

Infusion Monitoring System for Patients Based on The Internet of Things (IoT) with Android Notification System

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Abstract— Infusion is one of the medical needs that are needed by many patients in various hospitals or health centers. Infusion is a way in which a patient can introduce fluids or drugs into the body quickly or slowly and continuously. Therefore, nurses always monitor the infusion manually and periodically to ensure the condition of the infusion fluid. The experimental method used in this study was by adding several features to make it easier for nurses to monitor patient infusions. The Infusion Monitoring System device used is based on the Internet of Things (IoT) with the Android Notification System. This research is expected to be able to monitor infusions more practically and can be monitored mobile using cellphones anywhere and anytime. To present this tool in this study, the author uses Nodemcu used to process data and also serves to connect to the internet. Then the sensors used are the Load cell sensor as a measuring tool for infusion volume and the Photodiode sensor as a detection tool for infusion fluid droplets. Then the calculation data from the sensor is sent to Firebase which acts as a database, and later it will be accessible and monitored via mobile phones through an android application created by the researcher. From the test results of the tools that the researcher made and the testing of comparison tools. The average of these tests gets an accuracy difference of approximately 2%. (*Abstract*)

Keywords—Android, Node mcu, Infusion, Monitoring.

I. INTRODUCTION

Along with the rapid development of medical science and technology in the field of medical devices, medical personnel are required to accurately administer drug doses and treatments to patients. Currently, infusion monitoring in various hospitals and health centers is still carried out manually [1][2]. A nurse monitors the number of droplets of infusion fluid by traveling every 4-6 hours in each patient's room periodically. One of the obstacles that arise with the manual monitoring system is that patients experience difficulties when the infusion fluid runs out if the nurse is busy not at the nurse's desk. So, the patient is more likely to wait until the nurse comes to the room [3][4].

From this problem, the author took the initiative to make a study with the title "Infusion Monitoring System Device in Internet of Things (IoT) Based Patients with Android Notification System"[5][6]. from this study is expected to be able to monitor infusions more practically

and can be monitored mobile using mobile phones anywhere and anytime [7][8].

II. METHOD

Research on the infusion monitoring system in patients based on the internet of things (IoT) with the android notification system is carried out through two stages, the first stage is the system design stage and the second stage are the device testing stage [9]. The stages of system design include product design, among others, product design, application design, device wiring, etc. In the design of this product there are two parts, the first is hardware design (hardware) and software design (software) [10].

A. Hardware Design

The hardware design consists of a photodiode sensor, a load cell sensor, a Node mcu microcontroller Wi-Fi module, a buzzer and an LCD.

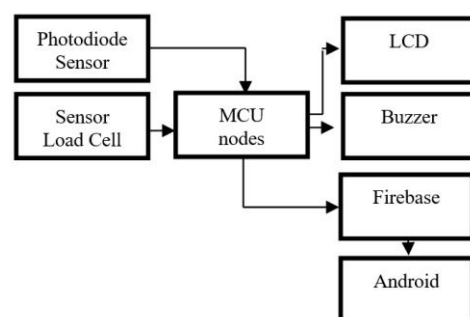


Figure 1. Hardware design flowchart

B. Software Design

The software flow chart starts with registering health workers which includes the name (ID) and Pin password. After the registration process is carried out, health workers are directed to the login menu to log in to the account that has been previously registered. After logging in to the account, then the installation of the infusion device to the patient as well as the configuration of the tool with the android application to connect with each other.

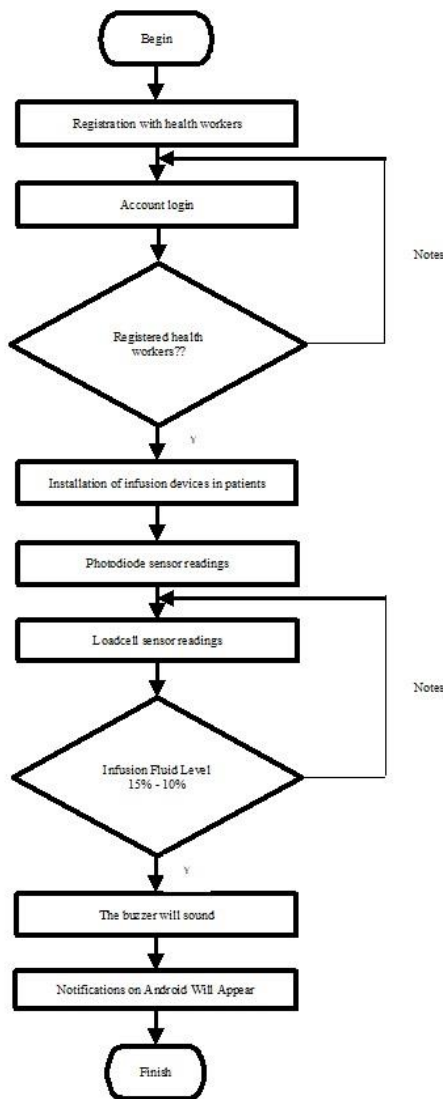


Figure 2. Software design flowchart

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C. Writing Products

The working principle is to start from the photodiode sensor that processes data by detecting objects that block light from the photodiode. Then the load cell detects the pressure from the sensor and then processed by the HX711 module as an amplifier in order to read the weight with precision, in the HX711 module there is an EEPROM IC which functions as storing calibration data for the loadcell. Both sensors send data to node mcu and

the lcd displays the status of whether the sensor reads successfully or not. Then node mcu forwards data from the two sensors to be sent through the web server used for the firebase platform, then from the firebase platform the data is forwarded to the client through the codular application that has been created.

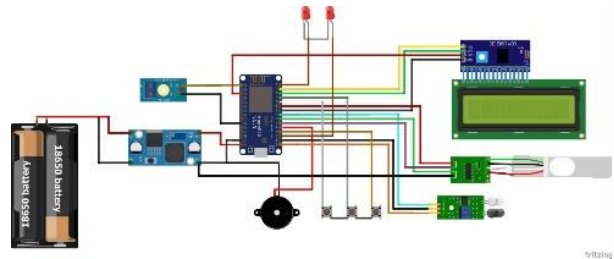


Figure 3. Wiring Products

D. Product Design

In figure 4 is an overview of the product design that the researcher will make. This tool uses a custom project box and there is an LCD, power button , start and reset.

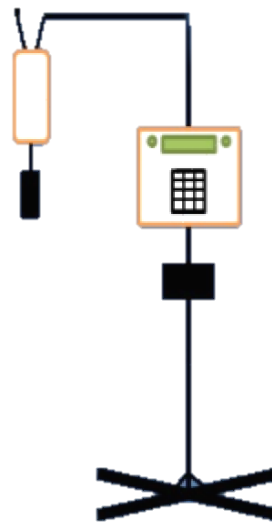


Figure 4. Product design

Variable Operational Definition

- Free variables

In this study, the free variables were the volume of liquid and the speed of infusion droplets. Where the volume and drip speed of this infusion fluid will be monitored by the application.

- Bound variables

Infusion, where we will monitor the volume of liquid and the speed of the infusion droplets read from the load cell sensor and photodiode connected to Node mcu and the value will be visualized in the form of a dashboard applied by Android.

E. Data Analysis Methods

The data analysis method used from this study is an empirical study, which is in the form of observations that will be used to collect data by making observations and recording directly and conducting research in a systematic time. The empirical study in question was carried out by taking data on an infusion monitoring device made before being applied directly.

III. RESULT AND DISCUSSION

A. Result

The device that has been built can be seen in the following image.



Figure 5. Complete product display



Figure 6. Load cell sensor for measuring weight of infus

Information:

- 1) Load Cell Sensor
- 2) HX711 Module

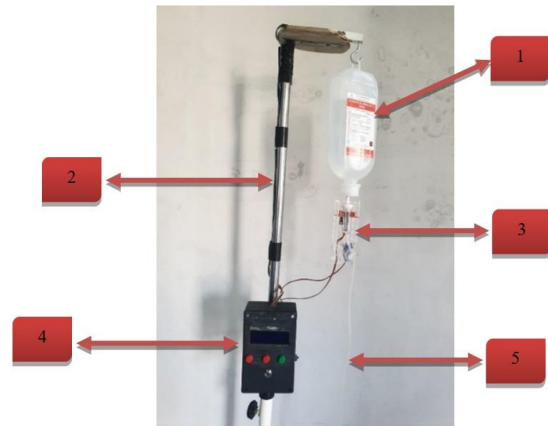


Figure 7. Infusion drip measuring system on infusion monitoring system

Information :

- 1) Infusion Fluids
- 2) Infusion Pole
- 3) Photodiode Sensor
- 4) Control Box
- 5) Infusion Tube (Infusion Set)

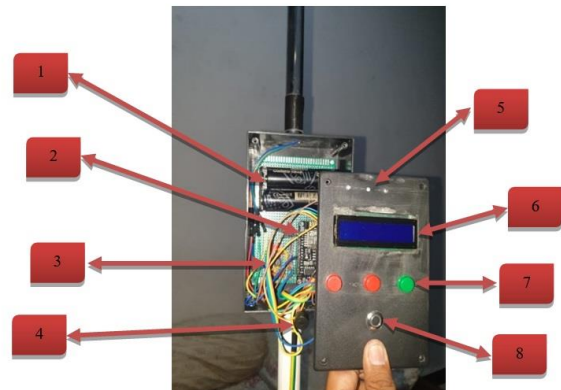


Figure 8. Components in the control box of infusion monitoring system

Information:

- 1) Lithium-Ion Battery 18650
- 2) MCU Node (ESP 8266)
- 3) Step Down Module
- 4) Buzzer
- 5) 3mm LED Light
- 6) LCD I2C
- 7) Push Button
- 8) On/Off Button

B. Product Test

Researchers tested the infusion monitoring tool on the functions and menus of the existing tool system. There are 2 items tested, namely hardware devices and software devices

Testing is carried out many times, this hal is carried out with the aim of obtaining valid and accurate data.

B.1. Load Cell Sensor Testing

Testing on a load cell sesor to determine the weight of the infusion when it is in full condition until the infusion fluid runs out. Before application, the sensor must first be calibrated several times to obtain the appropriate face value.

Table 1. Load cell sensor test results

No.	Percentage of Volume of Infusion Fluids	Readings		
		Sensor Load Cell	Scales Conventional Digital	Difference
1	100 %	546.2 Grams	545 Grams	1.2 Grams
2	90 %	502 Grams	500 Grams	2 Grams
3	80 %	433 Grams	430 Grams	3 Grams
4	70 %	382 Grams	380 Grams	2 Grams
5	60 %	328 Grams	330 Grams	2 Grams
6	50 %	277 Grams	275 Grams	2 Grams
7	40 %	216 Grams	205 Grams	11 Grams
8	30 %	167 Grams	155 Grams	12 Grams
9	20 %	122 Grams	110 Grams	12 Grams
10	10 %	55 Grams	44 Grams	11 Grams
11	0 %	32 Grams	0 Grams	32 Grams

Comparison The load cell sensor test is carried out by comparing the weight measurement between what is read by the Load Cell monitoring tool with the readings bythe calibrated digital conventional scales.

B.2. Photodiode Sensor Testing

Testing on the Photodiode sensor is to see the value on the photodiode sensor, because the sensor uses an attach interup as a Nodemcu input, code example in testing the infusion drop sensor using the timer library as a matter of drops per second and per minute.

Table 2. Test results of photodiode sensors

No.	Amount Testing Infusion Drops (Drops)	Measurements from sensors	Difference
1	10	10	0
2	20	20	0
3	30	30	0
4	40	40	0
5	50	50	0
6	60	60	0
7	70	70	0
8	80	80	0
9	90	90	0
10	100	100	0

Every minute of every second the sensor is tested periodically in order to get a calibration value on each drop.

B.3. Codular Application Testing

Testing this application aims to find out whether an application that has been created with a codular can display the value obtained from the firebase database or not. This application is as a client that accesses value data on the load cell sensor and photodiode sensor.



Figure 9. Main Views of the App

Table 3. Notification test results

No.	Number of Trials	Delay Time
1	Data Transfer 1	10 seconds
2	Data Transfer 2	12 seconds
3	Data Transfer 3	9 seconds
4	Data Transfer 4	15 seconds
5	Data Transfer 5	8 second

IV. DATA ANALYST

From the data from the test results of the infusion monitoring tool, we can analyze as follows:

A. Load cell sensor data analysis

The results of data analysis between the load cell sensor and conventional digital scales. From the chart, it can be seen that there is not too much difference because the sensor has been calibrated repeatedly first. When the infusion fluid is in full condition up to half the difference in value between the two tools is not too much, but when the liquid is below half it appears visible the difference in value is quite a lot because the digital conventional scales cannot detect properly.

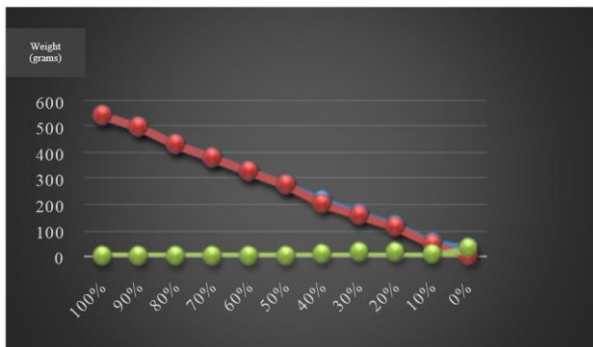


Figure 10. Load cell sensor data analyst graph

B. Analysis of photodiode sensor data

The results of the photodiode sensor testing with the number of droplets that have been regulated by the researcher. It can be seen that there is no difference between the test and the results read by the tool. That way the sensor runs well and smoothly even though it is tested with different droplet speeds.

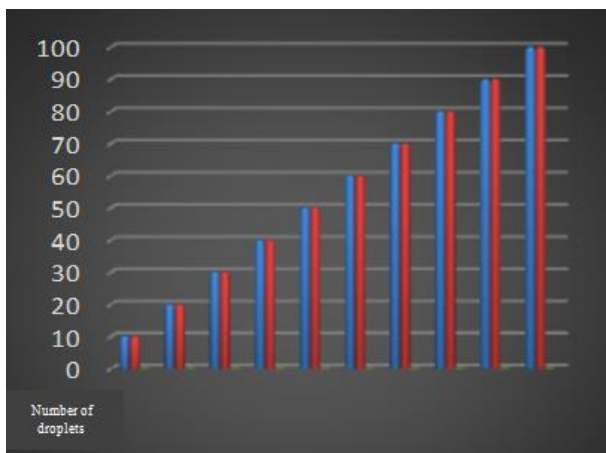


Figure 11. Photodiode sensor data analysis graph

C. Data analysis of notification delivery

Results from notification delivery testing. From the chart above, it can be seen that there are different time delays due to unstable connections. So that the data transmission is delayed and the data obtained is not accurate.

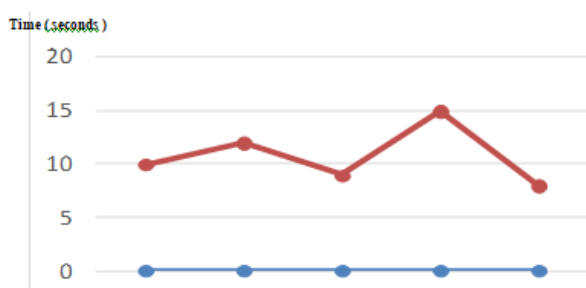


Figure 12. Notification delivery data analysis graph each iteration

V. CONCLUSION

From the research and testing of the infusion monitoring tool, it can be concluded as follows:

- 1) The setting system is done manually, namely using the push button to activate the tool
- 2) Use a stable internet connection so that the data obtained is more accurate.
- 3) From the application side, there are no obstacles or errors, it's just that this application requires a stable connection in order to display monitoring in real time.
- 4) From the test results of this tool, the drip sensor works well even though it is tested using different droplet speeds.
- 5) From the test results of this tool, the load cell sensor functions properly even though it must be calibrated repeatedly to find the right result.

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