IMPLEMENTATION OF PERISTALTIC PUMP FOR DRUG DELIVERY CONTROL

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ABSTRACT

Generally, during any kind of operations the temperature and respiration rate of the patient has to be maintained constant and it has to be supervised. To maintain the body temperature constant we need to infuse the blood and saline at constant rate. Now in this we developed a real time application of infusion model with bio-signal feedback. In our project, we will sense the respiration temperature to calculate the respiration rate. We have two temperature sensors which are used to sense the body and the surrounding temperature.

The difference in the temperature can be ±5. If the difference is above +5, then the temperature of the body will be high. Hence saline has to be provided to reduce body temperature. If the difference is below -5, then the temperature of the body will be low. Hence blood has to be supplied to increase the body temperature. The pump will work in the peristaltic action.

The infusion mechanical model will be made up of lightweight non-corrosive fabric Hylam. For perfect infusion control, self excited dc motor-based rotary to linear motion mechanical model will be developed for real time application.

1. INTRODUCTION

Nowadays there are many problems during the operation period due to variation of temperature of the person undergoing operation. This is due to improper supervision of the patient. This can be reduced by using the continuous monitoring of the patient's temperature. This is achieved by measuring the patient's temperature for every nano seconds. A pump called peristaltic pump is used to inject the drug at the rate depending on the temperature variation. Self excited dc motor is used to rotate the pump depending on the temperature. The pump used will be very advantageous as it does not produce any contamination to the drug.

2. PROPOSED SYSTEM

The proposed system is the combination of advanced technique and new dosage forms which are far better than conventional dosage forms and involves mechanical drives. It provides drug potency, control drug release to give a sustained therapeutic effect, provide greater safety and target a drug specifically to a desired tissue. The modes of modified drug delivery systems are Targeted drug delivery system, controlled drug delivery system, and modulated drug delivery system. Drug delivery control is the method of controlling the rate of flow of drug into the human body. Controlled drug delivery is one which delivers the drug at a predetermined rate, for locally or systemically, for a specified period of time. Continuous delivery of drugs at predictable and reproducible kinetics for predetermined period throughout the course is required. This is achieved more efficiently with the help of peristaltic pump.

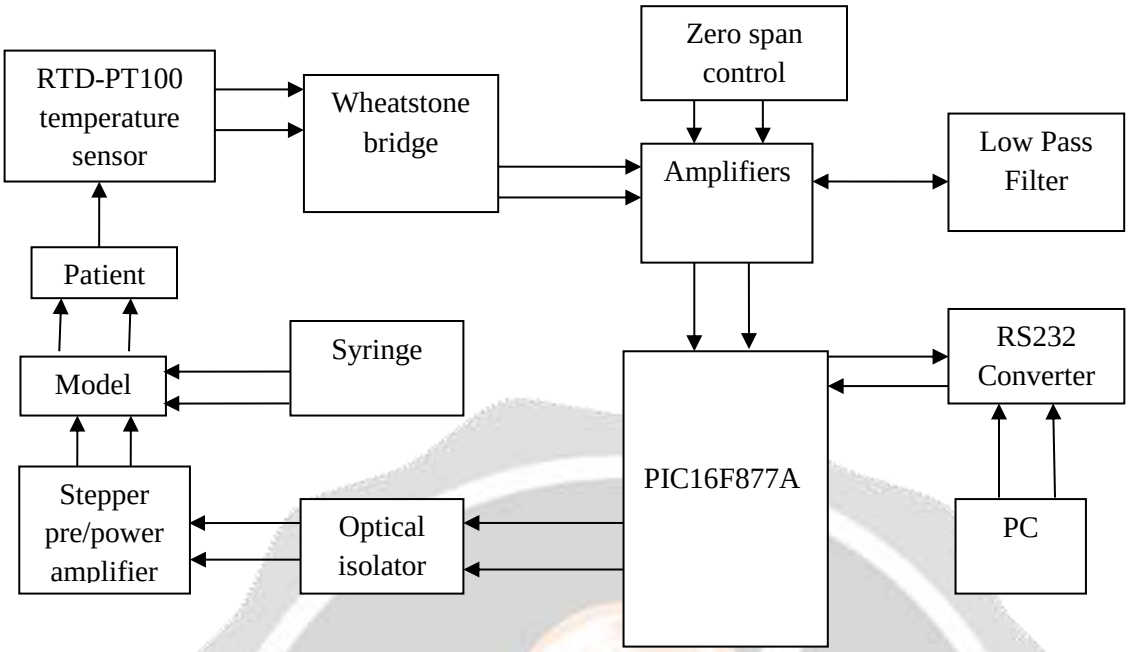

Fig -1: Block diagram

3. BLOCK DIAGRAM OF PROPOSED SYSTEM

The general block diagram of proposed system consists of sensors, signal conditioners, drug delivery mechanism, embedded system and personal computer. The aim of the project is to control the rate of flow of drug using peristaltic pump. PIC microcontroller is used in the embedded system.

The respiration rate of the human is sensed with the help of RTD. Transducers are used for conditioning the signal from the sensor and the signal gives an equivalent voltage to the microcontroller in the embedded system. The signal from the embedded system is stored in the personal computer for analysis purpose. To interface embedded system and personal computer RS232 is used as serial communication protocol.

The signal from the embedded system is given to the peristaltic pump which is present inside the drug delivery mechanism. Through tube and needle the blood and the saline are injected into the human body.

Figure 1 shows the actual block diagram of drug delivery control. This block consists of four modules. The modules are

- Data acquisition
- Data processing
- Data conversion
- Data manipulation

Sensors acquire the data from the patient and these parameters are converted into electrical signals using signal conditioners thus the data is processed and then rectifiers acts ad converter to convert the given signal into required form and finally the data is manipulated with the help of feedback.

A real-time application of infusion model with bio-signal feedback is developed. The ultimate parameter to be maintained during entire operation is respiration rate of 12-17 per minute. Respiration rate can be maintained if the patient is cooperative to the operation by accepting the blood or the saline. So the flow of fluid and control of fluid infusion is most important. If respiration rate is above 17 per minute the patient may feel pain then they may be facing hyper-tension (B.P.).If respiration rate is lower than 12 per minute then the patient will faint and also suffer from heart and brain problems.

The feedback parameters are respiration rate, body temperature and also heart rate. In this project, body temperature and respiration rate are considered to be the major parameter which has to be maintained properly. Thus

to sense the body temperature a RTD sensor is used to sense the temperature. In our system we sense the respiration temperature to calculate the respiration rate instead of regular chest expansion measurement principle. Respiration temperature measurement can be possible by using RTD PT100 temperature sensor, which can be placed in mask. RTD PT100 temperature sensor is a passive transducer with high reliability, repeatability and has international standard code.

The RTD 100 sensor will be connected to wheat-stone bridge and to appropriate signal amplifiers. Amplified output then fed to state of art embedded controller 16F877A. PIC 16F877A is a embedded micro-controller with lot of built in features. Output of the embedded micro-controller will be plotted on the computer screen to view the breathing cycle. By viewing the graph, doctors can analyze the entire breathing system of the body not only breathe rate.

Now based on the breath rate, infusion will be carried out by mechanical system specifically developed for this application. Such a mechanical system includes self excited DC motor and a positive displacement peristaltic pump. Before starting the surgery, a predefined percentage of fluid will be set to flow and can be constantly infused by our system. The infusion mechanical model will be made up of lightweight non-corrosive fabric Hylam.

There will be two RTD sensors for sensing the body temperature and the operating temperature. If the difference in temperature is zero then neither blood nor saline has to be infused inside the human body. This shows that the patient is under normal condition. Only during abnormal condition temperature difference arises. If the difference is above +5, then the temperature of the body will be high. Hence saline has to be provided to reduce body temperature. If the difference is below -5, then the temperature of the body will be low. Hence blood has to be supplied to increase the body temperature. This control can be achieved by the microcontroller. The infusion of drug is done with the help of peristaltic pump and the syringe connected to it.

To record the status of parameters of human body the measured parameters are stored in the PC with the help of RS232 interface. This status is only readable these parameters can't be altered in the PC.

4. PERISTALTIC PUMP

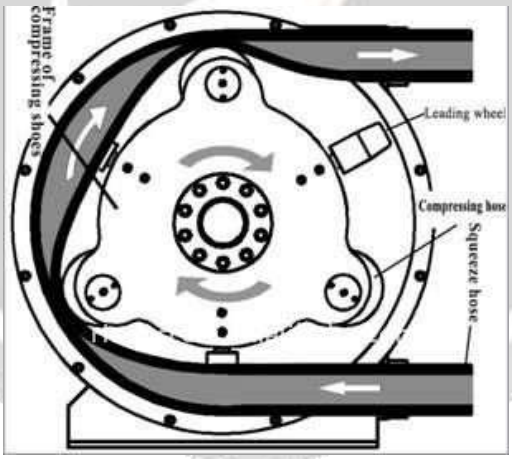

Fig-2 Peristaltic pump

It is a type of positive displacement pump used for pumping variety of fluids. It offers flow rate as low as 0.0007 mL/min to 45 liters/min. The fluid is contained within a flexible tube fitted inside a circular pump casing. A rotor with a number of rollers attached to the external circumference of the rotor compresses the flexible tube. As the rotor turns, the part of the tube under compression is pinched closed thus forcing the fluid to be pumped to move through the tube. Additionally, as the tube opens to its natural state after the passing of the cam fluid flow is induced to the pump. This process is called peristalsis. This pump is operated with the help of self excited DC motor.

5. HARDWARE CIRCUIT DESCRIPTION

The reference analog supply after being regulated by the 9V regulator enters the zener diode through the resistance R_4 where it is again regulated to 5V since the zener diode used here has a cut off of 5V. Thus we have a double regulated completely filtered analog reference source. R_6 is a potential divider used for setting the dynamic response range of the reference supply. This means that the reference 5V can be used as it is or it can be made into a fraction of the 5V for example 1V so that readings in this range can be read with more precision because of 10 bit ADC. The pins 2-5, 7-10, 35 and 36 are used as the 10 channels of the ADC. To these pins the analog inputs to be processed by the ADC are given. Y_1 is the crystal oscillator used. It is of 10 MHz and gives a baud rate of 9600 bits/s. The capacitors C_2 and C_3 are used as decoupling capacitors to remove the high frequency noise signals. The capacitor C_1 is in the off condition when power is switched off. When the power is switched on or reset then this capacitor gets charged through the resistor R_2 and then through R_1 this appears at the MCLR pin of the PIC. This is the memory clear pin and thus the memory is cleared and is ready for use as soon as power is switched on. S_1 is the synchronous switch which is also used for the same operation and for PC and PIC synchronous operation.

6. HARDWARE COMPONENTS

The hardware comprises of the following components of this drug delivery system using peristaltic pump consists of,

- Power supply units

  As we all know any invention of latest technology cannot be activated without the source of power. So in this fast moving world we deliberately need a proper power source which will be apt for a particular requirement. All the electronic components starting from diode to Intel IC's only work with a DC supply ranging from $\pm$5v to $\pm$12v. We are utilizing for the same, the cheapest and commonly available energy source of 230V - 50Hz and stepping down, rectifying, filtering and regulating the voltage.
- Step down transformer.

  When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/15-0-15v is used to perform the step down operation where a 230V AC appears as 15V AC across the secondary winding. One alteration of input causes the top of the transformer to be positive and the bottom negative. The next alteration will temporarily cause the reverse. Apart from stepping down AC voltages, it gives isolation between the power source and power supply circuitries.

- Rectifier unit.

  In the power supply unit, rectification is normally achieved using a solid-state diode. Diode has the property that will let the electron flow easily in one direction at proper biasing condition. As AC is applied to the diode, electrons only flow when the anode and cathode is negative. Reversing the polarity of voltage will not permit electron flow. The type of rectifier used for the rectification process is bridge rectifier.
- Filtering unit.

  Filter circuits which are usually capacitors acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to 'short' the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output.

7. HARDWARE SNAPSHOT

It consists of three main parts. They are hardware setup for sensors, hardware setup for embedded circuit, and hardware circuit for power amplifier. The hardware setup for sensors is used for sensing respiration rate and the body temperature. The hardware setup of the embedded circuit is provided in which program for performing various operations is interfaced. The power amplifier circuit is the setup used for amplifying the signal obtained from the embedded circuit.

The supply for the sensor hardware circuit and embedded hardware circuit is given by using the step down transformers which is used to step down the supply given. This will provide the input to enable the circuit to work.

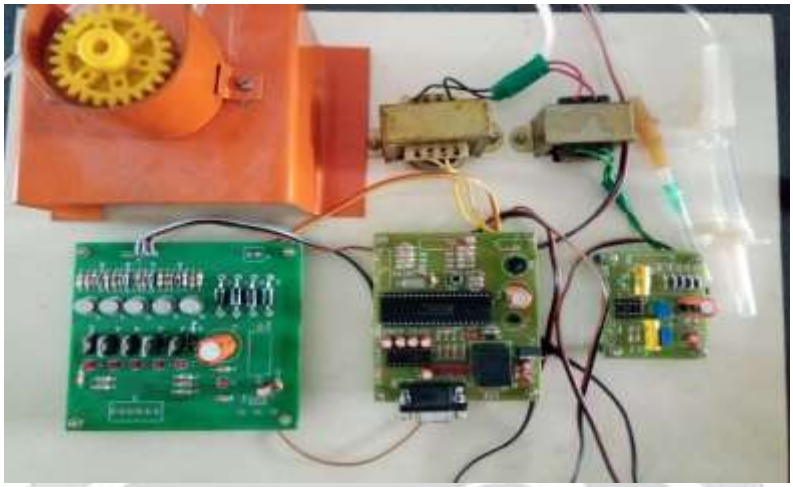

Fig-3 Hardware Snapshot

8. RESULTS AND DISCUSSION

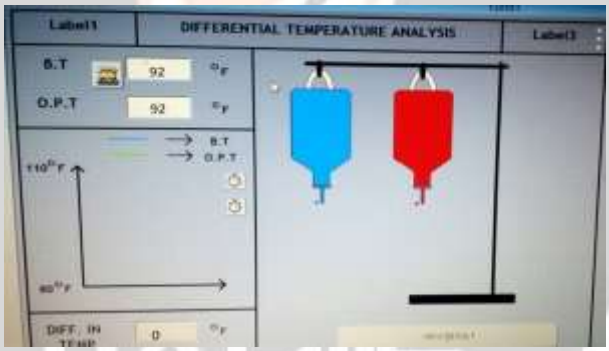

Fig-4 Hardware output when B.T=O.P.T

In this, the body temperature (B.T) and the operating temperature (O.P.T) will be equal. Hence, there will be no difference in the temperature. No saline or blood will be supplied to the person's body. The patient will be cooperating well to the operations done by the doctor.

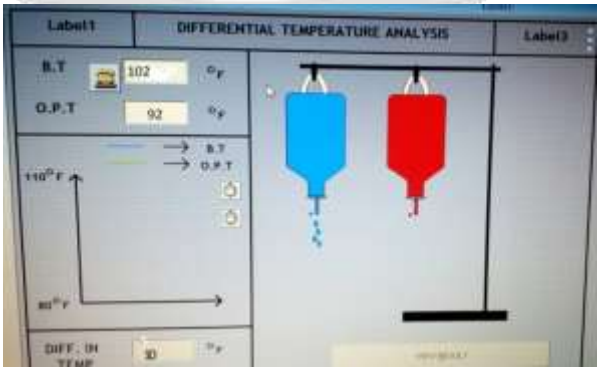

Fig-5 Hardware output when B.T > O.P.T

When body temperature (B.T) is greater than the operating temperature (O.P.T) the difference in temperature will be +10 this means than the human body should be supplied with the saline.

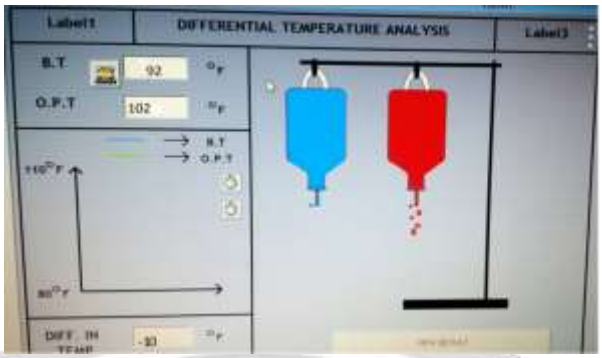

Fig-6 Hardware output when B.T < O.P.T

When body temperature (B.T) is lesser than the operating temperature (O.P.T) the difference in temperature will be -10 this means than the human body should be supplied with the blood.

9. CONCLUSION

Thus, this new methodology of using a pump and sensors will enhance the safety of the person undergoing any kind of operation. In this we use sensors made of platinum which is used to detect the patient's condition at every nanoseconds. Hence this will provide future source for the person's safety.

10. FUTURE ENHANCEMENT

The peristaltic pump is developed on bowel peristalsis by improving closing area rates and suction pressure measurement. An innovative transport system is required for this pump. Hence, bowel peristalsis can be used as a model for mechanism that can transport fluids, such as sludge with little water. We can develop a peristaltic pump based on the bowel mechanism by using an artificial rubber muscle, and confirmed its capabilities. In addition, we can develop new tube to achieve a perfect close of the tube, and confirm the basic characteristics of the new tube.

11. REFERENCES

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