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IV Bag Online Monitoring System using Microcontroller

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ABSTRACT:

It is common practice to use saline to treat dehydration or loss of fluid. A bag usually contains crystalloid solutions example salty water or sugar water to treat dehydration. In recent times with the rise in health issues, the number of patients for saline treatment has increased and it is getting difficult for treating staff to constantly keep a check on them. With the advancement in technology and collaboration of engineering and medicine, we are able to find a solution using IoT i.e. Internet Of Things. Through this project, nurses and doctors will receive a notification and an alarm when the liquid in a saline bottle reaches a critical level. The non-contact level sensor will constantly keep a check on the level of liquid. When the level reaches a threshold level as programmed in the Arduino a notification will be sent to the treating staff over the WIFI module and an alarm will be raised. The app has been made using Flutter framework and Dart programming language on Visual Studio Code, through which, the treating staff as well as the patient's relatives will be able to constantly keep track of liquid level and have access to patient's data as well. Thus, the nurses will be able to fill the saline liquid level before a critical level is reached. In this way, we will be able to use technology in the healthcare industry where there will be errorless saline level treatment, constant level monitoring, and also easy management of patient data hence facilitating the treatment process. Our aim is to use minimum components and provide the most user-friendly and the above things used favor the condition. In this paper, we would like to give an introduction, give a brief about the components used, explain the implementation of hardware and the software process, and a conclusion with its future scope. We believe our project will reduce the workload on treating staff and give a safer treatment process.

Keywords: Saline Level Monitoring, weight sensor, automation, flutter, microcontroller.

INTRODUCTION:

As we read in the abstract, we know saline treatment is a common practice to compensate for the loss of fluid inside our body. Usually, saline treatment is done through intravenous access (i.e. through the veins of the body). An average hospital has 250 beds for saline treatment with each patient requiring a minimum of two days. With the rising population and diseases, there is a heavy inflow of patients every day. It is difficult for treating staff to keep a check on patients which is a threat to patient's life. If the saline liquid runs out the patient might have to re-prick or in the worst-case causes backflow of blood or inject air into veins. For Patients with congestive heart failure slight overdose of normal saline solution can lead to a worsening of systolic or diastolic heart failure leading to death. Therefore, doctors and nurses have to constantly monitor the level of saline liquid.

It is believed that saline treatment for the medical field in 1831 during the Indian Blue Cholera Pandemic which affected Europe. Proposed by William Brooke which was later implemented by Thomas Latta actively in humans. The current and most common saline system has IV bags clamped on the metal rod which contains crystalloid solutions which are mostly 0.9% salt solution or sometimes 0.45% salt solution. Saline-level detectors and alarmers have been used in the medical industry since the 1950s. The first models were simple devices that could only detect whether or not there was fluid in a container, but they have since evolved into much more sophisticated machines with many different functions.

There are usually two types of saline systems colloid solution and crystalloid solution. The most commonly used is the crystalloid solution which is mostly used in cases of dehydration, metabolic alkalosis due to fluid loss, and mild sodium depletion. It is really important to decide on daily dosage according to the patient's history and current health. Mostly, the dosage level is calculated using Dr. Holliday and Segar's formula which indicates that one can use the "100-50-

25" or "4-2-1" rules. Here the weight is considered as one of the parameters. Hence, we have provided a way to store patients' data in the app using Firebase since it is compatible with Flutter. The data will be available to both doctors and nurses and thus, can immediately decide the level and type of dosage to be given.

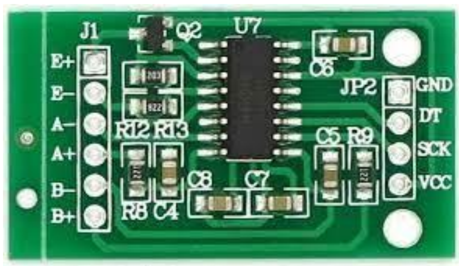
We have used the IoT or Internet of Things which is a group of objects having sensors, software, and hardware embedded together and performing their functions according to their settings/connections. With its recent advancement, we are able to perform many tasks, automate processes and connect across devices. Using this same concept, we are able to automate saline-level detection. The non-contact liquid level sensor, NodeMCU, and Arduino UNO are some of them. Using only these 3 devices we are able to build the hardware of our work. The WIFI is connected to Arduino to transmit the data The Arduino is coded to read data from the level sensor and send the data over the WIFI module using an HTTP request.

The application is developed using a popular Google development framework i.e. Flutter. It is a natively developed open-source development toolkit used to develop web and mobile apps using mostly Dart language. Initially developed in 2017, it developed wide popularity due to its ease of use and fast development cycles. Due to its feature which offers cross-platform compatibility a code developed for an app in Android can be used for Ios thus easing the workload on developers. Having a pre-defined set of widgets, it is relatively easier to develop beautiful user-friendly interfaces thus making it easier for anyone to use the app. Due to this feature, we are using Flutter to develop our app so that it is easier for nurses, doctors, and any patient or acquaintances to use the app. Flutter's built-in package can help provide real-time data about the patient thus reducing any kind of error. When the saline liquid has reached a critical level data will be sent over the WIFI module and notification will be generated on the app. Additionally showing the patient's bed so that nurses can take immediate action. As we read, it is important to take the patient's health update from time to time to decide the next saline concentration, the app will also show the patient's history for the same.

COMPONENTS

The following components are used in our project.

i. HX711 Amplifier



The HX711 is a precision based 24-bit analog-to-digital converter (ADC) intended for use in applications involving pressure and weight monitoring. It is frequently employed in a variety of industries, including the agricultural, medical, and industrial sectors. It can operate at a voltage between 2.6V to 5.5V hence making it compatible with many simple board applications.

The HX711 ADC was created by Avia Semiconductor, which is now owned by the business known as Avia-IC, to replace the HX710 ADC. In order to address the need for a high-precision, affordable solution for weight-measuring applications, the HX711 was brought to the market.

The HX711 adheres to the Wheatstone Bridge, a system of bridge measuring. It is made up of a strain gauge and a load cell, a sensor that turns pressure or force into an electrical signal. The displacement of the load cell under applied force results in minute variations in electrical resistance, which are measured by the strain gauge. The strain gauge's modest differential voltage output is amplified by the HX711 before being transformed into a digital signal via a built-in delta-sigma ADC. Applications that call for precise weight readings can benefit from the 24-bit resolution's ability to support high-precision measurements.

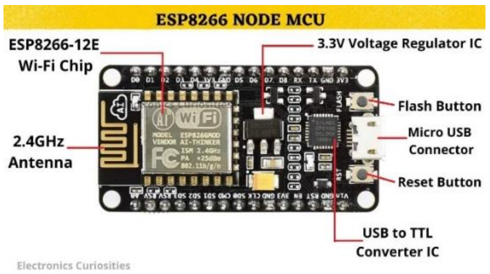
The system design is simplified since it uses a straightforward two-wire serial interface to communicate with the host device.

Since the HX711 has an on-chip oscillator, no additional parts are required.

Selectable gain possibilities are available, enabling customization based on the particular needs of the application.

The HX711 is appropriate for a variety of environments with limited space due to its small size and simplicity of integration.

ii. Node MCU ESP8266



NodeMCU is a microcontroller that has a built-in WIFI module. It is basically an open-source firmware built by Chinese company Espressif Systems after they built the WIFI chip ESP8266. After the chip gained immense popularity company launched the firmware NodeMCU to make it easy for developers. It is cheap and easy to use hence gaining immense popularity. Many prototype designs are available for the same. It has many Lua APIs thus making it easy to interact with sensors, WIFI, ADC, etc.

The firmware also provides web-based IDE in Lua. The IDE has a built-in debugger and serial monitor. The NodeMCU development board has several features that make it popular among developers. It is relatively cheap compared to other development boards like Arduino and Raspberry Pi, has a built-in WIFI chip, is small in size, and is easy to program. The NodeMCU board has a large community of developers who have created many libraries and examples that can be used to build various IoT projects.

iii. Load Cell

A load cell is a transducer used to convert weight or a kind of force into an electrical signal. Load cells have been an idea since the early 20th century. Mechanical devices like strain gauges and mechanical levers were used to create the first load cells. With the development of load cell technology throughout time, electronic load cells with improved precision, dependability, and simplicity of electronic system integration were introduced.

Load cells operate on the strain gauge principle, which consists of thin metallic wires or foils connected to a flexible framework or metal element. When a force is applied to the load cell, the metal element deforms, causing the electrical resistance of the strain gauges to change.

The strain gauges are positioned in a Wheatstone bridge design to measure minor changes in resistance. The resistance of the strain gauges fluctuates as the force is applied, causing an electrical imbalance in the bridge. This imbalance is transformed into a proportional electrical signal to the applied force.

Load cells have a variety of load capacities ranging from a few grams to several thousand tonnes, depending on the application. Before the electrical signal can be used by the measuring system, load cells frequently require signal conditioning to amplify and filter it.

Load Cell and HX711 together make the weight sensor where Load Cell calculates the load and HX711 and converts data in analog form from load cell to digital.

Literature Review

[1] The use of IoT has not only helped nurses to a vast level by providing an online saline-level monitoring system but also providing an errorless monitoring system thus reducing the threat to patient safety. But managing and saving vast heterogeneous IoT data is difficult hence the paper introduces a way to manage this. In the first paper, apart from the components listed in our project, the authors used a 16cm display to display the current saline level and a GSM module to send the SMS regarding the patient's current health and saline level to nurses so as to keep track of the liquid level in the IV bag. The GSM module helps to communicate the saline level over the mobile network and gives notifications via SMS. Though there is no facility to store patient data the GSM helps overcome the use of a WIFI network.

[2] In the case of saline liquid treatment, it is important that the liquid is transmitted at the correct rate. The use of sensors has helped to keep a check on the same. Sensors are devices that help the system to be aware of the environment it is

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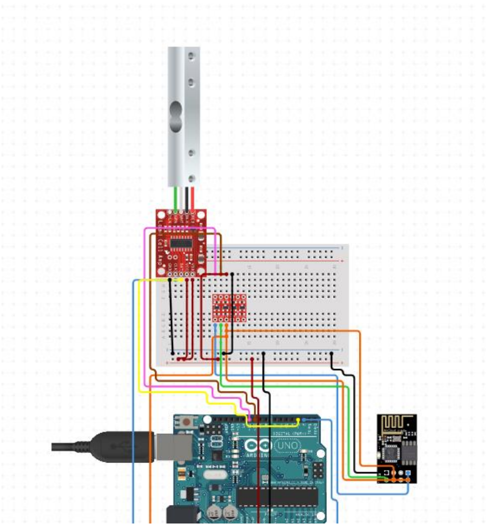
working in. In the saline setup, it is usually done manually by rolling the roller cap which compresses or expands the tube. But to get a perfect measure, authors have introduced an IR sensor to keep track of the drop rate. IR sensors are IOT devices that emit infrared radiations to detect any object accordingly by reflection or absorption of light. Here the IR sensor is a level sensor that does not detect drop for a certain period of time like the 30s would conclude that the liquid is over and send a notification to nurses and close the tube as well in order to prevent backflow of blood. Here the notification will be generated after the saline bottle is completely empty which is a very critical situation and a buffer level before the bottle becomes empty should be kept.

[3] Through the third paper, we are able to understand another application along with saline monitoring which is ECG detection of the patient. ECG stands for electrocardiogram which is a simple activity to test the heart's electrical activity and detect heart attacks or their potential to occur in the future. In this paper, ECG is detected through 3 lead electrode systems via AD8232 which is used to amplify small bio-signals for processing in Aurdino along with saline-level testing.

IMPLEMENTATION

1. HARDWARE SETUP



Circuit Diagram

Hardware Setup

The ESP8266 microcontroller is utilized as the main processing unit for the system. To interface with the load cell and measure weight, the HX711 load cell amplifier is connected to the ESP8266. The load cell's data output pin is connected to pin D1 (GPIO5), and the clock input pin is connected to pin D2 (GPIO4) on the ESP8266.

Software Configuration

The software development environment used for this project is the Arduino IDE, with the ESP8266WiFi and HX711 libraries incorporated for WIFI connectivity and load cell interfacing, respectively. The necessary libraries are imported at the beginning of the code to enable their functionality.

Network Connectivity

The ESP8266 is programmed to establish a connection with a WIFI network using the provided SSID (WIFI network name) and password. The connection status is continuously checked using the WL_CONNECTED flag until a successful connection is established. This ensures that the device is connected to the network before proceeding.

Load Cell Calibration

The HX711 library functions are employed to initialize the load cell and calibrate it. The set_scale() function sets the conversion ratio between the raw sensor readings and weight units. The tare() function adjusts the scale's reference point to zero, eliminating any initial load or environmental variations.

Data Acquisition and Transmission

Within the loop() function, the weight is continuously measured using the get_units() function provided by the HX711 library. If a valid weight reading is obtained, the value is stored in a variable for further processing.

Server Communication

The ESP8266 establishes a client connection with the specified server address and port using the WiFiClient class. The weight data is then sent to the server using an HTTP POST request. The weight value is converted to a string and appended to the request payload as a parameter.

Data Handling and Response

The server receives the weight data through the specified API endpoint. The server-side implementation processes the received data as per the application's requirements. In this case, the weight value could be stored in a database or used for real-time monitoring and analysis.

Iteration and Delay

To enable continuous weight measurement and data transmission, a delay of 5 seconds is introduced at the end of the loop() function. This delay ensures a suitable interval between successive measurements, which can be adjusted based on the specific application requirements.

2. SOFTWARE PART

Above is the First Page that will first appear when the user opens the app and if not already login.

As the data will be sent to the server from the WIFI module, the app will collect the data by including an HTTP package that has the necessary functionality required to collect the data, using from the server and show the real-time liquid level with the patient's name and bed as well.

Above is the login page that will appear when the new user wants to log in.

1) Designing the User Interface:

We used a wide variety of built-in widgets and custom widget compositions that Flutter has in order to develop the desired user interface. The Login and Signup page is designed where a particular hospital if not registered can sign-up or log in to get into the app securely. On the main homepage, we created a list of elevated cards each representing the specific bed of the hospital. We can add a new card for a new bed or delete a card. For each card, we have an animated container for updating the level of saline bottles in real time. It basically changes the level and shows its percentage value accordingly. We also utilized the Material Design principles for a clean and intuitive user interface

2) Data Storage and Management:

In the case of monitoring the saline bottle level and managing related data, we preferred Google's 'Firebase Realtime Database' as an efficient and reliable database solution.

Firebase Realtime Database is a cloud-based NoSQL database that allows for real-time data synchronization between devices. It eliminates the need for a separate database server and provides seamless integration with our cross-platform Flutter application, supporting both iOS and Android platforms. This ensures consistent and reliable data management across different devices and platforms.

One key advantage of Firebase Realtime Database is its ability to handle real-time updates. With our application requiring real-time monitoring and synchronization, Firebase's real-time synchronization capabilities allow us to receive and update data instantaneously. Whenever new data is received from the Wi-Fi module, Firebase Realtime Database automatically synchronizes the changes across all connected devices, ensuring that the latest data is always available to users in real time.

Additionally, Firebase Realtime Database simplifies the data management process by providing a flexible JSON-based structure. We can easily store and retrieve data without the need for complex SQL queries or managing data schemas. This simplifies the development process and allows us to focus more on the core functionalities of our application.

The change in the values in Realtime Database will reflect the changes in the app's UI as well. This change will be reflected in UI using Flutter's state management technique in the "Provider" package.

TESTING

Unit testing is crucial for ensuring that each component and function of the project is working properly while it is being developed. For instance, you can verify precise weight measurement by testing the HX711 load cell interface. The Firebase integration can also be tested to confirm data delivery and retrieval.

Integration testing: Integration testing makes sure that all of the project's parts function properly together. It entails examining how the ESP8266 module, HX711 load cell, WiFi, and Firebase database work together. This testing guarantees that information is reliably gathered from the load cell and successfully communicated to the Firebase database.

Error management: Throughout the project, it's crucial to create reliable error management procedures. Wi-Fi disconnections, problems with Firebase authentication, or issues with the load cell interface can all result in errors. To handle these circumstances graciously, proper error handling and recording methods should be put in place. To inform the user or developer of any failures, you may, for instance, send notifications or log error messages to the Serial Monitor.

Conclusion

Hence, when the weight sensor (which includes the load cell and HX711 amplifier) detects that the bag has reached a critical weight it will trigger the Arduino board and a notification will be sent over the WIFI module on the app. The nurse will check the patient's name, bed, etc, and rush to the spot immediately thus preventing a possible threat to the patient's life. Also, she will be able to continuously track the saline liquid level and hence can refill the weight reaches a critical level. This real-time monitoring is possible due to WIFI connectivity. The app also provides a feature to store patients' data and history and current data in an organized manner which helps the staff to decide the type of saline and its duration. The data is stored in Firebase since it is more compatible with Flutter. Most of the research is limited to IOT applications and notifications are sent via WhatsApp we have included a whole application to organize and simplify the process for healthcare professionals.

In conclusion, the real-time saline level monitoring system described in this research study, which uses a load cell, NodeMCU microcontroller, and HX711 amplifier, provides a dependable and effective solution. The system is appropriate for a variety of applications in the medical, laboratory, and industrial sectors due to its accuracy, scalability, and remote accessibility.

By putting this system in place, businesses may increase operational effectiveness, cut waste, and guarantee a steady supply of saline solutions. To further optimize saline level control, future research can concentrate on combining cutting-edge analytics and predictive capabilities. Overall, this system offers a substantial advancement in the automated and efficient monitoring of saline levels, enhancing resource management and quality control.

Hence, the saline health monitoring system is a boon to the healthcare industry.

Future Scope

There are yet many challenges in healthcare industry and with the rise in population and patients and it is really important to address them and for which we can use the technology. Though the aim of our project is to saline level alert system we could include additional features like

•Integrating with blood pressure, and heart rate monitoring systems (ECG) which will help to show the real-time blood pressure and heart rate to staff so as to increase effective monitoring.Also, this system can be set to solve challenges in the agriculture field in the following ways:

•Similar monitoring system can be used in crop monitoring where the water around crops can be monitored for excess salts which is a potential danger to the health of plants.

•Also, farmers can check the concentration of soil seasonally thus deciding the pattern of the crop cycle which is important for high yield.

•Lastly, this system helps to keep a check on over-irrigation which has the potential to damage crops and worsen health if consumed.

•Machine Learning and Artificial Intelligence: Using machine learning and AI algorithms, saline-level monitoring systems may learn and adapt to changing consumption patterns. These technologies can improve saline inventory management, forecast usage trends, and make recommendations for resource allocation.

References:

[1] "Survey on patient health and saline level monitoring system using IoT" Rutuja Deshmukh, Kshitija Jadhav, Tejaswee Borude, Harashada Lanke.

[2] "AUTOMATIC SALINE LEVEL MONITORING SYSTEM USING IOT" Mr. Jayant Ingale, 2Ms. Sharvari Sahare, 3Ms. Pradhnya Kanchane, 4Mr. Nikhil Tonge, 5 Mr. Akshay Shah

[3] "Real Time ECG and Saline Level Monitoring System Using Arduino UNO Processor" P. Kalaivani, T. Thamaraiselvi, P. Sindhuja, G. Vegha

[4] "IoT-based saline level monitoring system"
G. Sunil[1,5], Srinivas Aluvala[1,5], G. Ranadheer Reddy[2], Vedantham Sreeharika[3], Parupally Sindhu[4], and Sriramula Keerthana.

[5] "Internet of Things Based Smart Hospital Saline Monitoring System" P. Nagaraj; V. Muneeswaran; K. Muthamil Sudar; R. Sabik Ali; A. L. Someshwara; T. Sangeeth Kumar

[6] "Design and Development of a Monitoring System for Saline Administration" Sumet Umchid, Pakkawat Kongsomboom, and Matuve Buttongdee

[7] "Smart Saline Level Monitoring System Using ESP32 And MQTT-S"
Debjani Ghosh; Ankit Agrawal; Navin Prakash; Pushkal Goyal

[8] "Automatic and low-cost saline level monitoring system using wireless Bluetooth module and cc2500 transceiver" Mansi Chidgopkar and Aruna Phatale.