Smart Intravenous Drip Monitoring system based on IoT for Advancements in Healthcare

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Abstract. The aim of this project is to automate the monitoring of glucose levels in a glucose bottle during IV therapy, eliminating the need for manual monitoring. In order to determine the amount of liquid within the glucose bottle, the system calculates the weightof the bottle using a load cell amplifier. A GSM modem notifies the medical staff via SMSand call notifications when the liquid level dips to the minimum. This technology is a part ofthe Internet of Things (IoT) and can be integrated into hospital management systems to reduce costs and improve patient care. While automated health monitoring devices exist, monitoring patients during IV therapy remains a challenge.

Keywords: IV therapy, load cell amplifier, liquid level, GSM modem, SMS alert, IoT, health monitoring, intelligent devices, patient safety, IV monitoring.

1 Introduction

The Internet of Things (IoT) has been rapidly growing and changing the way we interact with our physical environment. It is a network of physical objects embedded with electronics, software, and sensors that facilitate data collection and exchange among each other. One area where IoT can make a significant impact is in the healthcare industry, specifically in the monitoring of patients during intravenous (IV) therapy. Despite the availability of advanced automated devices, monitoring the level of fluid in a glucose bottle during IV therapy remainsa challenging task. To address this issue, we propose an Intravenous Drip Monitoring System (IV system) that automates the monitoring process and notifies hospital staff of the fluid level in real-time. The system utilizes a load cell amplifier attached to the glucose bottle to calculate the weight and the corresponding fluid level. When the fluid level reaches the minimum level, the system uses a GSM modem to send alerts to hospital staff via SMS and call. The IV system helps hospitals to save operational costs, improve patient experience, and reduce the labor intensity of medical staff. As the population density increases, the emphasis on healthcare also increases. Everyone must take good care of their health, and IoT can be a significant part of the system for monitoring health. Hospitals can minimize their operational costs, improve the patient experience, and lessen the capital and labor intensiveness of their medical personnel by incorporating intelligent equipment and sub systems. The discovery of automated health monitoring devices has brought a drastic change in the medical field by monitoring physical

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and environmental parameters like heartbeat rate, detection of heart attack symptoms, and temperature. However, monitoring the fluid level in a glucose bottle during IV therapy is still a manual task in our current medical care system. Therefore, we propose an IV system that utilizes IoT to automate the monitoring process and notify hospital staff in real-time. The IV system utilizes a load cell amplifier attached to the glucose bottle to calculate the weight and the corresponding fluid level. When the fluid level reaches the minimum level, the system uses a GSM modem to send alerts to hospital staff via SMS and call. The first alert is sent when there is 50 ml of liquid present, giving hospital staff enough time to reach the room and replace the bottle. The second alert is sent when there is 30 ml of liquid left, indicating the urgent need to replace the bottle.

A. IoT in Healthcare

IoT has numerous applications in the healthcare industry, such as remote patient monitoring, telemedicine, medication management, and smart medical devices. IoT devices can bemused to collect and transmit real-time patient data to healthcare professionals, enabling them to remotely monitor patients and make informed decisions about their care. For example, wearable devices can monitor vital signs like heart rate, blood pressure, and oxygen levels, and send that data to healthcare providers in real-time. This allows doctors and nurses to detect and address potential health issues before they become serious. In addition to remote patient monitoring, IoT can also be used to improve medication management. Smart medication dispensers can be programmed to dispense medications at specific times, remind patients when it's time to take their medication, and even track medication adherence. This can help patients manage complex medication regimens and reduce the risk of medication errors.

B. Automated Health Monitoring Devices

Automated health monitoring devices are a key component of the current healthcare industry. These devices have revolutionized the way that healthcare providers monitor patient health, offering a wide range of benefits including increased accuracy, ease of use, and reduced labor costs. With the help of these devices, healthcare providers can now monitor various physiological and environmental parameters such as heartbeat rate, blood pressure, oxygen levels, temperature, and more [16]. These devices have significantly reduced the need for manual monitoring, which can be labor-intensive and prone to human error. Automated monitoring ensures that patient data is collected in real-time, allowing healthcare providers to make quick and accurate decisions when necessary. Additionally, these devices can alert healthcare providers when readings fall outside of normal ranges, allowing for timely interventions and improved patient outcomes.

C. Intravenous Drip Monitoring System

An automated device called an intravenous drip monitoring system is created to keep track of the amount of fluid in a glucose bottle that is being delivered into a patient’s vein during IV therapy. As the liquid level in the bottle drops to the minimum standards, the system notifies the hospital staff and does away with the necessity for manual monitoring. The device employs a load cell amplifier to determine the weight of the glucose bottle, and from this weight, one may determine the amount of liquid that is contained in the bottle. A GSM modem alerts mobile phones via SMS and call notifications when the liquid level drops below the minimal level, indicating the urgent need to replace the bottle. An important advancement in the healthcare sector is the Intravenous Drip Monitoring System, which lowers the capital and labor intensity of medical staff while also aiding hospitals in operating costs savings. It is an example of how

IoT can be implemented in the healthcare system to introduce intelligent devices and subsystems for patient safety and stress reduction for medical staff. The Intravenous Drip Monitoring System is an important step towards automating healthcare tasks and providing a better quality of life for patients. It makes it possible to monitor patients in real-time while they are undergoing IV therapy, which is a significant challenge in the contemporary healthcare system. With the implementation of this system, hospitals can ensure the safety of their patients and reduce the burden on medical staff.

2 Related work

Recently many techniques are proposed for the Intravenous bag monitoring system. Even so, it has some limitations which are listed below.

Prasanna M et al., [1] proposed A Survey on Isolated Monitoring of Glucose Bottle Level in Hospital Using GSM. This system uses IoT and mobile phones to alert doctors and nurses about patient glucose levels and may raise concerns about the security and privacy of patient information.

Rajanayaki S et al., [2] discussed Smart Saline Bottle But, The IoT-Based Liquid Level Monitoring System may need to be integrated with existing hospital systems and electronic health records to be fully effective. This could pose challenges if the system is not compatible with existing hospital infrastructure.

Sincy Joseph et al., [3], proposed the Intravenous Drip Monitoring System For Smart Hospital Using IOT . The main issue with this system is the potential for technological failure, which could result in incorrect or incomplete monitoring of a patient's IV drip. Additionally, the system may not be affordable or accessible for all individuals, particularly those in low-resource settings.

Muhammad Raimi Rosdi et al., [4], proposed the A Smart Infusion Pump System for Remote Management and Monitoring of Intravenous (IV) Drips. The study demonstrates strategies for remote management and monitoring of IV drips, including the use of automatic counting and detection of flow changes. The main issue is the time lag of about 1 minute for drops count monitoring, although near real-time performance was observed in the detection of in-line bubbles

The existing system proposes the current I.V. the alert system, developed in 1989, employs a CMOS circuit that is capable of detecting individual drops as they pass through the drip chamber. The system relies on a counter that is triggered by each drop, and if the counter is not reset withina predetermined time frame, an alarm signal is generated to alert the hospital staff.

However, this existing system has certain drawbacks that need to be addressed. Firstly, the alarm signal can potentially disturb the patient, which could lead to increased stress and discomfort. Additionally, the system requires the caretaker of the patient to request the hospital staff to replace the empty bottle, which may not always be feasible or practical. Therefore, there is a need for a more advanced and patient- friendly system that can accurately monitor the liquid level in the I.V. bottle without causing any disturbance to the patient. Such a system would help reduce the workload of hospital staff and ensure timely replacement of the I.V. bottle, thereby improving patient safety and care.

3 Proposed Methodology

The proposed system aims to improve the monitoring of glucose bottle levels in hospitals and alert hospital staff when the liquid level drops to a critical point. This system utilizes a load cell and a load cell amplifier to calculate the weight of the glucose bottle and predict the liquid level. Instead of constant manual monitoring, this system sends two intimations through a GSM modem. As soon as there are 50 ml of liquid left, an SMS alert is sent, giving hospital staff time to replace the bottle.

A call warning suggesting the urgent need to replace the bottle is the second indication. The suggested system has a number of benefits over the current system. It eliminates the need for constant manual monitoring, which reduces the workload of hospital staff and ensures accurate and timely monitoring of the glucose bottle level.

The two intimations sent through the GSM modem ensure that the hospital staff is alerted well in advance, which prevents any delays in replacing the bottle. Overall, the proposed systemis an efficient and reliable solution for monitoring glucose bottle levels in hospitals.

The system makes use of a load sensor with inverting and non-inverting outputs as its two output kinds. The glucose bottle hangs on one end of the S-shaped load cell, which is suspended in the glucose hanger. Using this setup, the bottle's weight is transferred into a corresponding voltage, which is then recorded by the load cell as voltage.

Fig 1. Load cell attached to the glucose bottle Load cell

The system feeds the load cell's non-inverting output as input to one of the PWM pins on the ATMEGA board after amplifying the voltage level. The maximum PWM pin value for the load cell's maximum range is 255, and the load cell's range is 0-750 gm. The glucose bottle can only hold 500 gmat a time, which causes a PWM pin output of 170 when the bottle is full. The GSM module now transmits the message "The bottle is full." When there is a break in the measurement of the glucose level in the bottle, the GSM module transmits the message "check the apparatus." The GSM module transmits the message "the bottle is reduced to 50%" when the glucose level in the bottle falls to half, and the PWM pin output is 85 at that time.

The GSM module generates an emergency alert with the phrase "emergency, the bottle is decreased to 10%" if the glucose level exceeds 10%, the PWM output is 17, and the PWM output is 17 otherwise. The power supply for both the GSM module and the AT mega board comes from a 12V adapter.

Table 1. Glucose Schedule

S.No	Weight	PWM Values	Message
1	500 g	170	The bottle is full
2	250 g	85	The bottle is reduced to 50%
3	50 g	17	Emergency, the bottle is reduced to 10%

4 Design and Implementation

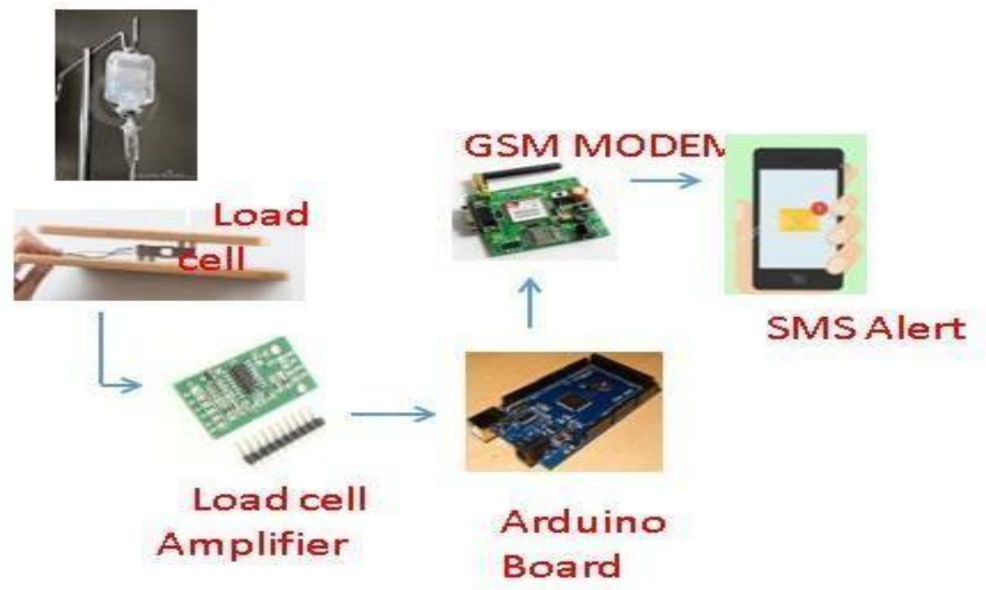

Fig 2. Architecture Diagram

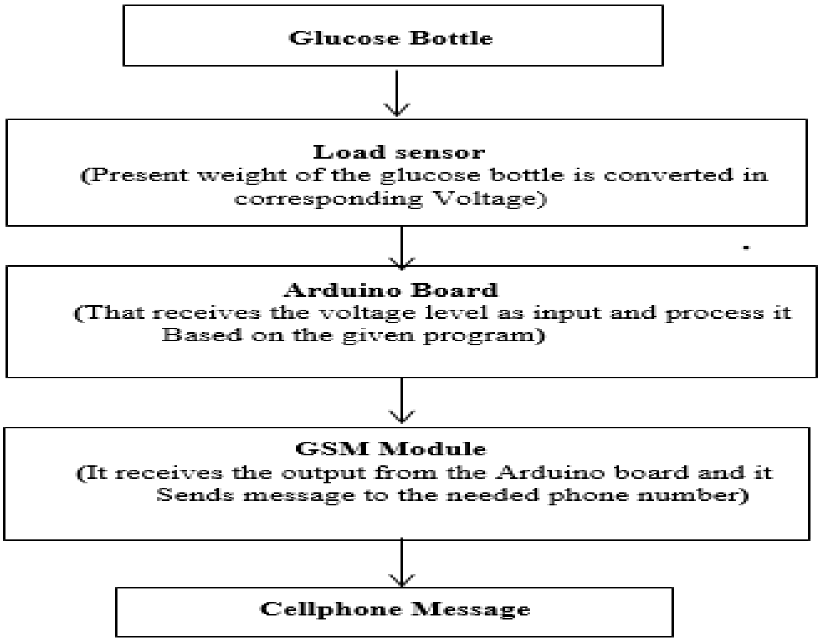

Fig.3. Block Diagram

If nurses working in hospitals forget to change the glucose trip bottle once it is emptied, it will bring a bad consequence to the patient. To extract the nurses, user can send an alert message to their phones saying that glucose bottle is going to be empty, as everyone will repeatedly, use their mobile phones in this modern world. The system contains of micro controller which receives input from the load sensor and it send output to the GSM module. An alerting signal using sound alarms for replacing the glucose trip bottles is being used in very few hospitals.

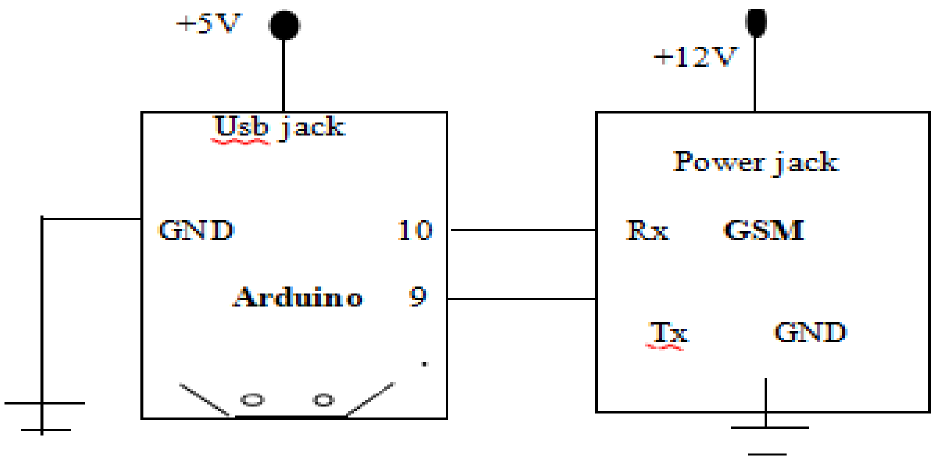

Fig 4. Circuit Diagram

An alarm system that sends messages to nurses' mobile phones reminding them to change the glucose bottle is inferred to stop occurrences like nurses forgetting to replace the bottle. The system consists of a microcontroller that transmits output to the GSM module and takes input from the load sensor. The fact that nurses usually have their phones with them makes this approach more effective than sound alarms. The system can be attached to the glucose bottle using temporary adhesive, making it reusable for the next bottle. In the case of intravenous dripping systems, wireless sensor systems can detect when the intravenous liquid runs out or if there are obstructions in the catheter. One such technology is the IV DRIP, which delivers intravenous fluid in low- resource situations using a mechanical automated volume regulator. Two levers make up the system; one is used to hold an IV bag and the other to hold a counterweight. The amount of fluid dispensed is controlled by the position of the counterweight, and when the desired volume is attained, the levers tip and kink the IV tubing, stopping the flow of fluid and preventing dehydration. An automated system will be conjured up to measure the intravenous fluid level and instantly transmit crucial data; the results will be shown on a dashboard. The glucose bottle system sends an SMS alert when the liquid level reaches 50 ml and a call alert when the liquid level reaches 30 ml. These systems can alert hospital staff well in advance to replace the glucose bottle or address the intravenous fluid level, avoiding the danger of air bubbles entering the patient's bloodstream, which could be life-threatening. The wireless sensor system used for intravenous dripping can provide real-time monitoring of the patient's fluid levels, allowing for more accurate treatment and reducing the risk of complications.

5 Intravenous Fluid Monitoring in Hospitals

Intravenous (IV) therapy is a common medical treatment that involves delivering fluids, medications, and other substances directly into a patient's bloodstream through a vein. However, administering IV fluids can be challenging, and it requires careful monitoring to ensure that the right amount of fluid is delivered to the patient at the right time. IV fluid monitoring in hospitals involves the use of sensors to measure the flow rate and volume of fluid delivered to the patient. High precision capacitive sensors are commonly used for this purpose as they can accurately measure the small changes in capacitance that occur as the fluid flows through the IV tubing. The data collected by the IV fluid sensors can be transmitted wirelessly to a central monitoring system, where healthcare professionals can monitor the patient's fluid levels in real-time. This allows them to detect any abnormalities or changes in the patient's condition that may require intervention. IV fluid monitoring systems are particularly useful in critical care units, where patients require continuous monitoring and adjustments to their fluid intake. By using IV fluid sensors, healthcare professionals can ensure that the patient receives the right amount of fluids at the right time, reducing the risk of complications and improving patient outcomes. In addition to monitoring fluid levels, IV fluid sensors can also detect air bubbles in the IV tubing, which can be a serious and potentially life-threatening complication. By alerting healthcare professionals to the presence of air bubbles, IV fluid sensors can help prevent these types of complications and improve patient safety. Overall, IV fluid monitoring is an important aspect of patient care in hospitals, and the use of high precision capacitive sensors is a key technology in ensuring that patients receive the right amount of fluids at the right time while minimizing the risk of complications.

6 Drip Remote Monitoring

Intravenous (IV) drips remote monitoring is a technology that enables healthcare professionals to monitor patients' IV drips remotely, without having to be physically present at the patient's bedside. This technology has become increasingly important in recent years, particularly in the wake of the COVID-19 pandemic, which has placed a strain on healthcare systems worldwide. IV drips remote monitoring typically involves the use of sensors or devices that can be attached to the IV tubing or the infusion pump. These sensors can measure various parameters, such as the flow rate, volume, and temperature of the IV fluid, as well as the presence of air bubbles or blockages in the tubing. The data collected by the IV drip sensors can be transmitted wirelessly to a central monitoring system, which can be accessed by healthcare professionals on their computers or mobile devices.

This allows them to monitor multiple patients IV drips simultaneously, from a remote location. IV drips remote monitoring offers several benefits over traditional methods of monitoring, including increased efficiency, reduced errors, and improved patient safety. By providing real-time data on patients' IV drips, healthcare professionals can quickly detect any abnormalities or changes in the patient's condition that may require intervention, such as a change in the flow rate or volume of the IV fluid. In addition, IV drips remote monitoring can help to reduce the risk of errors and complications associated with IV therapy, such as over hydration, dehydration, and infections.

By monitoring the IV drip remotely, healthcare professionals can ensure that the patient receives the right amount of fluids at the right time, while minimizing the risk of complications. IV drips remote monitoring is particularly useful in critical care units, where patients require continuous monitoring and adjustments to their IV fluid intake.

By using IV drip sensors, healthcare professionals can ensure that the patient receives the right number of fluids at the right time, reducing the risk of complications and improving patient outcomes. Overall, IV drips remote monitoring is an important technology that can help to improve patient safety and outcomes, particularly in critical care settings. As healthcare systems continue to face challenges posed by the COVID-19 pandemic and other healthcare crises, the use of IV drips remote monitoring is likely to become increasingly common.

7 Applications of Internet of Things in Health

The Internet of Things (IoT) has a variety of applications in healthcare. One of the most significant is remote monitoring, which allows healthcare providers to track patient health data from a distance. This can include everything from monitoring vital signs and glucose levels to tracking medication adherence and detecting falls. IoT- enabled devices such as wearables, sensors, and mobile apps can transmit this data in real-time to healthcare providers, allowing for early intervention and improved outcomes. IoT technology can also improve hospital efficiency through asset tracking, inventory management, and patient flow monitoring. By using IoT sensors and devices to track the location and status of equipment, supplies, and patients, healthcare providers can optimize workflows and reduce wait times. IoT technology is also transforming patient engagement and patient-centered care. By providing patients with access to IoT-enabled tools such as telemedicine platforms, remote monitoring devices, and mobile apps, patients can take a more active role in managing their health.

This can lead to better outcomes, reduced hospital readmissions, and increased patient satisfaction. IoT technology is also being used for drug management and supply chain optimization. IoT-enabled sensors and devices can monitor medication inventory levels and ensure that medications are stored and transported at the correct temperature, reducing waste and improving patient safety. Finally, IoT technology is being used for public health surveillance and disease outbreak management. By collecting data from IoT-enabled devices such as wearables and sensors, healthcare providers can track the spread of diseases and detect outbreaks early, allowing for prompt intervention and prevention of further transmission. Overall, the applications of IoT in healthcare are diverse and rapidly expanding, offering significant potential for improving patient outcomes and healthcare system efficiency.

8 Results and Discussion

The system described involves the use of a load cell to sense the weight of a liquid container, specifically a glucose bottle, in order to predict the level of liquid inside.

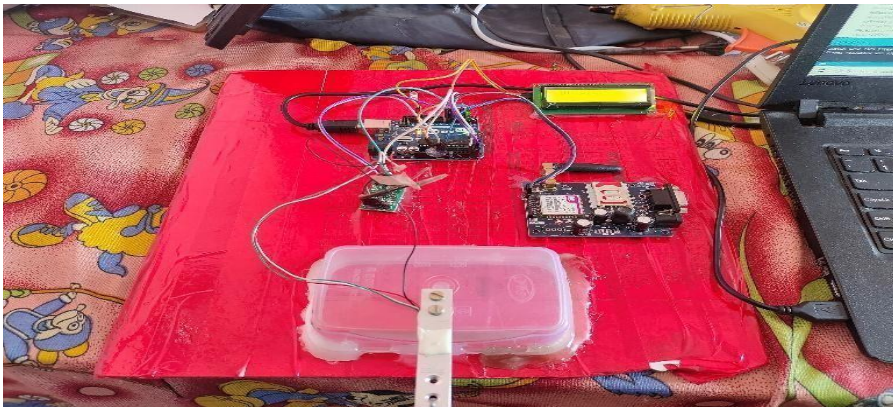

Fig 5. Proposed System

To facilitate this process, the HX711.zip library is imported into Arduino Nightly, which allows for the accurate weight to be recorded. To make the measurement results easily accessible and understandable, the weight of the glucose bottle is displayed on an LCD screen. The load cell is connected to a load cell amplifier, which is then linked to a microcontroller to accurately measure any changes in resistance of the load cell, thereby providing precise weight measurements.

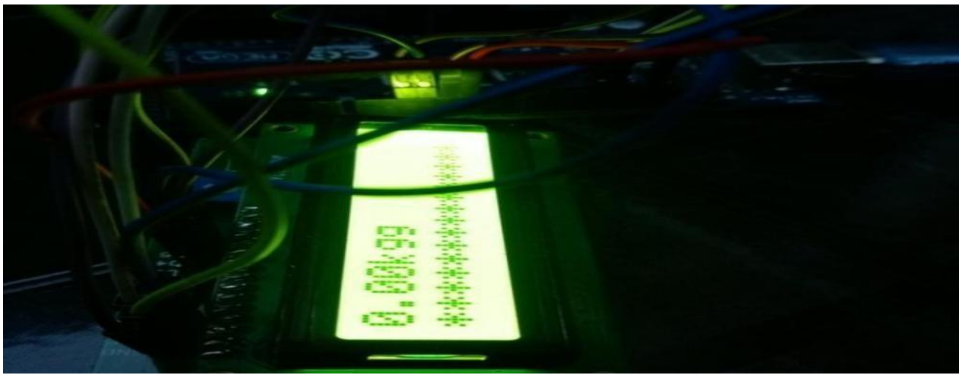

Fig 6. Weight of Glucose bottle is on an LCD

This makes it convenient for hospital staff to monitor the level of the liquid in the bottle without having to refer to any complicated measurement devices. In the event that the level of liquid inside the bottle reaches 50ml, an SMS alert is sent through a GSM modem to notify hospital staff of the situation as in Fig:8. This serves as an initial notification and provides ample time for staff to take appropriate action and replace the bottle.

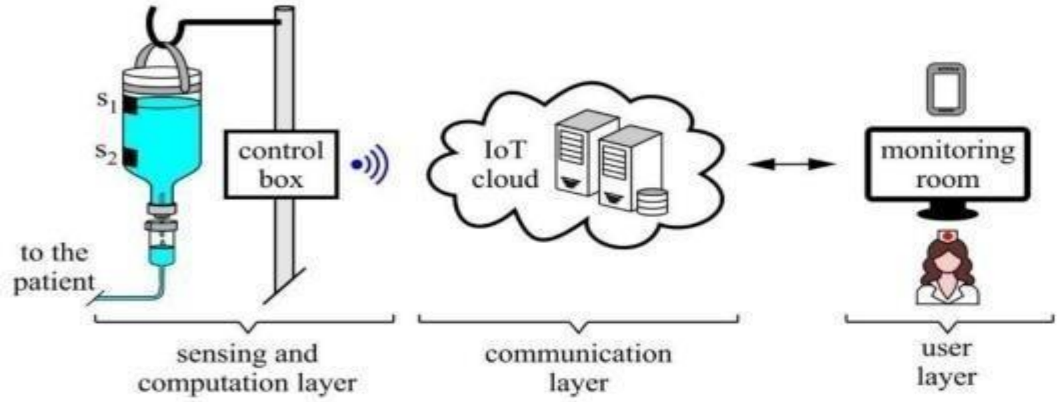

Fig. 7. Activity Diagram

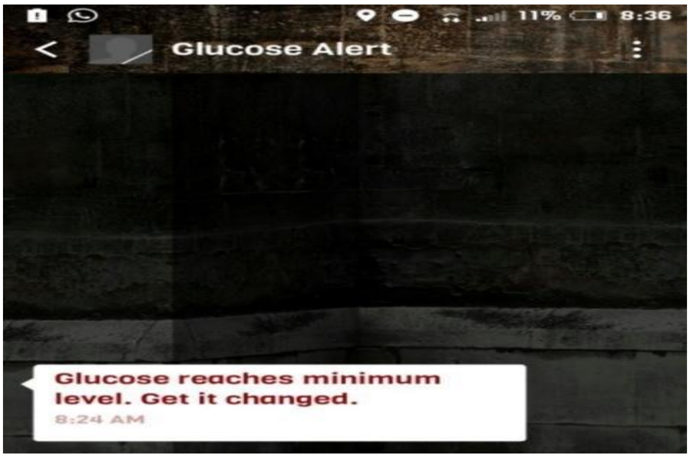

Fig 8. SMS Alert

If the first notification is not attended to, a second alert is triggered when the level of liquid reaches 30ml. This time, however, it is a call alert that is sent through the GSM modem, alerting staff to the urgent need to replace the bottle. that showed in Fig: 9. Overall, this system provides an efficient and effective means of monitoring the level of liquid in a container and notifying hospital staff of any necessary changes, ensuring timely intervention and preventing any potential issues that may arise from a depleted liquid supply. In addition to sending SMS alerts to notify hospital staff of a low level of liquid in the glucose bottle, the monitoring system can also make phone calls through a GSM modem to alert authorized personnel. When the liquid level in the bottle reaches 30ml, a call alert is triggered; indicating that the situation requires immediate attention. The system ensures that hospital staffs are promptly notified of any issues and can take appropriate action to address them. This feature adds an additional layer of security to the monitoring system, ensuring that critical situations are attended to in a timely manner. Overall, the system's ability to send both SMS and call alerts makes it a reliable and effective solution for monitoring the level of liquid in a container and ensuring that hospital staffs are notified of any necessary changes.

9 Conclusion

The proposed system offers several advantages over manual monitoring of glucose levels in hospitals. By sending glucose bottle alerts to hospital staff, the need for continuous manual monitoring of glucose levels is eliminated, which can be especially beneficial during night shifts when staff may be more prone to fatigue or distraction.

Fig 9. Call Alert

In addition, the system helps to avoid the potentially fatal risk of air bubbles entering a patient's bloodstream. Air bubbles in the bloodstream can cause immediate death, making it essential to closely monitor the levels of glucose in patients' bodies. The proposed system helps to prevent such incidents by providing accurate and timely information on the glucose levels in the bottle. With this information readily available, hospital staff can take the necessary measures to prevent any risks to patients' health and safety. Overall, the proposed system provides an efficient and reliable means of monitoring glucose levels, which is critical in ensuring the well-being of patients.

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