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ANESTHESIA CONTROL SYSTEM WITH MULTI SENSOR USING ARDUINO

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Abstract: For any operations, the patient being in an anesthetic condition is must. The patient won't feel any pain during the medical procedure using anesthetics. The impact of the anesthesia should be there how long the operation goes and for that, the specified time intervals are administered. What happens if it is not administered at that particular time interval? It will be creating serious health problems and to overcome such unfavorable situations this project has been designed to develop an automatic anesthesia controller using Arduino Uno. The anesthetist can set the amount of anesthesia to be given to the patient. Using the switch panel, the anesthetist can start the process and once the start signal is received by the Arduino Uno it controls all the system, sends a signal to the motor driver to switch on the motors and start infusing the anesthesia. A minimum amount of anesthesia will be injected to the patient body, while doing this the heartbeat will be monitored. After administration it will check whether the heartbeat count is normal or not. If normal, then the second dose of the medicine will be injected. If the heartbeat shows any abnormality then the administration will be stopped and will notify the doctor and continue only after everything becomes normal. Additionally, temperature parameters are checked by corresponding sensors. The keypad switch is also used in case of any urgent manual operation that can be controlled by keypad.
Keywords: Arduino; infusion; control;anesthesia; sensors.

INTRODUCTION

A patient must be anesthetized before any major surgery by the doctors to start their surgical procedure. In case of major surgeries which could take upto 4 or 5 hours, the complete dosage of anesthesia could not be administered in single dose to patient. Since excess dose may cause critical condition to the patient which could lead to permanent unconsciousness. To overcome this problem, the anesthetist need to designed automatic direction of anesthesia based on clinical parameters of patient to minimize future side effects. Anesthesia is very much essential to carryout painless surgery so an automatic direction of anesthesia is essential for a successful surgery. At present in clinical practices an anesthetist employs manual system of anesthesia administration to the patient. This may originate many complexities such as, dose of anesthesia getting varied and chances of getting adverse side effects in future life. Moreover anesthetist may fail to administer the accurate dose of anesthesia for the period of the predestined time which might be disturbed the patient during surgical procedure. The anesthetic processes are recurring and require keen attention of the anesthetist. The incidence of error is drastically reduced due to automatic mechanism of drug administration. In this context, there is a need to automate the processes related to anesthesia to minimize human error, disturbance from routine repetitive activities could be minimized and anesthetist may have more time to take direct care to patient. Now a day's embedded system is used in many applications in medical industries to control various biological and biomedical parameters.

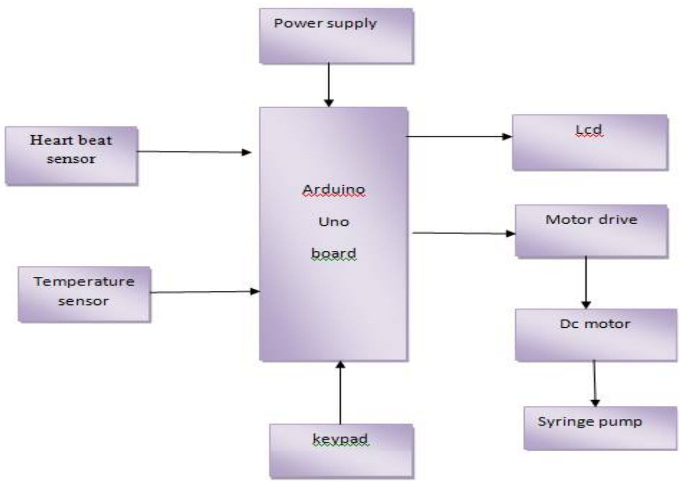
Arduino is used to regulate the anesthesia machine automatically depending upon the various clinical parameters such as body temperature, heart rate. The system decides the direction of rotation of the DC motor. The rotary motion of the DC motor initiate the Syringe Pump to move in forward and backward direction and the anesthesia supplied in the syringe is injected to patient's body. Embedded based systems are applied in many applications in medical field for controlling various biomedical signals, biomedical parameters and monitoring patient's health. The main aim of this project is to control the drug injection speed depending upon the patient's state during the surgical procedure. The main reason for automating is the administration of anesthesia is to relieve the anesthesiologist so that they can dedicate their attention to other tasks as well fluid balance, ventilation, drug application etc thus to increase the patient's safety. The dosage given manually by doctors at times may vary from its standard value and result in ill effects on the patient. In order to achieve efficient injection of anesthesia by automatic anesthesia controller, the heart beat sensor plays an important role which takes into account the heart rate of the patient and injects anesthesia accordingly and reducing the work of the doctors. The mode switch is used for emergency manual operation that can be controlled by keypad.

Methods

In the present proposed system, the mode switch is added for dual operation. The arduino uno based system is used for injecting the drug to maintain the level of anesthesia administered to the patient. The dose of anesthesia must be known in advance, as a predefined value is programmed as input for the anesthetic control. The actual dose of anesthesia is predetermined based on the body parameters of the patient. The arduino uno is programmed using embedded system to regulate the dose of anesthesia.

Anesthesia control system

Block Diagram



Fig,no.1.1 block diagram

Hardware Requirements

1) Arduino uno.
2) LCD.
3) Motor driver.
4) DC motor.
5) Heart beat sensor.
6) Respiration sensor.
7) Temperature sensor.
8) Syringe pump.
9) Keypad.

Arduino Uno

The Arduino uno is an open-source microcontroller board based on microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins. The board has 14 Digital pins, 6 Analog pins, USB connector, Power port, Microcontroller, Reset Switch, Crystal Oscillator, USB interface chip, TX RX LEDs.

LCD: LCD (liquid crystal display) is the technology used for displays in electronic gadgets and other smaller computers. LCDs allow displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED. There are two types of LCD, they are active matrix LCD and passive matrix LCD.

Fig.no.1.2 LCD diagram

A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently, improving the screen refresh time. Some passive matrix LCD's have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology. However, active matrix is still a superior technology.

Motor driver (L293D)

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off.

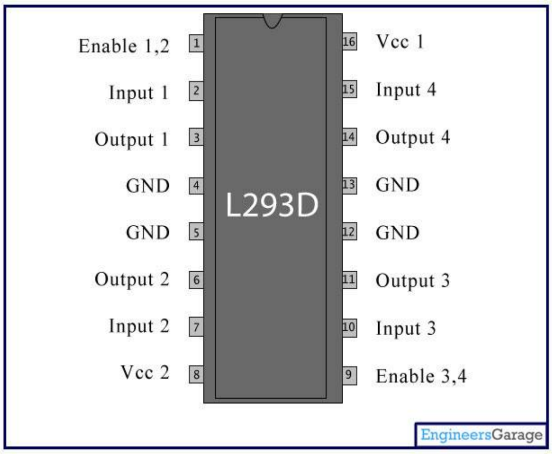


Fig.no:1.3 Motor Drive diagram

DC Motor

A **DC motor** is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but lightweight brushed motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles or in drives for steel rolling mills.

Heart beat sensor

The heart beat sensor is made to shine an infrared led through patient's finger.

Fig.1.4.Heart beat sensor

The infrared sensor on the other side can pick up slight changes in the light transmittance through finger when blood is pumped. The device composts of an infrared (IR) transmitter LED and an infrared sensor phototransistor. The transmitter sensor is clipped on any one of patient's finger. The fixing position of the heart beat sensor is displayed in Fig.1.4. The LED bombards infrared light to the finger of the patient. The phototransistor detects the light rays and calculates the change of blood volume from the finger artery. The signal in the form of pulses is amplified, filtered and finally fed to the arduino uno for display. The arduino uno counts the total number of pulses over a defined time interval to obtain the heart rate of the patient. Several readings are received over a specific period of time to get mean accurate reading of heart rate. The calculated heart rate is displayed on LCD in beats per minute using the following format: Rate is equal to nnn bpm where, nnn is an integer between 1 and 999.

Temperature sensor

LM35 temperature sensor is employed to detect the body temperature in the present study. The LM35 series are accuracy integrated circuit temperature sensor, output voltage is linear proportional to the temperature in Celsius (Centigrade). The LM35 devices have advantage over linear temperature sensors calibrated in degree Kelvin. The LM35 does not need external calibration to provide typical accuracies of ± 1/4° C at room temperature and ± 3/4° C over temperature range of from −55 to +150°C.

Syringe Pump

Syringe pump can be used in almost any application that involves precise metering, especially at the micro- and nano scale. They are used in many research fields as precise dosing systems or to accurately deliver small quantities of reagents, mix miniscule volumes, and add traces of specific chemicals over the course of the experiment. Syringe pump can be used for scale-up, new material development, and materials characterization in chemical, pharmaceutical, catalysis, and materials science research. They can also play a major role in minimizing errors. Syringe pumps can also facilitate precise infusion in medical and biological research.

Keypad

In this control system, we use mode switch that consists of dual operation i.e. automation mode and manual mode. This switch is controlled by keypad.

Working

Arduino Uno board is the main controller of this project. To the analog inputs heartbeat, respiration and temperature sensors are connected. Heartbeat sensor will give the heartbeat per minute of the patient. The patient will wear the sensor on his finger. It consists of a light detector and an LED. The light intensity variation arises whenever heart pumps the blood. This variation is converted to an electric pulse. The number of pulses generated per minute will give the heartbeat per minute. Simultaneously, the parameters like body temperature and respiratory rate are sensed by respective sensors. These values are given as inputs to the Arduino board. A minimum value for the anesthetic dosage has been set which can be altered using the increment and decrement buttons provided in the board. The values of the heartbeat count and the dosage cycle remaining will be displayed in the LCD. Whenever the situation arises, the administer provide anesthesia by pressing the start button, the DC motor turn on which in turn is connected to a syringe pump that will start injecting the anesthetics. The DC motor is driven by a motor driver L293D. The motor can be driven in bi-directional i.e. forward and backward directions. If the parameters counts get abnormal, the anesthesia administration gets hindered until it reaches the normal value. The mode switch is used for emergency manual operation that can be controlled by keypad. Seconds, it was intimated as abnormal condition and the pump infused according to the programmed condition. The Normal Condition Heart Beat rate and Abnormal Condition of Heart Beat rate was already programmed.. The utilization of Automatic Anesthesia control System increases patient's safety and comforts the anesthesiologist by providing direct attention to other physiological variables under his control. This helps to protect the environment by using optimum anesthetic agent and cost effective operation. The proposed system calculates the initial dose of drugs to be injected to the subject thereafter the essential parameters of the patient are continuously monitored by the device. If any parameters deviate from the normal range at any moment during the surgical procedure, the system recalculates the required dosage of the anesthesia and the same must be injected by using infusion mechanism. The mode switch is also used in case of any urgent manual operation that can be controlled by keypad.

CONCLUSION

Modern Technologies have developed automation in every sphere of biomedical instrumentation. This project is also based on automation drug regulation system will be very much useful to surgeon to check the current position of anesthesia so that the proper anesthesia will be injected to patients. PREVENTION IS BETTER THAN CURE but PROTECTION IS INTELLIGENT THAN PREVENTION AND CURE. This project on automatic anesthesia regularization system is one of the efficient protecting systems in medical industries. This system is very useful to the anesthetists who monitor the particular parameter for the patient and regularize the anesthesia.

This module can be connected the anesthesia ventilator for future implementation. They can also connect with the EEG parameters for major operations. Advantages of using the proposed system are physical presence of anesthetist is not always required, the required level of anesthesia is exactly calculated and administered so that future side effects due to variations in anesthesia levels are eliminated.

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