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Infus liquid monitoring system using web-based loadcell sensor

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ABSTRACT

Improvements in the efficiency and precision of using the Internet of Things (IoT) to monitor infusion fluid volumes have been particularly beneficial to the health sector. It is now feasible to create intelligent solutions that replace labor-intensive and error-prone manual techniques with the aid of affordable devices like the ESP8266 and accurate sensors. Through the use of an internet connection, the server may easily receive data on the volume of infusion fluids collected by the ESP8266-based system and precision sensors. This enables remote access to real-time monitoring using a web platform. The main advantage of this technology is that it allows medical personnel to adequately monitor patients even when they are nearm not them. This reduces patient distraction and gives patients more time to focus on important medical tasks. By using this technology, healthcare personnel can improve the quality of treatment they give by reducing the chance of human error when calculating and changing IV bags. When medical staff has access to dependable and real-time data updates, they can manage IV fluid management more skillfully and respond to changes in patient situations more quickly. All things considered, these advancements represent significant strides forward in the administration of intravenous fluids, offering more accurate, effective, and conveniently accessible solutions that elevate the bar for healthcare overall.

Keywords: Infusion fluids; ESP8266; internet of things; server; technology

1. INTRODUCTION

To improve patients' quality of life, medical staff monitors patients around the clock using assistive devices. Despite routinely gathering data from the patient's body, medical staff occasionally fails to replace the patient's IV fluids sufficiently. For medical professionals to monitor patients more easily, the process must be automated. Consequently, a monitoring system was developed that continuously checks the patient's IV fluid levels, heart health, and body temperature using Internet of Things technology [1].

Through infusion fluid monitoring, it is possible to measure the infusion fluid flow rate and provide support to patients and caregivers. This infusion system uses Internet of Things (IoT) technology to automatically monitor the infusion fluids' drip rate, assisting nurses and patients in changing infusion fluids on a scheduled basis [2][3].

Infection control is essential in healthcare facilities because it can lower the risk of deaths from treatment delays and overcrowding. A mechanism has been implemented to monitor the rates of infection and the dosages of infusions for every person. This system determines each person's infusion amount and infection rate using load cell sensors and InfraRed, with a 99.8% detection accuracy rate. The web platform allows for instantaneous tracking of this status [4][5].

A medical infusion is a frequently used device that assists patients in regularly receiving fluids. This study looked into the possibility of using a microcontroller to solve the problem of delayed infusion administration. The research methodology includes the literature review, hardware examination, infusion function analysis, and presentation of the study's results [6]. To address this problem, an infusion monitoring tool utilizing NodeMCU esp8266 and sensor readings from a microcontroller has been developed. This sensor module can count infusion drips precisely, which allows for a quicker calculation of the infusion volume [7].

Rapid developments in medical research and technology are becoming more apparent, especially in the field of health care. One feature that is often observed is the use of infusions, which are currently done by hand. The Internet of Things (IoT) is now being researched for potential uses to reduce medical hazards. The purpose of this project is to develop a working prototype of an Internet of Things infusion monitoring system by utilizing waterfall sensors, NodeMCU V3, and the Thing Talk web server [8][9]. The Infusion Volume and Drip Pace Control and Monitoring Tool (Blynk), a wireless gadget that regulates and logs the pace and volume of patient infusion drips, is driven by an Internet of Things NodeMCU ESP8266 microcontroller. This apparatus uses a load cell sensor and a photodiode sensor to determine the patient's infusion volume. In Indonesia, this device has been widely utilized to monitor and control patient infusion conditions.

The use of accurate and timely information technology is growing in the healthcare sector, especially in assisted living facilities. To collect patient data and alert medical professionals when patients need care, researchers have deployed an Internet of Things (IoT)-based monitoring system. This system allows for up to 98.89% accuracy in patient data monitoring and successful telegram notifications [10]. Health requires accurate, timely, and fast information access, and the internet is essential for this. The manual monitoring of each hospital patient's infusion is considered inefficient. This technique allows for faster handling of infusion replacement and assurance of the infusion monitoring process [11].

Infusion is an essential, yet sometimes hazardous, treatment for patients requiring a source of body fluids. It is risky to put off replacing IV fluids because of the differential fluid pressure between the vein and the IV bag. The purpose of this research is to monitor the volume of infusion fluid and develop a device that can automatically stop the flow of fluid before it runs out. This device consists of a solenoid pinch valve, an HX711 ADC module, an Arduino Uno CPU, and a load cell [12]. The objective of this project is to develop a system that uses web-based platforms, Ethernet shields, load cell sensors, LEDs, photodiodes, and Arduino Uno to measure and monitor the infusion volume (infusion fluid) in patients. All of the connected sensors' operations are managed by the main controller, Arduino. Real-time infusion volume monitoring is made possible by the Ethernet shield, which sends the data generated by the sensors to the website. This system achieves a 0.05% error rate and needs a minimum volume of ±50ml [13].

Technology has made it easier for people to create systems that increase production and efficiency, especially in the medical industry, which has become more crucial since the COVID-19 epidemic. In a comparative investigation, the ESP8266, Firebase, MLX90614, and XKC-Y25-V sensors were utilized to measure the severity of COVID-19 infection and symptoms. The error rates of 1.8% and 0.99% indicated in the results demonstrate how important the data transfer interval was in determining the error rate [14].

To support medical professionals in the administration and monitoring of infusions, the objective of this project is to establish automatic IV fluid drop monitoring. An infusion sensor, a NodeMCU ESP8266, and the Telegram communication app are all used in this monitoring system. If the infusion volume is 50 ml or more, the sensor records a value of "0"; otherwise, it records a value of "1" [15]. This work provides novelty value by measuring the volume of infusion fluids using Loadcell sensors, an Internet of Things (IoT) app, and a Design Thinking methodology. The data shows a low error rate of 0.15% in Load Cell A and 0.112% in Load Cell B. This approach presents a new approach that has never been looked into before in the context of infusion fluid volume monitoring to improve infusion fluid management precisely and effectively [16]. Using Internet of Things (IoT) technology, this technique combines a load cell sensor and a NodeMCU. A MySQL database receives the data, which is then shown in milliliters (ml). Furthermore, the system provides a visual representation of recent volume and changes and allows the program to be adjusted based on the volume values stored in the database [17].

2. METHOD

The two fundamental methodologies combined in this study are the experimental strategy and the-descriptive analytic methodology. Because these two approaches have been integrated, researchers can now evaluate and detail existing problems as well as practical solutions in detail. A quantitative descriptive research design was chosen because this case involved the application of a quantitative technique. The objective of this approach is to compile data regarding existing facts and issues [17].

2.1 Research flow diagram

Flow diagrams are used to develop algorithms and display the sequence in which processes happen in a system. This image uses lines and symbols to represent the steps involved in conducting research, making it easier for readers to understand the ongoing process. This flow diagram refers to Figure 1 of this study. It is anticipated that by using this flow diagram, researchers will be able to measure and carry out research activities in an organized manner and within the allocated time to accomplish the desired research findings. Research implementation can proceed by the plans that have been developed in a systematic, quantifiable, and trouble-free manner with the aid of the flow diagram that is attached above.

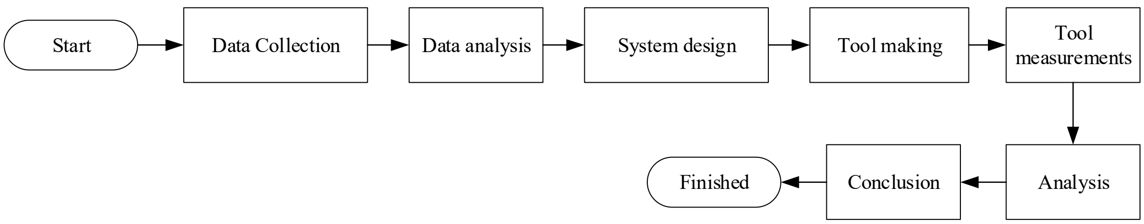

Figure 1. Research flow diagram

Figure 2. depicts the general design of the tool, which is made up of several important parts. Using the load cell sensor, the load on the infusion fluids is first precisely measured. The ESP8266 WiFi module is then used as a data transmitter from the load cell sensor to the PC, enabling remote and real-time monitoring. To protect every portion from external interference, especially to prevent displacement caused by the movement or vibration of the IV pole, a box is used as a barrier. Its battery-operated power source also makes this instrument more portable and flexible because it allows it to function on its own without requiring a connection to an external power source. All of this is done to guarantee that intravenous fluids are administered to patients in a manner that is accurate, safe, and tailored to their individual medical needs.

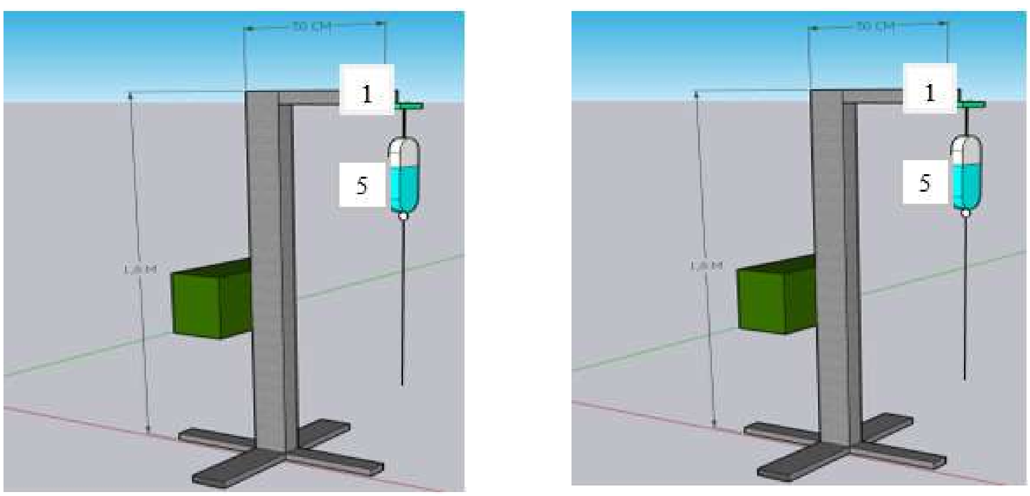

Figure 2. The overall design of the tool

a) Loadcell sensor
   A load cell sensor, a kind of sensor used to detect loads, is used to determine the weight of infusion fluids.
b) ESP8266
   This gadget uses the flexible ESP8266 WiFi module to transfer data from a loadcell sensor to the desktop for Internet of Things applications.
c) Box
   The enclosure is used to protect the equipment components from the IV pole movement, which could disrupt the system.

d) Battery
Batteries are electrical power sources that provide the energy required to power various parts of electronic devices. When the device is battery-operated, it can function without the need for an external power source, providing users with mobility and freedom.

e) Infusion fluids
Infusion fluids are pharmaceutical solutions that are given to patients via an IV line when they need vital medications, electrolytes, or fluids. These infusions may include saline solutions, glucose, medications, or a combination of other substances, depending on the patient's particular medical needs.

3. RESULTS AND DISCUSSION

The results of the web system design show that the load cell sensor of the NodeMCU ESP8266 produces accurate pressure data. Data analysis shows that useful pressure information can be obtained by efficiently converting the electrical voltage from the sensor. Additionally, the NodeMCU ESP8266 operates effectively while sending data via an internet connection to the web server, giving users instant access to pressure data produced by the load cell sensor. The web server on the laptop can display this data with reliability, enabling effective applied pressure monitoring. However, it should be emphasized that the network's stability is a vital component of the system's success, thus precautions must be made to ensure that it remains dependable and linked. Given this, the findings and discussion show that the system as designed can fulfill the desired functional requirements; however, to guarantee the system's overall success, network stability issues need to be carefully taken into account.

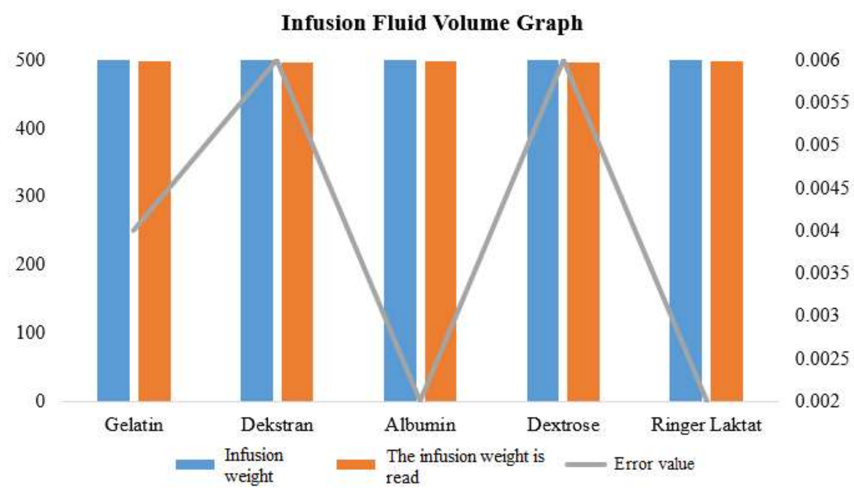

Figure 3. Graph of infusion fluid volume

3.1 Loadcell sensor test results

The table lists the infusion weight measurements for each of the five different types of infusions. For every kind of infusion, there are two volumes: the planned volume (500 ml) and the volume as read by the weight measuring equipment (ml). The error value expresses the difference between the read volume and the expected volume as a percentage of the projected volume. For example, the needed volume for Infusion A is 500 ml, while the volume readout is 498 ml. Because it should be 500 ml, the error value is 0.004%, which is rather small in comparison to the intended and read volumes. This data offers crucial information about the precision of the IV weight monitoring apparatus. The smaller the error value, the more accurate the measuring instrument is in estimating the infusion volume. Because this infusion weight measuring device has a low error value for all forms of infusion, it can be assumed that it has a high degree of accuracy when measuring infusion volume.

Table 1. Loadcell sensor test results

No.	Infusion Name	Infusion Weight (ml)	Readable Infusion Weight (ml)	Error Value %
1	A Infusion	500	498	0,004 %
2	B Infusion	500	497	0,006 %
3	C infusion	500	499	0,002 %

No.	Infusion Name	Infusion Weight (ml)	Readable Infusion Weight (ml)	Error Value %
4	D infusion	500	497	0,006 %
5	E infusion	500	499	0,002 %

This test was conducted to evaluate the accuracy of load cell measurements that are shown immediately on the server. It is clear from Table *1* data that the recommended system has been successful and is performing as planned. Testing is conducted to evaluate the accuracy of the load cell measurements, which are displayed directly on the server. The graph shown in Figure 3 makes it possible to see the level of precision reached.

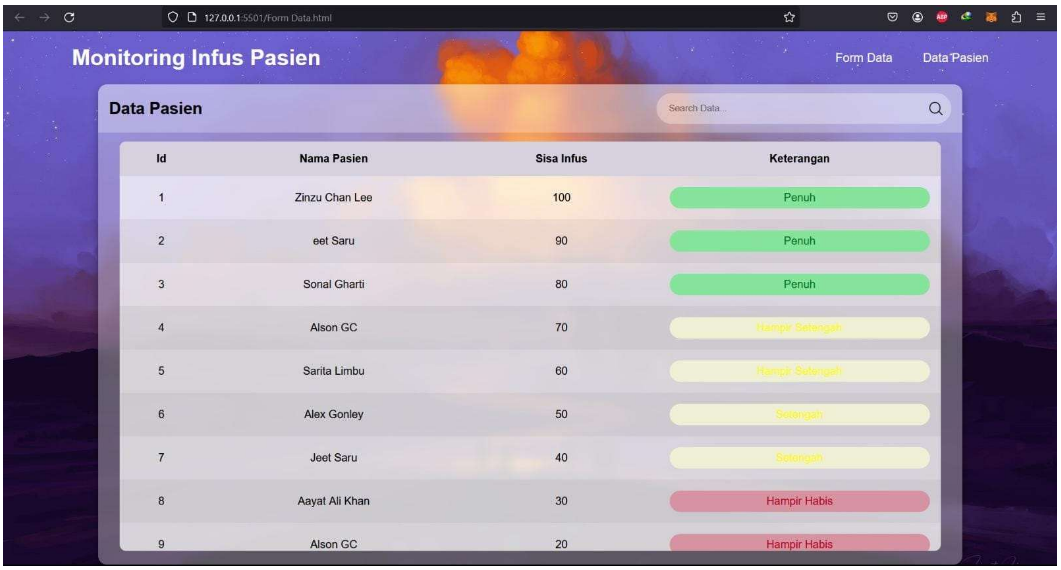

Figure 4. Web page display

Figure 4 depicts an online page interface designed to provide real-time infusion fluid volume monitoring. This page provides an informative and dynamic display that allows you to keep an eye on the infusion process with a normal value of 500 ml. Thanks to information that is instantaneously shown, users, such as nurses or medical experts, can quickly and effectively monitor the patient's status and adjust the infusion settings as needed.

Upon closer inspection, this interface looks to have been carefully designed to provide data in an understandable and user-friendly manner. Thanks to the dynamic and educational display, users can quickly observe the status of the infusion and gain a comprehensive understanding of critical data including flow rate, remaining infusion volume, and time left till completion. One advantage of this interface is that it allows nurses or other medical personnel to observe the infusion procedure in real time without having to be near the patient. By doing this, IV fluid administration can be finished faster, giving nurses more time to focus on patient care or other important medical tasks. Web pages need to be securely secured to avoid unwanted access or data theft of important medical information. All things considered, this web page interface has the potential to be a helpful tool for raising the standard and efficacy of patient care by precisely and quickly monitoring the infusion process. If medical practitioners consider design, security, and privacy when developing this interface, they can treat patients with conditions that require fluid infusion more effectively.

3 CONCLUSION

We may conclude that the recommended system works well and meets its objectives. The high level of measurement accuracy and precision is shown in the error number of 0.004% for all assessed types of infusions. The smallest error values for each kind of infusion further show the measurement data's stability and reliable operation under a variety of conditions. The system's capacity to track load cell measurements directly on the server emphasizes how crucial its installation is. This accomplishment allows for increased monitoring and assessment efficacy without requiring a significant amount of manual labor. Therefore, the study's conclusions confirm that the system can precisely and consistently produce measurement data in addition to meeting monitoring needs by integrating directly with the server.

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