpose we are sending the data to the basic android mobile App, through using the Wi-Fi module. When bottle gets a threshold level it intimates to the Wi-Fi module and sends the data to the Doctor and hospital staff. Doctors can control the flow rate by sending commands from the phone. For the treatment of unhealthy patient Saline is used. When patient cannot intake the food during major operations saline will be provided for their health. dengue fever, diarrhea, malaria, fever are the main disease. Saline will be provided for the people who are suffering from the above stated diseases, if not able to stop the saline infusion when there is low saline in the bottle then there is a chance of the blood to be returned to the bottle and also if there is a more infusion of the saline than the specified prescription then there is a chances of death of the patient.

In drips process the fluid weight is measured by the Load sensor and information about it is sent to Doctor ,where Doctor can control the flow rate by sending commands from phone using IOT. When the bottle weight gets empty, ARM controller sends to valve mechanism. Interfacing of temperature sensor is used to monitor the body temperature after drip is injected to patient. If the temperature detects low values it will be intimated to doctors. Load sensor is used intimate glucose level. Interfacing of WIFI module for transferring the above parameters information for attenders and respective Doctors using basic android mobile app.

II. RELATED WORK

Prof. Fan Yang describes the proper research In order to achieve the function of the quantitative control in a variety of flow systems, a new type of electronic valve with quantitative control is designed. The valve collects flow pulse signal from the impeller Hall flow sensor. STM32 chip is used to calculate the flow value and cumulate the total value. It's also used to control relay in order to real-time control solenoid valve. The communication network of upper and lower computer is built through the serial port of STM32, which achieves remote real-time monitoring between the upper computer and multiple quantitative control valves. Experiment results show that the electronic valve has a high precision and the error is less than 2.5%.[1]

Prof. shuxiang Guo describes about the solenoid actuator based novel type micro pump, In the medical field and in biotechnology, a new type of micro pump that can supply micro liquid flow has urgently been demanded. It is our purpose to develop a novel type of micro pump that has the characteristics of flexibility, driven by a low voltage, good response and safety in body. In this paper, we propose a new prototype model of a micro pump using solenoid actuator as the servo actuator. This paper describes the new structure and the motion mechanism of a micro pump using a solenoid actuator and discusses the possibility of the micro pump. This micro pump consists of two one-way valves, a pump chamber made of elastic tube, and a casing. The overall size of this micro pump prototype is 18mm in diameter and 54mm in length. Characteristic of the micro pump is measured. The e xperimental results indicate that the micro pump has the satisfactory responses, and the proposed micro pump is able to make a micro flow and is suitable for the use in medical applications and in biotechnology.[2]

Prof. Takalkar Atual S describes about design of nozzle/diffuser and the use of piezoelectric effect for the actuation of diaphragm of valve-less micro pump which has application in medical field for drug delivery. A three dimensional FE model of nozzle/diffuser and actuator is used for numerical simulation. Fluid flow analysis of nozzle/diffuser is performed to calculate their efficiency and frequency. The simulation is performed for variable converging and diverging angle by varying their length and width to calculate steady flow rate. Analysis of actuator unit is also carried out by using the COMSOL multi-physic software. The simulation of actuator unit depends on mechanical properties of material such as Young's modulus, Poisson's ratio. The numerical result used to predict the actual behaviour of actuator unit for higher frequency range which helps in proper selection of material. The comparison between analytical and numerical results is done which helps in predicting the flow rate and actual working of micro pump.[3]

III. METHODOLOGY

Interfacing of load sensor which measures the flu id weight in drips process and information about it is sent to Doctor, where Doctor can control the flow rate by sending commands from phone using IOT. Interfacing of electronic valve system, when the bottle weight gets completely empty ,ARM controller sends the command to Valve mechanis m such that it will be blocked and there will be no reverse blood flow solution. Interfacing of temperature sensor is used to monitor the body temperature after drip is injected to patient.

If the temperature detects low values then it will be intimated to doctors. Interfacing of pulse sensor to check the patients Heart rate which is also sent and displayed to attenders and Doctors digitally. Similarly load sensor is used to intimate sugar level. Interfacing Buzzer gives an intimation through sound that glucose is reached threshold level. Interfacing of wifi module for transferring the above parameters information for attenders and respective Doctors using basic android mobile app as shown in Fig.4.4.

FLOW CHART

BLOCK DIAGRAM

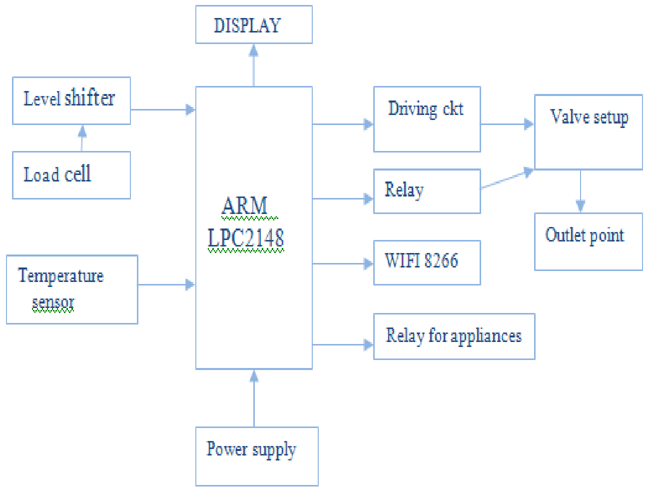

Fig 3.1. Block diagram

In this Electronic Va lve system we Interface the load sensor, LCD, keypad and measuring the weight of fluid in milliliter. The relay and solenoid valve will be us ed to verify the functionality. The hall flow sensor and inlet, outlet will verify the flow rate for the different flow rate cases. Then all the information is displayed on the LCD screen (Fig.4.3) and it sends all the data to the Android app through the WIFI Module. The Fig.3.2 shows the Model of the saline level monitoring and control system. When drips is given to the patient, load cell continuously measures the weight of the fluid present in the bottle and sends it to the ARM controller , ARM controller processes the data obtained from the load cell and updates the doctor continuously and also receives the commands from the doctor and invokes The driving circ uit by sending instructions I.e. either to reduce the flow rate or to completely close the valve when the bottle is empty.

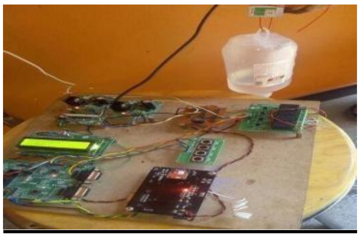

Fig 3.2. Electronic valve model

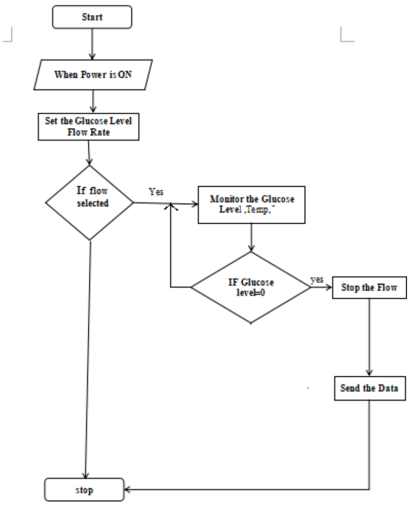

Fig 3.3. Flowchart

The Fig 3.3 flowchart shows the hardware description of this project, when the hardware in itializes with the power supply on, then it checks for the glucose level flow rate in the switch rates, if we sets flow rate for the 25% then, it checks for the body temperature by using the temperature sensor .If glucose level is below threshold level then it will stop the flow and sends the data to the hospital faculty through the Wi-Fi module of his Android App and automatically the buzzer alarms nearby faculty through an alarm. The same will repeat for the 25%, 50% and 75% of the flow rates of the glucose level.

Hardware used in the proposed system:

- ARM micro controller
- Load sensor
- Solenoid valve
- keypad, LCD
- Power supply
- relay
- Hall flow sensor
- ESP 8266 W i-Fi Communicator
- Electronic buzzer
- Android Smartphone
- Temperature and heart rate sensor

Software requirements in the system are:

- Embedded C
- Keil M vision Software

IV. RESULTS

the doctor**.** Temperature sensor senses the patient's body temperature. Heart rate sensor senses the heart rate of the patient and this information is sent to the ARM and from there it gets displayed on the LCD. Communication between the doctor and the device i.e sending and receiving of messages happen through wifi signal.

In our proposed system the weight of the glucose bottle is measured by using a load cell and display the output on LCD. If the weight of the glucose bottle is below 30ml the flow of the liquid in a bottle is stopped, and we measure the body temperature and pulse rate of the patient and the output displays on LCD and Android app.

- First step is to select the auto mode or the manual mode in the system as shown in the fig.4.1 auto mode is for controlling the system remotely and manual mode is for controlling the system using switches.

Fig 4.1. Auto/ Manual mode

- Flow rate of the glucose is selected by pressing the switch in manual mode.

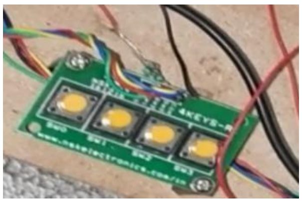

Fig 4.2. Flow rate selection

- The flow rate is displayed on the LCD and it has three options to select from 25%, 50%, 75%. Now flow of the glucose starts.

Fig 4.3. LCD Dis play

- The above process can be performed remotely through an app in auto mode by connecting the IP address of the wifi module.

Fig 4.4. Auto mode

- After successful connection and selection of flow rate the app shows body temperature, heart rate and glucose level in the bag, the glucose level in the bag is determined by the load cell, heart rate and body temperature are determined by the sensors which is displayed on the LCD screen and also in the android app as shown in Fig.4.5 .

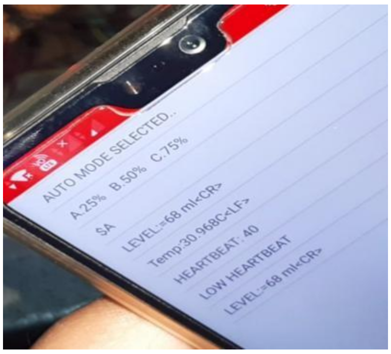

Fig 4.5. Data displayed in the app

- The system determines the glucose level and if it is below the threshold level it automatically stop the glucose flow and prevents reverse blood flow using electronic valve control. Also the buzzer makes an alarming sound to indicate the low level.

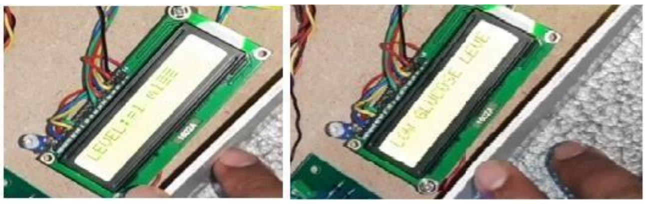

Fig 4.6. Low le vel indication

- The solenoid valve stops pressure on both the sides of the valve so there is no reverse flow of blood.

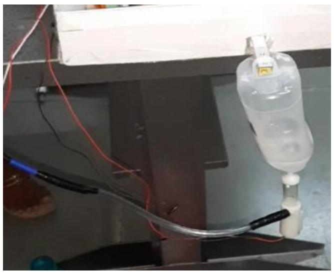

Fig 4.7. Electr onic val ve

V. CONCLUS ION AND FUTURE S COPE

This paper presented Electronic valve with Quantitative control system, In order to realize for flow control in drip, as a small, compact and advanced technology in the medical field. Here the continuous flow of medicine through drip to the patient is automatically controlled for three different flow rates 25 %, 50%, 75% of the IV cannula pipe. This can be done by measuring the level of medicine through the drip and is compared with set point and flow of medicine is stopped when it reaches the desired critical point. This method can be used for the overcoming of the human interference mistakes such as blood oozing back to bottle, when the nurse has not on time to patients place. The proposed model implemented using manual switches to control the flow rate of saline, the same model can be achieved using IOT concepts. Here IOT replaces manual switches by software like user friendly mobile apps so that doctors can control flow rate by sitting at a place. IOT concept models can be implemented for remote destinations like villages. Doctors can sit in a different city, different floor of a building, or in their house and patient can be anywhere, monitoring and flow rate controlling can be done. Using same IOT concepts one doctor can monitor several patients report on the mobile app or computer screen so one doctor can monitor several patients.

FUTURE WORK:

- Continuous Glucose Monitoring(CGM) device can be used.
- Avoidance of e xtre me hypoglycemic/hyperglycemia e xcursions as well as minimize deviations outside the normal glucose range, thus preventing both life - threatening events and the debilitating complications associated with diabetes.Data can be stored in cloud databases for easier retrieval and referral.
- Wifi module can be replaced by GSM accessing the cloud database.

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