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Article Title: IoT Based Automatic Saline Monitoring System Using Arduino

IoT Based Automatic Saline Monitoring System Using Arduino

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Abstract

The need for health prevention is growing daily along with the global population. Therefore, it is imperative that everyone in this world take adequate care of their health. In order to ensure that hospital patients recover quickly, technical breakthroughs in the domains of sensors, micro-controllers, and computers have led to a rapid increase in medical treatment in recent years. The primary and most important need for all hospitalised patients is that they receive improved care and monitoring, as well as the right amount of essential nourishment at the right time. Saline therapy is the most crucial treatment among the many options that hospitals provide to their patients. Patients are given a bottle of saline to relieve dehydration and enhance their overall health. Patients in hospitals require constant administration of saline by a nurse or other caretakers whenever saline is given to them. However, due to a number of critical situations, such as patients' blood reflexing back into the saline tubing system as a result of carers' busy schedules and negligence towards saline completion, a significant number of patients are suffering from or dying in hospitals. Thus, the saline level monitoring and automatic alert system was created to safeguard the patient's safety and life during saline feeding hours. The proposed system is made up of a sensor that tracks the critical amount of saline liquid in the saline bottle and a mechanism that, once the saline bottle is empty, automatically stops the saline flow. or on a specific level. Patients will greatly benefit from this, especially at night. Additionally, this technique eliminates the potentially catastrophic risk of air bubbles leaking into the patient's bloodstream. Air bubbles in blood can result in instantaneous death. Patients will be certain that they won't suffer any harm thanks to this equipment.

Keywords: Automatic saline monitoring, Arduino Board, Load sensor, Wi-fi module, IOT.

1 Introduction

Internet of Things (IoT) encompasses a network of physical objects, including devices, vehicles, and buildings, embedded with electronics, software, and sensors to collect and exchange data. This evolution results from the convergence of multiple technologies, including embedded systems, real-time analytics, machine learning, and sensors. To address issues of patient safety and caregiver oversight, an IoT-based saline level monitoring system is proposed. Using load cell sensor, the system detects when the saline level drops below a threshold. A load cell driver continuously checks the sensor output against this threshold. If the level is too low, an alert is sent via a web page or app to notify caregivers. Additionally, weight difference serves as another indicator of saline level, accessible through a smartphone app or web page. To prevent adverse effects like reverse blood flow due to an empty saline bottle, a sensor mechanism can block the tube, ensuring patient safety. This system aims to reduce dependency on caregivers and enhance patient monitoring in healthcare settings. The system monitors the level of saline in a bottle and alerts nurses or caregivers when the level is low to prevent potential health risks to the patient. This system utilizes a comparator to continuously monitor the output, and if the level is too low, it alerts the observer via a web page or app. additionally, it uses weight sensors to measure the amount of saline and provide real-time data to the attendant or nurse. If the nurse doesn't attend to the patient promptly, a sensor blocks the arrangement to prevent reverse flow. This system leverages IoT technology to enable communication between devices and enhance patient care. It addresses the need for constant monitoring to prevent complications due to saline depletion.

The load cell sensor keeps track of the weight of the saline bottle and compares it to a predetermined threshold. The Arduino controller detects that the fluid level is too low when the transceiver output is negative, at which point it notifies the observer via an app or web page. An alert is created to notify the nurse that the patient's saline feeding is ending when the saline dips to a predetermined low level. The difference in weight is utilized to determine how much saline is in the bottle, which allows an attendant or nurse room to have access to a smartphone app or computer-based website. A sensor block is implemented if the nurse does not attend to the patient right away. It flattens and inhibits the saline tube. As a result, saline cannot move upward from the veins to the bottle. The Internet of Things, or IoT, is a network of physical objects that includes all gadgets, cars, buildings, and other things that have electronics, software, and sensors installed in them so they can communicate with one another and gather and share data. The convergence of several technologies, real-time analytics, machine learning, commodity sensors, and embedded systems has led to the evolution of the Internet of things. Every time a patient is given saline, a nurse or other family member must keep a close eye on them. Most of the time, a hectic schedule, inattention, or a higher patient load cause the nurse to forget to replace the saline container as soon as it is completely empty. Due to a differential in blood pressure between the inside of the empty saline container and the surrounding air, blood rushes back to the saline bottle immediately after the saline runs out. This could result in their vein's blood flowing backwards into the saline bottle. Patients have a drop in their haemoglobin levels as a result, and they may also experience a lack of red blood cells (RBCs), which makes them feel exhausted. As a result, creating a saline level monitoring system is necessary in order to lessen the patient's reliance on caregivers or nurses.

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The "next big thing" in the world today is the Internet of Things, or IoT, which is predicted to have 30 billion gadgets by the end of this decade. The network of physical object "things" that are installed with sensors, programming, and other technologies in order to communicate and exchange data with other devices and systems over the internet is Internet of Things (IoT). Stated differently, it is a tangible item that is linked to the Internet. IoT systems frequently link extremely specialized devices with constrained customizability and programmability. One of the most popular developing technologies nowadays is the Internet of Things, which finds extensive application in a variety of fields including telehealth, farming, analytics, machine learning, online shopping, smart cities, smart homes, self-driving cars, flight services, health, and traffic monitoring. Corona viruses are known to cause respiratory diseases in humans. For Covid-19 patients, hypertonic saline solution is used to lower inflammation in various body parts, including the skin, heart, kidneys, and lungs. It is also used to give extra water to rehydrate patients or to meet their daily salt and water needs if they are unable to take them orally. However, hypertonic saline can have detrimental effects as well, such as fever, a drop in oxygen saturation, and the pulse rate of the patient.

It is necessary to monitor this procedure continuously. The drip chamber, which administers the solution to the patient in the necessary quantity, is used to modify the saline drop rate. A person must always keep an eye on the glucose level and the glucose flow rate, possibly at regular intervals, while there is a saline leak. The patient who is worried needs to be closely monitored. Here, the nurses or doctors should regularly check the patient's saline fluid level because, once the patient has finished the saline fluid, there are two possible outcomes: either the patient's blood will flow backward into the saline bottle due to low pressure inside the bottle, or the patient's blood will flow into the bottle at high pressure. Here, the nurses or physicians should regularly check the patient's saline fluid level because, should the saline fluid run out, there are two possible outcomes: either the blood flows from the patient's body backward into the saline bottle as a result of low pressure in the bottle and high blood pressure in the patient's body, or there is a chance that air from the saline bottle enters the bloodstream as air bubbles and stops the blood flow, putting the patient in a dangerous condition. The patient should be regularly monitored by nurses and doctors to prevent this dangerous state. Because of their busy schedules, they are in this pandemic circumstance due to their busy schedules this might be difficult for the nurses/doctors.

In order to save lives and lessen the need for constant fluid monitoring in hospitals where there are many patients assigned to a small number of nurses, an automated system of saline fluid monitoring is therefore suggested in this study. Using a variety of sensors, this system can also be used to determine whether the patient has a high body temperature, low oxygen levels, or a slowing pulse.

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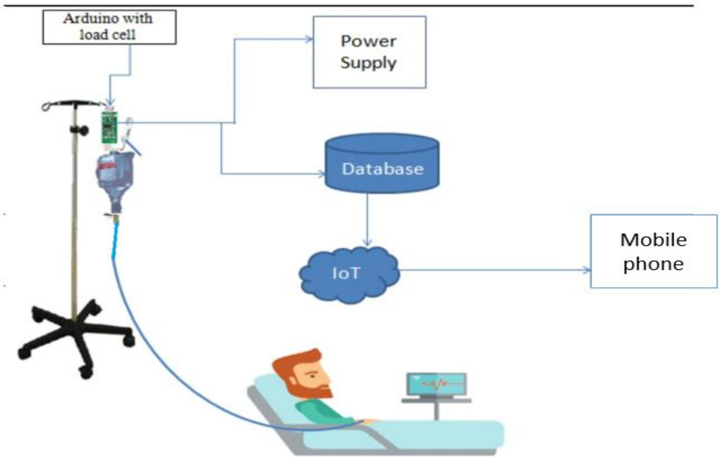

Figure 1: *Block diagram of proposed project*

2 Literature Review

Kriti Ojha et al. proposed the IoT based saline level monitoring system. Level sensor is used in this system which provides the accurate readings. If the saline level goes below the threshold point, notifications sent to the nurses by using bluetooth device but it slowly drains the battery of the cell phone.

P. Kalaivani et al. proposed this system which monitors cardio patients using ECG sensor in addition to saline level. All the patient details will be displayed in a LCD monitor.

Mansi G. Chidgopkar et al. Proposed the Automatic and low cost saline level monitoring system using wireless Bluetooth module and cc2500 Trans receiver. This system monitors the saline flow and it also predicts the remaining time to empty the saline. There is a buzzer which is fixed near to the patient bed and when the saline is going to empty, the buzzer starts to ring.

Sagnik Ghosh et al. Proposed Development of intelligent and smart saline bottle. In this system linear regression algorithm is used to predict the future moment when the saline bottle needs to be changed by the nurses/ doctors.

Anusha Jagannathachari et al. Proposed Saline level indicator. This system monitors the saline flow and if the saline gets over with the help of the DC motor and a spring which will prevent the reverse flow of blood in the tube.

Sanjay. B et al. proposed IoT based drips monitoring at hospitals. This system monitors the saline level with a different component called load cell and also sends the alert messages if the saline gets completed.

Karthik Maddala et al. proposed the system which monitors the saline flow and it also displays the level of the saline in a LCD display (16*2). When the saline gets over an alert message is sent to the nurses/ doctors.

Ashika A. Dharmale et al. [8] proposed IOT Based Saline Level Monitoring & Automatic Alert System. In this system three IR sensors are used to indicate the level of the saline. This system

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also stops the flow of saline by using a micro servo motor. All the patient and saline details are stored in the database for the future use.

Vyankatesh Gaikwad et al. Proposed this system to monitor the saline level by using an Ultrasonic sensor and it also sends a notification to nurses using the wifi module. In this system the patients can be accessed by using a mobile application.

Pooja Pandit Landge et al. Proposed Smart Saline Level Monitoring and Control System. This system uses IR sensor to monitor the saline level and a DC motor is utilized to stop the flow of saline. The patient details will also be displayed in an android application.

3 Existing Project

The design and implementation of an automated liquid observation and controlling method that uses an inexpensive liquid flow sensor and a microcontroller to help a healthcare provider control the saline circulation rate using an Android phone or Matrix keypad. Together with an Android phone and a 3x4 matrix keypad, the Arduino Mega (2560) platform has been utilised as the controlling unit to provide the necessary control over the drop per minute, both manually and through the use of a Bluetooth module. In order to calculate the precise number of saline drops and the saline flow rate, the developed flow sensor will be connected to the saline container's drip chamber. The sensor's outputs are continually obtained the microcontroller drives the servo motor to adjust the circulation rate in order to balance with the issued command after continuously comparing the sensor's outputs with the command. Following the completion of the required hardware development, the gadget has been tested. The results are satisfactory, suggesting that there may be a use for improving patient care.

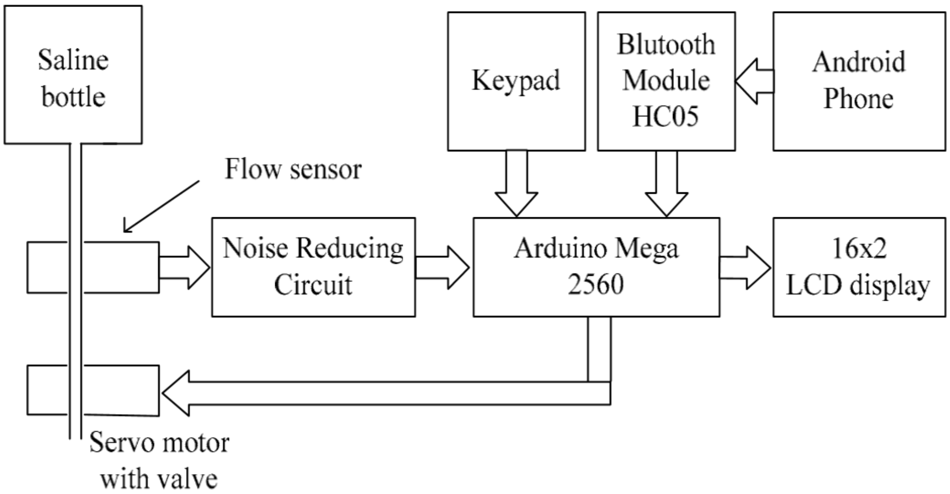

Figure 2: *Block diagram of automatic saline monitoring system using IoT.*

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3 Proposed Project

The system continuously monitors the saline level in a saline bottle and sends alerts to medical staff when the level falls below a certain level. The load cell sensor and driver are used to measure and control the saline level, while the buzzer provides audio notifications and the LCD displays the current status. The Node MCU is used to connect the system to the internet via Wi-Fi, and the Ubidots IoT platform is used to store and analyze data from the system. The proposed system is cost-effective, easy to implement, and has the potential to improve patient safety in healthcare settings.The aim of the system for proposes an Internet of Things (IoT) based automatic saline monitoring system using Arduino microcontroller, load cell sensor, load cell driver, buzzer, LCD, Node MCU (ESP8266), and IoT platform (Ubidots). We designed and developed the entire idea into a device, where we integrate all the mentioned components into a single unit.

4.1. Block Diagram

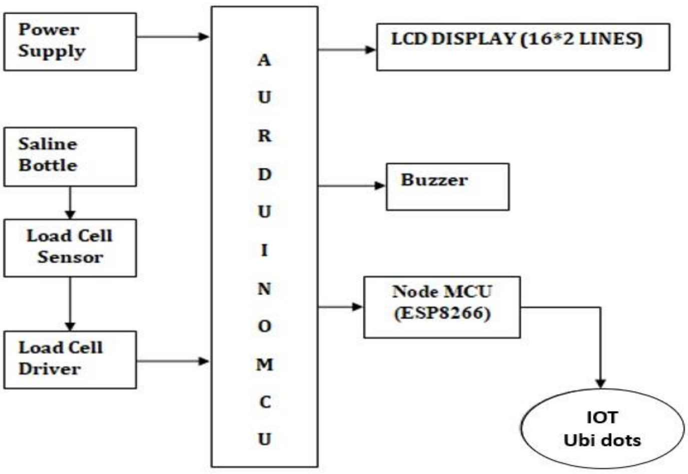

Figure 3: *Proposed project block diagram*

4.2. System Description

Proposed system consist of various blocks for different methodologies that is discussed below.

A. Arduino UNO

The Arduino Uno is a microcontroller board in context of AT mega 328. It has 14 electronic data/yield pins (of which 6 can be utilized as PWM yields), 6 clear data sources, a 16 MHz

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stylish resonator, a USB association, a power jack, an ICSP header, and a reset get. It contains everything foreseen that would help the microcontroller just interface it to a PC with a USB association or power it with an AC-to-DC connector or battery to begin.

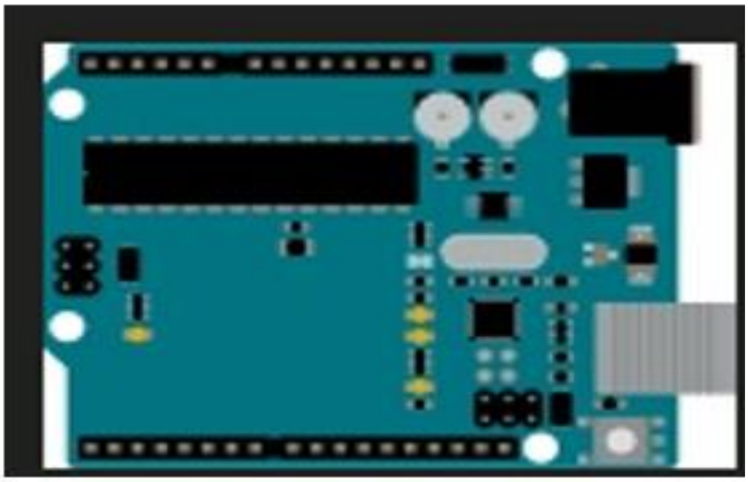

Figure4: *Arduino Uno*

B.WI-FI MODULE (ESP8266)

With its inbuilt TCP/IP protocol stack, the self-contained SOC ESP8266 WiFi Module allows any microcontroller to connect to your WiFi network. Either an application can be hosted on the ESP8266, or it can delegate all WiFi networking tasks to another application processor. Since each ESP8266 module has an AT command set firmware pre-programmed, all you have to do is connect it to your Arduino device to obtain roughly the same amount of WiFi functionality as a WiFi shield—and that's right out of the box! The ESP8266 module is a very affordable hoard with a sizable and constantly expanding community.

Figure5: *Wi-fi module*

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C.LOAD CELL (HX711) SENSOR

This top of the line load cell amplifier mounted on a breakout board pairs perfectly with the load cell to provide fast, accurate force measurements. It measures small changes in the resistance of the strain gauges mounted to the load cell and passes these values directly to any micro controller.

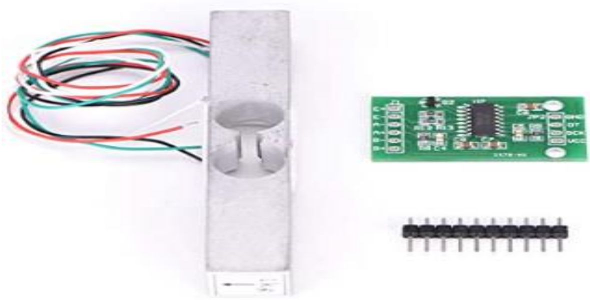

Figure 6: *load cell sensor*

D. LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits and devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for mulit-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive, simply programmable, animations, and there are no limitations for displaying characters, special and even animations etc.

Figure7:*LCD Display*

E. Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

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Figure7: *Buzzer*

6. Results and Discussion

Programming for the Arduino platform is done with the C compiler.The results are obtained on Smartphone with the help of WI-FI module terminal and are obtained on computer or laptop using serial port test software. The results contain weight of the saline bottle, alert message notifying about status of saline bottle, remaining solution in bottle, humidity and temperature of the patient.

Figure8: *Hardware arrangement*

Figure 9: *Output on the LCD indicating the weight of the saline bottle*

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Figure 10*: Output on the LCD indicating temperature of the patient*

Figure 11: *Output on the LCD indicating humidity of the patient*

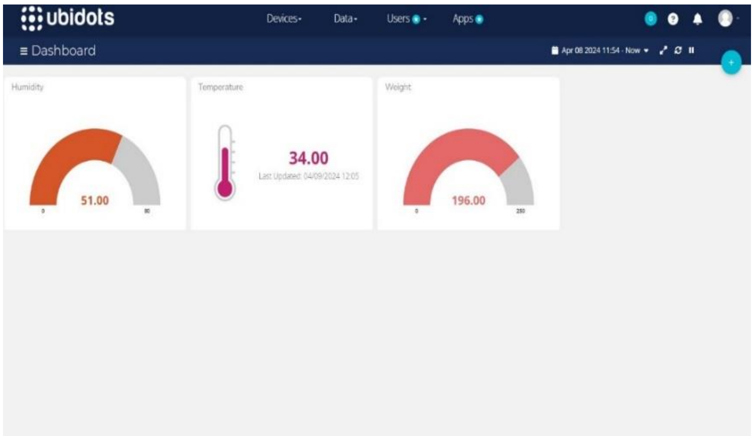

Figure 12: *Output screen of ubidots IOT*

The wi-fi module transmits the weight, temperature, humidity. Load sensor stores the weight, temperature, humidity values and Arduino will gathers these information to the IOT. The Ubidots cloud analyses and stores the data. The output screen of the ubidots is shown in fig.12.

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7. Alert Notification

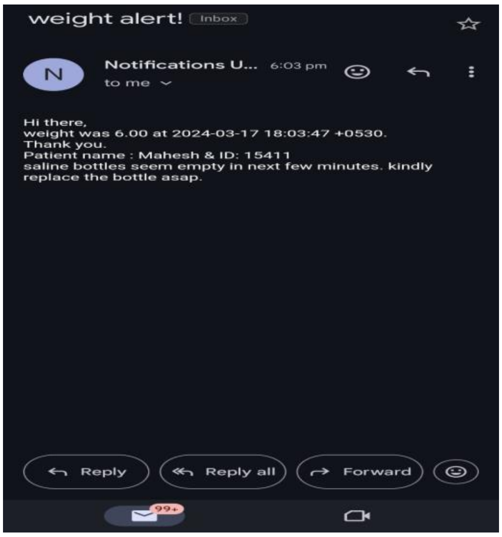

Figure 13: *Alert message*

Alert notification sent to the nurses or care tackers showing the weight of the saline bottle with date, time and patient name with patient id. It is also contains a message that saline bottle is empty in next few minutes kindly replace the bottle.

8. Conclusion

The implementation of an IoT-based saline level monitoring system offers a revolutionary advancement in healthcare management. By automating the monitoring process, significant reductions in manual effort by nurses are achieved. This automation not only saves time but also ensures a consistent level of vigilance over patients' saline levels, even during nighttime hours when staffing may be limited. One of the standout advantages of this system is its ability to provide real-time alerts to healthcare providers when saline levels reach critical thresholds. This proactive notification system mitigates the need for nurses to make frequent bedside visits solely for saline level checks, thereby streamlining their workflow and allowing them to focus on other essential aspects of patient care. Consequently, patients benefit from uninterrupted treatment and a decreased risk of complications due to saline depletion. Moreover, the continuous monitoring capability of the IoT system significantly reduces the stress associated with constant vigilance among healthcare professionals. Nurses and doctors can have peace of mind knowing that the system is diligently watching over patients' saline levels, allowing them to allocate their attention to other critical tasks while still ensuring patient safety. In terms of cost-effectiveness, while there may be initial investments in setting up the IoT infrastructure, the long-term benefits far outweigh the costs. Not only does the system potentially save lives

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by preventing saline shortages, but it also optimizes resource utilization within healthcare facilities, leading to overall cost savings.

In conclusion, the adoption of an IoT-based saline level monitoring system represents a transformative shift in healthcare management, offering unparalleled efficiency, patient safety, and stress reduction for healthcare providers, all at a reasonable cost.

Future Scope

In future the proposed method can be extended with

- Integration with other medical devices: The automatic saline monitoring system can be integrated with other medical devices such as infusion pumps, ECG machines, and pulse oximeters to create a complete patient monitoring system.
- Real-time data analysis: The system can be enhanced to provide real-time data analysis of the saline solution to detect any anomalies or variations in the solution's concentration. This can help prevent adverse reactions in patients and improve patient outcomes.

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