Anesthesia Regularization using Heart Beat Sensor

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Abstract:
In the hospitals when any major operation is performed, the patient must be in anesthetize condition. If the operation lasts for a long time, say for suppose for 4 or 5 hours, complete dose of anesthesia cannot be administered in a single stroke. It may lead to the patient’s death. If lower amount of anesthesia is administered, the patient may wakeup at the middle of the operation. To avoid this, the anesthetist administers few milliliters of anesthesia per hour to the patient. If the anesthetist fails to administer the anesthesia to the patient at the particular time interval, other allied problems may arise. To overcome such hazardous problems the design of an automatic operation of an anesthesia machine based on a micro-controller is effective. In general, Anesthesia provides depression on Central Nervous System of patient to lose his consciousness and ease to further treatment. Local anesthetic affects sensation at the applied region and aids to surgical operation performed. To maintain the anesthesia levels considering the patient’s health anesthesiologist works as multi task feedback controller to regulate drugs titration. In Automatic Anesthesia Controller, anesthesia levels are controlled as well as feedback is regulated by microcontroller considering the physiological parameters of patient especially including heart beat. Automatic Anesthesia Controller designed of microcontroller aids in controlling anesthesia levels during surgery, Heart Beat Sensor to calculate heart rate of patient and mechanical arrangement of syringes for the provision of anesthesia to patient. In this system a keypad is provided along with the microcontroller and syringe infusion pump. The anesthetist can set the level of anesthesia in terms of milliliters per hour to administer anesthesia to the patient with the help of keypad. After receiving the signal from the keypad, the microcontroller controls the signal to the desire level and fed into the DC motor to drive the infusion pump in proper manner. The anesthesia is administered to the patient according to the DC motor rotation (the syringe will move forward or backward direction). This particular module will be very much useful to physicians to see the current position of anesthesia of the patients. If the level of anesthesia is decreased to lower level (set value), the alarm will be initiated to alert the physician to refill the anesthesia in the Syringe Pump to continue the process. On the basis of heartbeat of the patient the required amount of anesthetic drug will be injected accordingly as per the normal and abnormal ranges. It can also use to measure body temperature of patient.

Keywords: Anesthesia, Drug titration, Heart beat sensor, Microcontroller, Syringe Pump.

INTRODUCTION

Major operations are performed to remove or reconstruct the infected parts in the human body. These operations will lead to blood loss and pain. Therefore it is necessary to arrest the pain and the
blood loss. Anesthesia plays an important role in the part of painkilling. AAI can be defined as “Automatic administration of anesthesia based on the bio-medical parameters of the patient, eliminating future side effects and the need for an anesthetist.” Anesthesia is very essential in performing painless surgery and so an Automatic administration of Anesthesia is needed for a successful surgery.

At present anesthetist controlled manual operation is employed, which may cause many difficulties such as, Level of anesthesia may get varied and there is a chance of getting side effects in future. If suppose the anesthetist fails to administer the level of anesthesia during the predetermined period, the patient may be disturbed during the operation. Other systems developed to administer anesthesia operates by sensing the consciousness level of the patient and not by measuring his overall body conditions.

Now days, embedded systems are used in many applications in medical field for controlling various biomedical parameters. In this design, a microcontroller is used for controlling the anesthesia machine automatically, depending upon the various biomedical parameters such as body temperature, heart rate.

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1. WORKING OF THE SYSTEM

By using the keypad provided along with the Microcontroller, the anesthetist can set the level of anesthesia to be administered to the patient in terms of milliliters per hour (1ml to 1000ml). After receiving the anesthesia level from the keypad, the microcontroller sets the system to administer anesthesia to the prescribed level. It then analyses various bio-medical parameters obtained from the sensors to determine the direction of rotation of the DC motor. The rotation of the DC motor causes the Infusion Pump to move in forward or in a backward direction and the anesthesia provided in the syringe is injected into the body of the patient.

Block diagram

Figure 1: Block diagram of microcontroller based anesthesia injector

2. MEASUREMENT OF BIO-MEDICAL PARAMETERS

The measurement of bio-medical parameters is a vital process. These parameters determine the overall condition of the patient. It plays a very significant process in the level of anesthesia that has to be administered to the patient; depending on these parameters the movement of the DC motor is determined. Transducers and Thermistors are the key links in all sensors designed to describe and analyze the bio-medical parameters. The transducers used here are just those that find applications in patient monitoring systems and experimental work on four parameters namely, temperature, heartbeat. Both transducers and thermistors are made in a wide variety of forms.
suitable for use in medical applications. They are available as Wafers for applying on the skin surfaces.

3. HARDWARE IMPLEMENTATION

It comprises of detailed information about the set of design specifications. The hardware design consists of the selection of system components as per the requirement, the details of subsystem that are required for the complete implementation of the system and full hardware schematic for the PCB layout. In the later stage design of the circuit and its testing has been carried out. It involves the components selection, components description and hardware details of the system design.

1) Component selection.
2) Hardware details of the system designed.

3.1 COMPONENT SELECTION:
The automatic anesthesia injector based on a micro-controller includes the following components:

1) Power supply
2) Heart Beat Sensor
3) Temperature sensor
4) Microcontroller (ATMEGA16)
5) Liquid Crystal Display (16*2)
6) GSM Module
7) L298 Motor Drive IC
8) DC Motor

3.2 POWER SUPPLY SECTION:

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 the diode to Intel IC’s will work with a D.C. supply ranging from +5V to +15V.

We are utilizing the cheapest and the commonly available energy source of 230V/50Hz and Stepping down, rectifying, filtering and regulating the voltage. This will be dealt in the fourth coming sections.

3.1 STEP-DOWN TRANSFORMER:
When A.C. is supplied to the primary winding of the transformer it can be either step-down or step-up depending on the D.C. needed. In our circuit the transformer of 230V/0-5V are used to perform the step-down operation where a 230V A.C. appears as 5V across the secondary winding.

One alteration of the input causes the top of the transformer to be positive and the bottom negative. The next alteration will temporarily will cause the reverse. Apart from stepping down A.C. voltages, it gives isolation between the power source and power supply circuitries.
3.2 RECTIFYING UNIT:
In the power-supply unit rectification is normally achieved using a solid-state diode. Diode has the property that let the electron flow easily in one direction at proper biasing condition. As A.C. is applied to the diode, electrons only flow when the anode is positive and the cathode is negative. Reversing the polarity of voltage will not permit electron flow.
A commonly used circuit for supplying large amount of D.C. power is the bridge rectifier. Bridge rectifier of four diodes (4*IN4007) are used to achieve full wave rectification. Two diodes (D2,D4) will conduct during the negative half cycles and the other two diodes (D1, D3) will conduct during the positive half cycle.
A D.C. voltage appears across the output terminals of the bridge rectifier will be somewhat less than the 90% of the applied R.M.S. value. Normally in one alteration of the input voltage will reverse the polarities. Opposite ends of the transformer will always be 180 degrees out of phase with each other. For a positive cycle two diodes D1, D3 are connected to the positive voltage at the top winding and only one diode (D1) conducts.
At the same time one of two other diodes D2, D4 conducts for the negative voltage that is applied at the bottom winding due to the forward bias for that diode. In this circuit due to the negative half cycle, D1 and D2 will conduct to give pulsating D.C.
The D.C. output has a little frequency of 100 Hz. Since one alteration produces resulting output pulse frequency equal to (20*50 Hz). The output obtained is not a pure D.C. and therefore filtering has to be done.

3.3 FILTERING UNIT:
Filtering circuit which is usually capacitors acting as surge arrester always follow the rectifier unit. This is also called as decoupling capacitor or a bypassing capacitor, is used not to short the ripple with frequency of 120Hz to ground but also to leave the frequency of the D.C. to appear at the output.
A load resistor R1 is connected so that a reference to the ground is maintained. C1R1 is for bypassing the ripples C2R1 is used as a low pass filter that is it passed only low frequency signals and bypasses high frequency signals. The load resistor should be 1% to 2.5% of the load.

3.4 VOLTAGE REGULATOR (IC 7805):
General Description:
The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although, designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents. The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating. Considerable effort was expanded to make the LM78XX series of regulators easy to use and
minimizes the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

4 HEART BEAT SENSOR:

Heart beat is sensed by using a high intensity type LED and LDR. The finger is placed between the LED and LDR. As a sensor, a photo diode or a photo transistor can be used. The skin may be illuminated with visible (red light) using transmitted or reflected light for detection. The very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Various noise sources may produce disturbance signals with amplitudes equal or even higher than the amplitude of the pulse signal. Valid pulse measurement therefore requires extensive preprocessing of the raw signal. The new signal processing approach presented here combines analog and digital signal processing in a way that both parts can be kept simple but in combination are very effective in suppressing disturbance signals. The setup described here uses a red LED for transmitted light illumination and a LDR as detector. With only slight changes in the preamplifier circuit the same hardware and software could be used with other illumination and detection concepts.

Features:

- Output current in excess of 1A
- Internal thermal overload protection
- No external components required
- Output transistor safe area protection
- Internal short circuit current limit
- Available in the aluminum TO-3 package

5 TEMPERATURE SENSOR:

LM35 Sensor Datasheet and Circuit Schematic Overview

The LM35 sensor series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

LM35 Sensor Specification

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 sensor thus has an advantage over linear temperature sensors calibrated in °Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 sensor does not require any external calibration or trimming to provide typical accuracies of ±0.25°C at room temperature and ±0.5°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level.
The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C sensor is rated for a -40° to +110°C range (-10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D sensor is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

6 ATMEGA16 MICROCONTROLLER:

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

The basic architecture of ATMEGA16 consists of the following features:

- High-performance, Low-power AVR® 8-bit Microcontroller
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single-clock Cycle Execution
  - Up to 16 MIPS Throughput at 16 MHz
  - On-chip 2-cycle Multiplier
- Nonvolatile Program and Data Memories
  - 16K Bytes of In-System Self-Programmable Flash
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
  - Endurance: 100,000 Write/Erase Cycles
  - 1K Byte Internal SRAM
  - Programming Lock for Software Security
- JTAG (IEEE std. 1149.1 Compliant) Interface
  - Boundary-scan Capabilities According to the JTAG Standard
  - Extensive On-chip Debug Support
  - Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
Internal Calibrated RC Oscillator
- External and Internal Interrupt Sources
- Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby
- I/O and Packages
  - 32 Programmable I/O Lines
  - 40-pin PDIP, 44-lead TQFP, and 44-pad MLF
- Operating Voltages
  - 2.7 - 5.5V for ATmega16L
  - 4.5 - 5.5V for ATmega16
- Speed Grades
  - 0 - 8 MHz for ATmega16L
  - 0 - 16 MHz for ATmega16

Figure: Block diagram of ATmega16.
7 LCD (LIQUID CRYSTAL DISPLAY):

![LCD Display](image.png)

**Figure : LCD Display**

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD, each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

**CONCLUSION**

Nowadays, Modern Technologies have developed automation in every spears of Biomedical instrumentation this project is also based on the automation and this will be very much useful to physician to see the current position of anesthesia of patient so that the proper anesthesia will be injected to patient. Protection is intelligent than prevention and our project on automatic anesthesia injector is one of the efficient protecting system.

**ACKNOWLEDGEMENTS**

We express our sincere gratitude to our Guide, Head of The Department Prof. Ravi Varma. N for their valuable guidance.

We are thankful to our BIOMEDICAL ENGINEERING department for their cooperation, guidance & help from time to time. We thank all our friends for their help & cooperation.

Finally we also thankful to our Dr. Bhausheeb Nandurkar College of Engineering & Technology Yavatmal, for providing all required facilities & for constant encouragement.

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