p-ISSN: 2252-3006
e-ISSN: 2685-2411

Design and Development of Water Pump Controlling and Monitoring Tools Based on the Internet of Things

I Made Pastika Rahayu[a1], I Nyoman Piarsa[a2], A.A.K. Agung Cahyawan Wiranatha[a3]
[a]Information Technology Department , Udayana University, Indonesia
e-mail: [1]pastika.rahayu01@gmail.com, [2]manpits@unud.ac.id, [3]agung.cahyawan@unud.ac.id

Abstrak

Air yang ada di tandon lantai satu sering kosong, sehingga mengakibatkan masing – masing toilet yang ada di prodi TI tidak ada air yang mengalir, selain itu pompa air yang ada pada prodi TI masih dihidupkan secara manual, sehingga petugas harus sesekali mengontrol pompa air tersebut. Metode yang akan digunakan dalam penelitian ini yaitu menggunakan metode *Software Development Life Cycle* (SDLC) model *Waterfall*. *Hardware* yang digunakan yaitu, NodeMCU ESP8266 yang berfungsi sebagai mikrokontroler, HCS-R04 yang berfungsi untuk mengukur ketinggian air dan volume air, relay digunakan untuk menyalakan dan mematikan pompa air, serta YF-B10 yang berfungsi untuk mengukur debit dan volume air. Hasil yang didapatkan yaitu, ketinggan air yang diukur menggunakan HCS-R04 yaitu setinggi 11 cm, sedangkan diukur menggunakan meteran didapatkan ketinggian air 10,7 cm. Debit air yang didapatkan yaitu 6 L/m. Fitur status pompa air, dan fitur ON/OFF pada aplikasi Android yaitu dinyatakan berhasil untuk menyalakan, dan mematikan pompa air.

Kata kunci: *Internet of Things*, Pompa Air, *Waterfall, SDLC,* NodeMCU.

Abstract

Water in the reservoir on the first floor is often empty, resulting in no running water for each toilet in the Information Technology. In addition, the water pump in the Information Technology is still turned on manually, so the officer must occasionally control the water pump. The method to be used in this study is the Software Development Life Cycle (SDLC) Waterfall model. The hardware used is NodeMCU ESP8266, HCS-R04 which functions to measure water level and water volume, relay, and YF-B10 which functions to measure water discharge and volume. The results obtained were that the water level measured using the HCS-R04 was 11 cm high, while the water level was 10.7 cm measured using a meter. The water discharge obtained is 6 L/m. The water pump status feature, and the ON/OFF feature on the Android application are declared successful for turning on and turning off the water pump.

Keywords : *Internet of Things, Water Pump, Waterfall, SDLC, NodeMCU.*

1. Introduction

Technological advances have recently increased very rapidly in various fields, many technologies have facilitated and assisted human work efficiently and effectively. There are tools created with IoT (Internet of Things) which are tools that can be connected to the internet, so that the tools that are made can communicate with each other via mobile devices, or PCs [1].

Water is an important thing in human life, water is usually taken from wells or from reservoirs that already contain water [2]. The tool that is usually used to drain water is a water pump. A water pump is a tool for sucking water from a well into a water tank, or from a water tank to another water tank. In the IT study program the water pump is used to raise water from the tank on the first floor to the water tank on the fifth floor. However, the water in the water tank on the first floor is often empty, when the water pump is turned on, the water pump that should suck up water actually sucks up the wind, resulting in the water pump breaking down quickly, wasting electricity, and there are no toilets in IT study programs flowing water. In addition, the water pump in the IT study program is still turned on manually, so the officer must occasionally control the water pump.

As a way to streamline time and make it easier for officers to monitor the water pumps and reservoirs in IT study programs, a device is needed to find out the volume of water in the reservoirs. Therefore, a tool was created using the Internet of Things to carry out controlling and

p-ISSN: 2252-3006
e-ISSN: 2685-2411

monitoring in real time connected to a mobile application, on water pumps and storage tanks. The results of making this tool are expected to save time, make it easier for officers, minimize damage to water pumps, reduce electricity bills, and each toilet has running water.

2. Research Method / Proposed Method

Software Development Life Cycle (SDLC) method with Waterfall model is the method used in this research. The Waterfall model defines a number of sequential stages, so they must be completed step by step and move on to the next stage when the previous stage has been completed. The Waterfall model is recursive where each step can be repeated indefinitely until it is perfect [3]. Figures from the stages of the Waterfall model can be seen in the figure below.

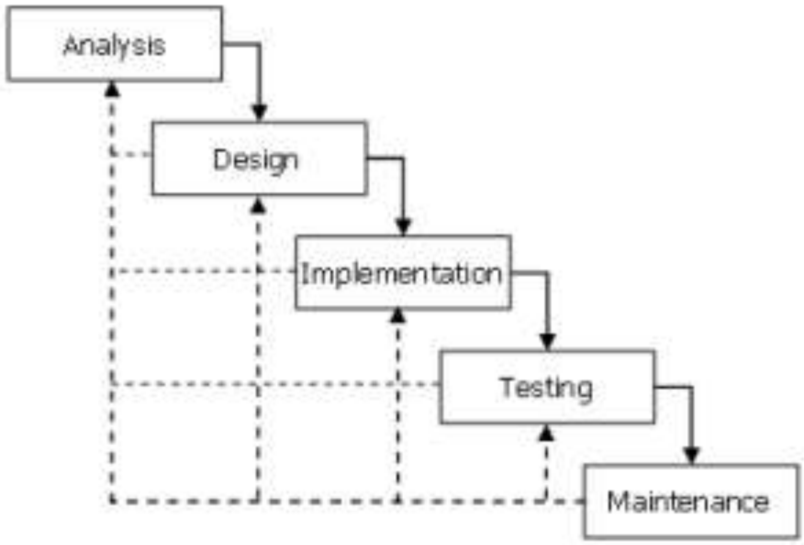

Figure 1. Waterfall Model

Figure 1 is the Waterfall model SDLC method. The Waterfall model is used because each stage can be repeated endlessly until the stage is completed. The stages in the waterfall model are analysis, design, implementation, testing and maintenance [4]. This study uses the Internet of Things to monitor water pumps in real time connected to a mobile application. The following is an overview of designing Internet of Things (IoT) tools.

Figure 2. IT Study Program Water Pump Topology

To find out the volume of water in the first floor reservoir, an ultrasonic sensor is needed to determine the volume of water. In addition, there is a water flow sensor to determine the water discharge, and a relay to turn on the water pump. All existing sensors will be connected to the NodeMCU microcontroller. NodeMCU will process all the data provided by the sensor, and send data to the internet which is received by the smartphone. So the water pump will start when the water tank on the first floor contains water, while the water pump will stop when the water tank on the first floor doesn't contain water.

3. Literature Study

The theoretical basis compiled to be able to solve existing problems include the following.

3.1 Internet of Things

The Internet of Things (IoT) is hardware that can communicate between devices over the internet using a microcontroller. Internet of Things is commonly used on refrigerators, TVs, air conditioners, and others that can be controlled using a smartphone or the web to turn off or on devices [5].

3.2 NodeMCU ESP8266 Microcontroller

NodeMCU ESP8266 is a microcontroller based on the ESP8266 chip that can accept input and output from hardware and software, so it can connect to the Internet [6]. The NodeMCU ESP8266 module has the same function as Arduino, but the difference is that the NodeMCU ESP8266 has an ESP8266 chip or WiFi which makes it easy to connect to the internet.

3.3 Ultrasonic sensor

HCS-R04 is a type of ultrasonic sensor that can be used to measure the distance from an object. The HCS-R04 can emit full wave with a frequency of 40000 Hz, when the wave hits an object it will be reflected again to the HCS-R04 ultrasonic sensor, the distance that can be measured is around 2 cm to 450 cm[7]. This device uses two digital pins to determine the distance obtained, and GND, VCC pins to provide electrical power.

3.4 Relay

Relay is an electrical component that has two parts, coils and points. The function of the relay is to control and transmit electricity, the relay is used to be a switch. The switch in question is like a switch in general but the relay works at a low electric current, when the relay receives a low electric current the relay can be used to cut off the flowing electric current [8].

3.5 Water Flow

Water flow sensor is a sensor that is used to measure the discharge of fluid flowing in the pipe. The water flow sensor consists of a water rotor and a half effect sensor and there is a valve body (plastic valve). The way the water flow sensor works is when the fluid passes through the sensor, the half effect sensor will detect the rotor rotation on the water flow sensor. The rotation generated by the rotor will generate a digital pulse that is proportional to the amount of fluid entering through the water flow sensor [9].

3.6 Software Arduino

Arduino software is an opensource platform used to write programs that will be included in a microcontroller. The types of microcontrollers are Arduino, NodeMCU ESP8266, ESP 32CAM, and so on. The language used in the Arduino software is C++ which has been simplified through the library, so it is very easy to use for beginners who don't have a basic programming language. [10].

3.7 Android

Android is an operating system that Android developers can view and modify and use to manage hardware resources such as smartphones and tablets, as well as an open source Linux-based operating system. The Android operating system is distributed under the Apache Software License (ASL/apache2), which allows for second distribution and so on [11].

p-ISSN: 2252-3006
e-ISSN: 2685-2411

4. Result and Discussion

Realization of the design results of the hardware design as well as testing of the water pump controlling and monitoring system is carried out by conducting experiments to send and receive data from Android applications and from Internet of Things (IoT) tools.

4.1 Implementation of Water Pump Monitoring and Controlling Design

Hardware implementation such as the NodeMCU ESP8266 microcontroller, HCS-R04 (ultrasonic sensor), relay, and YF-B10 (water flow sensor). The following is the result of the implementation of the hardware design.

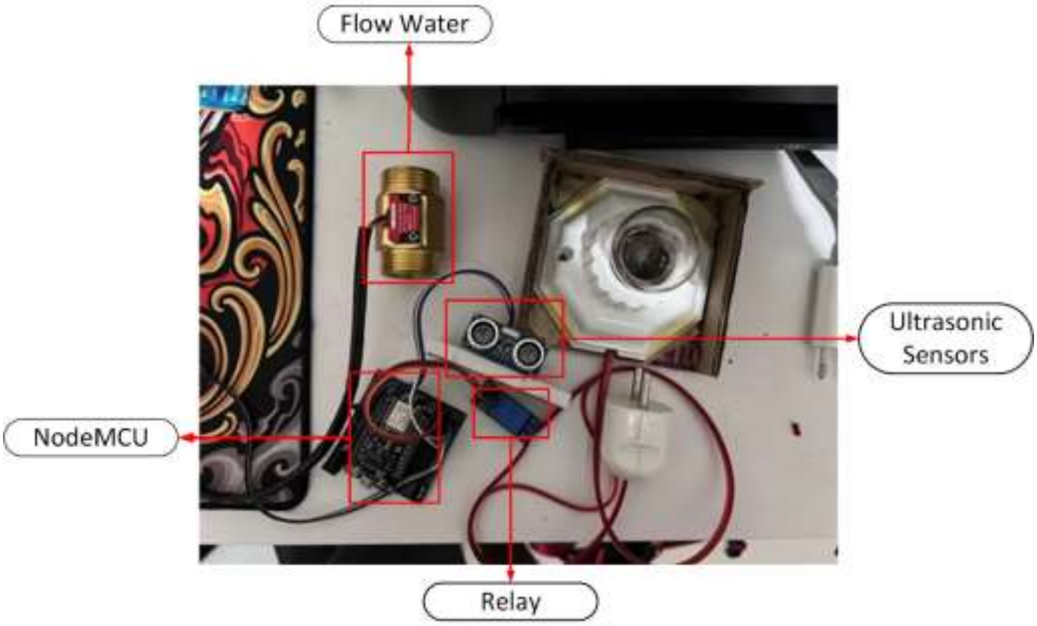

Figure 3 Hardware Implementation

Figure 3 is the implementation result of the hardware design. The hardware that has been implemented is the NodeMCU ESP8266 microcontroller, HCS-R04 ultrasonic sensor, relay, and YF-B10 water flow sensor. The following is the result of implementing HCS-R04, and relay.

Figure 4. HCS-R04 and Relay Hardware Implementation

p-ISSN: 2252-3006
e-ISSN: 2685-2411

Figure 4 is the result of HCS-R04 hardware implementation, and relay. Based on the implementation of figure 4, the measurement results are obtained, and at a certain height the relay will cut off and conduct electric current. The following is the measurement result from the HCS-R04 ultrasonic sensor.

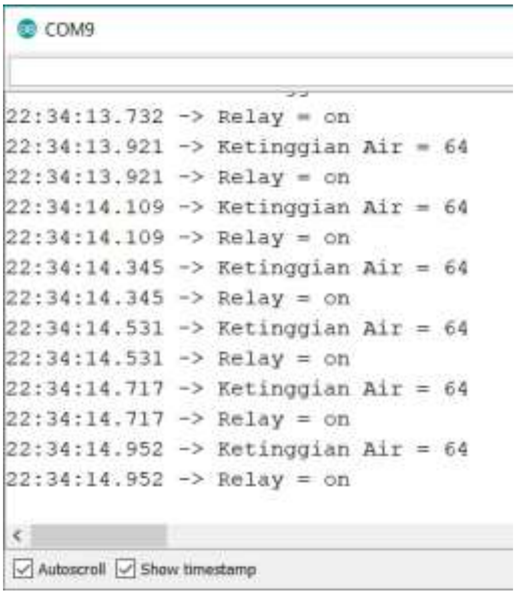

Figure 5. HCS-R04 Measurement Results

Figure 5 is the measurement result from the HCS-R04 ultrasonic sensor. The results of the measurement experiment obtained were that when the water level was above 20 cm the water pump could be turned on, and when the water level was below 20 cm the water pump would automatically be turned off. The following is an implementation of the YF-B10 water flow sensor.


Figure 6. YF-B10 Hardware Implementation

Figure 6 is the result of the YF-B10 hardware implementation. Based on the implementation of the figure, the measurement results obtained from the water flow sensor. The following is the measurement result of the YF-B10 water flow sensor.

p-ISSN: 2252-3006
e-ISSN: 2685-2411

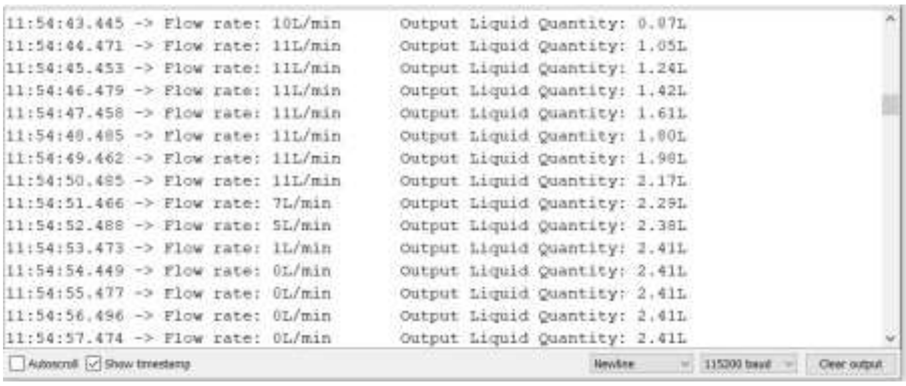

Figure 6. YF-B10 Measurement Results

Figure 7 is the measurement result of the YF-B10 water flow sensor. The measurement results obtained are the range of water discharge from 0L/min to 11L/min, and the final water volume result is 2.41L. The results of measuring the volume of water on YF-B10 compared to manual measurements using a measuring cup, obtained a difference of 0.01L to 0.02L.

4.2 Android Interface Design Implementation

Implementation of software mockup designs such as the display of the application title, the amount of water level, and other features. The following shows a software mockup design for the design of a water pump controlling and monitoring tool based on the Internet of Things.

Figure 7. Main View

Figure 8 is the main display of the Android application on the design of a water pump controlling and monitoring tool based on the Internet of Things. The main display contains the title of the application, as well as the main feature which displays the amount of water level in the water tank, water discharge, and there is an ON/OFF button to turn on and off the water pump from the Android application. Figure 8 is a display for monitoring and controlling the water tank, where monitoring and control is only use in the water tank at first floor.

4.3 Test Sending and Receiving Water Level Data

The test sends and receives water level data using HCS-R04 (ultrasonic sensor), and Android application. The following is the HCS-R04 test.

Figure 8. HCS-R04 testing

Figure 9 is the result of testing HCS-R04 at water level. The test was carried out by filling a bucket with water, and placing the design of an Internet of Things-based water pump controlling and monitoring tool on a 2.5” pipe. The results obtained are the water level measured using HCS-R04 which is 11 cm high, while measured using a meter the water level is 10.7 cm.

Table 1. Water Level Monitoring Feature

No	Feature/*Hardware*	Description	Result
1	Sensor Ultrasonik (HCS-R04)	Function to measure the water level in cm	Success
2	Water Level feature on Android app	Function to display the water level in the Android application in cm	Success

Table 1 is a display of monitoring features for water levels from research on the design of water pump controlling and monitoring tools based on the Internet of Things. The results obtained in testing the ultrasonic sensor and the water level feature on the Android application are declared successful for measuring the water level.

4.4 Test Sending and Receiving Water Discharge Data

The test sends and receives water discharge data using YF-B10 (waterflow sensor), and Android application. The following is a test of the YF-B10, and the Android application.

Figure 9 YF-B10 testing

Figure 10 is the result of testing the YF-B10 (waterflow sensor) in measuring the water discharge. The test was carried out by flowing the water in the bucket using a water pump to the YF-B10. The water discharge results obtained were 6 L/m, the water level obtained was 8 cm.

Table 2 Water Discharge Monitoring Feature

No	Feature/*Hardware*	Description	Result
1	*Water Flow Sensor* (YF-B10)	Function to measure water debit in L/m units	Success
2	Water Debit feature on the Android application	Function to display the water discharge on the Android application in L/m units	Success

Table 2 is a display of monitoring features for water discharge from research on the design of water pump controlling and monitoring tools based on the Internet of Things. The results obtained in testing the water flow sensor and the water discharge feature on the Android application are stated to be successful in measuring the water discharge.

4.5 Test Turning on and Off the Water Pump

Testing turning on and off the water pump using a relay and an Android application. The following is a test of turning on and off the water pump with a relay and an Android application.

Figure 10 Test Turning on the Relay

Figure 11 is the result of testing to turn on the relay. Testing is done by pressing the on button on the Android application so that it can turn on the water pump. The results obtained are that the pump status on the Android application will be "On", and the water pump on the IoT device will live.

Figure 11 Test Turning Off the Relay

Figure 12 is the result of testing to turn off the relay. Testing is carried out by pressing the Off button on the Android application so that the water pump can be turned off. The results obtained are that the pump status on the Android application will be "Off", and the water pump on the IoT device will die. The water level in the bucket is 7 cm, and the water discharge is 0 L/m.

Table 3 Water Pump Controlling and Monitoring Features

No	Feature/*Hardware*	Description	Result
1	*Relay*	Function to turn on and off the water pump	Success
2	Water Pump Status Features on Android Applications	Function to know the water pump status	Success
3	ON/OFF Feature on Android Application	Function to turn on and off the water pump	Success

Table 3 is a display of the water pump controlling and monitoring features from the research on the design of water pump controlling and monitoring tools based on the Internet of Things. The results obtained in the relay test, the water pump status feature, and the ON/OFF feature on the Android application were declared successful for turning on and turning off the water pump.

5. Conclusion

The conclusion from the research on the design of a water pump controlling and monitoring tool based on the Internet of Things, namely the water pump controlling and monitoring tool, has been successfully operating according to the system design in this study.

1. The design of a water pump controlling and monitoring tool based on the Internet of Things was made using NodeMCU ESP8266 which functions as a microcontroller, HCS-R04 which functions to measure water level and water volume, relays are used to turn on and turn off water pumps, and YF-B10 which functions to measure the water discharge. The main feature is that it displays the total water level in the water tank, water discharge, water pump status, and there is an ON/OFF button to turn on and off the water pump from the Android application.
2. The Internet of Things-based water pump controlling and monitoring tool is built using acrylic material. While the software used is Arduino Ide, for connection using WiFi, and data storage using Firebase.
3. The results obtained in testing the water pump controlling and monitoring tool based on the Internet of Things, namely, the water level measured using the HCS-R04 was 11 cm high, while the water level was measured using a meter to obtain a water level of 10.7 cm. The water discharge obtained is 6 L/m, the water level obtained is 8 cm. The water pump status feature, and the ON/OFF feature on the Android application are declared successful for turning on and turning off the water pump.

References

[1] P. R. Mahardika, F. A. Lani, and R. Suwartika, "Perancangan sistem control tandon air menggunakan sensor hc-sr04 berbasis internet of things," vol. 07, pp. 1–9, 2022.

[2] Y. M. Djaksana and K. Gunawan, "Perancangan Sistem Monitoring Dan Kontroling Pompa Air Berbasis Android," *SINTECH (Science Inf. Technol. J.*, vol. 4, no. 2, pp. 146–154, 2021, doi: 10.31598/sintechjournal.v4i2.741.

[3] S. T. ind, Karambir, "A Simulation Model for the Spiral Software Development Life Cycle," *Int. J. Innov. Res. Comput. Commun. Eng.*, vol. 03, no. 05, pp. 3823–3830, 2015, doi: 10.15680/ijircce.2015.0305013.

[4] R. P. Prawira, A. H. Brata, and B. Priyambadha, "Pembangunan Sistem Monitoring Rumah Menggunakan Mikrokomputer," *J. Pengemb. Teknol. Inf. dan Ilmu Komput. Univ. Brawijaya*, vol. 2, no. 12, pp. 6885–6893, 2018.

[5] Wilianto and A. Kurniawan, "Sejarah , Cara Kerja Dan Manfaat Internet of Things," *Matrix*, vol. 8, no. 2, pp. 36–41, 2018.

[6] N. H. L. Dewi, M. F. Rohmah, and S. Zahara, "Prototype Smart Home Dengan Modul Nodemcu Esp8266 Berbasis Internet of Things (Iot)," *J. Tek. Inform.*, p. 3, 2019.

[7] F.- Puspasari, I.- Fahrurrozi, T. P. Satya, G.- Setyawan, M. R. Al Fauzan, and E. M. D. Admoko, "Sensor Ultrasonik HCSR04 Berbasis Arduino Due Untuk Sistem Monitoring Ketinggian," *J. Fis. dan Apl.*, vol. 15, no. 2, p. 36, 2019, doi: 10.12962/j24604682.v15i2.4393.

[8] J.- -, T. R. -, and A. F. -, "Perancang Alat Sistem Monitoring Volume Air Pada Tangki Air Berbasis Telegram Dengan Mikrokontroler NodeMCU," *J. Ilm. Poli Rekayasa*, vol. 16, no. 1, p. 27, 2020, doi: 10.30630/jipr.16.1.190.

p-ISSN: 2252-3006
e-ISSN: 2685-2411

[9] N. Dida and R. Watiasih, "ID : 10 Aplikasi Teknologi IoT Pada Sistem Kontrol dan Monitoring Tandon Air Application of IoT Technology in Water Tank Control and Monitoring Systems," no. November 2021, pp. 60–72.

[10] L. N. Z. H. JauhariArifin, "Jurnal Arduino Ide," *Peranc. Murottal Otomatis Menggunakan Mikrokontroller Arduino Mega 2560*, vol. 1858, no. 2680, pp. 89–98, 2016.

[11] N. Nurhidayati and A. M. Nur, "Pemanfaatan Aplikasi Android Dalam Rancang Bangun Sistem Informasi Persebaran Indekos di Wilayah Pancor Kabupaten Lombok Timur," *Infotek J. Inform. dan Teknol.*, vol. 4, no. 1, pp. 51–62, 2021, doi: 10.29408/jit.v4i1.2989.