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An IoT Based Monitoring and Automatic Administration of Anesthetics in Human Body

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Abstract— In this paper, we present a system that utilizes IoT technology to regulate anesthesia drugs by constantly and precisely monitoring three critical bodily indicators: heart rate, body temperature, and SpO2. The complete system comprises a microcontroller-based control system that reads and processes signals from the sensors. In the event that there are readings out of the ordinary for heart rate, SpO2, or body temperature taken by sensors monitoring a patient's vitals, an automated system immediately shifts its focus to adjusting servo motors in order to regulate the delivery of anesthesia drugs to align with current health conditions. The adjustment is made primarily due to abnormal readings being detected from these devices during continual check-ups on patients' bodily functions throughout their surgeries. The IoT network is supported by a cloud framework that allows specialists to monitor patient data in real time via Cloud. The patient's data is transmitted in real-time, along with the current state of drug administration for anesthesia. This information reaches the hospital cloud where it can be scrutinized by an expertly skilled anesthesiologist. If abnormal body temperature and heart rate are detected, the system immediately alerts concerned personnel, and anesthesia delivery is stopped until the patient's condition returns to normal. The approval process includes a thorough check of the system's effectiveness in simultaneously monitoring and controlling sedation. Ultimately, deactivating the mechanism can be accomplished through a physical switch that must be operated manually. In this project, we aim to automate the anesthesia delivery process and make it more efficient and cost-effective.

Keywords— Anesthesia, Heartbeat sensor, Temperature sensor, pulse oximeter, microcontroller, IoT cloud.

1. INTRODUCTION

Prior to any significant surgical intervention, anesthesia is administered to patients to help manage pain during the operation. Despite this, for procedures that may last as long as 5 or 8 hours on end, the entire quantity of anesthetic can't be administered to the patient at once. This is because a superfluous amount could bring about grave situations or even brain death. To address this issue, an automatic anesthesia control system is required to perform the surgery painlessly. Traditionally, an anesthesiologist employs a manual system of anesthesia administered to the patient, which can result in complexities such as a varied dose of anesthesia and adverse side effects in the future. Moreover, the anesthetist may fail to administer the accurate dose of anesthesia for the predestined time, leading to disturbances during the surgical procedure. To minimize human error and repetitive activities, an automatic mechanism of drug administration is needed. Currently, integrated systems are widely used in various medical applications to regulate diverse biological and biomedical processes. The latest approach involves a mechanism that utilizes small computing devices to control the anesthesia machine, taking into consideration various complex medical factors. such as temperature fluctuations, heart rate variability, along with oxygenation levels within blood circulation. The system investigates various clinical parameters obtained from the sensors to decide the direction of rotation of the servo motor. The commencement of the infusion pump's forward and backward motion is set in motion by the servo motor's rotational movement. As a result, anesthesia present within the syringe is dispatched into the patient's anatomy with precision. The main objective of the system is to control the drug injection speed depending on the patient's state during the surgical procedure. By using an automatic anesthesia controller, doctors can dedicate their attention to other tasks, such as fluid balance, ventilation, and drug application, thus increasing the patient's safety. The dosage given manually by doctors at times may vary from its standard value, resulting in ill effects on the patient. Therefore, the heartbeat sensor and temperature sensor play an important role in achieving efficient injection of anesthesia by taking into account the patient's heart rate and injecting anesthesia accordingly, reducing the work of the doctors.

2.PROPOSED SYSTEM

A. Aim

Ensuring a patient is under anesthesia is crucial during a surgical procedure. It guarantees the patient does not feel any discomfort while the surgery is ongoing. Monitoring biomedical parameters like body temperature and heart rate is also essential in this process. Administering anesthesia doses accurately and timely is critical as incorrect doses can have detrimental effects on the patient. This project aims to develop an automated anesthesia control system that will administer the appropriate doses of anesthesia while monitoring the patient's clinical parameters, such as heart rate and temperature.

B. Method

The proposed system utilizes a microcontroller-based approach to automatically administer a predetermined number of anesthesia doses to the patient at regular intervals. The desired amount of anesthesia is pre-programmed into the system as input. The microcontroller, embedded into the system, controls the amount of anesthesia to be administered. In addition, the vital signs of an individual including their pulse rate, oxygen saturation level in the blood, and overall temperature are constantly monitored by doctors. These biomedical parameters play an essential role as they help keep track of one's state of being. Based on the readings obtained from these sensors, the stepper motor is adjusted to administer the correct dose of anesthesia.

C. Hardware Used

Components used are

1. Microcontroller is used to control the overall operation
2. Temperature Sensor(LM35) is used to measure body temperature
3. Heart Beat Sensor to be used to measure heartbeat
4. Servo Motor to control the movement of the Syringe Infusion Pump
5. LCD Display to display the condition of the parameters.
6. Pulse Oximeter to measure blood oxygen level.
7. ESP8266 is a WIFI module used for enabling IoT connectivity in electronic devices.

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Brief about the components used:

1. Microcontroller - The AT89S52 is a high-performance CMOS 8-bit microcontroller that operates with low power consumption. It has 8K bytes of in-system programmable Flash memory and utilizes Atmel's high-density non-volatile memory technology. Additionally, the device is designed to be compatible with the 80C51 instruction set and pinout, which is a widely used industry standard.

2. Temperature Sensor (LM35) - The LM35 sensor belongs to a series of highly precise IC temperature devices. It produces an output voltage that varies linearly with changes in the temperature, measured in degrees Celsius. The sensor is designed to operate without any external calibration and has an average accuracy of ± 1/4°C at room temperature.

3. Heart Beat Sensor - The heartbeat sensor uses an infrared LED to shine light through the patient's finger and an infrared sensor phototransistor on the other side to detect changes in light transmittance when blood is pumped. The pulse signal is sent to the microcontroller for display, which determines the heart rate by counting the total number of pulses over a set time interval. Multiple readings are obtained to obtain a more precise heart rate reading.

4. Servo Motor - A servo motor is a type of electric motor that uses feedback control to precisely position its output shaft. Frequently utilized in the field of robotics, automation, and other similar fields that necessitate precision as well as speedy motion management. The servo motor has a small size and high torque output, making it ideal for use in tight spaces and in applications where precise positioning is essential.

5. LCD - LCD stands for Liquid Crystal Display. A kind of flattened panel exhibit is oftentimes employed in electronic gadgets like televisions, computer displays, and mobile phones. The application of liquid crystals in the creation of images on LCD screens is achieved utilizing manipulation whereby light can either be allowed through or blocked.

6. Pulse Oximeter - A pulse oximeter is a non-invasive medical device used to measure the oxygen saturation level in a person's blood. It works by shining a light through a person's finger or earlobe, and then detecting the amount of light that is absorbed by the oxygen-carrying proteins in the blood. The device then displays the oxygen saturation level and the person's pulse rate. Pulse oximeters are commonly used in hospitals, clinics, and by individuals with respiratory conditions to monitor oxygen levels.

7.ESP8266 - In the wide-ranging domain of Internet-connected electronic devices, there exists a highly acclaimed and widely implemented Wi-Fi microcontroller unit (MCU) recognized as ESP8266. The ESP8266 is an elaborately designed microcontroller (MCU) that effectively combines low power consumption, affordability, and optimal integration. This innovative device includes a pre-installed Wi-Fi module, making seamless wireless network connectivity possible while enabling easy internet communication with other devices in close proximity.

D. Mechanism:

Perform a simulation of the AUTOMATIC ANESTHESIA CONTROL SYSTEM. This simulation requires the input of the number of doses to be administered. The initial dose will be injected automatically by the system. Subsequently, the system will constantly monitor the patient's condition by checking the signals from the sensors. The next dose will be injected if the heartbeat is within the normal range. However, if the heartbeat is abnormal, the system will alert the doctor by displaying a message on the LCD screen. This process will continue for the specified number of doses until the system completes its task.

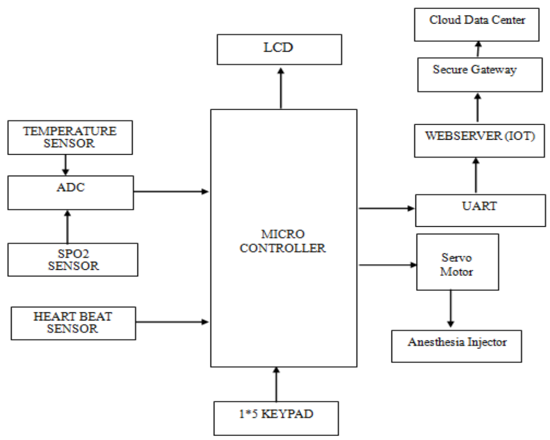

Fig. 1. The block diagram of the proposed model

E. Working

The main controller of the project is the Microcontroller. Connected to the board's inputs are three distinct sensors: those that measure heartbeat, pulse oximetry, and temperature. The heartbeat sensor is placed on the patient's finger and measures the patient's heartbeat per minute by detecting light intensity variation caused by blood pumping. This sensor consists of an LED and a light detector, and the number of pulses generated per minute indicates the heartbeat per minute. The other sensors measure the patient's body temperature and respiratory rate. The Arduino board has buttons for incrementing and decrementing the minimum anesthetic dosage value, which can be modified as required. The LCDs the patient's heartbeat count and the remaining dosage cycle. As soon as the button designated for initialization is engaged, a Servo motor comes to life and synchronizes with an accompanying syringe pump in order to administer anesthetic medicine. The motor can operate in both forward and backward directions. If any of the observed metrics deviate from their typical bounds, proceedings involving anesthesia are ceased until they have been returned to customary levels. In the event of contingencies, keypad-controlled manual operation is made possible by the mode switch. The system is programmed to recognize both normal and abnormal heartbeat rates. The Automatic Anesthesia Control System ensures patient safety by continuously monitoring their physiological variables and recalculating the required anesthesia dosage as necessary. This results in the use of the optimal anesthetic agent and a cost-effective operation. In synopsis, the purpose of the above system is to automatically monitor the patient's physiological variables continuously and guarantee that the anesthesia dosage is appropriate. This method enables the anesthesiologist to direct their attention to other critical aspects of the surgery, while the system takes charge of the patient's anesthetic needs.

F. The following requirements are met by the program:

1. The program should read input from the microcontroller's keypad.

2. The program should verify the correctness of parameter values and trigger the system's alarm when the anesthesia level drops.

3. The internal timer should be activated to interrupt the AT 89S52 whenever it overflows.

It is crucial to measure certain indicators of one's physical state, including pulse rate, level of oxygen saturation in the blood, and overall body heat at designated time periods.

5. The servo motor movement should be calculated based on sensor-provided parameters by adjusting the speed up or down.

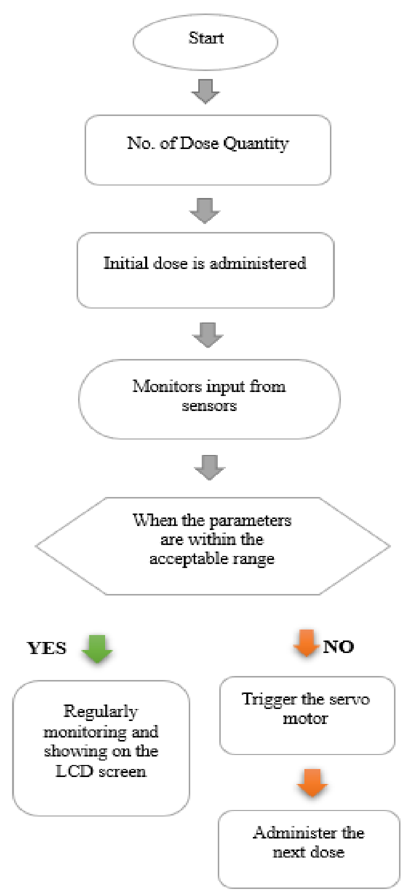

Fig. 2. Flowchart of the working model

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3.RESULT AND EXPERIMENT

The system under consideration requires the anesthesiologist to input the number of doses, and it monitors parameters such as heart rate, Blood oxygen level, and temperature. The servo motor's movement is dependent on the above body parameter conditions. Provided that the physical indicators are deemed satisfactory, the motion of the stepper motor will ensue, and this outcome shall be visually illustrated on the liquid crystal display monitor. In the event that the body vitals fall below or above the acceptable range, the servo motor will rotate, and a warning message will appear on the LCD screen, alerting the user via the IoT cloud.

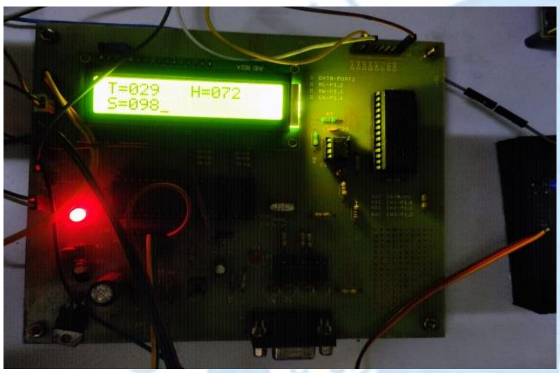

Fig. 3. Displaying the monitored body vitals on LCD

4. CONCLUSION

The primary aim is to design a system that can continuously observe the crucial metrics of an individual's physiological state and dispense the precise dosage of anesthesia at prescribed intervals. This technique intends to offer additional assistance for anesthesiologists in executing their responsibilities with greater effectiveness and security, while not endeavoring to supplant them. The system boasts high accuracy and responsiveness, making these parameters essential in assessing the patient's overall health. If the vital signs fall below the desired level, the microcontroller and motor actions are used to automatically control the anesthesia dosage. The syringe infusion pump is connected mechanically to the motor, and the precise amount of anesthesia required is calculated and administered to eliminate future side effects that may occur as a result of variations in anesthesia levels. With the aid of a secure record-keeping system and IoT technology, data can be effectively monitored to ensure its safety.

A. Advantages

a) The proposed system has the advantage of not requiring the physical presence of an anesthetist during surgery to monitor the administration of anesthesia doses.

b) This eliminates the possibility of human error, thereby increasing precision.

c) The system measures biomedical parameters, which are crucial in determining the patient's overall condition.

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6. SCOPE FOR FUTURE WORK

To further develop this project, one could consider taking inputs for static parameters of the patient, such as age, weight, and medical history. These inputs could be used to calculate the appropriate anesthesia doses required for different modes of surgery. The calculated dosage values could then be stored in a database, allowing for easy retrieval and use during future surgeries. Such capability would further allow the system to deduce the appropriate quantity of administered medication necessary in accordance with a given medical procedure, thus mitigating any need for manual computations and elevating overall efficiency. The development of such a system would improve patient safety, and accuracy, and reduce the workload for medical staff.

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