**IJEEE: Indonesian Journal of Electrical Engineering and Electronics**
| Vol. X | No. X | Pages XX - XX
[Month] [Year]

# Design ESP32-Based Automatic Infusion Fluid Monitoring System And SPIN Aplication (Smart Pantau Infus)

1st M Arif Rahman Hakim[1] Achmad Zuchriadi[2], Fajar Rahayu[3]

[1 23]Electrical Engineering, Universitas Pembangunan Nasional Veteran Jakarta
2010314014@upnvj.ac.id

Received 30 November 201x **|** Revised 30 Desember 201x **|** Accepted 30 Januari 201x

**Abstract**

Monitoring of patients' intravenous fluids in the hospital is crucial because replacement delays or problems can be fatal. Various constraints on medical infusion devices, such as mismatched drips and empty infusion tubes that are delayed in replacement, often occur. To address this challenge, the study introduced an ESP32-based automatic intravenous fluid detection device integrated with nurses' smartphones application. The aim is to identify the volume of the infusion, determine the fluid droplets and the presence of blood in the infusion tube, and facilitate automatic adjustment using the servo motor on the smartphone. This innovation makes it easier for nurses to monitor infusions, improves monitoring efficiency, and reduces cases of late infusion replacement. Development research methods are used by utilizing hardware and software development from previous products. Its benefits involve the assistance of medical personnel in the treatment of infusions and contribute to the development of software innovations.

**Keywords**: ESP32, detection, infusions.

## 1. introduction

Technology develops very rapidly every year in various sectors of people's lives. With this development, people realize the direct benefits of these technological developments, including in the health sector, the technology can help medical personnel who are their main task in handling each patient. In this case, monitoring intravenous fluids in patients who are being treated in the hospital becomes an important thing because if the intravenous fluid is changed late or experiences problems it can be fatal to the patient.

Organs in the body are two or more tissues that combine to form a part or organ such as the kidneys, stomach, heart, eyes and others (Setiadi, 2007), each tissue has a different shape and function, some function to protect weak organs or are useful for uniting parts of the organ, there are also organs that function to respond to conditions in the surrounding environment such as those in the brain (Arissusila, 2019).

Infusion or Intravenous is a method of giving drugs to patients directly through blood vessels, this method is done when the patient's body condition is no longer possible to take drugs directly through the mouth (Akbar & Gunawan, 2020). There are two ways that can be done in inserting fluids into the patient's blood vessels, namely manually and by using an electric pump, the administration of intravenous fluids must be in accordance with the needs of the patient both from the type of drug and the dose given in order to maintain drug intake (Varizarie, 2020).

There are previous studies discussing intravenous fluid monitoring, such as infusion monitoring using UB's YS1020 radio frequency module with a frequency of 433 (A. Muslim, I. Setiawan, & B. Setiyono, 2020), there is also a design of an infusion fluid level monitoring system using nodeMCU and photodiode sensors for the level of infusion fluid (high level, medium level, and low level) (Zufa, 2020), there is also a design of a measuring instrument for the number of drops and the volume of remaining infusion fluid using a botton to open and close the infusion tube (Fauziyyah & Yohandri, 2019), there is also intravenous fluid monitoring using Convolutional Neural Networks (CNN) (Westlund & Svennsson, 2018), there is also infusion monitoring using LDR sensors and the information is displayed on an OLED LCD (Venkatesh, et al., 2022).

In supporting the development of health sector innovation, the author hereby makes "**Design a smartphone integrated infusion monitoring tool"** so that it can be a development of previous research and design. It is hoped that the development of this technology can make it easier for nurses and minimize cases of nurse negligence in handling patients who need an infusion process.

## 2. Methodology

### 2.1 Theoretical Foundation

The number of drip drips that must enter the patient's body varies depending on the doctor's instructions, the patient's needs and the type of infusion given. There are two methods that can affect the droplet factor, namely the micro set and the macro set, where the micro set has a drip hole that is more popping than the macro set so that the droplets per minute of the micro set are more than the time with the macro set, this droplet difference will affect the length of infuse time. Generally, the drip factor for micro sets is 45-60 drops/ml, while the macro drip factor amounts to 10-20 droplets. The formula remains drip infusion as follows (Puruhito, 1995).

$$Droplets\ per\ minute = \frac{Liquid\ Volume(ml) x\ Drip\ Factor}{Time\ \ (seconds) x\ 60} \text{......... (1)}$$

Microcontrollers are microcomputer devices used to control every command entered into the system, having an operating voltage of 3.3Volts (S. Bipasha Biswan and M. Tariq Iqbal, 2018). The ESP32 microcontroller has more pin outs and analog pins and a larger amount of memory compared to the previous NodeMCU (M. Babiuch, P. Foltynek, dan P. Smutny, 2019). ITR8105 (optocoupler) is a type of gallium arsenic infrared emitting diode that is coupled with a silicon photo transistor in a plastic container. The Load Cell is used to determine the weight of the infusion tube which will later be converted from analog information to digital using hx711, (Stano, Nisio, Lanzolla, & Parcoco, 2020). Servo motor is a type of motor that has a low rotation speed, which is usually controlled using a slow rotation speed. (A. hilal and S. Manan, 2015). Liquid Crystal Display (LCD) is an electronic screen display media that works by reflecting light around it (front-in) or channeling light from behind (back-lit) so that the display can be seen (Yusa, M, Santoso, JD, & Sanjaya, A, 2021). In its use piezo is commonly applied to home security alarms, fire alarms, clock weakers, sensors for car parking and others (Baballe, Ya'u, Ibrahim, Muhammad, & Mustapha, 2023).

Arduino IDE uses the C ++ programming language which has been made easier by adding libraries as coding examples. The Arduino IDE is used to create programs, compile into a binary number code, upload it to memory, 6 and use a microcontroller as a program management tool (Fezari & Dahoud, 2018). Android Studio is an integrated development media based on the Integrated Development Environment (IDE) for the development of an Android application developed by IntelliJ, Android Studio has various features that can increase user activity in making Android applications (Anwar, 2019).

### 2.2 Tool Planning

In the design of the ESP32-based automatic infusion fluid detection device integrated with this smart phone, it consists of several components that are used as inputs and outputs that work according to their respective functions and needs. Device diagrams ranging from inputs on sensors to controllers and outputs on LCD DC motors, firebases and applications.

1. Input
   - The power supply serves to provide power to be used in a series of automatic intravenous fluid detection tools.
   - The HX711 Load Cell sensor is used as a sensor that will detect the weight of the infusion tube to be converted into percent so that it can find out when the estimated IV fluid will run out. To calibrate the Load Cell sensor readings can use the formula (Iman, 2017).

$$Settings\ factor = \frac{\sum \text{load cell sensor readings}}{\sum \text{Scale Readings}} \quad (2)$$

   - The optocoupler photodiode sensor is used as a sensor to detect the infused fluid that falls from the infusion tube into the drip chamber in which how many droplets fall within one minute and will be adjusted using a dc motor actuator to be able to adjust to the desired number of droplets.

2. Output
   - The buzzer functions as an alarm when the load cel hx711 sensor detects the amount of IV fluid is approaching to run out, the buzzer will sound.
   - LCD functions as a sensor value reading viewer Load Cell hx711 as an infusion volume weight measuring sensor, displays optocoupler sensor readings as an infusion droplet detector.
   - The DC motor functions as an actuator that regulates the number of infusion droplets, if the optocoupler sensor detects that the number of droplets does not match the desired initial conditions, the DC motor will move to open or close the infusion hose so that the number of drops is as desired.

It can be seen that there are three parts, namely the first at the top there is an electronic component storage box, at the bottom of the box there is a hx711 Load Cell sensor with a hanger for infusion tube measurement, then in the middle there is a photodiode optocoupler sensor used to detect drip infusion and a DC motor as a driving actuator to open and close the infusion hose, And finally at the lower end of the infusion hose there is a TCS34725 color sensor as a medium to detect blood in the infusion tube.

### 2.3 How Tools Work

This drip infusion monitoring tool works by detecting two parameters measured in the infusion process, namely the amount of infusion tube volume detected using the hx711 loadcell sensor by working to convert the weight of the Load Cell sensor readings in analog form into data in digital form, detecting the initial weight of the infusion tube and providing a warning when the infusion fluid is running out.

The second parameter is to detect drip infusion fluid, calculate the number and calculate per minute of the drip infusion, if the number of drip drops per minute exceeds the initial setting, the servo motor will move to reduce the angle of rotation of the servo, while if the calculation of drip per minute is less than the initial setting, the servo motor will move to increase the angle of rotation until the condition of the calculation of drops per minute is in accordance with the desired initial conditions. The working diagram of the tool can be seen in figure 1.

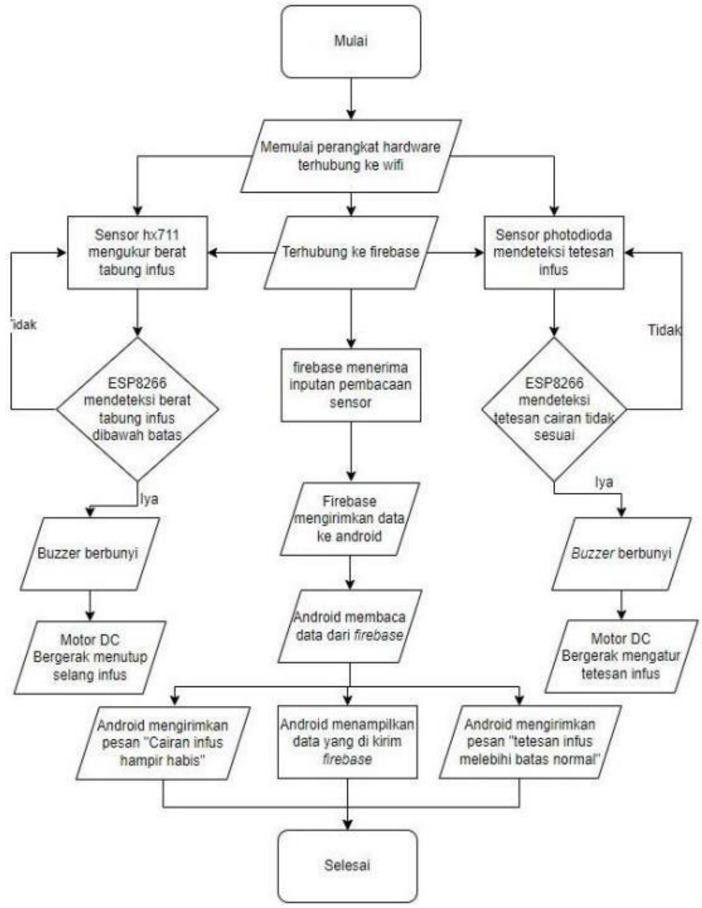


**Figure 1.** Tool Working Diagram

The reading of the three test parameters will be processed by a microcontroller, then displayed on a 16x2 LCD display screen and send the reading data to firebase by entering APIs from firebase into the code of devices connected to the Internet of Things. Firebase sends sensor data sent by the microcontroller to the SPIN: Smart Monitor Infusion app as the final output.

### 2.4 Data Analysis

Data analysis is a process carried out as a step of processing data obtained from information that can be understood and conclusions drawn from the data obtained. In this study, the process of analyzing data from the day of the HX711 Load Cell sensor reading was compared with digital scale readings, the readings of the photodiode optocoupler sensor were compared with observations made using the eye directly To get the results obtained, an equation is needed to calculate the error value on sensors, the following equation is used to calculate the error value on the sensor used to be able to determine the level of precision on the sensor (Lopez-Vargas & Fuentes, 2019).

## 3. RESULT AND DISCUSSION

SPIN as an automatic intravenous fluid detection device that uses ESP32 as a microcontroller that can regulate the overall work of the tool. In measuring the amount of fluid in the infusion using the hx711 Load Cell sensor at the weight of the infusion tube which will be converted into a unit of volume by the microcontroller. If the load cell sends information in the form of weight below 50mL to the microcontroller, then the microcontroller sends data to Firebase and the data will be read in the SPIN application and then acts to send a message in the form of an alarm notification on the nurse's phone.

Furthermore, by using the Uptocoupler photodiode sensor to be able to measure the number of droplets per minute that fall from the infusion tube to the infusion chamber whose number of droplets per minute has been regulated before the infusion process begins. In setting the number of droplets after the infusion process, the author uses a DC motor as an actuator to close and open the infusion hose according to the desired conditions. The DC motor is paired with a semicircular object measuring approximately 3cm in diameter with a width.

The blood measuring device on the infusion tube uses a TCS34725 color sensor, where the color sensor is attached to the infusion tube near the patient's arm to find out if there is blood coming out of the patient's body into the infusion tube. The color sensor works to classify the intensity of light read by the sensor to be able to know what type of color is in front of the color sensor, in this SPIN tool the red color is used as a benchmark if the color sensor detects red then the sensor will classify that there is blood detected by the sensor.

The design of the tool is carried out to answer the formulation of the problem that has been determined, starting from making the design of an automatic intravenous fluid detection device. The circuit components include a load cell sensor microcontroller, buzzer, battery located in the box at the top, at the bottom of the box used a cantolan where the infusion tube is placed. The load cell sensor calculates the weight of the infusion tube which is then converted into a unit volume.

The optocoupler sensor is used on the infusion tube to detect droplets falling from the infusion tube to the chamber, the readings from the sensor will be sent to the microcontroller which will then be processed under the condition that the infusion drip readings are not in accordance with the initial settings, the dc motor will move to press and open the hose so that the number of droplets is as desired.

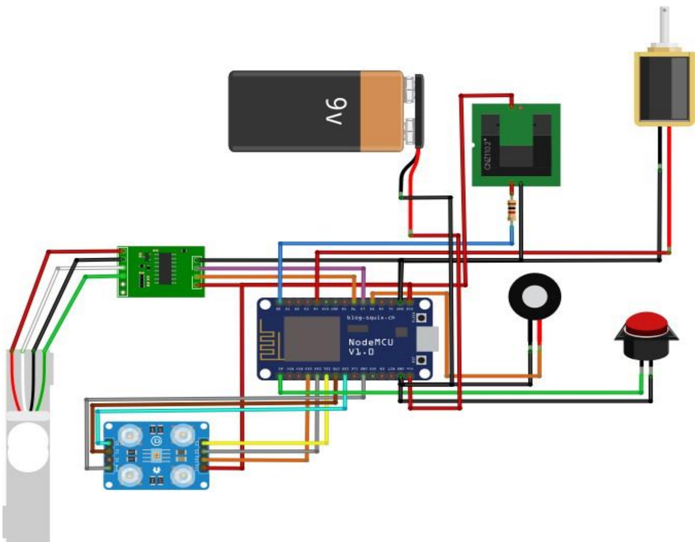


**Figure 2.** Electronic wiring

The design design of the automatic infusion monitoring device is solid as shown in figure 3.

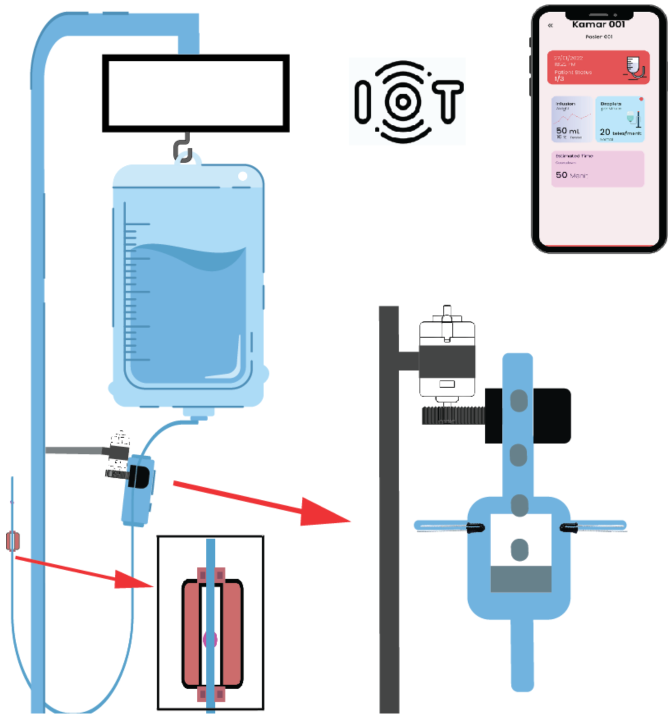


**Figure 3.** Tool Design Design

## 4. CONCLUSIONS

This intravenous fluid detection device is a development of a tool that has been designed previously by previous researchers by considering the shortcomings and new innovations that can be applied to this tool. This tool uses ESP832 as a microcontroller which is the brain of the system works by using two sensors, namely the HX711 weight sensor as a weight gauge from the infusion tube and the photodiode sensor as an infusion droplet detection device. When the measurement results that the intravenous fluid runs out or the drip infusion is not in accordance with the provisions that have been set, ESP832 will send a message to the nurse through the telegram application that can be accessed using the nurse's computer or smart phone, hopefully with the ability of the application that can be accessed through various devices This can help provide better information to nurses when problems occur with a patient's IV. In addition, this tool is equipped with a buzzer as an alarm on the patient's bed and in the nurse's guard room, this is intended to add information to the nurse, it is hoped that the nurse can see notifications on a computer or smart phone or hear the alarm that sounds.

## LIST OF REFERENCES

A. hilal and S. Manan. (2015). Pemanfaatan Motor Servo Sebagai Penggerak CCTV Untuk Melihat ALat-Alat Monitoring dan Kondisi Pasien Di Rang ICU. Gema Teknologi, 17(2), 95-99.

A. Muslim, I. Setiawan, & B. Setiyono. (2020). Monitoring Cairan Infus Menggunakan Modul Radio Frekuensi YS 1020 UB Dengan Frekuensi 433 MHZ. Jurnal Teknik Elektro.

Akbar, T., & Gunawan, I. (2020). Prototype Sistem Monitoring Infus Berbasis IoT (Internet of Things). Edumatic: Jurnal Pendidikan Matematika, 4(2), 155-163.

Anwar, R. S. (2019). Rancang Bangun Aplikasi File Materi Perkuliahan Di Akademi Telkom Jakarta Berbasis ANdroid Menggunakan ANdroid Studio. eMIT, 1(1), 2-5.

Apress, Berkeley, CA. (26 January 2017). I2C LCD Displays In: Custom Raspberry Pi Interfaces. Apress, Berkeley, CA, 35-54. Diambil kembali dari https://doi.org/10.1007/978-1-4842-2406-9_4

Arissusila, I. (2019). Organ Tubuh Manusia Sebagai Sumber Inpirasi Penciptaan Kriya Seni. Jurnal Pendidikan Agama dan Seni, 13.

Baballe, M. A., Ya'u, A., Ibrahim, S. F., Muhammad, A., & Mustapha, N. K. (2023, Jan-Mar). CCIDENT DETECTION SYSTEM WITH GPS, GSM, AND BUZZER. TMP UNIVERSAL JOURNAL OF RESEARCH AND REVIEW ARCHIVES, 2(1), 28-36.

Fauziyyah, A. S., & Yohandri. (2019, Desember). Rancang Bangun Alat Ukur Jumlah Tetes dan Volume Sisa Cairan Infus Dengan Warning System pada Sistem Monitoring Cairan Infus Berbasis Arduino. (Dr. Ratnawulan, M.Si (Universitas Negeri Padang), Penyunt.) Pillar of Physics, 12, 25-30. Diambil kembali dari https://ejournal.unp.ac.id/students/index.php/pfis/index

Fezari, M., & Dahoud, A. A. (2018, October). Integrated Development Environment "IDE" For Arduino. ResearchGate. Diambil kembali dari https://www.researchgate.net/profile/Mohamed-Fezari-2/publication/328615543_Integrated_Development_Environment_IDE_For_Arduino/links/5bd8c6d24585150b2b9206df/Integrated-Development-Environment-IDE-For-Arduino.pdf

Iman, K. (2017). ALAT PENGISI GULA PASIR OTOMATIS BERDASARKAN MASSA DAN VOLUME MENGGUNAKAN SENSOR LOAD CELL BERBASIS ARDUINO MEGA 2560. repository.unj. Diambil kembali dari http://repository.unj.ac.id/30040/1/Skripsi%20%5BKhoirul%20Iman-5215125351%5D.pdf

Lopez-Vargas, A., & Fuentes, M. G.-R. (2019). Low-Cost Datalogger Intended for Remote Monitoringof Solar Photovoltaic Standalone Systems Based on ArduinoTM. IEEE Sensors Journal, 19(11), 4308-4320. Diambil kembali dari https://doi.org/10.1109/JSEN.2019.2898667

M. Babiuch, P. Foltynek, dan P. Smutny. (2019). Using the ESP32 microcontroller for Data Processing. Carpathian Control Conference(ICCC), 1-6. doi:10.1109/CarpathianCC.2019.8765944

Puruhito. (1995). Dasar-Dasar Pemberian Cairan dan Elektrolit Pada Kasus-Kasus Bedah. Airlangga Univercity Press.

S. Bipasha Biswan and M. Tariq Iqbal. (2018). Solar Water Pumping System Control Using a Low Cost ESP32 Microcontroller. IEEE Canadian conference on Electrical and Computer Engineering (CCECE). doi:8447749

Setiadi. (2007). Anatomi & Fisiologi Manusia. Yogyakarta: Graha Ilmu.

Stano, G., Nisio, A. D., Lanzolla, A., & Parcoco, G. (2020, March). Additive manufacturing and characterization of a load cell with embedded strain gauges. Elsevier, 64, 113-120.

Steveen, B. (2018). APLIKASI SISTEM MONITORING PADA RANCANG BANGUN PENYORTIR BARANG BERWARNA MERAH DAN HIJAU DENGAN HMI BERBASIS PLC SCHNEIDER. repository UNDIP, 26-27.

Varizarie, R. (2020). Infus: Fungsi, Prosedur Pemasangan, Efek Samping. Dipetik February 27, 2023, dari https://doktersehat.com/informasi/tindakan/infus/

Venkatesh, K., Alagundagi, S. S., Garg, V., Pasala, K., Karia, D., & Arora, M. (2022). DripOMeter: An open-source opto-electronic system for intravenous (IV) infusion monitoring. HardwareX, 12, 2-12. Diambil kembali dari https://doi.org/10.17605/OSF.IO/DYCMS

Westlund, J., & Svennsson, G. (2018). Intravenous bag monitoring with Convolutional Neural Networks. (R. U. Kovordanyi, Penyunt.) Digitala Vetenskapliga Arkivet, 12, 1-12. Diambil kembali dari urn:nbn:se:liu:diva-148449

Yusa, M, Santoso, JD, & Sanjaya, A. (2021). Implementasi Dan Perancangan Pengukur Tinggi Badan Menggunakan Sensor Ultrasonik. Pseudocode, ejournal.unib.ac.id,, 8(1), 93-94. Diambil kembali dari https://ejournal.unib.ac.id/pseudocode/article/view/8943

Zufa, M. F. (2020, 03 06). Perancangan Sistem Pemantauan Level Cairan Infus Menggunakan NodeMcU dan Sensor Photodioda Terintegrasi IoT (Internet Of Thing). UMSU REPOSITORY, 34-61. Diambil kembali dari http://repository.umsu.ac.id/handle/123456789/4661