Anaesthesia Machine Controlusing Raspberry PI Pico With Battery Backup & Machine Learning

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Abstract- *This study suggests a method for using the raspberry pi an inexpensive microprocessor, to operate anesthetic machines. In order to precisely provide anesthetic gases and vapours to patients during surgical procedures, aesthesia 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. To further enhance system reliability, especially in critical surgical environments, a battery backup module is integrated to ensure uninterrupted operation during power outages, providing continuous monitoring and control even in emergency conditions.*

Keywords- Anesthesia, RaspberryPi Pico, Heartrate, Temperature, SPO2, Blood Pressure, infusion, Battery

I. INTRODUCTION

Anesthesia plays a crucial role in modern healthcare, ensuring patient comfort and safety during surgical procedures. Traditional anesthetic machines rely on proprietary hardware and software, limiting flexibility and integration with contemporary medical technologies. This study presents a novel approach to anesthesia drug control by leveraging real-time patient parameters, including heart rate, SpO_2 levels, and temperature, to optimize drug delivery. The system incorporates a battery backup to enhance reliability, ensuring uninterrupted functionality. Additionally, machine learning techniques are employed to monitor and analyse blood pressure, enabling dynamic adjustments for precise aesthesia administration. By utilizing open-source microcontroller platforms such as the Raspberry Pi Pico, this method provides an adaptable, cost-effective, and intelligent solution for aesthesia management, contributing to advancements in patient care and surgical efficiency.

II. EXISITING MODEL

The research paper "A Review of Anaesthesia Machine Control using Raspberry Pi" offers an economical and versatile solution for controlling anaesthesia machine functions using the Raspberry Pi microcontroller. Proprietary hardware and software-based conventional anaesthesia systems do not support customization and integration with state-of-the-art healthcare technologies. This research discusses using Raspberry Pi to overcome this restriction by allowing real-time monitoring and regulation of essential parameters such as oxygen concentration, gas pressure, and flow rate. The system uses sensors to gather patient information and dynamically regulate anaesthetic delivery for better security and accuracy. The data is also relayed to cloud platforms for remote monitoring and can be interfaced with electronic health records (EHR) for effective patient monitoring. The research stresses the viability of using Raspberry Pi as an intelligent, programmable, and inexpensive option for developing next-generation anaesthesia devices, citing its usefulness in resource-limited or rural healthcare settings.

III. PROPOSED MODEL

The computer-automated syringe control system for anesthesia using a Raspberry Pi Pico adapts drug infusion in accordance with live patient monitoring. A syringe attached to a lead screw mechanism is powered by a stepper motor driven through an L298N motor driver. A pulse oximeter input is processed by the Raspberry Pi Pico, which adjusts movement of the stepper motor correspondingly. With the trigger, the motor spins, shifting movement of the lead screw to advance or retract the syringe plunger for accurate delivery of the drug. Patient vitals are monitored constantly, and infusion is altered in accordance. Safety features, i.e., halting drug delivery or sounding an alarm, are included to avoid overdose or side effects. In addition, for continuous operation in the event of power outages, a battery backup module is included in the system, making it highly reliable in emergency scenarios. Moreover, in addition to this, an approach using machine learning is utilized to predict blood pressure trends for highly responsive adjustment in terms of anesthetic dosage in accordance with expected patient status. This arrangement provides high patient safety while automating administration of anesthesia and decreasing human intervention.

BLOCK DIAGRAM

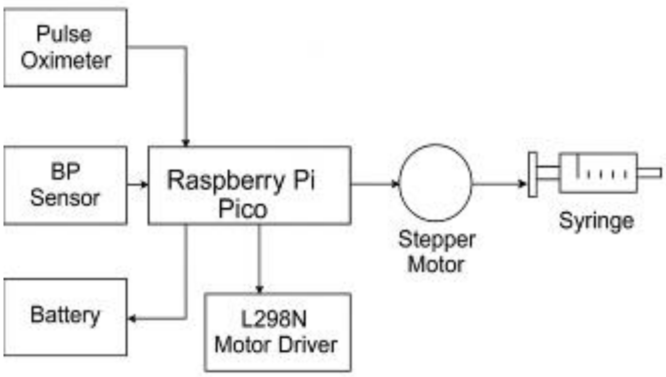

Fig No 1

WORK FLOW

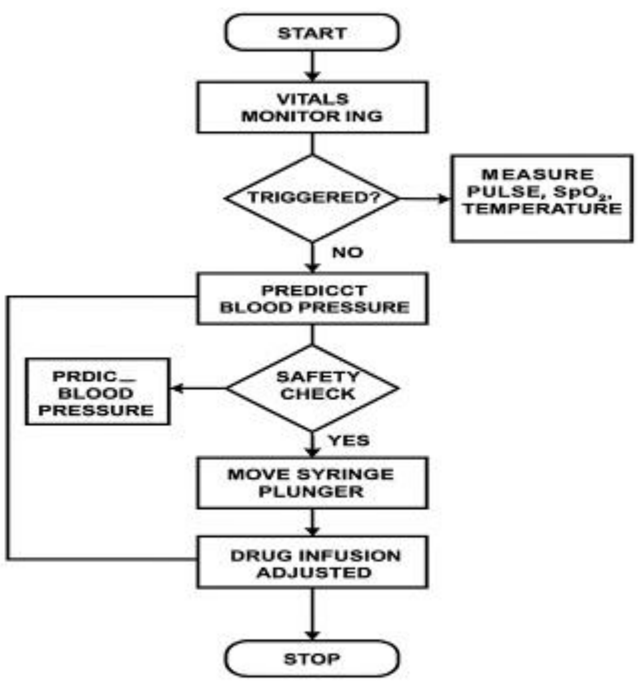

Fig No. 2

IV. COMPONENTS

1. RASPBEERRY PI PICO

The Raspberry Pi Pico is a low-cost, high-performance microcontroller board developed by the Raspberry Pi Foundation. Unlike the traditional Raspberry Pi boards that function as full-fledged computers, the Pico is designed for embedded systems and electronics projects. Released in January 2021, it marked the foundation's first step into the microcontroller world

Fig No. 3

2. STEPPER MOTOR

A stepper motor is an electromechanical device that converts electrical pulses into discrete mechanical movements. Each pulse moves the shaft by a fixed angle, making it ideal for applications requiring precise position and speed control.

Fig No. 4

3. L298N MOTOR DRIVER

The L298N motor driver is a key component in this project, providing the necessary power amplification and directional control to the stepper motor. It ensures that the anaesthesia delivery mechanism operates smoothly, safely, and in sync with patient monitoring sensors.

Fig No. 5

4. **OXIMETER**

The oximeter sensor is a critical component that enables real-time monitoring of the patient's vital signs. By integrating it with the Raspberry Pi Pico and cloud services, the system ensures safer, smarter, and more responsive anaesthesia management—minimizing risk and reducing the need for constant manual supervision.

Fig No. 6

5. **12V ADAPTER**

The 12V adapter is a key component in ensuring that the power-hungry parts of your anaesthesia control system, especially the stepper motor and driver, receive a stable and reliable power supply. Its role is crucial in maintaining the accuracy, consistency, and reliability of the anaesthesia delivery mechanism during medical procedures**.**

Fig No.6

6. DSA318 TEMPERATURE SENSOR

The DSA318 temperature sensor is a critical component in ensuring patient safety during anaesthesia. By providing accurate, real-time temperature readings, it allows the system to respond intelligently and automatically, making the anaesthesia process smarter, safer, and more efficient—especially in surgeries that require constant monitoring.

Fig No.7

7. I2C MODULE

I²C (Inter-Integrated Circuit) is a serial communication protocol used to connect low-speed peripherals to microcontrollers. It was developed by Philips (now NXP) and is widely used in embedded systems due to its simplicity and efficiency.

It operates on just two wires:

1. SCL (Serial Clock Line): Carries the clock signal.
2. SDA (Serial Data Line): Transfers data.

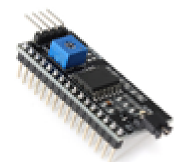

Fig No.8

8. LCD DISPLAY

An LCD (Liquid Crystal Display) is a flat-panel display that uses liquid crystals to produce visual output. In embedded systems, a 16x2 LCD module is most commonly used. It can display 16 characters per line on 2 lines, and it is often used to show real-time data or system status directly on the device.

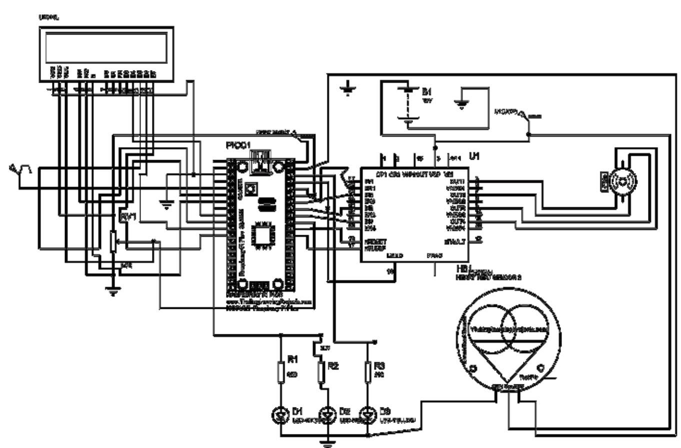

Fig No.9

V. SCHEMATIC DIAGRAM

Fig No 10

VI. MACHINE LEARNING

Blood pressure (BP) is a crucial health parameter that indicates cardiovascular health. Machine learning techniques, particularly linear regression, can effectively predict blood pressure levels based on dependent and independent variables. In this approach, systolic and diastolic blood pressure (BP) serve as the target variables (Y). The goal is to establish a linear relationship between these variables and BP measurements. By analyzing historical health data, the model learns to predict BP values based on input features. It minimizes error using the least squares method, adjusting weights to improve accuracy. Once trained, the model can predict an individual's BP based on their health parameters. This technique helps in early detection of hypertension and cardiovascular risks, aiding in preventive healthcare and personalized treatment recommendations.

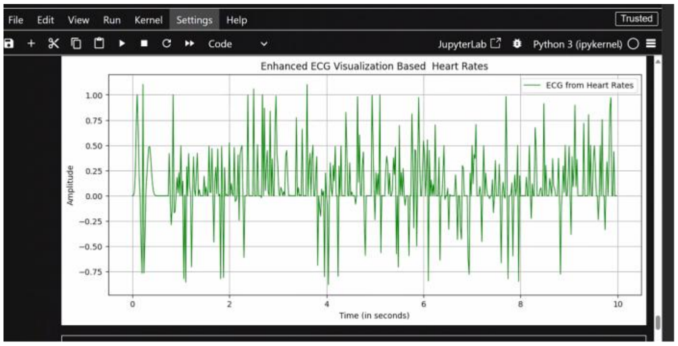

Fig No.11

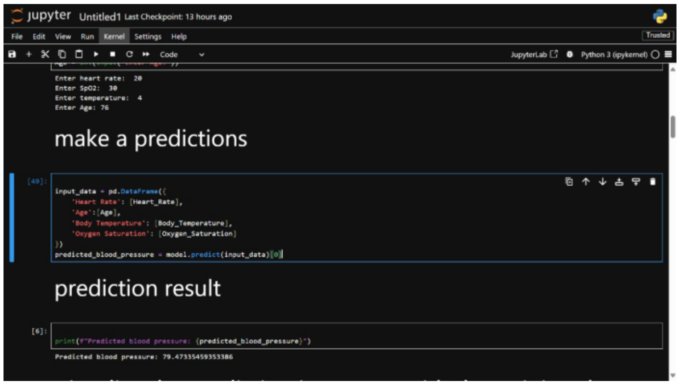

Fig No.12

VII. RESULTS

Based on the vitals of patient the syringe movement takes place since the syringe is in off position the red colour led blinks if the syringe is on position green led blinks. If the vitals are within the threshold value the syringe doesn't move if the vitals aren't in the given threshold the syringe movement

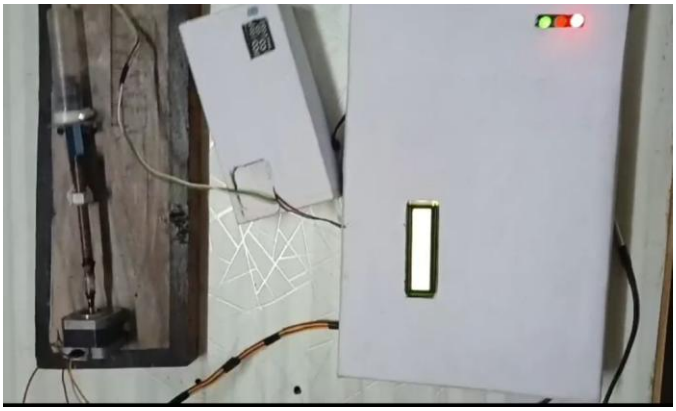

Fig No.13

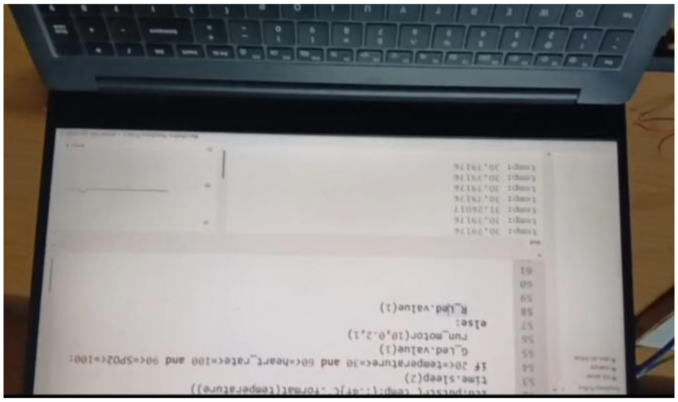

Fig No.14

SPO2: 98
HEART BEAT: 72
TEMPERATURE: 30

VIII. CONCLUSION & FUTURE SCOPE

This project introduces an innovative and cost-effective approach to anaesthesia drug delivery by integrating machine learning, biomedical sensors, and a stepper motor-driven syringe mechanism for precise control. The system leverages real-time patient monitoring, detecting key vital signs such as blood pressure, heart rate, SpO_2 levels, and temperature to optimize anaesthesia dosage dynamically. By utilizing Raspberry Pi Pico, the solution offers a lightweight and adaptable platform for intelligent automation in healthcare. Machine learning algorithms enhance predictive accuracy, ensuring personalized anaesthesia adjustments while improving patient safety and surgical efficiency. Future advancements in this system could focus on wireless monitoring, expanded sensor integration, and real-world clinical validation to further refine its functionality. The combination of mechanical precision, AI-driven intelligence, and automated drug control represents a significant step toward smarter, more reliable anaesthesia administration. This project contributes to the advancement of modern healthcare, enabling more responsive, efficient, and patient-focused surgical solutions

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Dr. V Adhinarayana was born in 15-04-1979. He received his B. Tech (ECE) degree from GITAM College of Engineering Viskhapatnam, AP, India in 2000. He received his M. Tech from Andhra University, Visakhapatnam, AP, in the field of Optical Fiber and Radiofrequency Microwave engineering in 2003.He received Ph.D. in wireless communication, Department of School of Engineering, Andhra University, Visakhapatnam, (2022). Currently, he is working as Associate Professor in ECE dept. Gayatri vidya Parishad college for Degree and PG Courses(A), Visakhapatnam. His research fields include Mobile and wireless communications