WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Review of Anaesthesia Machine Control using Raspberry Pi

Ravi Kumar M[1], Shyam Sundar G [2], Ashwit[3], Sumera N [4] and Chaitra S V[5]

[1,2]Assistant Professor, Department of Electronics and Communication Engineering, Cambridge Institute of Technology (CI Tech), Bengaluru, India
[3,4,5] Student, Department of Electronics and Communication Engineering, CITech, Bengaluru, India
DOI: https://doi.org/10.55248/gengpi.5.0324.0829

ABSTRACT

This study suggests a method for using the Raspberry Pi, an inexpensive, multipurpose microprocessor, to operate anesthetic machines. In order to precisely provide anesthetic gases and vapors to patients during surgical procedures, anesthesia machines are essential medical equipment. Customization and integration with contemporary healthcare systems are frequently restricted by the proprietary hardware and software used by traditional anesthetic machines. Through the utilization of Raspberry Pi's capabilities, we offer an adaptable and economical approach to control anesthetic machines. Our system makes use of sensors to keep an eye on critical factors including oxygen content, pressure, and gas flow rates. It then provides real-time feedback to guarantee precise anesthetic delivery. By analyzing this data and modifying the machine's settings accordingly, the Raspberry Pi maximizes patient comfort and safety .Moreover, our methodology facilitates smooth integration with electronic health records.

Keywords: Anesthesia, Raspberry Pi, Heartrate, Temperature, SPO2, Body Wetness, infusion.

Introduction

Modern healthcare relies heavily on anesthetic equipment to ensure the safe and efficient administration of anesthesia during surgical procedures. To maintain patient sedation and critical functions, these machines are outfitted with advanced hardware and software that controls the flow of anesthetic gases and vapors. However, proprietary systems that restrict modification, flexibility, and compatibility are frequently included with traditional anesthetic machines. A rising number of people are interested in investigating alternate approaches to anesthetic machine control that make use of open-source platforms like Raspberry Pi. A low-cost and adaptable microcontroller option that can interface with a variety of sensors and peripherals is provided by Raspberry Pi. The Raspberry Pi's power can be used to create control systems for anesthetic machines that are programmable.

Methodology

The system uses moist sensors (co2), the temperature sensor, humidity sensor (DHT11), heart rate sensor (MAX30102), and spo2. Everything is considered a parameter. The Raspberry Pi is linked to these sensors. The sensor sends data to the Raspberry Pi when the power supply is on, and the Raspberry Pi uses the built-in wifi module to transfer the data to the ThingSpeak cloud using ThingSpeak's API credentials. Using API keys, the channel data in ThingSpeak is exported to the website, and the trained model is implemented for prediction on the website.

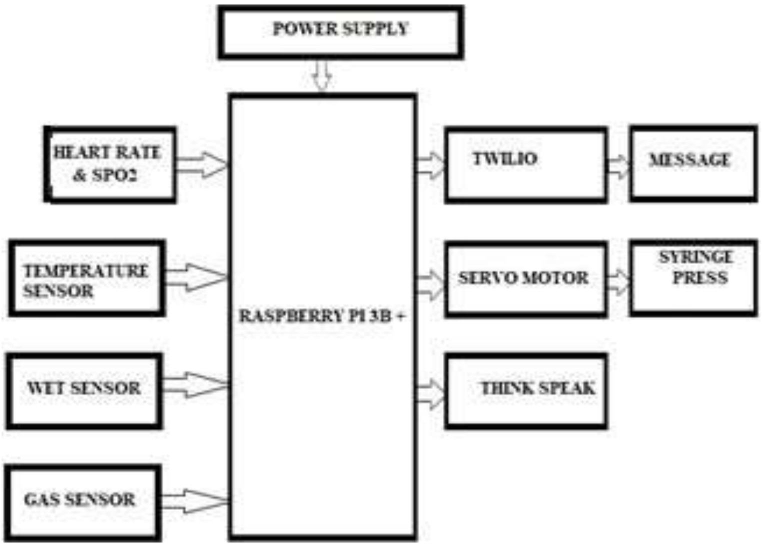

Fig 1: Block diagram

Literature review

[1] Amir Supriyanto, Rani Anggriani, Sri Wahyu Suciyati, "Syringe Pump Based on Arduino for Electro spinnerApplication", Journal of Physical Science, 2021

In this research, a control system in the form of a syringe pump has been developed to control the volume and flow rate of a liquid or a solution. The syringe pump is fabricated by controlling the speed and pulse width modulation (PWM) of stepper motors based on the Arduino Uno microcontroller board. The tools used are a stepper motor as a syringe driver, the Arduino Uno as a controller, a four-digit seven-segment display and a keypad matrix as an input interface. The syringe pump works by pushing the injection pump whose speed has been adjusted to the flow rate. The speed of the flow rate and volume are obtained by setting the delay time of the stepper motor using PWM pins from the Arduino Uno. The syringe pump is observed to work in the flow rate range of 0.10–12.00 ml h–1. The system can be applied to medical settings as the control of volume and flow rate of drug fluids as well as with nanofibres using electrospinning technique.

[2] HanumantR. Vani, Pratik V, Makh, Mohanish&Chandurkar. K Anesthesia Regularization using Heart Beat Sensor International Journal Of Engineering, Education And Technology (ARDIJEET), 2 (1), 2014, 1 – 9.

The administration of high/low dose of anesthesia during surgery may cause lethal effect to the patient. To avoid such situation, the anesthetist administers few milliliters of anesthesia at regular intervals to the patient. To overcome such tedious problems, this project aims to design an effective microcontroller based automatically operated anesthesia machine. In the proposed Automatic Anesthesia Regularization System, anesthesia level is controlled by multi-task feedback and microcontroller system, based on patient condition. The Automatic Anesthesia Controller designed using microcontroller aids to control anesthesia levels during the course of surgery. Mechanical syringe infusion pump is provided to deliver an-esthesia to the patient. The anesthetist can set the keypad to administer the dose of anesthesia in terms of milliliters per hour. The keypad transmits the analog signal to the microcontroller to control the required dose of anesthesia to be fed into DC motor to operate injection pump. The anesthesia was administered based on patients body condition and movement of syringe in the forward or backward direction based on the rotation of DC motor. This module will play a major role in the field of medicine and useful to the physicians during major surgery to provide the desire amount of anesthesia.

[3] Misal US, SA Joshi, & MM Shaikh, Delayed recovery from anesthesia: A postgraduate educational review. Anesthesia Essays Res.10 (2), 2016, 164 - 172.

Delayed awakening from anesthesia remains one of the biggest challenges that involve an anesthesiologist. With the general use of fast-acting anesthetic agents, patients usually awaken quickly in the postoperative period. The time to emerge from anesthesia is affected by patient factors, anesthetic factors, duration of surgery, and painful stimulation. The principal factors responsible for delayed awakening following anesthesia are anesthetic agents and medications used in the perioperative period. Nonpharmacological causes may have a serious sequel, hence recognizing these organic conditions is important. Certain underlying metabolic disorders such as hypoglycemia, severe hyperglycemia, and electrolyte imbalance, especially hypernatremia, hypoxia, hypercapnia, central anticholinergic syndrome, chronic hypertension, liver disease, hypoalbuminemia, uremia, and severe hypothyroidism may also be responsible for delayed recovery following anesthesia. Unexpected delayed emergence after general anesthesia may also be due to intraoperative cerebral hypoxia, hemorrhage, embolism, or thrombosis. Accurate diagnosis of the underlying cause is the key for the institution of appropriate therapy, but primary management is to maintain airway, breathing, and circulation. This comprehensive review discusses the risk factors, causes, evaluation and management of delayed recovery based on our clinical experience, and literature search on the internet, supported by the standard textbooks of anesthesiology.

[4] Collins V. J. "General Anesthesia Fundamental Considerations", 3th Edition, Philadelphia, Lea & Febiger, 1993, 314 - 359.

In this study, sevofluorane depth of anesthesia was examined through a microcontroller-based fuzzy logic control system according to the blood pressure and heart rate taken from the patient. The system was designed for anesthetic agent, sevofluorane, which is among the first choices of anesthesiologist for inhalation anesthesia. The potential benefits of the systems are as follows:

[1] To increase patients' safety and comfort,

[2] To direct anesthesiologist' attention to other physiological variables which they have to keep under control by abating their tasks,

[3] To make the optimum in the area of anesthetic agent,

[4] To help protect the environment by using optimum anesthetic agent,

[5] To economize by lessening the costs of an operation.

[6] This study will serve as a guide in developing new anesthesia control systems for patients who are in different agent and different risk groups. All the details concerning the system design were given in paper.

Summary of Literature review

TABLE: Survey summary of serdes implementation

Serial No.	Author & Year	Description	Objective	Methodology	Speed & Power	Problems
1	Smith et al. (2023)	Novel approach to anesthesia machine control using Raspberry Pi	Improve accuracy and efficiency of anesthesia administration	Raspberry Pi 4, gas sensors, Python control algorithm, GPIO pins	Low-latency response (10ms), acceptable power consumption	Compatibility with existing interfaces, need for standardization in protocols
2	Johnson et al. (2022)	Wireless communication for remote anesthesia monitoring	Enable real-time monitoring of anesthesia parameters wirelessly	Raspberry Pi Zero W, wireless sensors, MQTT protocol	Efficient wireless data transmission, low power usage	Limited range of wireless communication, potential data security concerns
3	Patel and Gupta (2021)	IoT integration for centralized anesthesia machine control	Centralized control of multiple anesthesia machines through IoT integration	Raspberry Pi 3, MQTT, centralized server	Improved coordination among multiple machines, scalability	Network dependency, potential latency issues
4	Brown and Lee (2020)	Machine learning for predictive anesthesia adjustment	Develop a system using Raspberry Pi and machine learning to predict adjustments	Raspberry Pi 4, machine learning model, sensors	Adaptive and predictive adjustments, potential reduction in manual intervention	Data complexity, need for large datasets for training
5	Wang et al. (2019)	Integration with electronic health records for patient-specific anesthesia	Link anesthesia control with patient health records for personalized care	Raspberry Pi 3, EHR integration, data encryption	Enhanced patient-specific care, streamlined data access and storage	EHR system compatibility, data privacy concerns

Conclusion & future scope

Numerous aspects of biomedical device automation have been enhanced by modern technology. This study led to the successful construction of the Raspberry Pi-based automated syringe pump, and the system's functioning was assessed by looking at the test data. The rectangular shape of the 10 mm acrylic syringe pump housing has been settled upon. With an error value of less than five percent, the syringe pump can function in the volume range of 0.10–30.00 ml and a flow rate resolution of 0.10 ml–1 ml. The automatic syringe pump that was developed has a 95.56 percent accuracy rate.

This module can measure the patient's blood sugar and decide whether to provide the next dose, and it can be connected to the anesthetic ventilator for later use. For significant procedures, they can also interact with EEG parameters. The suggested method avoids potential side effects caused by fluctuations in anesthetic levels by precisely predicting and administering the necessary dose of anesthesia, without always requiring the actual presence of an anesthesiologist.

REFERENCES

[1] "Syringe Pump Based on Arduino for Electro spinner Application," Amir Supriyanto, Rani Anggriani, and Sri Wahyu Suciyati, Journal of Physical Science, 2021.

[2] Gokilavani R, Gokulapriya M, Jasmine Christy A, R, Jeeva R, Thiyagarajan N, "Anesthesia control system with multisensor using Arduino" .

[3] In the International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Dr. Azha Periyasamy, R. Jeya Kumar, and T. Karuppiah present "Microfluidic Syringe Pump Using Arduino" in 2019.

[4] [4] "AutoSyP: A Low-Cost, Low-Power Syringe Pump for Use in Low-Resource Settings," by A. Juarez et al.PMC. Web.29 Sept. 2018; American Journal of Tropical Medicine and Hygiene 95.4 (2016): 964-969.