IoT Intravenous Bag Monitoring and Alert System.

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***Abstract*— The day-to-day monitoring of patients in a hospital is a challenging task under our existing medical care system. During Health Hazard times like Covid 19 physicians or nurses are too busy to keep track of every patient. This leads to numerous issues. Work relating to health should be completed correctly and accurately. Saline or intravenous (IV) fluid injections into patient veins are an example of this kind of activity in our hospitals. Inadequate drip system monitoring can result in issues like blood loss, fluid backflow, and other issues. We present a solution called the IoT Intravenous Bag Monitoring and Alert System in order to lessen the strain and resolve such a dire issue in the domain of an intravenous drip monitoring system. Healthcare workers found themselves overburdened at the height of the Covid-19 Epidemic due to the constant influx of new patients. Frontline staff members cannot directly monitor and care for every patient during such periods. A medical procedure called Intravenous treatment is used to inject nutrients, medicines, and fluids straight into a patient's vein. IV therapy is essential to aid a patient in recovering quickly because it is frequently used to rehydrate and supply nutrients. Nonetheless, IV drips require routine inspection and replacement. Depending on the patient and their condition, the fluid flow must also be measured. The Weight Sensor used by this IoT intravenous fluid monitoring system detects when the fluid level in the IV infusion bottle drops and broadcasts the information over IoT.**

Keywords: Intravenous Therapy; IoT; Covid-19; Monitoring.

I. INTRODUCTION

Intravenous (IV) drip monitoring systems are used to monitor and regulate the delivery of fluids and medication to patients through an IV line. The purpose of IV drip monitoring systems is to ensure the safe and effective delivery of fluids and medications to patients in healthcare settings, including hospitals, clinics, and home healthcare. IV drip monitoring systems can help healthcare providers to: Monitor the rate of infusion: IV drip monitoring systems can measure the rate at which fluids and medications are delivered to a patient, helping to ensure that the right number of fluids or medication is administered at the right time. Monitor the volume infused: IV drip monitoring systems can keep track of the total volume of fluids or medication that has been infused into a patient, which can help to prevent overhydration or dehydration.

Detect potential problems: IV drip monitoring systems can alert healthcare providers to potential problems such as air bubbles in the IV line or an occlusion (blockage) in the line, allowing for prompt intervention to prevent harm to the patient. Overall, IV drip monitoring systems help to ensure the safe and effective delivery of fluids and medications to patients, improving patient outcomes and reducing the risk of adverse events.

Contributions of the paper are as follows:

1. A Health Monitoring system is developed using IoT and an embedded system.
2. Use of IoT for building Health Monitoring Systems has been emphasized.

This paper has been organized into five sections – introduction, related works, methodology, results and analysis and conclusion.

II. RELATED WORKS

Author [1] Design and implementation of a wireless intravenous infusion monitoring system" by Gao et al. (2018): This study presents the design and implementation of a wireless intravenous infusion monitoring system that can monitor the infusion process and provide alerts when there is a problem. The system is designed to be portable, low-cost, and easy to use. Author [2] Development of an intravenous infusion monitoring and safety system using internet of things technology" by Kim et al. (2020): This study presents the development of an intravenous infusion monitoring and safety system using IoT technology. The system can monitor the infusion process, detect any problems, and send alerts to healthcare providers. Author [3] Wireless Intravenous Monitoring System using ZigBee technology" by Kumar et al. (2015): This study presents the design and implementation of a wireless intravenous monitoring system using ZigBee technology. The system can monitor the flow rate of the infusion and detect any anomalies, sending 3 alerts to healthcare providers when necessary. Author [4] Design and implementation of a smart intravenous infusion monitoring system" by Lu et al. (2019): This study presents the design and implementation of a smart intravenous infusion monitoring system that can monitor the infusion process and detect any problems, such as occlusion, air bubbles, or disconnection of the IV line. The system uses an IoT platform and can send alerts to healthcare providers in real-time. Author [5] Wireless Intravenous Drip Monitoring System Based on the Internet of Things" by Wang et al. (2018): This study presents the design and implementation of a wireless intravenous drip monitoring system based on the

IoT. The system can monitor the infusion process, detect any problems, and send alerts to healthcare providers.

Author [6] reviewed the use of wireless sensor networks in healthcare, including intravenous drip monitoring systems. The authors discussed the advantages and disadvantages of different wireless sensor network technologies and highlighted the need for secure and reliable communication protocols in healthcare systems.

Author [7] conducted a qualitative study to explore the experiences of nurses using intravenous drip monitoring systems in a hospital setting. The authors found that the use of these systems improved the efficiency and safety of medication administration, but also required additional time and effort from nurses to learn and use the technology.

Author [8] conducted a systematic review of the literature on smart infusion pumps, which are a type of intravenous drip monitoring system. The authors found that the use of smart infusion pumps reduced medication errors and improved patient safety, but also noted that the implementation of these systems can be challenging and requires careful planning and staff training. Author [9] conducted a retrospective analysis of medication error reports in a hospital setting before and after the implementation of smart infusion pumps. The authors found that the use of these pumps reduced the number and severity of medication errors, and suggested that their use should be expanded to other healthcare settings.

III. METHODOLOGY

A. Block diagram

The components used in our project are: 1. ESP 32. 2. Load Cell. 3. Moisture Sensor. 4. Water Pump Motor. 5. LCD Display. 6 Motor Driver Module. 7. PCB Circuit Board. 8. LDR Sensor Module. 9. Load Cell Amplifier. 10.Thing Speak (Software). 11. Telegram (Software). The Block Diagram consists of the following Hardware components: ESP 32, Load cell, Water Pump Motor, Motor Driver, LDR Sensor Module, PCB Circuit Board, LCD Display, Moisture Sensor. The Software components used in this project are ThingSpeak and Telegram. First the ESP 32 is given power supply via 12v DC Power adapter and is connected to a PC/Laptop through a USB port. Once turned on the ESP Module is connected to a registered Wireless Network (Wi-Fi), on successful connection the ESP asks the user to place a weight on the Load cell which is displayed through the LCD Display connected to the ESP processor. After an object/bag is placed on the Load cell the weight of the object/bag is calibrated and is both displayed on the LCD and will be uploaded to the cloud which can be seen on the ThingSpeak Platform. Live Monitoring of the weight of the bag can be seen on the ThingSpeak Website. If the weight/liquid level of the bag is below a certain threshold level an alert message is sent to the user via the Telegram app to Refill/Replace the bag. Also the Water Pump Motor is automatically turned on after the reduction in weight below the Threshold value, this indicates that the refilling of the bag is active.

B. Components

1) ESP 32

ESP32 is a powerful, low-cost system-on-chip (SoC) microcontroller that combines Wi-Fi and Bluetooth capabilities. It is designed and manufactured Department of Electronics and Communication Engineering 7 by Espressif Systems, a Chinese company known for creating cutting-edge IoT solutions. The ESP32 is the successor to the ESP8266, offering improved performance and added features.

2) Load Cell

A load cell is a device used to measure force or weight. It converts the physical force applied to it into an electrical signal that can be measured and analyzed. Load cells are commonly used in industrial and commercial applications to measure the weight of materials or products during manufacturing, shipping, and other processes.

3) Moisture Sensor

Moisture sensors are devices used to measure the moisture content of soil, air, or other materials. They are commonly used in agricultural, environmental, and industrial applications to monitor moisture levels and make decisions based on that data. Moisture sensors come in a variety of types and designs, each with its own strengths and weaknesses.

4) Water Pump Motor

The R385 water pump is a miniature, high-quality, and low-cost water pump that is widely used in a variety of applications. It is a DC (direct current) brushless motor pump, which means it is highly efficient and operates quietly. The R385 water pump is compact in size, with a maximum length of only 53mm and a diameter of 39mm.

5) LCD Display

The 16x2 LCD display is a type of alphanumeric display that can show up to 16 characters in each of its 2 rows. It is widely used in electronic devices, such as calculators, clocks, and appliances, to display information to the user. The 16x2 LCD display is typically made up of a liquid crystal display (LCD) panel and a controller, which communicates with the microcontroller to display the desired characters.

6) Motor Driver Module

The L298N motor driver is a popular motor driver used in robotics and other electronic projects to control DC motors and stepper motors. The L298N is a dual H-bridge motor driver, which means it can control two motors independently or control one motor with increased torque.

7) PCB Circuit Board

A printed circuit board (PCB) is an essential component in the design and manufacture of electronic devices. It is a flat board made of a non-conductive material, such as fiberglass, with conductive pathways etched onto its surface to connect various electronic components. PCBs are widely used in electronic devices, ranging from small consumer electronics to large industrial systems.

8) LDR Sensor Module

An LDR (Light Dependent Resistor) sensor module is an electronic component that detects the amount of light in its surrounding environment. It consists of an LDR and a comparator circuit that converts the analog signal from the LDR into a digital signal that can be processed by a microcontroller or other digital circuits.

9) Load Cell Amplifier

A Load cell amplifier is an electronic device used to amplify and condition the signal output from a load cell. Load cells are used to measure weight or force, and they generate a small voltage output in response to changes in the applied load. This voltage signal is very small and requires amplification to be accurately measured by a data acquisition system.

10) Thing Speak (Software)

ThingSpeak is an Internet of Things (IoT) platform that allows users to collect, analyze, and visualize data from connected devices. The platform was developed by MathWorks, a software company that specializes in engineering and scientific computing.

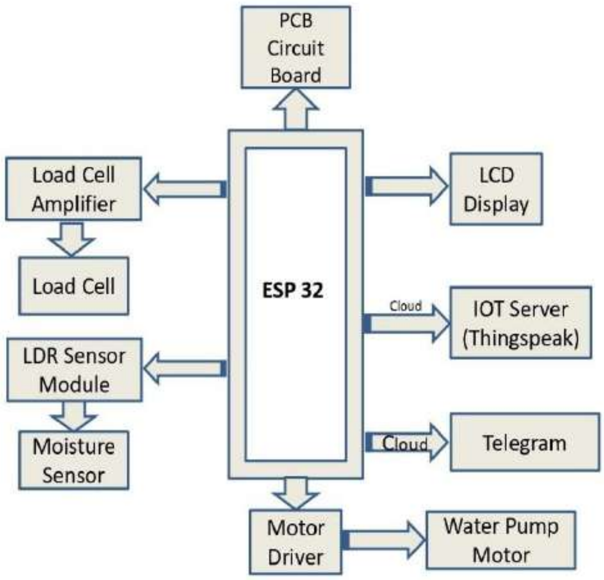

Fig. 1. Block diagram of the proposed system

11) Telegram (Software).

Telegram is a cloud-based instant messaging app that was launched in 2013. It was developed by two Russian brothers, Pavel and Nikolai Durov, who also founded the social network VKontakte (VK). Telegram is available on multiple platforms, including iOS, Android, Windows, macOS, and Linux. It is known for its strong focus on privacy and security, with end-to-end encryption for all messages and the ability to send self-destructing messages.

C. Flow of execution

Figure .2 shows the flow of execution. Once the system is turned on the it asks to place a bag/bottle on the Load cell. Once a weight is placed the Load cell calibrates the weight of the bottle/bag and sends the measured data to the IoT Server via cloud. Also, the moisture sensor measures the liquid level of the placed bag. The Preset threshold values are also simultaneously checked by the system. If the measured weight is less than the threshold value (below 50g) or if the liquid level of the bag is less, then an alert message is sent via the telegram app followed by a red alert on the IoT Server. The Water Pump is also turned to indicate automatic refilling of the bottle.

If the weight of the measured bag is above the threshold value (above 50g) or if the water level measured by the moisture sensor is proper, then no alert is sent and the weight of the bag placed is continuously monitored and is kept updated via the IoT server through Cloud. The Weight can be seen by both the LCD Display or via the IoT server.

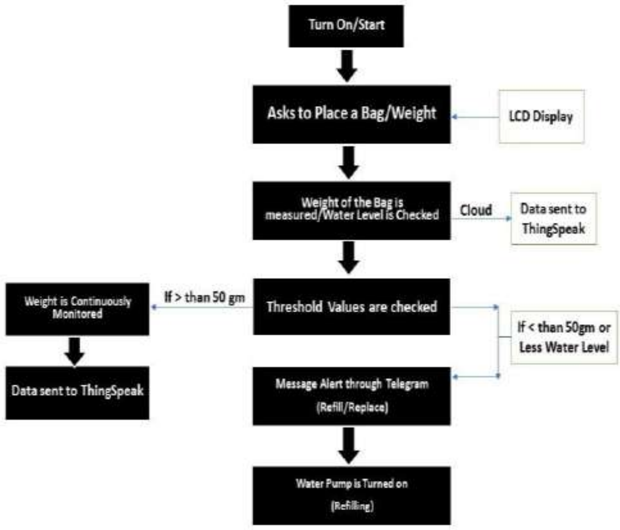

Fig. 2. Proposed Flow of Execution

IV. RESULTS AND ANALYSIS

The Working of the system is divided into different steps of analysis and results to get a clear picture and understand the functioning of the project. In the following steps different operations and results are shown where the flow chart of the project is satisfied.

Fig. 3. Title is displayed.

- As the system is turned on the Title of the Project is displayed on the LED Display.

Fig. 4. Message displayed on Wi-fi Connection.

- The System is automatically connected to a saved Wi-Fi Network named "Elegant." Once connected to the Wi-Fi a message is displayed on the LED.

Each image is an output image of the project which represents several stages of execution of the system.

Fig. 5. Title is displayed.

- Several Messages and alerts through out the process of the project are shown on the LED.

Fig. 6. Message will be also sent in Telegram.

A Message on successful Wi-Fi Connection is also sent on Telegram to identify the user through mobile/laptop.

Fig. 7. Asks the user to place a bottle/bag.

- Once the system is successfully connected to the Wi-Fi the system asks the user to place a saline bottle/bag to measure the weight of the bag.
- The Weight of the Bag is calibrated by using the Load Cell. Weight up to 500gms can be measured using the Load Cell.
- Once the weight of the bottle is measured it is both displayed on the LED Display and simultaneously updated on the ThingSpeak server which can be seen in Fig.8&9.

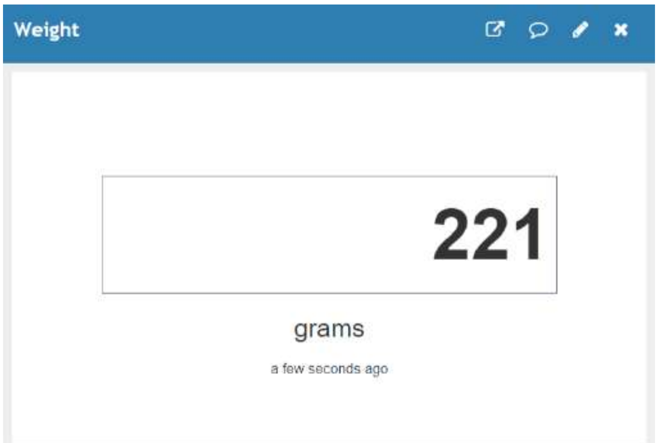

Fig. 8. Measured Weight is shown on the ThingSpeak Server.

- Once the data is sent to the ThingSpeak Server the weight of the measured bag is displayed on the Website as shown in the above figure.

Fig. 9. Figure.8: Weight displayed on LED.

- The Measured weight of the bottle is shown on the LED Display.
- A Bottle of 222gms is placed on the system. Any weight up to 500gms can be measured by the system using the Load Cell.
- The Calibrated Weight of the bottle is sent as data via the cloud to the ThingSpeak server.

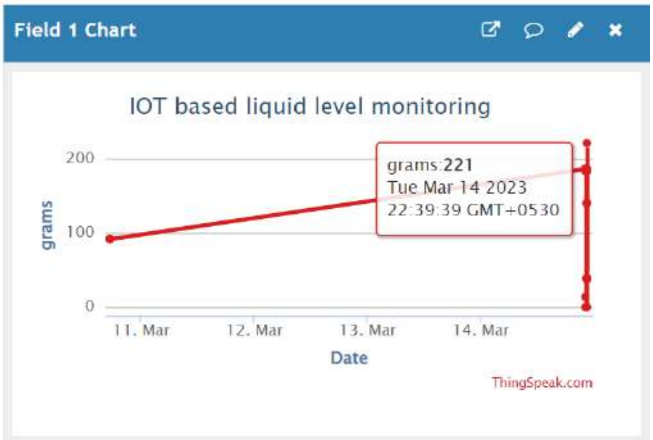

Fig. 10. Graph of Different Measured Weights

The Above graph shows different weights measured by the system at different intervals. Depending upon the weight placed the graph is automatically adjusted.

Fig. 11. Lamp Indicator

- A Lamp Indicator is used as a widget on the ThingSpeak server to indicate the reduction of weight. It glows when the weight falls under the Threshold Level(<50gms). The Above Lamp Indicator is a result for 221 gms of weight.

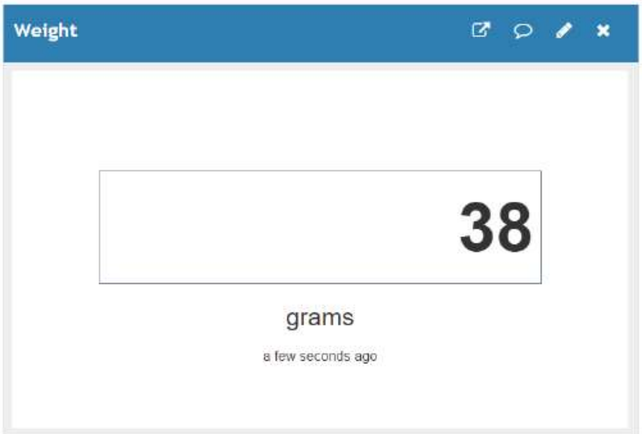

Fig. 12. Weight displayed on ThingSpeak

- As the weight is changed, the weight of the bag is simultaneously updated on the ThingSpeak server which is shown in the above figure.

Fig. 13. Another Weight is Placed on the System.

- The Previous Bag which weighed 221 gms is removed, and another bag is placed on the system whose weight is calibrated as shown in the above diagram.

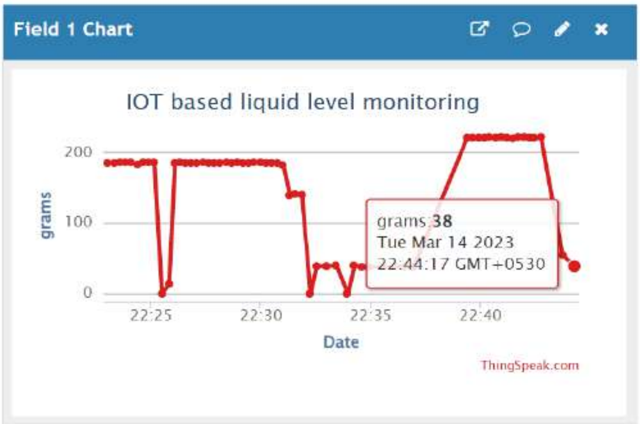

Fig. 14. Weight updated on the Graph.

- The Above Graph represents several weights which are measured by the system as a graph. The Updated weight can be also seen on the graph.

Fig. 15. Lamp Indicator turns Red.

Since the new weight placed(38gms) falls below the threshold level(<50gms) the Indicator glows. The Indication is also to replace/refill the bottle/bag placed.

Fig. 16. Alert on LED Display

Therefore, the alert to replace/refill the bottle is given through three sources:

1. First on the LED Screen.
2. ThingSpeak Server.
3. Telegram.

Fig. 17. Alert through Telegram.

Once the weight falls below the Threshold level the user is alerted through telegram as well. An alert "Replace with New Bottle" is sent on telegram.

V. CONCLUSION AND FUTURE SCOPE

Intravenous (IV) drip monitoring systems play a critical role in ensuring the safety and efficacy of patient treatment. These systems can help healthcare professionals to accurately monitor the delivery medications and fluids, detect any deviations from prescribed dosages or flow rates, and quickly respond to any potential complications or adverse events. The use of an Intravenous Bag Monitoring system can help healthcare providers to monitor the status of intravenous therapy in real-time and take appropriate actions if any issues arise. Intravenous Bag Monitoring systems have several benefits for patients and healthcare providers. They can help reduce the risk of medication errors, improve patient outcomes, and reduce healthcare costs. By providing real-time monitoring of intravenous therapy, healthcare providers can quickly identify and respond to issues, such as changes in fluid levels, that could negatively impact patient care. In conclusion, IV drip monitoring systems are essential tools for modern healthcare settings, and their use can significantly improve patient outcomes and safety. As technology continues to advance, it is likely that these systems will become even more sophisticated and effective in the years to come, further enhancing the quality of care provided to patients receiving IV treatments.

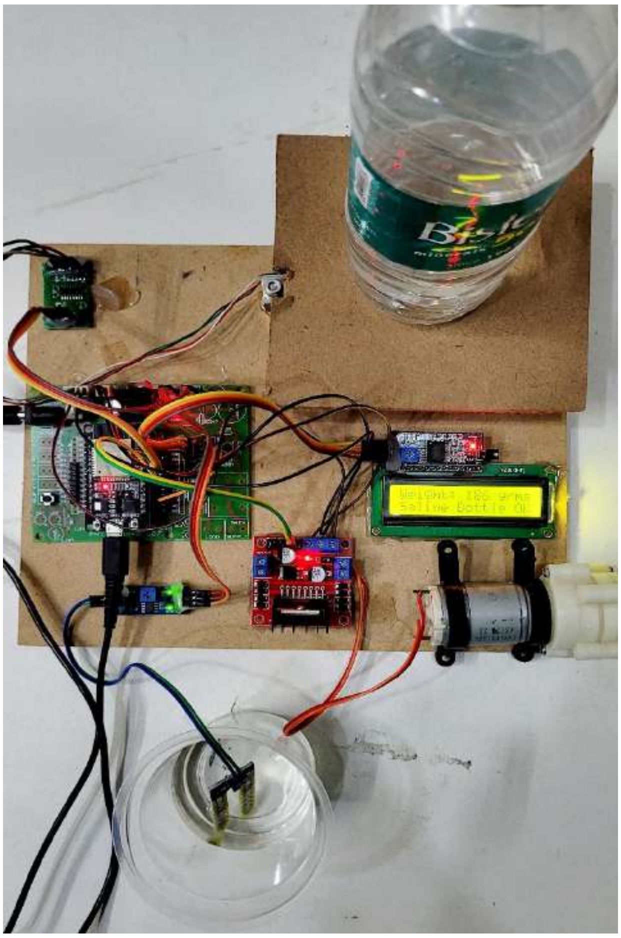

Fig. 18. Prototype of the Proposed Model.

The future of intravenous (IV) bag monitoring systems is promising as new technologies and advancements are being made in the healthcare industry. Some potential areas for development and expansion in IV bag monitoring systems include:

Integration with electronic medical records (EMRs): The integration of IV bag monitoring systems with EMRs could allow for real-time monitoring of IV fluids and medications, providing healthcare professionals with accurate and up-to-date information.

Use of wearable technology: Wearable technology such as smartwatches or other sensors could be used to monitor IV bag levels and flow rates, allowing patients to move around and engage in activities while receiving IV therapy.

Artificial intelligence (AI) and machine learning: AI and machine learning could be used to analyze data from IV bag monitoring systems to predict potential complications, such as blockages or air bubbles, and provide alerts to healthcare professionals.

Remote monitoring: Remote monitoring capabilities could allow healthcare professionals to monitor patients receiving IV therapy outside of the hospital or clinic setting, enabling home-based care and improving access to treatment for patients in rural or underserved areas.

Automated IV bag replacement: Automated IV bag replacement systems could be developed to replace empty or near-empty bags, reducing the need for manual interventions by healthcare professionals and potentially improving patient outcomes.

Overall, the future of IV bag monitoring systems looks bright, with the potential for new technologies and advancements to improve patient outcomes, increase efficiency, and reduce costs in the healthcare industry.

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