

# AUTOMATIC DRUG DELIVERY MECHANISM FOR SAFE ANESTHESIA ADMINISTRATION

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**Abstract:** During Surgical procedure anaesthesia monitoring and administrations are required to ensure the patient's safety. Existing anaesthesia monitoring techniques are having multiple risks such as underdose, overdose or human error which causes huge impact on patient health. To overcome these problems in the proposed work anaesthesia is carried out with the help of IOT devices which has capability of drug loading automatically. There are different physical parameters from the patient are monitored in the real time such as spo2, heart rate as well as blood pressure from the advanced biomedical sensors. Based on the mentioned threshold values and proposed mechanism, the proposed model is able to regulate the rate of infusion of anaesthesia drug. Patient data is transmitted to the dashboard on the cloud so that anaesthesiologists can easily monitor as well as can take necessary reactions for timely administration as well as adjustments based on the patient anaesthesia level and threshold values. System is surgically safer than the existing methods as it avoided human errors by improving the efficiency and precision of monitoring anaesthesia patient. For surgical procedure the identifying the optimal dosage is required in anaesthesia. Mobile or Web based interface can be used for accessing the real time patient data from the cloud platform.

**Keywords:** Internet of Things (IoT), Anaesthesia Monitoring, Automated Drug Infusion, Real-Time Patient Monitoring, Biomedical Sensors, Cloud-Based Healthcare.

## I. INTRODUCTION

Anaesthesia has become an important part of contemporary surgical practice as it provides painless surgery and guarantees the comfort of the patient. It is the regulated use of anaesthetic medicine to produce sensory or mental unconsciousness. Nevertheless, a precise dosage is one of the key factors since underdosing and overdosing might result in severe complications, such as intraoperative awareness and even life-threatening conditions [1]. Thus, monitoring and delivery of anaesthesia must be controlled and accurate in terms of patient safety.

Conventionally, administration of anaesthesia has been dependent on the ability of anaesthesiologists who are in charge of constantly checking vital parameters like heart rate, blood pressure, and oxygen saturation. Although improvements have been made to medical equipment,

manual cooperation remains the most common, thus creating the possibility of human error, slow reaction, and drug delivery inconsistency [3], [11]. These shortcomings point to more solid and automated anaesthesia management systems.

The new automation and smart health care systems have led to sophisticated drug delivery systems. Automated anaesthesia systems are based on control algorithms, sensors and feedback mechanisms that govern the rate of drug infusions to be delivered depending on real-time data on the patient. Research has revealed that closed-loop and knowledge-based systems can bring a great deal of enhancement into the accuracy, workload on medical staff, and overall surgical outcomes [7], [8], [10].

In addition, the combination of Machine learning (ML) and Internet of things (IoT) technologies has also increased the efficiency of the systems of delivering anaesthesia. The ML algorithms are able to process patient-specific data to suggest the best possible dosage of the drug, whereas the IoT allows monitoring patients and accessing their records remotely. Such smart systems are able to reduce risks like intraoperative awareness and dosage mistakes hence enhancing patient safety and quality of healthcare [2], [4], [5].

In this regard, the proposed IoT-based automatic drug delivery system intends to be better than the traditional measures as it is to guarantee the real-time monitoring, accurate dosage, and accessibility remotely. The system is able to utilize biomedical sensors, automated control mechanisms, and cloud-based communication, which improve system reliability, minimizing human intervention, and is a major move towards smart and safe administration of anaesthesia.

## II. LITERATURE SURVEY

Copot carried out an extensive investigation on computer-aided drug delivery systems in anaesthesia, which is concerned with the usage of control engineering methods in medical systems. This explains that the mechanisms of

feedback control observe the parameters of the patients continuously and this is achieved by regulating the rate of drug infusion. This lessens the necessity of manual supervision at all times and enhances the accuracy of administration of drugs. Another issue that the study observes is the stability and reliability of the system in order to administer anaesthesia safely when performing surgery [1].

Lichoń et al. presented an in-depth review of the case of the use of the Machine Learning (ML) algorithms in the context of automatic anaesthetic drug delivery systems. The authors stressed that ML models are able to perform predictions based on patient-specific details to forecast the optimal drug dosage in real time. This improves the decision-making process, minimizes possible human error, and facilitates the use of individual treatment methods. Their article demonstrates that the integration of ML contributes to the efficiency and flexibility of contemporary anaesthesia systems to a considerable level [2].

Zaouter et al. examined the possibilities of a totally automated total intravenous anesthesia (TIVA) drug delivery system, particularly in cardiac operations. The researchers proved that closed-loop systems will be capable of achieving a stable level of anesthesia through constant adaptation of drug infusion according to patient feedback. This will decrease the number of anesthesiologists working and also guarantee coordinated and perfect drug administration in acute operation rooms [3].

Drug administration systems that are intelligent and automated are discussed by Sharma et al. as a developing trend in healthcare technologies. Their study underscores application of artificial intelligence, smart sensors and real-time monitoring system to enhance therapeutic results. The research also highlights the fact that these systems can reduce the error rate, optimize drug dosage, and allow more efficient and effective healthcare provision [4].

Chen et al. paid attention to preventive measures that could decrease the occurrence of intraoperative awareness as a result of mistakes in anaesthetic drugs delivery systems. The research found out that incorrect dosage and lack of promptness may cause severe complications during surgery. In a bid to address such problems, the authors proposed new sophisticated monitoring methods and predictive algorithms so that the drug delivery is continuous and correct to facilitate patient safety [5].

To minimize medication errors in clinical practice, Jelacic et al. proposed a barcode-based system of anesthesia drugs administration. They are based on a combination of barcode labeling and anaesthesia management software that allows proper identification of drugs and tracking. By minimizing human error, enhancing precision, and having the ability to provide better traceability in the procedure of drug administration, the system is safer [6].

Simanski et al. introduced Rostock Assistant System of Anaesthesia Control (RAN), which is an automated computer-controlled system that is aimed at control of the delivery of anaesthetic drugs. The paper also emphasizes

the application of adaptive control methods that regulate dynamically the drug infusion depending on the response of the patients. The strategy will increase accuracy, system reliability, and decrease the need to use manual intervention during the process of anesthesia management [7].

### III. PROPOSED METHOD

Proposed block diagram is explained below

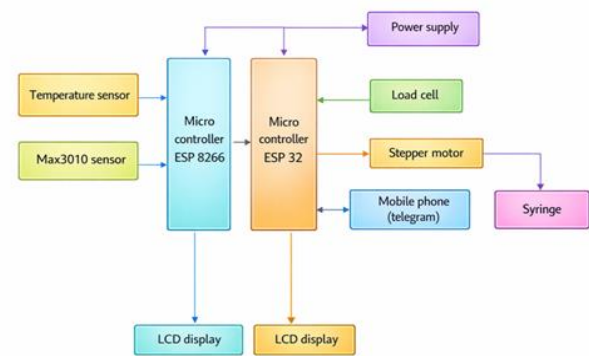


Fig.1. Block Diagram of Proposed Method

In the block diagram it is observed that the input data such as SPO2 and temperature are continuously monitored and processed using microcontroller ESP8266 and telegram and even controls drug delivery. Microcontroller ESP32 is used for weight checking, syringe and telegram application side

#### Important steps in the proposed system are

##### a) Patient monitoring

The different health parameters of the patient such as temperature, measure weight, SPO2 level and heart rate are calculated and continuously monitored as well as displayed on the lcd display and for further processing it is sent to the cloud. The sensors used are MAX30100, etc.

##### b) Data Processing

The data obtained from the sensor it's sent to the controller for further processing. This data will be continuously monitored as well as compared with the threshold values provided. The values obtained from the sensor are within the range of threshold or no is calculated and if the values in the range then continuously monitoring will happen else correct dosage required for the patient are calculated and delivered.

##### c) IOT Module for communication

Using iot module the data is transmitted continuously to the cloud and this data can be monitored by doctors remotely with the help of Telegram Channel as well as dashboard. This application even provide access to the doctors for controlling the drug delivery.

##### d) Infusion of drug

The system has ability to inject the amount of anesthesia required for the patient as per the calculation. To avoid the manual intervention this application provides accurate and controlled delivery of drugs which is infusion of drug

#### e) Loading and Discharging

Using the Telegram application, The delivery can be started or can be stopped by this application. There are two commands are used as below,

- /home: to stop drug infusion
- /loaddrug: starting the drug delivery

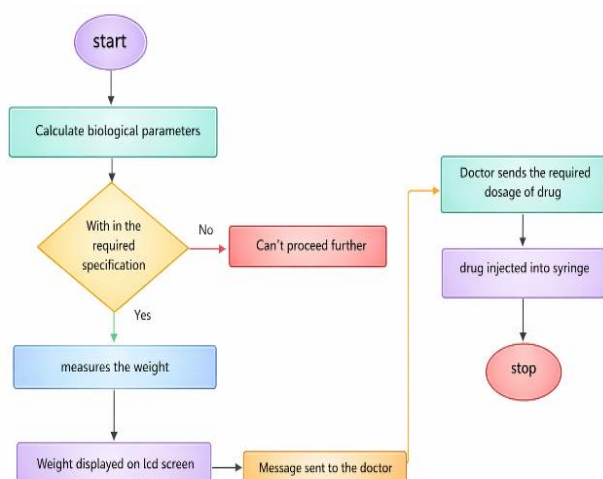


Fig.2.Flowchart of Proposed Method

The flowchart of the proposed system starts with setup of the system and multiple sensors. The patient health parameters such as temperature, SpO<sub>2</sub> and heart rate are continuously monitored. To understand the patients normal or abnormal condition obtained values are continuously compared with threshold values set. Anaesthesia dosage required can be analyzed and calculated using this. Two conditions are mainly highlighted in this flowchart are

- Patient Health parameters lies in Normal Limit: Continuously monitor
- Patient Health parameters not lies in Normal Limit: proceed with drug infusion

The amount of drug required is calculated and loaded by using telegram commands which is accessed with cloud and doctors can monitor as well as control. This flowchart shows that proposed model is able to continuously monitor and provide delivery of drug.

## IV. RESULTS AND DISCUSSION

The image shows a prototype of an IoT-based automated anaesthesia delivery and patient monitoring system developed using various electronic and mechanical components. At the top, a stepper motor is connected to a lead screw mechanism that controls the movement of a syringe, allowing precise and automated drug infusion. A load cell is placed on the left side to measure weight or pressure related to the drug delivery process. In the centre,

an ESP32 microcontroller serves as the main control unit, processing data from different sensors and managing the system's operation. An ESP8266 module is also included to enable wireless communication and send patient data to a cloud-based platform.

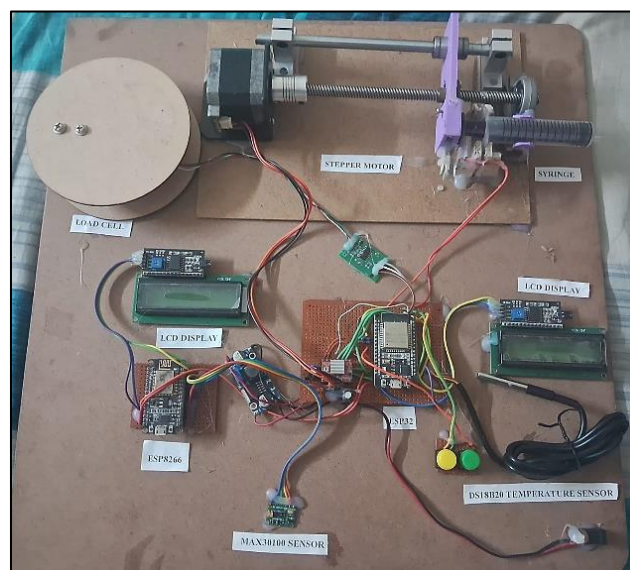


Fig.3.An IoT-based automated anaesthesia delivery and patient monitoring system

The system incorporates biomedical sensors such as the MAX30100 sensor for measuring SpO<sub>2</sub> and heart rate, and the DS18B20 sensor for monitoring body temperature. Two LCD displays are used to show real-time data and system status. Additionally, control buttons are provided for manual input or emergency control. All components are mounted on a base board and interconnected using wires. Overall, the setup demonstrates a smart healthcare solution that combines automation, real-time monitoring, and IoT technology to improve the safety and accuracy of anaesthesia administration.

The four major steps in this application are

- Calculation of Biological Parameters
- Calculation of Weights
- Infusion of Drug
- Loading and Discharging the Drug

#### a) Calculation of Biological Parameters

On LCD is showing the two health parameters such as BPM and SPO<sub>2</sub>.

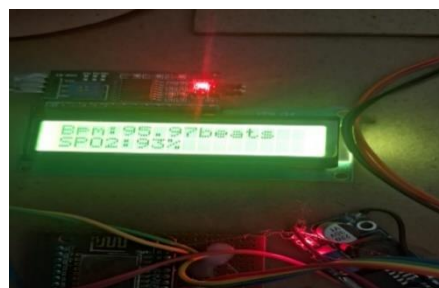


Fig.4.Calculating the health parameters

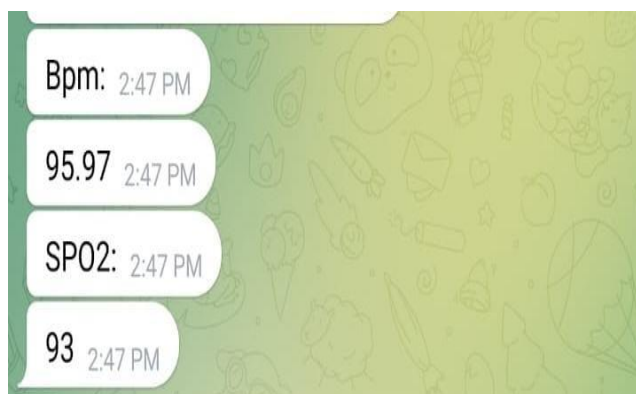


Fig.5.Message through telegram health parameters

In telegram bot we got the message with BPM and SPO2 values.

MAX30100 sensor is used for calculating SPO2 and the BPM (Beats per minute) values of patient. To get this values patient has to keep the finger on the top of MAX30100 sensor.

#### b) Calculation of Weights:

In this method bottle is used as a load to measure weight. The bottle's mass causes it to exert force when it is placed on the weighing platform. The load cell detects this force and transforms it into an electrical signal. This signal is processed by the system to determine the bottle's weight, which is then displayed on the LCD.



Fig.6.Weight placed on Load cell

The temperature sensor (DS18B20) makes direct contact with the patient's skin when it is placed on hand. The sensor measures the body temperature. The value is then displayed on the LCD.



Fig.7.Weight and temperature is displayed on LCD

#### C) Infusion of Drug:

The patient's vital data such as SpO<sub>2</sub>, BPM, weight, and temperature are displayed on the LCD screen. The collected data is transmitted to the doctor using the Telegram application



Fig.8.Connecting to the host

First welcome message is shown so that doctor can select the drug type based on the treatment/surgery.



Fig.9.Selection of drug

After selection of drug doctor calculates required amount of drug need to be injected into syringe.

**D) Loading and Discharging of the drug :**

Fig.10.Loading of the drug using /loaddrug

The drug can be loaded using /loaddrug command. At this stage drug is loaded into the syringe with the help of motor. The motor pushes the plunger forward, it carefully pushes the drug out of the barrel and drug is loaded.

Discharging is done using /home command through telegram. After home command plunger comes to its initial position.



Fig.11.Discharging the drug using /home

Using telegram this application has ability to load and discharge the drug required. Commands used are

- For Loading drug: /loaddrug
- For discharging drug: /home

Drug dosage is determined using weight-based formulas. Propofol has a consistent dosage per kg, whereas morphine varies significantly owing to clinical modifications, ensuring safe and effective anesthetic delivery.

Based on the algorithm,

The mg/ml and mg/kg are constants for any drug

**Eg:** Propofol drug

The mg/ml value is 1.10 and while mg/kg is 10.00

- The mg/ml is multiplied by weight of the load.
- The value obtained is divided by mg/kg (say 10.00) to determine the amount of medicine required for injection into the patient.
- To retrieve information between two distinct units, ml and kg, follow the steps outlined above.

- This value indicates the amount of drug needed to be injected into patient's body.

| Weight(kg) | Propofol(ml) | Morphine(ml) |
|------------|--------------|--------------|
| 20         | 2.23         | 0.68         |
| 30         | 3.29         | 1.0          |
| 40         | 4.36         | 1.32         |
| 50         | 5.48         | 1.6          |
| 60         | 6.57         | 1.9          |

Table 1: Drug dosage based on weight

**V.CONCLUSION**

The automatic drug delivery system suggested as an anesthesia administration system using the IoT is of great benefit in improving the accuracy, safety, and effectiveness of drug infusion in the operating room. The biomedical sensors, automated control mechanisms, and real-time monitoring of patients help the system to reduce human error and assure that it provides the correct dose to the patient, preventing underdosing, overdosing, and intraoperative awareness. All in all, the system helps to achieve better patient outcomes and is a secure step of smart and automated healthcare solutions.

**VI.FUTURE SCOPE**

Advanced machine learning methods to provide personalized anesthesia control can be also added to the system, and the adaptive closed-loop control can be used to make the system more responsive. Possible future developments could also incorporate real-time clinical validation, increased cybersecurity of the data protection, multi-drug delivery system support, and an easy interface with the hospital information systems, as well as the cost-effective improvements to the design to allow the widespread use in various healthcare facilities.

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