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# Integrated IOT Based Anaesthesia Management for Virtual Doctor Robot

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**Abstract**
*The power of anaesthesia is a controlled hypnotic state that is generated to reduce pain during surgery and work with the surgeon. That's why many people die. Improper use of anaesthesia can lead to blindness, breathing arrest, brain damage and even death. The impact varies from patient to patient. Our project is based on integrated smart anaesthesia management integrated with virtual medical robots and is a cutting-edge approach in modern healthcare systems. They provide recommendations based on current guidelines, historical data and ongoing real-time patient reviews to support critical medical decisions in their operation. IoT sensors are continuously embedded in anaesthesia and care devices important information such as heart rate, blood pressure, oxygen saturation, and anaesthesia depth. This data is safely transferred to the virtual doctor system for analysis. Provides insight into optimal anaesthesia adjustment, predicts patient responses, and informs health service providers about important situations that require immediate attention. Finally, the integrated IoT anaesthesia management and virtual health systems represent a transformative approach to the delivery of healthcare that IoT uses to achieve safe anaesthesia practices, continuous patient monitoring, and accessible medical knowledge regardless of physical proximity.*

## 1. Introduction

The area of anaesthesia management is essential for the successful surgical intervention and plays an important role in ensuring patient safety and comfort during surgery. Traditional anaesthesiologists need to know carefully monitor the patient's vital signs and adapt the drug rose when necessary [1]. However, this process is not without challenges. Human error in administration of anaesthesia can have serious consequences, including diplopia (double view), respiratory arrest, brain damage, and even death. Integration of the Internet of Things (IoT) in medical devices has revolutionized patient care by invigorating actual surveillance and data collection. An IoT-based system can monitor key patient signs, such as heart rate, blood pressure, blood oxygen saturation, and depth of anaesthesia, which are important aspects of surgery. This continuous data collection, combined with advanced clinical tools, helps to make more informed decisions about anaesthesia submissions and reduce human error. The entire structure of the anaesthesia monitor is shown in Figure 1. It consists of three main parts: data collection clamps, host monitors, and internet communications. At the same time, IoT cloud servers can control and monitor anaesthesia from afar, allowing doctors to treat as much as patients need it. Virtual PhD robots can support anaesthesiologists by providing real-time decision support using historical data, current guidelines and ongoing patient reviews. This way, we improve the accuracy and security of anaesthesia management and ultimately improve patient outcomes. [3]

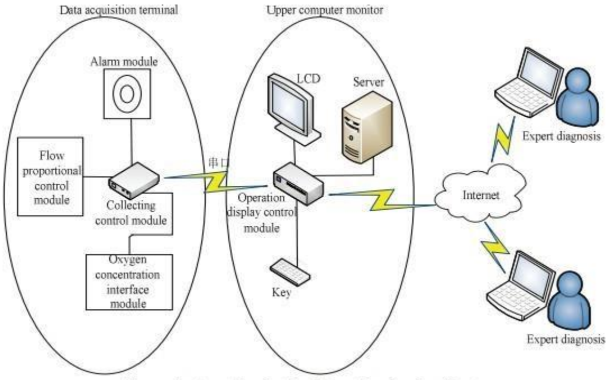


Figure 1. Anesthesia Machine Monitoring System

**Figure 1 Surgical Intervention**

## 2. System Structure

If the patient's physical condition is not good, the upper computer is promptly alerted to allow the doctor to adapt the patient's breathing, drug flow and other important factors of care. Therefore, normal anaesthesia and breathing can be ensured in the patient. Furthermore, the XHR and SSE systems are integrated into the realization of Internet communications, allowing experts to understand the patient's body via an Internet browser [4]. The robot can be programmed to ensure that data on patient health and lifestyle is collected, such as: B. Training habits, diet, and sleep patterns [5]. This information can be used to create a personalized health plan that takes into account the individual needs and goals of the patient.

## 3. Objective

The purpose of this project is to develop a modern anaesthesia management system that combines IoT technology with virtual medical to robots to significantly improve the security and effectiveness of surgical interventions. The system aims to minimize human error in anaesthesia administration by providing real- time decision support and allow for accurate dosage adjustments based on continuous monitoring of key critical functions such as heart rate, blood pressure, oxygen saturation, and anaesthesia depth.

### 3.1. Aim

The Aim of this project is to create a comprehensive IoT-based anesthesia management system that integrates into Virtual Doctor robots to improve the accuracy, security and accessibility of anesthesia care during surgical interventions.

### 3.2. Scope

The scope of this project involves the development and implementation of an advanced Iot based anesthesia management system integrated into virtual medical robots to allow for the continuous collection and transfer of critical functions.

## 4. Proposed Methodology

The system automates anaesthesia management and ensures accuracy and security, while virtual medicinal robots improve patient remote monitoring and diagnosis. An IoT-based approach makes it a reliable and innovative solution for telemedicine applications, minimizing human mistakes and enabling physicians to intervene in real time.

### 4.1. Anesthesia Management System

Anaesthesia Management System is an advanced IoT-based health solution developed to monitor and regulate the administration of anaesthesia during medical interventions. The system ensures accurate dose control, real-time monitoring of critical and automated patient warnings, reduced artificial errors, and improved patient safety. By integrating microcontrollers, sensors and automation mechanisms, this system provides an efficient and reliable way to manage anaesthesia in critical medical environments. [6]. The system includes several important components, including a microcontroller (Arduino/ESP8266), which acts as a central processing unit for processing data from various sensors. Heartbeat sensors and AD8232 ECG sensors continue to pursue key patient functions to ensure that the anaesthesia mirror is adapted to physiological real-time responses [7]. Additionally, the DHT11 sensor monitors ambient temperature and humidity, and is accompanied by optimal operating room conditions. Servo engine controlled syringe pumps are used to automate the administration of anaesthesia, ensuring accurate and controlled dosages. The system also has an LCD display that allows parents of health occupations to display real-time monitoring data. In anomalies, a summer alarm system is triggered and medical staff will notify you immediately. Additionally, the ESP8266-FI module enables remote monitoring via cloud platforms such as Blynk, allowing doctors to monitor the anaesthesia process from afar. [8].

### 4.2. Virtual Doctor Robot

Virtual Doctor Robot is an IoT-based health automation system that supports remote monitoring, diagnosis and medical assistance with remote control. By integrating sensors, microcontrollers and robotic components, the system enables real-time and automated patient care healthcare monitoring. (Figure 2)

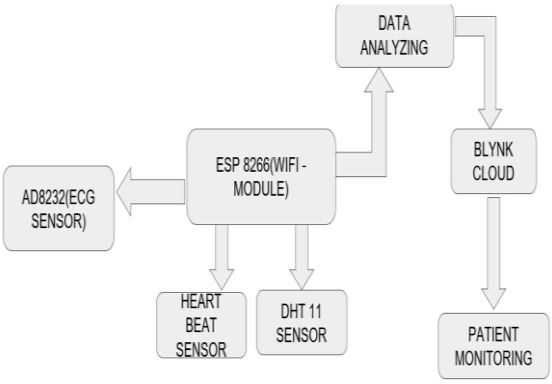


**Figure 2 Block Diagram of Anesthesia Management System**

The virtual medicine core is built with Arduino UN O, which acts as a central processing unit and contro ls the movement of various sensors and robots. The system is equipped with a heartbeat sensor and an E CG sensor (AD8232) to pursue patient vitals to ensu re continuous health surveillance. Additionally, ultr sound sensors for obstacle recognition are included, allowing for smooth navigation in hospital environm ents [10]. To improve patient interaction, the robot has a display screen that provides real-time health data, and the Wi-Fi module (ESP8266) connects systems with cloud-based platforms, such as Blynk, which allow remote access by physicians. [11].By automating routine testing and medical support, virtual physician robots improve accessibility of the healthcare system, reduce the burden on medical staff, and ensure efficient patient management [13]. (Figure 3)

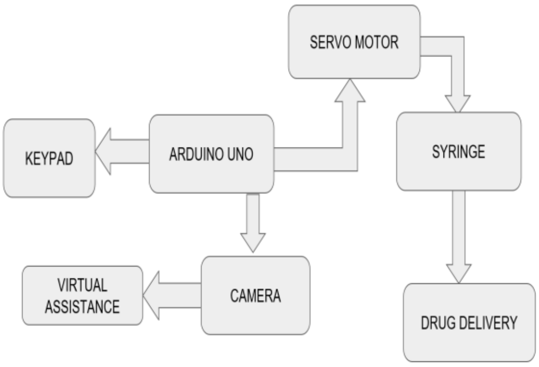


**Figure 3 Block Diagram of Virtual Doctor Robot**

## 5. Components Used

### 5.1. ESP8266 -Wifi Module

The ESP8266 is a cheap, Wi-Fi-enabled microchip developed by the Espressosif system, often used for its affordability, efficiency and versatility that is widely used in IoT applications. Delivered via an integrated 802.11 B/G/N Wi-Fi module that supports TCP/IP, UDP, HTTP, and MQTT protocols. This means it's perfect for cloud-based applications. Additionally, it has microcontroller functionality and can be programmed with Arduino IDE, Micropython, or commands. Several GPIO pens allow for seamless integration into sensors and other peripherals. (Figure 4)

**Figure 4 ESP8266 -Wifi module**

### 5.2. AD8232(ECG Sensor)

The AD8232 is a compact sensor module with a low-power electrocardiogram (EKG) that is used for heart rate monitoring and organic potential measurements. It was developed to extract, enhance and filter small bioelectrical signals in the presence of noise. It is perfect for portable health surveillance devices, medical devices and fitness streets. The module operates at a single supply voltage (2 v 3.6 V) and has a rapid repair mode, allowing for quick signal stabilization after readoff detection. Due to its compact design, low power consumption and high sensitivity, it is often used in portable ECG monitors, patient monitoring systems, and IoT-based health treatments. (Figure 5)

**Figure 5 AD8232 Sensor**

### 5.3. Heart Beat Sensor

The Heartbeat Sensor is a compact device used to measure pulse rate (heartbeats per minute - BPM) based on photoplethysmography (PPG) technology.

It typically consists of an LED and a photodetector that detects changes in blood volume as the heart pumps blood through the body. The sensor works by shining light through the skin (usually a fingertip or earlobe) and measuring the variations in light absorption caused by blood flow. It provides an analog or digital output, which can be processed by microcontrollers like Arduino, ESP8266, or Raspberry Pi for real-time monitoring. (Figure 6)

**Figure 6 Heart Beat Sensor**

### 5.4. DHT 11 Sensor

The DHT11 sensor is an inexpensive digital sensor used to measure temperature and humidity. It consists of a thermistor for temperature recording and a capacitive moisture sensor that provides reliable and accurate measurements. The sensor operates within the temperature range of 0°C to 50°C and within the 20% to 90% RH of moisture, making it ideal for weather monitoring, home automation and IoT applications. Due to its compact size, low power consumption and user-friendly, the DHT11 is often used in smart agriculture, HLK systems and environmental monitoring projects. (Figure 7)

**Figure 7 DHT 11 Sensor**

### 5.5. A4899 Stepper Motor Driver

The A4988 driver is a popular stepper engine driver module that controls bipolar stepper engines such as the NEMA 17. There is an H-bridge circuit that allows for accurate step and directional control with integrated overcurrent and thermal protection. The driver supports modes filled with step, half step, quarter step, 8 step, and 16th step modes. This allows for smooth and accurate motor movement. It operates in a voltage range of 8V to 35V and can supply up to 2A per coil with appropriate heat. (Figure 8)

**Figure 8 A4899 Stepper Motor Driver**

### 5.6. Arduino UNO

Arduino UNO is a popular open source microcontroller board based on the ATMEGA328P. It has 14 digital input/output hands, 6 analog inputs, 16-MHz quartz crystal, USB connection, performance socket, and ICSP header. With simple programming via Arduino -Ide, the board is often used in electronics projects, robotics, IoT applications and automation systems. It supports a variety of sensors, actuators and communications modules such as Wi-Fi (ESP8266), Bluetooth, and RFID. (Figure 9)


**Figure 9 Arduino UNO**

### 5.7. LN293d Motor Driver

The L293D engine driver is a double H-bridge engine driver that controls the speed and direction of the DC engine and stepper engine. This allows two engines to be controlled simultaneously with bidirectional control (such as the Arduino or Raspberry Pi). The L293D operates over a wide range of voltages (4.5 V to 36 V) and can handle up to 600 mA per channel. Built-in diodes for back EMF protection, ensuring safe operation with inductive loads. (Figure 10)

**Figure 10 LN293d Motor Driver**

### 5.8. Servo Motor

Servo motors are highly accurate rotary drives used in robotics, automation and position control applications in industrial systems. In contrast to a regular DC engine, the servo motor operates on a control system with a closed loop. That is, it continuously adapts the position based on feedback. This makes it ideal for applications that require accurate angular rotation, speed control and torque management. Work with PWM signals (pulse width modulation). This controls the engine position by changing the pulse time. Standard servo motors can rotate between 0° and 180°, while some advanced models allow for full rotation of 360°. (Figure 11)

**Figure 11 Servo Motor**

### 5.9. Security Camera

Surveillance cameras in patient surveillance are IoT-based surveillance systems that ensure ongoing real-time observation of patients in hospitals. Surveillance camera systems typically include night vision capabilities, motion detection, and two-way audio communication. This allows physicians and supervisors to monitor patients in a centralized control system or mobile app from afar. It can be integrated into cloud platforms such as Wi-Fi enabled microcontrollers (ESP8266, Raspberry PI) and Blynk. This allows for remote access and real-time alerts. (Figure 12)


**Figure 12 Security Camera**

### 5.10. Ultrasonic Sensor

Ultrasonic sensors are imagination and distance measurement devices that use high-frequency sound waves to identify objects that have no physical contact. It consists of a transmitter that abandons ultrasound waves and a receiver that recognizes reflected waves and determines the distance to the object. Virtual doctor robots help secure navigation in hospital corridors by recognizing obstacles. The patient surveillance system helps track autumn awareness and movements to ensure timely medical responses. It is also commonly used in smart hospital automation, security systems, and contactless disinfecting devices. (Figure 13)


**Figure 13 Ultra Sonic Sensor**

### 5.11. NEMA 17

The NEMA 17-Stepper engine is a compact, high-precision engine that is often used in automation, robotics and medical applications because it offers accurate and controlled movement. There is a 1.8° step angle. This means that a complete revolution takes 200 steps to ensure smooth and accurate movement. The engine operates in a mode filled with step, half step, or microstet modes, allowing for finer control via rotation. It can be used in bipolar (4 wires) and unipolar (6 wires, 8 wires) depending on the driver used. In an IoT-based anesthesia management system, the NEMA 17 engine is fully used in full steps (low, low, low, low, low) to regulate the syringe injection process. The stepping engine is integrated into the Nodemcu ADC channel to ensure controlled, automated submission of anesthesia based on real-time sensor data, providing a reliable and efficient solution for patient care. (Figure 14)

**Figure 14 NEMA 17 Stepper Motor**

## Results and Discussion

IoT-based anesthesia management system has proven to be extremely efficient in automating drug collection and ensured patient safety through continuous monitoring. The integration of cloud-based warnings minimized human error and became a reliable alternative to manual management . The inclusion of further improvement language-based diagnostic AIs such as can expand the functional area of a wider range of telehealth applications. Additionally, improved mobility solutions such as progressive lidar sensors could further improve navigation in complex environments. (Figure 15)

**Figure 15 Front View of Integrated IOT Based Anesthesia Management for Virtual Doctor Robot**

Figure 15 is the front view of integrated IoT-based anesthesia management system for virtual medicine. The robot is equipped with surveillance cameras mounted on a high stand to allow remote monitoring and diagnosis of patients. The robot's foundation includes essential electronic components such as motor drivers, microcontrollers, and sensors to ensure smooth mobility and control. This setup improves telehealth applications by being able to assess patients from afar, especially in rural and emergency scenarios. The syringe injection mechanism is controlled using the NEMA 17-Stepper engine and operates in full step mode (000-low signal). If abnormal values are found based on real-time patient life, the system causes an automatic response to stop or stop the anesthesia flow. Warnings are also sent via Blynk, which activates the buzzer to ensure safe and accurate anesthesia, but doctors can intervene remotely if necessary. (Figure 17)

**Table 1 Configuration of Srynige with NEMA 17**

| MS1 | MS2 | MS3 | U step res | Steps/Rev |
|---|---|---|---|---|
| L | L | L | FULL STEP | 200 |
| H | L | L | ½ STEP | 400 |
| L | H | L | ¼ STEP | 800 |
| H | H | L | 1/8 STEP | 1600 |
| H | H | H | 1/16 STEP | 3200 |

**Figure 17 Blunk interfence with Integrated IOT Based Anesthesia Management for Virtual Doctor Robot**

Figure 17 shows the output interface of an IoT-based anesthesia management system using the Blynk cloud platform. The dashboard displays real-time sensor data including temperature, heart rate and EKG values. This is extremely important for monitoring patients during admiration of anesthesia. The first part of the photo will display a Blynk notification. This indicates that the EKG sensor has determined abnormalities that trigger an automatic security response, stop the anesthesia injection and activate the summer of alarms for medical staff. The second section shows various control switches for managing the anesthesia process remote. The final part of the diagram shows a diagram of trends in ECG data and visualized changes in patient cardiac activity over time. Figure 18 shows the hardware implementation of an IoT-based anaesthesia management system, integrating the Nodemcu ESP8266 with the Nodemcu ESP8266 for real-time monitoring of several sensors. The LCD screen displays temperature humidity and BPM alarms. Specifies abnormal heart rate recognition. The DHT11 sensor measures the ambient conditions of the AD8232-KG sensor and heartbeat sensor-vital. The system triggers warnings when values exceed the threshold to ensure patient safety. The LED indicators provide real-time status and data are assigned to the Blynk-Iot platform for remote monitoring that supports automatic anesthesia regulation based on the patient's condition. (Figure 18)

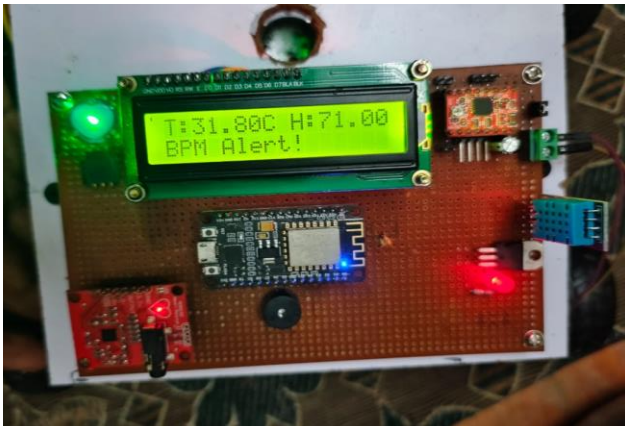


**Figure 18 Hardware Implementation of an IoT-Based Anaesthesia Management System**

Figure 19 – show the image captured by the camera of Integrated IOT based Anaesthia management for virtual doctor robot .


**Figure 19 Image Captured by Security Camera**

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