Automatic Anaesthesia Regularization System

Rajeshwari. R, Sumithra.K, Kiruthika.S and Anusuya.M

Abstract - Nowadays, in surgeries, the anaesthesia is delivered manually. During this process, there is a chance to commit minute mistakes which may lead to lethal complications. During anaesthesia drug injection, the doctors should concentrate on the drug dosage, amount of drug, response of vital body parameters. The vital body parameters include temperature, blood pressure, heart rate. The incorrect dosage administration may cause lethal effects. To avoid this, the anaesthetist administers few millilitres of anaesthesia in a regular intervals of time to the patient. Thus, a microcontroller based automatic anaesthesia regularization system is developed. So that the adequate amount of drug is injected in optimum level, which ensures the patient safety. The drug is delivered depending on the sensors output.

Keywords - Microcontroller, Stepper motor, Heartbeat sensor, Temperature, Syringe.

1. Introduction
Whenever a major surgery happens, the patient need made to be in an unconscious condition, so that the patient cannot feel the pain during operation. So that the anaesthesia plays a major roll. During surgery, the anaesthetist regularly monitors the patient and administer anaesthetic drugs or gases to the patient. The patient’s vital body parameter such as the heartbeat, blood pressure, glucose level of the blood and body oxygen level are to be monitored throughout the surgery [1]. If in case, there is any major variation in the parameters then it should alert the doctors. In some of major surgery, which takes around 4 to 5 hours, the complete dose of anaesthesia cannot be administered in a single attempt to the patient. If it done so, the heavy dose will lead to many complications. So that all these errors can be drastically reduced by this automatic anaesthesia regularization system. In medical industries, the embedded systems are majorly used [2]. The system is designed using microcontroller to control anaesthesia levels during drug injection. Microcontroller is used in this system, which regulates the anaesthesia injection depending on the vital body parameters like heart rate and body temperature [3]. The optimal heart rate ranges between 60 and 100 beats per minute for human. The normal body temperature for human lies between 97F and 99F, the sensors continuously monitors the range. If there is any abnormality, the message is displayed in the LCD, an alert is generated and the drug injection stopped. Initially, the supply is given to the kit [4]. And it asks the patient to place the finger on the heartbeat sensor, so that the heart rate of the patient is calculated. Simultaneously, the body temperature is also measured. Both the temperature and the heart rate are feed to the microcontroller [5]. If there is any abnormality in the temperature and heart rate the system stops and the alarm is generated. In normal condition, the microcontroller runs the stepper motor which is attached to a syringe. The syringe is already filled with the required ml of anaesthesia [6]. Thus, the stepper motor regulated the drug injection via syringe. Thus, the drug is injected automatically and effectively [7].

2. Method
In this system, the microcontroller regulates the drug injection speed and amount depending on the vital body parameters, which are measured using the sensors [8]. If the heart rate is low then the message will be displayed as “Low Heart Rate”. This is the same for high heart rate and also for temperature [9]. The syringe is attached to the stepper motor, so that whenever the motor runs, the drug which is filled in the syringe is injected. Throughout the process, the sensors will continuously monitor the body parameter [10]. The system stops when the whole drug is delivered or if there is any abnormality in the body parameters.

3. Working Technology
The AC supply is given to the transformer, which then converts AC to DC and it is been supplied to the two sensors [11]. The heart rate and temperature are monitored continuously and the values are displayed in the LCD. The output of the sensors is given as the input to the microcontroller. The relay is also connected to the microcontroller. The LCD and the buzzer are the two outputs of the microcontroller [12]. On the other hand, the motor runs with the help of relay and battery. The motor is finally connected to the syringe which delivers the drug depending on the rotation speed of the motor and the sensors output [13].

4. Materials and Methods

Microcontroller
PIC 16F877A is the microcontroller we used here. It is a 40 pin 8-bit microcontroller [14]. It has an inbuilt memory, CPU and ADC. Analog to digital converter is used to amplify the signals and fed to the microcontroller. This microcontroller consists of three memory blocks as shown in Figure 1.
Separate buses are allotted for program and data memory. One more memory is allocated for additional information [15]. The data memory is about 368 bytes used by the RAM and data EEPROM memory is about 256 bytes as shown in Figure 2.

**Heart rate sensor**

The optimum heart rate is between 60 and 100 (beats per minute). The unconscious patient heart rate would be below normal heart rate. At that time the motor runs and led display denotes the patient is awake [16]. The buzzer is alarmed and drug injection stops at abnormal condition. The heart beat sensor works in the principle PLETHYSMOGRAPHIC TECHNIQUE. It consists of infrared sensor transistor and infrared transmitter LED. LED in the sensor transmits the light to the finger of the patient [17]. The heart beat sensor is portable and is placed in the finger. On the other side, there is a phototransistor which receives the light rays and at the finger artery. The output is calculated in the form of pulses and connected to the PIC16F877A microcontroller [18]. In order to obtain the heart rate, the microcontroller counts the total number of beats that is the pulse rate. The output of the heart beat sensor is connected to the LCD display. In LCD heart rate is displayed in beats per minute as shown in Figure 3.

**Temperature sensor**

The body temperature is one another vital body parameter. This temperature is measured using LM35 temperature sensor. LM 35 is a linear integrated sensor whose produced voltage is proportional to the body temperature. Single power supply is enough for the temperature sensors [19]. LM 34 sensor operates from 4 to 30 volts. Temperature is calibrated in Kelvin. There are three wires connected to the circuit board. The output is displayed in the LCD as shown in Figure 4.

**Stepper Motor**

Stepper motor is a digital input-output device. The output of the microcontroller is connected to the stepper motor.
The dc input is given to the stepper motor which converts the input to the square wave [20]. The square wave in turn drives the individual motor windings to run the motor. Stepper motor run about 1.8 degrees per step, which denotes there is a 200 steps per revolution. The stepper motor runs effectively so that syringe pump delivers the injected drug correctly to the patient as shown in Figure 5.

Fig. 5: Stepper Motor

Syringe

Syringe (10ml) is used to deliver the amount of injected drug accurately and in a precise manner. Infrared is connected to the syringe pump in order to detect any air bubbles. If there is a presence of air bubbles inside the syringe pump, it will give an alarm. The syringe pump delivers the amount of injected drug to the patient continuously. If there is any abnormality is detected, the syringe pump stops the injection of anaesthetic drug immediately.

Anaesthetic drug (Lidocaine)

- Other name: Lignocaine
- Used with or without adrenalin(epinephrine)
- With epinephrine: for numbing, to decrease bleeding, make numbing effect last longer.
- Route of injection: intravenous, subcutaneous, topical, by mouth.
- Action within 1.5 min.
- 10 min to 20 min (IV), 0.5hr to 3hr(local) is the duration.

Time calculation

- \( t = 3 \text{ms} \times 2000 = 6000 \text{ms} = 6 \text{s} \).
- 1cc of drug injection takes 6sec.

Speed calculation

- 0.17 cc per s is the average speed to inject 1cc.

Frequency calculation

- \( F = \frac{1}{t} \)
- \( = \frac{1}{3 \text{ms}} = 334 \text{ Hz} \).
- \( F = 334 \text{ Hz} \) is the max frequency for step motion.
- \( F = 100 \text{ Hz} \) is the min frequency for step motion.

5. Conclusion

Thus, the system automatically injects the drug, not only the anaesthetic drug, but also can inject other prolonged trips. It is a kind of robot. The injection of lidocaine drug without epinephrine results in reduced of Blood Pressure and Heart rate. This is because of the vasodilative effect of lidocaine. But this method cannot measure other parameters like blood pressure, blood loss during surgery, which may also lead to changes in body parameters.

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