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Ivigilance – IOT Based Intravenous Drip Monitoring And Controlling System

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Abstract: The " IVigilance -Intravenous Drip Monitoring and Controlling System for Hospital Using IoT" project presents an IoT-driven solution designed to modernize and enhance intravenous therapy management within healthcare institutions. Intravenous (IV) drips play a pivotal role in patient care, yet their manual oversight poses potential risks, including medication errors and inefficiencies. This project leverages IoT technology to create an automated system that continuously monitors and regulates IV drip operations. By incorporating IoT sensors and microcontrollers into the IV drip infrastructure, real-time data on flow rates and drip status is collected. This data not only ensures precise medication and fluid delivery but also enables remote control and adjustment by healthcare professionals. The system's benefits are twofold. First, it reduces the likelihood of human error, significantly improving patient safety. Second, it provides data-driven insights that empower healthcare institutions to optimize resource allocation and make informed clinical decisions. In summary, the "Intravenous Drip Monitoring and Controlling System for Hospital Using IoT" project offers a transformative approach to IV therapy management. It promises to enhance patient care, streamline hospital operations, and usher in a new era of healthcare technology, where IoT-driven automation ensures the accuracy and safety of intravenous therapies, benefiting both patients and healthcare providers.

Index Terms - IoT-based system, IV drip therapy, Sensors, microcontrollers, and cloud computing, Remote adjustment and alerting, Real-time data.

I. Introduction

Intravenous (IV) therapy is a critical component of healthcare, providing patients with essential fluids, medications, and nutrients. Ensuring the precise administration of IV drips is vital for patient safety and recovery. To meet this need, the Intravenous Drip Monitoring and Controlling System for Hospitals using IoT is a groundbreaking project that leverages the power of the Internet of Things (IoT) to enhance the accuracy, efficiency, and quality of IV therapy in healthcare settings. In the realm of modern healthcare, the traditional method of manually monitoring and adjusting IV drips is labor-intensive, error-prone, and often always relies on the availability of healthcare professionals. The IoT-based system we propose revolutionizes this process by seamlessly integrating smart sensors, connected devices, and cloud computing to create a robust, automated, and real-time solution. The core objectives of this project are twofold: first, to monitor the infusion rate of IV drips with unparalleled precision, and second, to provide healthcare practitioners with the ability to remotely control and adjust IV parameters in real-time, ensuring patients always receive the correct dosage of fluids or medications. The key components of the system include smart IV infusion pumps equipped with sensors, a secure IoT network infrastructure, and a user-friendly interface accessible to medical personnel through smartphones, tablets, or computers. The system continuously collects data on the flow rate, volume, and status of IV drips, transmitting this information to a centralized cloud platform. Here, sophisticated algorithms analyse the data, raising alerts for any anomalies or deviations from the prescribed treatment plan. By deploying this IoT-based solution, hospitals can achieve several significant benefits. These include reducing the risk of medication errors, minimizing the workload of healthcare professionals, enhancing patient comfort, and potentially decreasing healthcare costs associated with complications from incorrect IV therapy.

Ultimately, our Intravenous Drip Monitoring and Controlling System represents a technological leap forward in patient care, combining the precision of IoT with the expertise of medical professionals to ensure safer and more effective IV therapy in hospitals.

Review Of Literature Study

Kothapally Aditya Reddy, Suggu Pavan [1], The paper presents a comprehensive solution for advanced patient monitoring in the Intensive Care Unit (ICU) by integrating multiple sensors for intravenous (IV) detection and employing Canny edge detection technology, alongside real-time Electrocardiogram (ECG) monitoring with a live feed. This innovative system enhances patient care by providing a holistic view of critical patient data. The integration of sensors for IV detection ensures accurate and timely monitoring of IV therapy, enabling healthcare professionals to track fluid administration and promptly detect any anomalies. The incorporation of Canny edge detection facilitates the recognition of subtle image details, allowing for more precise identification of critical patterns or objects. The real-time ECG monitoring with live feed offers continuous cardiac monitoring, enabling healthcare providers to closely monitor the patient's heart health and detect irregularities promptly.

Natapol Phetsuk, Sumet Umchid [2], The paper titled "Design, Development, and Fabrication of an Intravenous Infusion Monitoring Device" explores the creation of an innovative medical device aimed at improving the precision and safety of intravenous (IV) therapy. The device is designed to monitor and regulate IV infusion in real-time, offering numerous advantages in the healthcare setting. The primary focus of the paper is on the device's design and development, highlighting its capacity to provide accurate monitoring of IV infusion rates, ensuring that patients receive the prescribed fluids and medications. It also discusses the fabrication process, emphasizing the technical aspects and components of the device. The advantages of this device include enhanced patient safety through real-time monitoring, the ability to detect anomalies or deviations, and the capacity to provide immediate alerts to healthcare providers. Furthermore, the paper mentions the device's potential for integration with the Internet of Things (IoT), which could enable remote monitoring and control of IV therapy. In conclusion, the paper underscores the potential of the Intravenous Infusion Monitoring Device to significantly improve the quality and safety of IV therapy in healthcare settings. It represents a significant technological advancement with promising applications in patient care, remote monitoring, and research within the healthcare industry.

Muhammad Raimi Rosdi, Audrey Huong [3], This study presents an intelligent infusion pump system designed to enhance the management and monitoring of intravenous (IV) drips. The system employs an Arduino-based microcontroller for tasks such as drop counting, tube blockage detection, and monitoring drip bag emptying. It utilizes low-power laser diodes and optical sensors to achieve these functions. Data on flow rate and infusion interruptions are wirelessly transmitted to users' smartphones through the Blynk mobile app and computer-based applications. Notably, the study found no significant difference between manual and automatic drop counting readings. The system is also capable of notifying users of empty bottles and line blockages. Overall, the developed prototype holds promise for further enhancement and testing in real clinical settings, offering the potential for safer and more efficient IV fluid administration with remote monitoring capabilities.

Dragana Oros, Marko Pencic, Jovan Sulc, Maja Cavi´c, Stevan Stankovski, Gordana Ostoji´c and Olivera Ivanov [4], The paper titled "Smart Intravenous Infusion Dosing System" presents a novel healthcare technology designed to improve the accuracy and safety of intravenous (IV) medication administration. The system integrates advanced sensor technology, data analysis algorithms, and real-time monitoring to optimize IV dosing for patients. It continuously assesses a patient's vital signs and adapts the infusion rate accordingly, reducing the risk of underdosing or overdosing. Key features of the system include automated adjustments in response to changes in patient condition, the ability to calculate precise dosages based on individual patient factors, and the capacity to provide alerts and notifications to healthcare providers in case of any anomalies or deviations from prescribed dosages. By enhancing the precision and responsiveness of IV medication delivery, the Smart Intravenous Infusion Dosing System has the potential to improve patient outcomes, minimize adverse events, and streamline healthcare workflows.

Preethi S, Akshaya A, Haripriya Seshadri, Vaishnavi Kumar, R. Santhiya Devi, Amirtharajan Rengarajan, K. Thenmozhi, and Padmapriya Praveenkumar [5], the authors research aims to leverage Internet of Things (IoT) technology to revolutionize healthcare by creating a wireless system for real-time patient monitoring, with a primary focus on controlling and regulating Intra Venous (IV) fluid flow. The system also monitors pulse rate and body temperature, eliminating the need for physical presence to oversee patients and stop IV infusion. Instead, it automatically stops infusion and notifies healthcare providers via an app. The project employs a cyber-physical system architecture based on ontology, enhancing patient care with fewer human interventions and reduced emergency risks. Hardware components like Node MCU and solenoid valves, along with software tools like Arduino IDE, Firebase, and MIT App Inventor, are used for implementation. The system proves effective for efficient, secure, and automated healthcare monitoring, potentially saving lives.

Anagha R, Ashwini S, Keerthana G, Monica M, Prof. Vindhya [6], Electronic valve module includes a normally closed solenoid valve and a relay The load cell is used to continuously monitor the weightage of the saline bottle and it will be displayed on the LCD display, when it reaches the critical level, an automatic message will be sent to a hospital staff's Android app. The load sensor is fixed on a saline hanger and bottle is hung on it. This sensor converts the varying weight of the bottle into different voltages. The pressure in the dripping IV solution is detected by a pressure sensor, connected to the motor. The valve collects flow pulse signal from the Impeller Hall flow sensor through the Load sensor. Using this concept one doctor can monitor several patients' reports on the mobile app or computer screen so one doctor can monitor several patients.

Mohammed Arfan, Srinivasan M, Adithya Gowda Baragur, Vaishnavi Naveen [7], This paper presents an IoT-based drip monitoring and control device designed to enhance the safety and efficiency of Intravenous (IV) infusion setups. The current practice of estimating drip rates and monitoring IV bottles is error-prone and relies on human judgment. This device aims to mitigate these issues by integrating an IR sensor for drop detection, a microcontroller with Wi-Fi capability for data transmission, and an actuator for drip rate regulation. The IoT platform allows doctors and nurses to remotely monitor and control IV therapy through a web dashboard or mobile app. It ensures accuracy, stability, and reliability in the IV setup. The device's data is transmitted to an online server, stored in a SQL database, and visualized for easy readability. The paper discusses the device's design, testing, and battery capacity considerations. Additionally, the paper highlights the need for such technology in the context of the Internet of Medical Things (IoMT) and identifies existing IV monitoring devices that lack control features. Overall, this device represents a significant advancement in IV therapy management, offering both convenience and safety.

Nicola Giaquinto,Marco Scarpetta,Mattia Alessandro Ragolia [8], For patients who are hospitalised, intravenous (IV) infusion is one of the most popular treatments. Given that both over- and under-infusion can result in major health issues, it is crucial to monitor the fluid flow rate that is being given to the patient in order to ensure his safety. This paper presents a unique approach based on deep learning computer vision techniques for monitoring the IV injection flow rate. In essence, a camera records the drip chamber, and object detection is utilised to count the drips. As a result, compared to other techniques created for this goal, the suggested one is less invasive. It can generate an accurate real-time assessment of the drip's instantaneous flow rate, according to experimental data. t can generate an accurate real-time assessment of the drip's instantaneous flow rate, according to experimental data. These factors make the suggested approach suitable for implementing health facility monitoring and control systems. A deep learning computer vision solution for IV drip monitoring was put out. It was discovered that this method offered good accuracy performance without requiring direct interaction with the infusion kit, making it less intrusive than alternative solutions. Additional benefits of the system include its adaptability to various operating circumstances and modular design. It is in fact capable of receiving and analysing video signals from both nearby and far-off places. The estimating approach becomes more versatile and resilient to changing environmental variables with the use of deep learning algorithms.

Ms. Sincy Joseph, Ms. Navya Francis Ms. Anju John, Ms. Binsi Farha, Mrs. Asha Baby [9], The paper titled "Intravenous Drip Monitoring System for Smart Hospitals Using IoT" presents an innovative healthcare solution that leverages Internet of Things (IoT) technology to enhance the efficiency and safety of intravenous (IV) drip administration in hospital settings. In traditional healthcare setups, IV drip monitoring often relies on manual observations by nursing staff, leading to potential human errors and delayed responses to critical situations. This paper introduces a smart hospital solution that utilizes IoT devices to continuously monitor and manage IV drips. If any irregularities are detected, such as an incorrect drip rate or nearing completion of the IV bag, automated alerts are generated to notify medical staff for prompt intervention. Furthermore, the paper discusses the benefits of this system, which include improving patient safety, reducing the workload on nursing staff, and optimizing resource utilization in hospitals. It also highlights the potential for data-driven insights and predictive analytics to further enhance patient care. Overall, the "Intravenous Drip Monitoring System for Smart Hospitals Using IoT" paper underscores the transformative impact of IoT technology in healthcare, emphasizing its potential to revolutionize IV drip management, enhance patient outcomes, and streamline hospital operations.

Shohag Hossain, Shraboni Sharmin, Tasnuva Faruk, and Md Kafiul Islam [10], The paper titled "Low-Cost Digitization of Infusion Pump for Real-time Automated Flow Rate Monitoring and Warning" presents a novel approach to enhance the safety and efficiency of infusion therapy in healthcare settings. In healthcare, infusion pumps are commonly used to administer fluids and medications to patients. However, manual monitoring of these pumps is prone to human error, potentially leading to adverse events. This research addresses this issue by proposing a cost-effective digitization solution for infusion pumps. The paper discusses the design, implementation, and testing of the digitization system, demonstrating its reliability and effectiveness in improving patient safety and reducing the risk of medication errors. This innovation has the potential to revolutionize the way infusion therapy is administered, making it more precise, automated, and secure, ultimately benefiting both healthcare providers and patients.

Debjani Ghosh, Ankit Agrawal, Navin Prakash, Pushkal Goyal [11], Saline, one of the most used intravenous (IV) therapies, is crucial in the treatment of critically ill patients. Monitoring the level of the saline bottle is crucial because blood can spill into it if the bottle is emptied but the needle is left in the vein. Monitoring the saline bottle level is the responsibility of the nurses or carers in hospitals. Most often, due to carelessness and any odd circumstance, the precise timing of withdrawing the needle from the patient's vein is disregarded, which results in major injury and may even result in death. Furthermore, in order to offer telehealth services, remote monitoring is necessary. We have presented a cost-effective smart saline level monitoring device that combines sensor and Internet of Things (IoT) technologies in order to minimize accidents brought on by careers' ignorance and to enable remote surveillance in telehealth services. The load sensor and the ESP32 Wi-Fi System on Chip (SoC) microcontroller were used to build this system. The bottle's weight is converted to a specified voltage by the load sensor. Based on the voltage the sensor's microprocessor, the ESP32, sends out, the microcontroller develops and publishes a certain message. We have used the MQTT-S publish/subscribe protocol, which runs over TCP, to publish and deliver the messages to the devices (e.g., smartphone, tablet, laptop, etc.) of subscribers like doctors, nurses, or carers. The suggested monitoring system delivers messages to subscribers in a dependable manner, which is crucial for the healthcare industry.

Jayeeta Saha, Arnab Kumar Saha, Aiswarya Chatterjee, Suyash Agrawal, Ankita Saha, Avirup Kar, Himadri Nath Saha [12], The Internet of Things revolutionizes modern technology, making life easier and automated. It provides remote real-time health monitoring for patients, reducing human error and room occupied space. The combination of Raspberry Pi and IoT has solved the issue of patient anxiety by allowing remote monitoring of health conditions. Raspberry Pi offers a complete Linux environment at a low cost, allowing for interfacing services and actuators through general purpose I/O pins. This paper proposes an advanced IoT-based automated remote health monitoring system that offers alarm notifications, prescribed medicine names, and dose displays. This system reduces human error and allows patients to monitor their health from home, allowing for necessary action during minor ailments. Sensors are used for data measurement, and the system also provides automatic appliance control. Future improvements include a mobile app for managing data and strict security protocols. Phone or video call services can also be included for patient communication.

Shyama Yadav, Preet Jain [13], The authors introduce a remote drip infusion monitoring and control system designed to address the laborious and time-consuming nature of manual healthcare tasks, particularly in an era of increased population. The proposed system employs IR sensors, servo motors, and Wi-Fi communication to monitor and control drip infusion rates, detect remaining time, and alert when an infusion bag is nearly empty. This information is wirelessly transmitted to a central monitor in the nurse's control room, allowing nurses to remotely control infusion rates. The system eliminates the need for constant visual monitoring and enhances healthcare efficiency. The paper also discusses existing approaches and hardware components, showcasing its practicality and effectiveness in healthcare settings.

Pattarakamon Rangsee, Paweena Suebsombut, Phakphoom Boonyanant [14], This research suggests a saline droplet measuring system (SDMS) that is inexpensive. In rural public hospitals, the technique can be used to check the saline droplets in each patient's bed in hospital. All patient beds will have measurement modules installed. Each patient's saline droplet status will be displayed by the system. So, Nurses can accurately check a patient's saline droplet status. Saline droplet statuses are displayed on a computer. rate, time left, and drop rate. In rural public hospitals, nurses and patient relations monitor saline droplet status every hour, which is time-consuming and disrupts patient rest. Medical devices like infusion pumps and liquid droplets have been developed to check droplet status, but their prices are expensive. Liquid droplet devices use infrared sensors to detect and control medicine volume, while infusion pumps deliver fluids like pain relievers, chemotherapy drugs, hormones, insulin, and antibiotics. These devices are popular in hospitals but are only used in ICU rooms in Thailand. This paper proposes a low-cost saline droplet measurement system (SDMS) for common patient rooms in rural public hospitals. The system provides a low-cost device and program that can be installed in the patient's room, allowing nurses to check saline droplet status without walking around the room every hour.

Andrea Cataldo, Giuseppe Cannazza, Nicola Giaquinto, Amerigo Trotta, and Gregorio Andria [15], The paper "Microwave TDR for Real-Time Control of Intravenous Drip Infusions" presents a novel application of microwave Time Domain Reflectometry (TDR) technology for enhancing the precision and safety of intravenous (IV) drip infusions. Traditional IV systems often rely on manual adjustments, leading to dosage errors and patient discomfort. In this study, the authors propose a real-time control system that utilizes microwave TDR to monitor the fluid flow within the IV tubing. By measuring the dielectric properties of the liquid in real-time, the system can accurately determine the flow rate and adjust it accordingly to maintain a consistent infusion rate. This technology offers several advantages, including the ability to detect air bubbles, occlusions, and variations in tubing diameter, thus reducing the risk of complications, and improving patient care. The paper underscores the potential of microwave TDR as a valuable tool for enhancing the precision and safety of medical fluid delivery systems.

II. METHODOLOGY

When it comes to providing healthcare, an intravenous (IV) drip monitoring and controlling system is essential, particularly in environments like clinics, hospitals etc. Through intravenous access, this technology enables medical practitioners to precisely deliver fluids, medicines, and other therapies straight into a patient's bloodstream. For intravenous therapy to be administered safely and effectively, a sophisticated medical gadget called an IV drip monitoring and regulating system is essential. These devices assist healthcare professionals in accurately, confidently, and precisely delivering fluids and drugs by fusing cutting-edge technology with extensive safety features. The two main components of the project's overall operation are monitoring and controlling.

1. <u>Monitoring System:</u>

A special method is used in intravenous drip monitoring with load cells to guarantee precise and accurate control over the infusion rate of fluids given to a patient. Load cells are transducers that can measure the weight of fluid left in an IV bag by converting weight into an electrical signal.

a) Configuration of Load Cells:

The IV infusion system incorporates load cells, which are typically placed under the IV bag or container containing the fluid to be injected. The weight of the IV bag or container and the tubing attached to it are among the elements that the load cell is calibrated to account for when determining the precise weight of the fluid.

b) Weight Calculation:

The weight of the IV fluid within the bag reduces as the patient receives the fluid. The IV bag or container's weight is continuously measured by the load cell, which then sends the data to a control unit or monitoring system.

c) Calculating Infusion Rate:

The infusion rate can be instantly determined by the device by tracking the pace at which the IV bag weight drops over time. Based on the weight measurements and calibration data, the infusion rate is commonly represented in terms of volume per unit time.

d) Regulating and Observing:

Using a control interface that is linked to the monitoring system, healthcare professionals can configure the required infusion rate or volume settings.

2. Controlling System:

Using a servo motor, a method known as intravenous drip regulating allows the flow rate of IV fluids or drugs to be controlled by adjusting the motor's rotation. With this technique, the infusion rate can be precisely regulated in response to the motor's rotation.

a) Configuration:

The servo motor is a part of the IV infusion system and is usually installed where it can regulate the fluid flow via the IV tubing. The motor is coupled to a device that controls the IV fluid flow, like a roller clamp or valve.

b) Control of Infusion Rate:

The IV fluid flow rate directly relates to the servo motor's rotational speed. The infusion rate can be changed in accordance with the rotation angle or motor speed. The parameters for the intended infusion rate or volume are established using a control unit or interface. The servo motor receives commands from this unit to modify its rotation.

c) Features for Safety:

The system has safety measures in place to stop fluids from being infused too much or too little. Healthcare providers can be programmed to receive alarms and alerts in the event of any scenario.

III. DESIGN DETAILS:

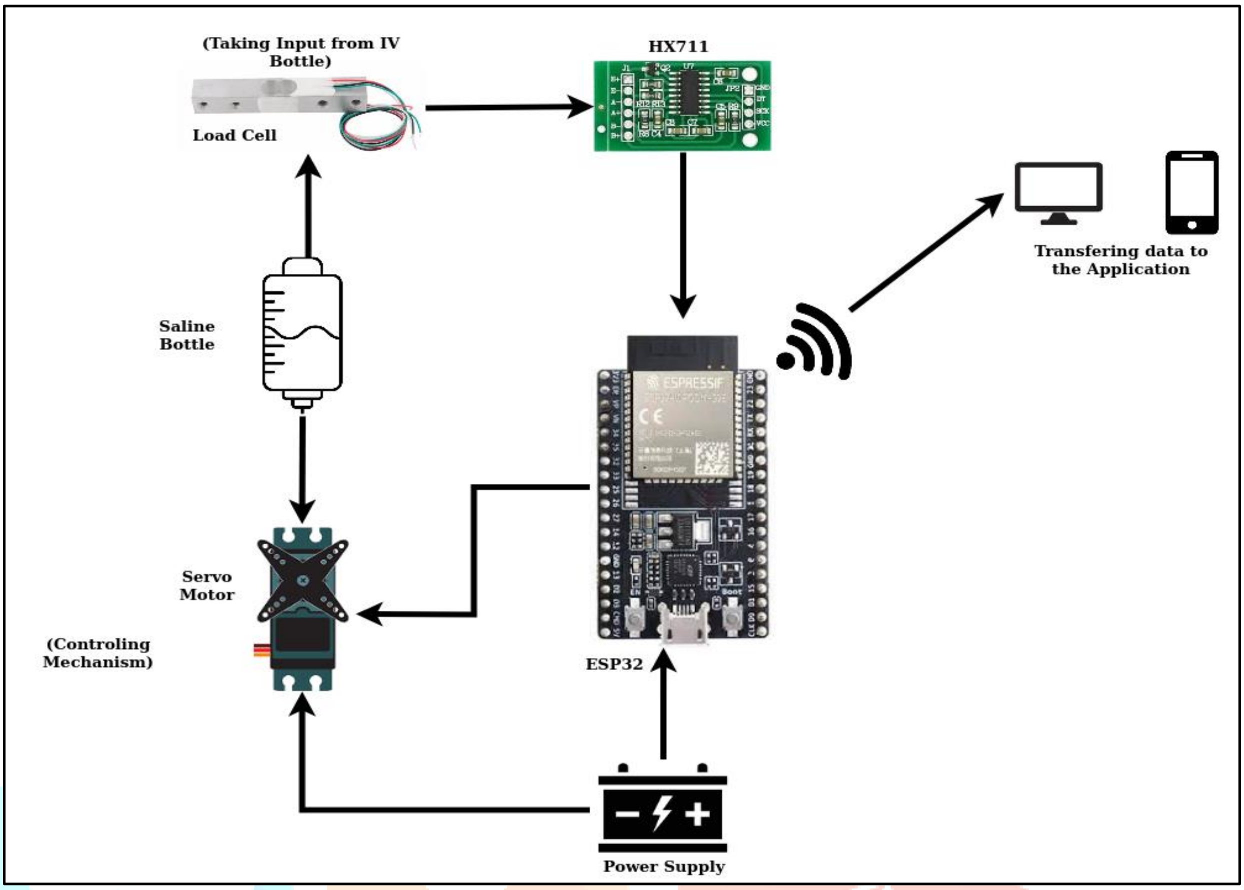

Fig. 1: Block Diagram

The block diagram for an IoT based Intravenous Drip Monitoring and Controlling system, shows ESP32 is first connected to the power supply and then with the help of ESP32, Servo Motor and HX711 are connected. HX711 uses load cell to measure the load of the Saline Bottle and sends the signal via ESP32 to the Devices (Mobile/Web Application). Servo Motor is used to control the flow/rate of the saline. All the Monitoring and Controlling can be done with the help of the Mobile/Web Application

IV. IMPLEMENTATION RESULTS:

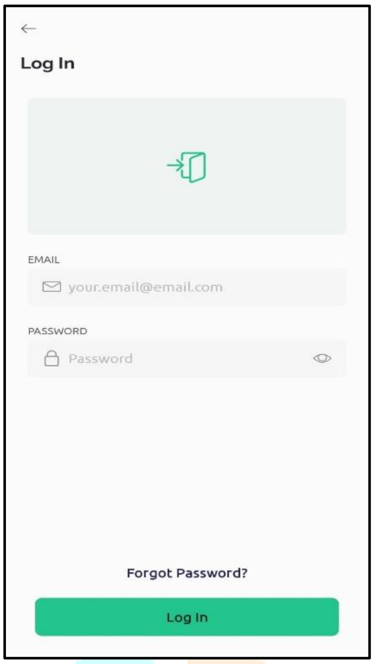

Fig 5.1: Mobile Application Login

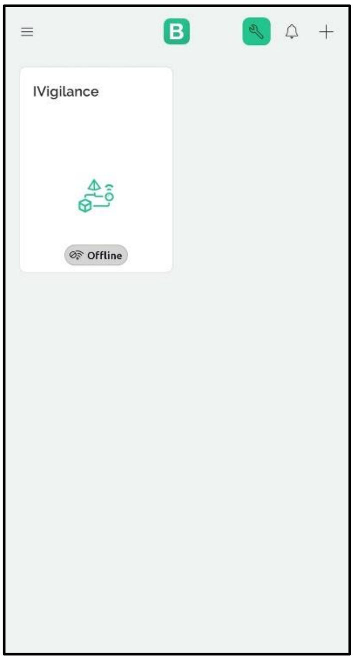

Fig 5.2: Homepage

The Figure 5.1 shows the login page of the project which consist of remote monitoring and controlling of the IV system and the Figure 5.2 shows the status of IVigilance system and number of systems connected in a single account.

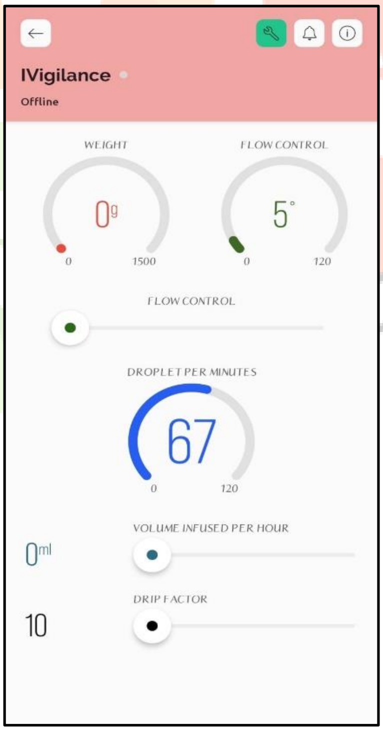

Fig 5.3: Main UI

The Figure 5.3 displays the UI of the application where monitoring and controlling of the IV system can be done remotely and also it displays the status of the device.

Fig 5.4: LCD Screen

The Figure 5.4 shows the LCD screen where name of the project is shown.

Fig 5.5: At base display without IV bottle

Fig 5.6: Displaying weight when IV bottle connected

The Figure 5.5 shows the base weight when no IV bottle is connected to the system and the Figure 5.6 shows the weight of the IV bottle when it is connected to the hook along with the amount of oz also with text as Bottle Empty Soon.

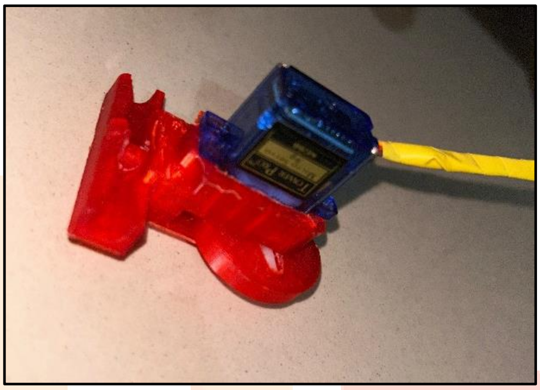

Fig 5.7: Clamp for the controlling of flow using Servo Motor

The Figure 5.7 shows the clamping mechanism using servo motor.

Fig 5.8: Prototype of the developed Project

The Figure 5.8 depicts the prototype of the overall project where the IV saline bottle is connected to the load cell using a hook. Also, the LCD display and clamping mechanism can be seen. For support a stand has been provided when the setup reside.

V. Conclusion:

In conclusion, the IV monitoring system will be able to detect and signal the liquid level in an IV container. Additionally, it will permit real-time monitoring and viewing of the IV infusion process from distant locations, such as a nurse room. It will also enable automatic management and cessation of IV tubing-based infusion flow. The suggested method will be totally automated, with very little human input. As a result, the nurses won't need to perform as much physical labor. It will be helpful at night since it will alert nurses, doctors, and caregivers when saline levels are low, eliminating the need for nurses to routinely check the patient's bed to see how much saline is in the bottle.

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