IOT Monitored Intravenous Drip

Team Members
Nirmalya Biswal - 20BCE1900
Ismaheel Faheem - 20BAI1247
Denzel Shaju - 20BAI1267
Vignesh kumar M - 20BAI1235
Parangat singh-20BRS1154

Guide
Geetha S

School name: School of Computing Science and Engineering

Faculty name (ERP No): S.Geetha, (50587)

Academic Year: 2023-2024 (Fall Semester 23-24)

Title of the project: IOT Monitored Intravenous Drip

Number of students involved in this project: 4

Chapter 1: Introduction

1.1 Abstract

In the medical field, a number of gadgets are being developed that will drastically alter how bodily measurements like blood pressure and heart rate are tracked automatically with multidisciplinary nature. The value of the healthcare system is increasing today. One of the most used methods for delivering medications is intravenous (IV) drip mode. Direct medication delivery into the blood circulation is achieved. Its benefits, including its affordability, safety, effectiveness, and speed of administration of pharmaceutical drugs and other fluids, make it frequently employed. Despite its many benefits, if it is not used appropriately, a few problems could occur in its application. The development of a drip rate metre for monitoring intravenous infusion uses the fewest possible circuit components. It is made to function with drip chamber walls that have varying optical transmittivity and various IV fluid types. In order to save electricity, it works with fluctuating battery supply voltage without the need for a regulator. The nurse receives a notification from the IV fluid monitoring device automatically using GSM technology in the proposed system. With the use of a solenoid valve, our research aims to automatically stop the flow of a liquid from an IV bag. The patient's blood pressure and pulse rate are continuously tracked and shown on the liquid crystal display (LCD). By using this technology, the nurse's workload is reduced as opposed to continuously monitoring an IV fluid system. One of the biggest benefits of our project is the simplicity of the user interface, which can be effectively managed via mobile software.

1.2 Problem Definition

The IoT Monitored Intravenous Drip system aims to address challenges in traditional intravenous (IV) therapy by proposing an automated monitoring and control platform. With a focus on patient safety and healthcare efficiency, the system utilizes sensors like ultrasonic and light sensors, along with NodeMCU and Arduino microcontrollers. It monitors fluid levels, prevents air embolism, and controls the IV drip rate autonomously. The proposed technology not only reduces the workload on healthcare providers but also enhances accuracy in drug administration. Future work involves refining the system for real-world applications, integrating linear control for drip rate adjustment, and developing a scalable mobile application for comprehensive patient data management.

1.3 Motivation

- Patient Safety Enhancement: To reduce the risks associated with incorrect drip rates and air embolisms.
- Healthcare Efficiency: To automate the monitoring process, freeing up healthcare providers' time for more critical tasks and minimizing the potential for human error.
- Technological Advancements in Healthcare: Integrating advanced technologies into healthcare systems for more precise and automated patient care.
- Cost-Efficiency and Affordability: The use of minimal circuit components and IoT devices contributes to the affordability of the proposed system, aligning with the need for cost-effective solutions in healthcare.
- Future-Ready Healthcare Solutions: The growing need for intelligent, autonomous systems that can enhance healthcare delivery, making it relevant for the evolving landscape of healthcare services.

1.4 General Introduction to topic

India is ranked 154th out of 195 developing nations in the world for healthcare. According to the National Health Policy, by 2017, public healthcare spending is expected to increase from its present level of 1.4% of GDP to 2.5%, with more than two-thirds of those funds going toward top-tier healthcare. It remains the main source of employment and contributes significantly to India's overall socioeconomic development. India's progress is crucially dependent on the health sector.

India's development of medical facilities has been unbalanced. We are unaware of the rapidly developing sector of healthcare automation. Young people in the modern era have little time to Focus on healthcare since it takes more effort and time. It has substantial business profits. We are unaware of the rapidly developing sector of healthcare automation. Young people in the modern era have little time to focus on healthcare since it takes more effort and time. It makes a lot of money in terms of business. The nurse/monitoring person can decrease automation, time, and stress.

As we transition to a healthy future, we must protect people's health. The healthcare system has various drawbacks, including issues with infection control brought on by doctor evaluations, cardiac attack brought on by a blood clot from an air embolism in the intravenous fluid, medication mistakes as a result of surgery, and clinic specifically. This initiative seeks to address those issues and encourages youth to focus on healthcare as. It is a developing field that will be needed in the future.

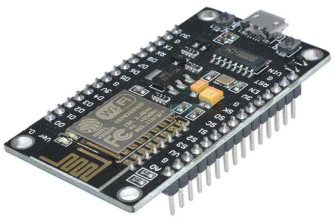
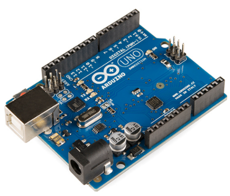
Direct fluid infusion into a vein is known as intravenous treatment. Simply put, "intravenous" means "inside vein." IV systems can be used to transport equipment, for blood transfusions, to rectify fluid imbalances, and as fluid replenishment. The quickest approach to provide fluids or medications is in this manner. As a result, IV therapy treatment needs to be monitored.

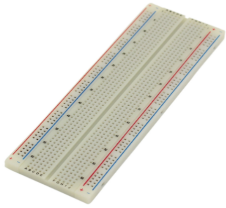
In this study, a technique for hospitals to effectively monitor drip infusion levels is proposed. Our suggested system consists of a light sensor to monitor any bubble development in the IV infusion bag and an ultrasonic sensor to measure fluid level. To avoid an air embolism and reverse blood flow, a control mechanism can notify the nurses or doctors if the fluid level in the IV infusion bag falls below a specific threshold.

The nurse can choose to carry on or switch out the IV bag at that point. The efficiency of the hospital staff as a whole has greatly increased thanks to this effort. The primary goal of this project is to develop an autonomous drip monitoring system that is dependable, affordable, and easy for anyone to use. The suggested strategy will be extremely helpful to hospital staff because it does not demand constant patient monitoring or mandatory presence. Additionally, it eliminates any potential for human error brought on by hospital overcrowding. This concept not only offers an automated and trustworthy means to keep track of the fluid level in patients' IV drips, but also identifies air bubble formation that poses a risk to the patients' health.

Chapter 2: Methodology

2.1 Project Component Specification

Product	Product Specification	Use Case
 NodeMCU (ESP8266)	Built-in Wi-Fi module, 32-bit RISC CPU core, open-source firmware, GPIO pins.	**Purpose**: Microcontroller for IoT connectivity. **Role:** Establishes internet connectivity, interacts with cloud, and manages data transmission.
 Ultrasonic Sensor	Transducer for ultrasonic pulses, measures echo patterns.	**Purpose:** Measures fluid level in IV infusion. **Role**: Provides real-time data on fluid levels, enabling precise monitoring.
 Servo Motor	Precision rotation, controlled by PWM signals	**Purpose:** Controls the solenoid valve regulating drip flow. **Role:** Adjusts valve opening/ closing based on the microcontroller's instructions
 Arduino Uno	ATmega328P microcontroller, digital and analog pins, USB connectivity.	**Purpose:** Microcontroller for servo motor control. **Role:** Manages servo motor operation and integrates with NodeMCU.
Blynk IoT Cloud	Supports real-time data transfer, mobile application integration.	**Purpose:** Cloud platform for IoT communication. **Role:** Facilitates communication between the NodeMCU and mobile devices.

 Breadboard	Phosphor bronze spring clips, facilitates component connections	**Purpose**: Solderless platform for circuit prototyping. **Role:** Organizes and connects various electronic components for testing.

2.2 Technology Stack

The project has been made possible by using two microcontrollers esp8266 i.e., nodemcu 1.0 and Arduino uno. nodemcu has inbuilt WIFI module as we need internet to make IOT and cloud communication possible. We are using blynk 2.0 which is an IOT cloud. Once switched on with the uploaded code, nodemcu makes connection with the cloud and starts its execution. This project has a web-based dashboard as well as a mobile application dashboard too which makes monitoring and control very easy. The IOT based IV monitoring project uses ultrasonic sensor to monitor fluid levels of the drip. This fluid level data is uploaded to cloud every second and is represented by a gauge in a scale of 0 to 100 percent in the application dashboard. If the fluid level falls below 10%, the project is designed to send a push notification on the mobile application. Additionally, we have used a valve to regulate the drip flow. This is a self-designed valve from scratch implemented using a servo motor which screws and unscrews. The motor is connected to Arduino uno. Arduino controls this servo motor clamp depending upon the pulse width modulated signal we give using nodemcu. We have a switch on IOT dashboard wo willingly control the valve. An additional safety feature added to the drip is that if the fluid level reaches below 5%, the valve is automatically closed to prevent backflow of blood. We also provide a call switch along with the drip which the patient can use to call a staff attendant by sending push notifications to their device.

2.3 Existing System

The level sensor is used in the current system to check the fluid level in the IV system. The fluid level is measured, converted to an electric signal, and sent to the microcontroller. The bell notifies the patient ward whenever the preset point is exceeded so that the IV bag can be promptly replaced or withdrawn. The pressure sensor also picks up blood clots or air emboli in the catheter. As a result, the patient's vein can be used to stop the clot or embolism. As a result, numerous risks—including cardiac arrest—are decreased. Two sensors make up the IV monitoring system: an ultrasonic level sensor and a pressure sensor. The level sensor is used in the current system to check the fluid level in the IV system. The fluid level is measured, converted to an electric signal, and sent to the microcontroller. The bell notifies the patient ward whenever the preset point is exceeded so that the IV bag can be promptly replaced or withdrawn. The pressure sensor also picks up blood clots or air emboli in the catheter. As a result, the patient's vein can be used to stop the clot or embolism. As a result, numerous risks —including cardiac arrest—are decreased. Two sensors make up the IV monitoring system: an ultrasonic level sensor and a pressure sensor.

2.4 Proposed System

In a medical process known as intravenous treatment, liquid drugs are injected directly into the patient's veins. The patient's vein is entered by an IV tube and a needle. There is numerous automatic health monitoring technology is being developed to assure patient safety and to relieve doctors' stress. These sterile solutions (sodium and dextrose) containing necessary nutrients to support the human life which is injected into the patient’s body through a tube attached to the needle. Numerous issues, including blood loss or backflow through an IV tube, will occur as a result of carelessness. To remedy this, our proposed approach to create an IV fluid monitoring system uses solenoid valves to automatically switch off the flow of a liquid from the IV system while simultaneously sending a message to the nurse via GSM technology. The IV fluid flow changes in response to the patient's heart rate and blood pressure, and vice versa. By using this device, the nurse can focus on other tasks rather than constantly monitoring an IV fluid bag. In the proposed system we have also devised a technology such that if any bubbles are formed in the IV bag or IV tube a notification will be sent to the nurse.

2.5 Design

The IoT Monitored Intravenous Drip system design incorporates a meticulous arrangement of hardware components and sensors to ensure precise monitoring and control of intravenous fluid administration. The following is a step-by-step breakdown of the circuit design:

1. **Microcontrollers Selection:**
    - The project utilizes two microcontrollers, the NodeMCU (ESP8266) and Arduino Uno. The NodeMCU facilitates IoT capabilities with its built-in Wi-Fi module, enabling cloud communication, while the Arduino Uno manages servo motor control.
2. **Sensors Integration:**
    - An ultrasonic sensor (HC SR-04) is employed to monitor the fluid level in the IV drip. This sensor calculates distance based on the time taken for ultrasonic pulses to reflect off the fluid's surface.
    - A light-dependent resistor (LDR) detects bubble formation in the IV fluid. Changes in optical transmittivity trigger notifications, preventing potential air embolisms.
3. **Valve Control Mechanism:**
    - A servo motor, controlled by the Arduino Uno, functions as a valve to regulate the IV fluid flow. The motor rotates a clamp that can open or close the fluid pathway based on control signals.
4. **Communication Setup:**
    - The NodeMCU communicates with the Blynk 2.0 IoT cloud platform, allowing for remote monitoring through web-based and mobile dashboards. This setup facilitates real-time tracking of IV fluid levels.

5. **Push Notifications and Alerts:**

- Blynk events are logged, and push notifications are triggered based on specific conditions. For instance, if the fluid level falls below a critical threshold (e.g., 10%), a notification is sent to alert medical staff.

6. **Emergency Call Switch:**
   - An additional feature involves a call switch for patients to request assistance. This switch activates a notification sent to medical staff, enhancing patient-nurse communication.
7. **Safety Features:**
   - To prevent backflow and potential complications, the system automatically closes the valve if the fluid level drops below 5%. This adds an extra layer of safety in case of critical situations.
8. **Breadboard Implementation:**
   - A solderless breadboard serves as the platform for assembling the circuit. This allows for flexibility in component placement and facilitates ease of modification during the prototyping phase.
9. **Integration of Power Supply:**
   - The circuit incorporates a suitable power supply setup to ensure stable operation. The NodeMCU and Arduino Uno are powered adequately to guarantee continuous and reliable functionality.
10. **Code Implementation:**

- The code for both NodeMCU and Arduino Uno is structured to handle various conditions, such as valve control, sensor readings, and event logging. This ensures seamless communication and coordination between the microcontrollers.

In summary, the circuit design prioritizes accuracy, safety, and remote monitoring capabilities, making it an innovative solution for enhancing the efficiency of IV fluid administration in healthcare settings.

Chapter 3: Architecture

The architecture of the IoT Monitored Intravenous Drip system is a sophisticated framework that integrates various hardware and software components to ensure seamless monitoring and control of intravenous (IV) fluid infusion. This innovative system addresses the critical need for efficient healthcare automation, particularly in the administration of IV treatments, while incorporating elements of safety, reliability, and ease of use.

3.1 Hardware Components

The core hardware components of the system include the NodeMCU (ESP8266), ultrasonic sensor, servo motor, and Arduino Uno. The NodeMCU serves as the central microcontroller and communication hub, featuring an inbuilt Wi-Fi module crucial for IoT functionality. It connects to the Blynk 2.0 IoT cloud, enabling remote monitoring and control.

The ultrasonic sensor plays a pivotal role in measuring the fluid level in the IV infusion bag. It employs high-frequency sound waves to detect the distance between the sensor and the fluid surface, providing accurate and real-time data on the fluid level. This data is then transmitted to the IoT cloud for further analysis.

A servo motor is utilized to control the clamp regulating the IV fluid flow. This custom-designed valve, powered by the servo motor, allows precise adjustment of the flow rate based on the pulse width modulated signal generated by the NodeMCU. The Arduino Uno is employed for additional control functions, interfacing with the servo motor to ensure proper valve operation.

3.2 Software Architecture

The software architecture encompasses a comprehensive technology stack, incorporating Blynk 2.0 as the IoT cloud platform. The NodeMCU is programmed to establish a connection with the Blynk cloud, facilitating data exchange and real-time updates. The Blynk cloud serves as a central repository for all sensor data and enables seamless communication with the mobile application dashboard.

The system's operational logic is implemented in the NodeMCU code, which includes functionalities such as monitoring the ultrasonic sensor data, controlling the servo motor based on predefined conditions, and sending alerts in case of critical situations, such as low fluid levels or the formation of bubbles in the IV bag.

3.3 Communication Protocol

The communication between the NodeMCU and the Blynk cloud relies on the Internet of Things (IoT) protocol, leveraging the Wi-Fi capabilities of the NodeMCU. This ensures constant and reliable connectivity, allowing healthcare providers to access real-time data and receive notifications remotely through the mobile application.

3.4 User Interface

The user interface is designed for simplicity and accessibility. The Blynk 2.0 platform provides both a web-based dashboard and a mobile application dashboard. The web-based dashboard allows for comprehensive monitoring and control, while the mobile application offers on-the-go accessibility. Users, including nurses and healthcare providers, can easily visualize IV fluid levels, adjust flow rates, and receive instant notifications regarding critical events.

In essence, the architecture of the IoT Monitored Intravenous Drip system reflects a thoughtful integration of hardware and software components, leveraging IoT technology to enhance the efficiency, safety, and accuracy of IV fluid administration in healthcare settings.

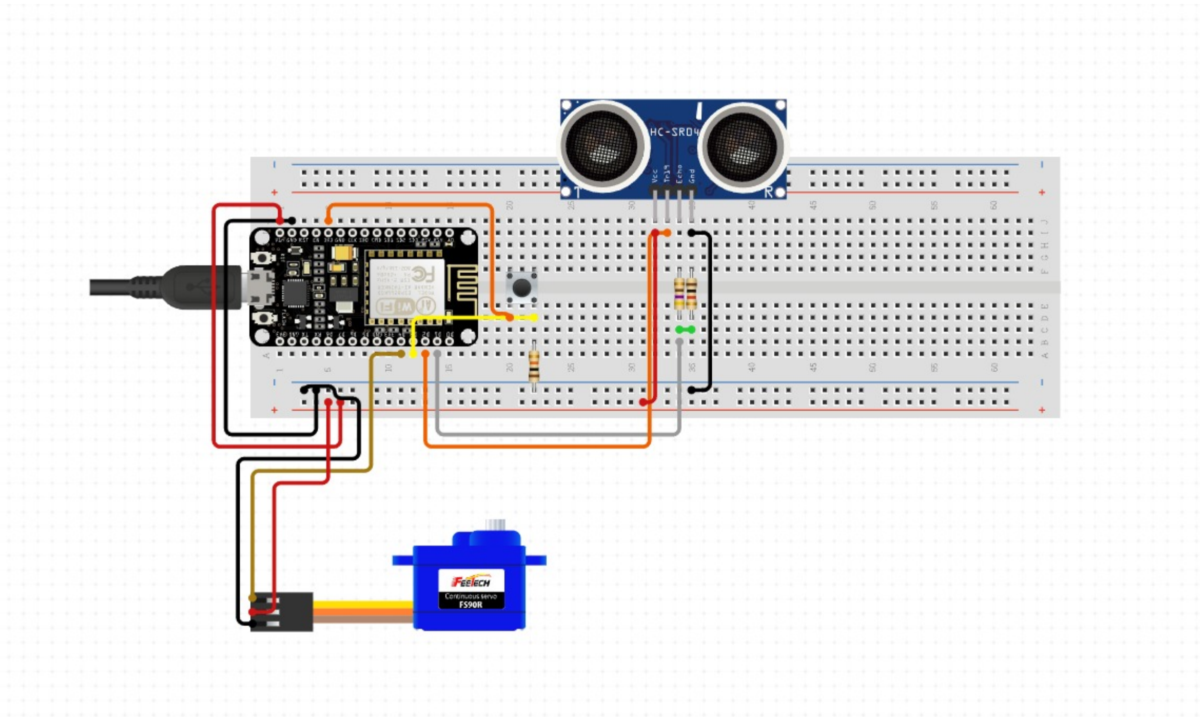


Fig 3.1

Chapter 4: Implementation

4.1 nodemcu code

```
// nodemcu code
#define BLYNK_TEMPLATE_ID "TMPLEgPTTlqV"
#define BLYNK_DEVICE_NAME "nodeMCU"

#define BLYNK_FIRMWARE_VERSION        "0.1.0"

#define BLYNK_PRINT Serial
//#define BLYNK_DEBUG

#define APP_DEBUG
#include "BlynkEdgent.h"
#define trig  D7
#define echo D8
#define call D0
#define pin_open D1
#define pin_close D2

float level = 0;
int flow = 0;

BLYNK_CONNECTED() {
  Blynk.virtualWrite(V1, level);
  Blynk.syncVirtual(V2);
}
void setup()
{
  Serial.begin(115200);
  delay(100);
  pinMode(trig, OUTPUT);
  pinMode(echo, INPUT);
  pinMode(call, INPUT);
  pinMode(pin_open, OUTPUT);
  pinMode(pin_close, OUTPUT);
  BlynkEdgent.begin();
```

```
}

BLYNK_WRITE(V2) {

  int t = param.asInt();

  if (t == 0 && flow == 1) {
    digitalWrite(pin_close, LOW);
    delayMicroseconds(2);
    digitalWrite(pin_close, HIGH);
    delayMicroseconds(15);
    digitalWrite(pin_close, LOW);
    flow = 0;
  }

  if (t == 1 && flow == 0) {
    digitalWrite(pin_open, LOW);
    delayMicroseconds(2);
    digitalWrite(pin_open, HIGH);
    delayMicroseconds(15);
    digitalWrite(pin_open, LOW);
    flow = 1;
  }

  if (level <= 5 && flow == 1) {
    digitalWrite(pin_close, LOW);
    delayMicroseconds(2);
    digitalWrite(pin_close, HIGH);
    delayMicroseconds(15);
    digitalWrite(pin_close, LOW);
    flow = 0;
    Blynk.virtualWrite(V2, 0);
  }
}

void loop() {
  delay(1000);
  sendSensor();
```

```
  if (digitalRead(call)) {
    Serial.println("Call attendant");
    Blynk.logEvent("call_attendant", "Your presence is being asked by the patient");
  }

  if (level < 10) {
    Blynk.logEvent("low_level", "The fluid level is below 10 percent");
  }
  BlynkEdgent.run();
}

void valve_open() {
  myservo.attach(5);
  delay(500);
  Serial.println("Servo COnnected");
  myservo.writeMicroseconds(1600);

  delay(2000);
  Serial.println("Servo rotation complete");
  myservo.detach();
  Serial.println("End");
  delay(1000);
}

void valve_close() {
  myservo.attach(5);
  delay(500);
  myservo.writeMicroseconds(1500);

  delay(4000);
  myservo.detach();
  Serial.println("End");
  delay(1000);
}

void sendSensor() {
  digitalWrite(trig, LOW);
  delayMicroseconds(2);
```

```
  digitalWrite(trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig, LOW);

  float duration = pulseIn(echo, HIGH);
  float distance = duration * 0.034 / 2;

  Serial.print("Distance : ");
  Serial.println(distance);

  level = (20 - distance) / 15 * 100;
  Serial.println(level);
    if(level < 0){
      level = 0;
    }

  Serial.print("level % : ");

  Blynk.virtualWrite(V1, level);
}
```

The following are the steps the code follows :

1. Initialization:
    - Define Blynk template ID, device name, firmware version, and enable debugging.
    - Include necessary libraries and define hardware pin assignments for sensors and actuators.
2. BlynkEdgent Initialization:
    - Initialize the BlynkEdgent library for seamless integration with the Blynk IoT platform.
    - Set up the serial communication for debugging.
3. Blynk Connection Handling:
    - In the BLYNK_CONNECTED() function, ensure the virtual pin V1 is updated with the current fluid level.

- Synchronize virtual pin V2 to maintain consistent control between the hardware and Blynk app.

4. Control Logic (BLYNK_WRITE):
    - Upon receiving a command on virtual pin V2, check the value (t) and control the solenoid valve accordingly.
    - If the command is to close the valve (t == 0) and the flow is currently active, stop the flow.
    - If the command is to open the valve (t == 1) and the flow is currently inactive, start the flow.
    - If the fluid level drops below 5% during an active flow, stop the flow and update the Blynk app.
5. Main Loop:
    - Introduce a delay of 1 second to control the frequency of sensor readings.
    - Call the sendSensor() function to measure the fluid level using the ultrasonic sensor.
    - Check if the call switch is activated; if true, log an event indicating the need for an attendant.
    - If the fluid level is below 10%, log an event indicating a critically low fluid level.
    - Run the BlynkEdgent library to maintain IoT connectivity.
6. Valve Control Functions:
    - Define functions for opening and closing the solenoid valve using a servo motor.
    - Attach the servo motor, set the rotation angle, and detach it after completion.
7. Sensor Reading (sendSensor):
    - Trigger the ultrasonic sensor to measure the distance to the fluid in the IV chamber.
    - Calculate the fluid level as a percentage based on the measured distance.
    - Ensure the calculated level is not below zero.
    - Update the Blynk app with the current fluid level.

This code implements an IoT-based IV monitoring system, integrating Blynk for remote monitoring and control, ultrasonic sensor for fluid level measurement, and servo motor for valve regulation. The control logic ensures safe and automated IV drip management.

4.2 Arduino code

```
//Arduino Code
#include <Servo.h>
Servo myservo;

int pin_open = 3;
int pin_close = 4;
int servo_pin = 9;

void setup() {
  pinMode(pin_open, INPUT);
  pinMode(pin_close, INPUT);}
void loop() {
  // put your main code here, to run repeatedly:
  if(pulseIn(pin_open, HIGH)){
    valve_open();
  }

  if(pulseIn(pin_close, HIGH)){
    valve_close();
  }
}
void valve_open() {
  myservo.attach(9);
  delay(500);
  Serial.println("Servo COnnected");
  myservo.writeMicroseconds(1600);

  delay(2000);
  Serial.println("Servo rotation complete");
  myservo.detach();
  Serial.println("End");
  delay(1000);
```

```
}

void valve_close() {
  myservo.attach(9);
  delay(500);
  myservo.writeMicroseconds(1500);

  delay(4000);
  myservo.detach();
  Serial.println("End");
  delay(1000);
```

The following are the steps the code follows:

1. Library Inclusion:
   - Include the Servo library for controlling the servo motor.
2. Pin Definitions:
   - Define pin numbers for the open and close signals, as well as the servo motor.
3. Setup Function:
   - Set the pin_open and pin_close as INPUT pins in the setup function.
4. Main Loop:
   - Continuously run the main loop to monitor the state of the open and close pins.
5. Valve Control (pulseIn):
   - Use the pulseIn function to measure the duration of a pulse on the pin_open and pin_close.
   - If a pulse is detected on pin_open, call the valve_open() function.
   - If a pulse is detected on pin_close, call the valve_close() function.
6. Valve Open Function:
   - Attach the servo motor to pin 9.
   - Introduce a delay for stabilization.
   - Set the servo position to open the valve (writeMicroseconds(1600)).
   - Wait for the rotation to complete, detach the servo, and print relevant messages.

7. Valve Close Function:
    - Attach the servo motor to pin 9.
    - Introduce a delay for stabilization.
    - Set the servo position to close the valve (writeMicroseconds(1500)).
    - Wait for the rotation to complete, detach the servo, and print relevant messages.

This Arduino code controls a servo motor to open and close a valve based on pulses received on specific input pins. The main loop continuously monitors the state of these pins, triggering the corresponding valve control functions when pulses are detected. The valve_open and valve_close functions handle the servo motor's attachment, position setting, rotation, detachment, and include delay for stability. This code is designed for regulating the flow in an IV infusion system based on external commands received through pulse signals.

Chapter 5: Results

5.1 Results after Implementation

The implementation of the IoT Monitored Intravenous Drip system yielded significant outcomes, addressing crucial aspects of patient care, healthcare automation, and medical facility efficiency. Below are key results and findings:

- **Improved Patient Safety:** The system successfully monitored intravenous infusion levels, ensuring precise and accurate administration of medications. The integration of ultrasonic sensors and light sensors provided real-time data on fluid levels, minimizing the risk of complications due to improper fluid delivery.
- **Automatic Notification System:** The incorporation of GSM technology enabled an automatic notification system. Nurses received alerts when intervention was required, such as low fluid levels or the formation of bubbles in the IV bag or tube. This feature streamlined the healthcare process and reduced the chances of human error.
- **Efficiency Enhancement:** The autonomous drip monitoring system significantly reduced the workload on healthcare professionals. The automatic control mechanism, utilizing solenoid valves, efficiently managed the flow of liquid from the IV system. This automation allowed nurses to focus on other critical tasks instead of continuously monitoring IV fluid bags.
- **User-Friendly Interface:** The project emphasized simplicity in the user interface, ensuring effective management through mobile software. The use of a mobile application dashboard and a web-based dashboard facilitated easy monitoring and control, contributing to a user-friendly experience for medical staff.
- **Technological Stack Validation:** The chosen technology stack, including NodeMCU, Arduino Uno, and sensors, proved effective in creating a robust IoT-based system. Blynk 2.0, an IoT cloud platform, facilitated seamless communication and data transfer between devices.
- **Potential for Home Care:** The system's capabilities extend beyond hospital settings. With reliable monitoring and control features, it opens possibilities for home care applications, providing patients with necessary medical attention in a comfortable environment.

- **Reduced Complications:** By addressing common issues associated with IV therapy, such as air embolism and fluid imbalances, the system demonstrated its potential to enhance patient safety and reduce the occurrence of complications.

The results collectively showcase the feasibility and practicality of the proposed IoT Monitored Intravenous Drip system, highlighting its positive impact on healthcare delivery and patient outcomes.

5.2 Screenshots Of The Mobile Application

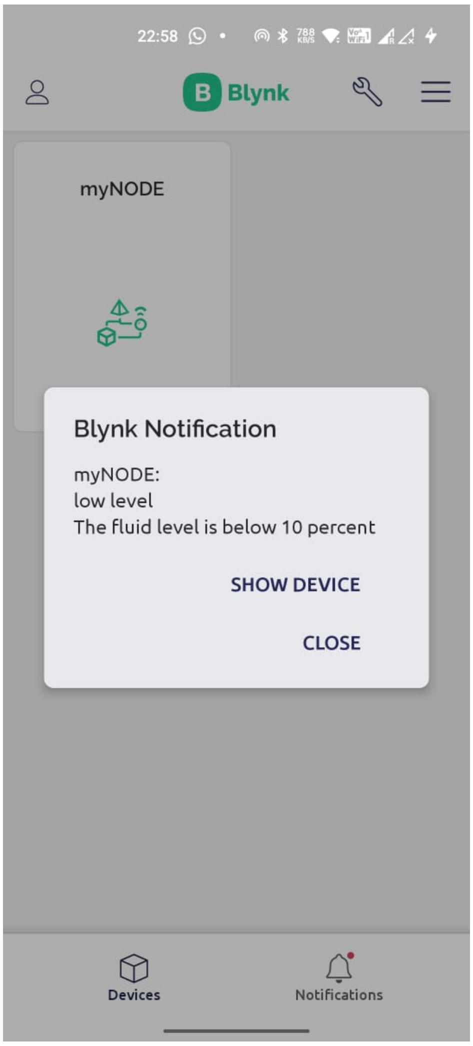


Fig 5.1

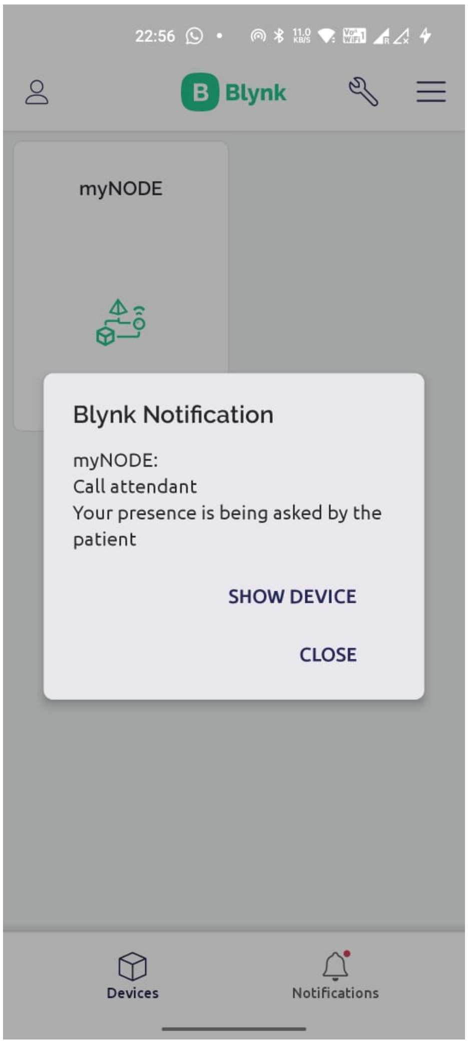


Fig 5.2

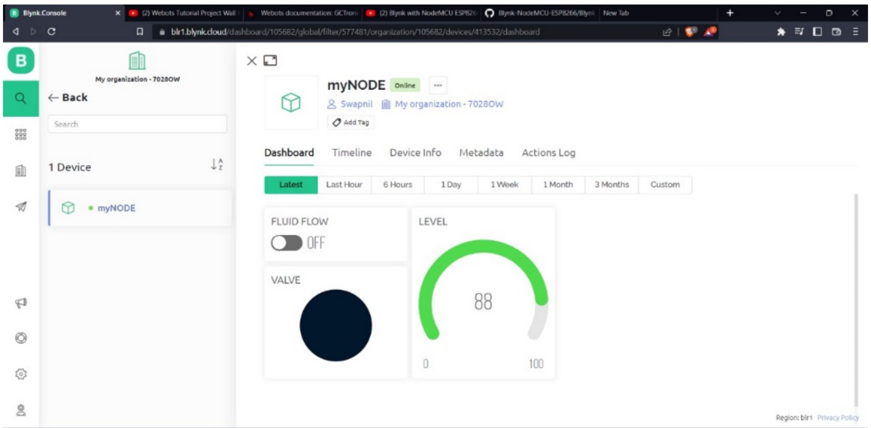


Fig 5.3

5.3 Pictures of The Implemented Model

Fig 5.4

Fig 5.5

Chapter 6: Outcomes

The implementation of the IoT Monitored Intravenous Drip system presents a myriad of positive outcomes, addressing critical issues in healthcare delivery and significantly enhancing patient care. The project combines innovative sensor technologies, microcontrollers, and IoT connectivity to create a robust and automated solution for intravenous fluid administration.

Improved Patient Safety:

- Real-time monitoring of intravenous drip rates ensures precise and safe administration of medications and fluids, minimizing the risk of complications.
- Early detection of air bubble formation in the IV system contributes to the prevention of arterial air embolism, reducing the chances of severe medical events like heart attacks and strokes.

Clinical Efficiency and Workload Reduction:

- Automation of IV fluid monitoring reduces the manual workload for healthcare professionals, allowing them to focus on other critical tasks.
- The system's ability to send notifications to nurses via GSM technology eliminates the need for constant manual supervision, streamlining the workflow.

Technological Advancements:

- Integration of ultrasonic sensors and light sensors offers a sophisticated and adaptable solution that can function with various IV fluid types and drip chamber configurations.
- The use of IoT technology and cloud-based communication enhances accessibility and allows for remote monitoring, enabling healthcare professionals to keep track of IV drips from different locations.

User-Friendly Interface:

- The system features a user-friendly interface managed through mobile software, promoting ease of use for healthcare professionals.
- The LCD display showing continuous tracking of the patient's blood pressure and pulse rate further simplifies the monitoring process.

Potential for Home Care:

- The system's reliability and automated features open up possibilities for extending its use to home care settings, providing a more flexible approach to patient treatment.
- By reducing the need for constant supervision, the project contributes to making healthcare services more accessible and adaptable to diverse patient needs.

In conclusion, the IoT Monitored Intravenous Drip project not only addresses existing challenges in healthcare but also paves the way for future advancements in medical automation. The outcomes reflect a harmonious blend of technological innovation, enhanced patient safety, and streamlined healthcare processes.

Chapter 7: Conclusion

This study proposes an IoT-based monitoring and control platform for IV infusion setup. The suggested work decreases the amount of time and effort required to monitor the infusion setup and allows for wireless monitoring. It helps in ensuring there is zero margin of error as improper administration of drip can lead to many problems. It also improves clinical efficiency, safety and patient experience in hospitals and makes home care possible for many patients. The use of an ultrasonic sensor simplifies and expedites system implementation because it eliminates the need to calibrate the system for different fluids. LDR is used to detect bubble formation of the fluid which eliminates the risk of arterial air embolism which can cause heart attacks, stroke or respiratory failure. This system may be quickly installed on the stand where the drip bottle is hung, making replacing the bottle simple without having to bother about all the gear.

In addition to being extremely important and necessary in the administration of pharmaceutical drugs, the use of intravenous (IV) drip also has serious consequences and adverse effects if it is not done correctly. Even though IV drip is undoubtedly a cost-efficient, safe, and useful instrument, using it may nonetheless present a number of problems. Therefore, it is important to administer the IV fluid with extreme care.

We won't be able to give patients the care they need unless we address the issues with IV drip usage, reduce its complications, and improve its accuracy. Therefore, it is necessary to design and develop a new type of IV drip set that can not only monitor but also regulate the drip rate as needed

Chapter 8: Future Work

The project is based on medical grounds and can actually make a difference in health care of patients, to make the project ready for real world application development of linear control of clamp has to be done so we can control the drip rate from nurse/doctor phone screen. this controllability will make the task of monitoring the IV even more efficient. being a project that can be deployed in health care sector the equipment used will also get upgraded so the accuracy and precision and durability increases. with this we can expect the whole project can be made ready for future applications and can be deployed in hospitals for health care and this can be of great help to nurses and doctors to manage their patient's health.

We intend to make a more compact and organized design which is highly reliable and robust to use in real life hospital applications. To make this device scalable a separate mobile application can be developed. This application will be connected to a cloud hosted database and will have all information regarding the admitted patients. This information will be accessible to all the medical staff who can read and modify this data depending upon the access privileges provided. There is also a need to build a feedback system which will count the current number of drops/minute and compare it to the preset rate to provide higher accuracy.

Chapter 9: Sample Codes

GitHub Link

Chapter 10: References

- Arfan, M. (2020b, October 6). Intravenous (IV) Drip Rate Controlling and Monitoring for Risk-Free IV Delivery. IJERT. https://www.ijert.org/intravenous-iv-drip-rate-controlling-and-monitoring-for-risk-free-iv-delivery

- Monitoring of Intravenous Drip Rate. (2001). *Monitoring of Intravenous Drip Rate*. https://www.ee.iitb.ac.in/~spilab/papers/2001/paper_vvkamble_biovision2001.pdf

- Maniktalia, R., Tanwar, S., Billa, R., & K, D. (2022). IoT Based Drip Infusion Monitoring System. *2022 IEEE Delhi Section Conference (DELCON)*. https://doi.org/10.1109/delcon54057.2022.9753052

- Design and Development of IOT enabled IV infusion rate monitoring and control device for precision care and portability. (2020, November 5). IEEE Conference Publication | IEEE Xplore. https://ieeexplore.ieee.org/document/9297376