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Data Acquisition for Monitoring IoT-Based Hydroponic Automation System Using ESP8266

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ABSTRACT
Hydroponics is a method of growing crops without using soil, by utilizing water as a solvent for the nutrients that plants need. The role of technology is also needed to help provide nutrition and monitor the state of plants automatically. This study aims to conduct data acquisition on an IOT-based hydroponic plant automation system using ESP8266. Data acquisition is used to monitor temperature data from the DS18B20 sensor, PPM levels from the TDS Meter v1.0 sensor, Ph levels from the Ph Meter v1.1 sensor, water level from TIP 42C, periodic plant growth monitoring based on an image from ESP32 Cam, and as an alternative energy backup using sonar panels on hydroponic plants. Acquired data from each sensor is sent to the Firebase real-time database, every data change is saved to the MySQL server database. The system development method uses the waterfall which includes requirements analysis, system design, implementation, and testing. The results of data acquisition are displayed on the dashboard page in real-time so that they can be easily read by the user. The results of functional and effectiveness testing went well. Monitoring and controlling are done through the website.

Keywords: *Hydroponics, Data Acquisition, IoT, Firebase*

INTRODUCTION
Along with population growth and national development, some problems will gradually decrease, namely agricultural land. This hydroponic system is expected to overcome this problem. The hydroponic method provides more optimal conditions for plant growth and thus higher yields are obtained (Anil & Snehal, 2019). However, the hydroponic method has a higher level of complexity than conventional farming (Tagle et al., 2019).

Factors that can affect the growth of hydroponic plants such as water circulation, light intensity, temperature, humidity and pH of the water that causes these plants to not grow optimally (Prasetyo et al., 2018). So it is necessary to implement an automated system on hydroponic plants that can help control and monitor plant growth.

Although the automatic system can work independently such as fertilizing plants, controlling pH levels, temperature, and water levels automatically, monitoring plant data is still needed to find out if there is a failure in the automatic system. In this day and age, tools will be more effective and efficient if they already have internet of things technology (Rohmah & Dewanto, 2019). Internet of things is communication between one device and another with the help of software with the help of the internet (Setiawan Hasanuddin et al., 2019).

In this study, the use of power utilizes solar cell energy as an alternative in the event of a power outage. with a 50Wp solar panel capacity, it produces 1563 watts of electrical energy per day (Samsurizal et al., 2020).

A good monitoring system can be done without being bound by time and place, anytime and anywhere. This study aims to acquire data on an IOT-based hydroponic plant automation system using ESP8266 to monitor important data on hydroponic plants.

METHOD

At this stage, it is very important because of the research method. With this research method, data can be obtained quickly and accurately so that it does not waste time in its implementation. Accurate data is very important in research to know the problem correctly and find a solution to the problem. In addition, accurate data can speed up the process of working on the final report.

In this study the system development method used is the waterfall which is divided into 5 stages as shown below:

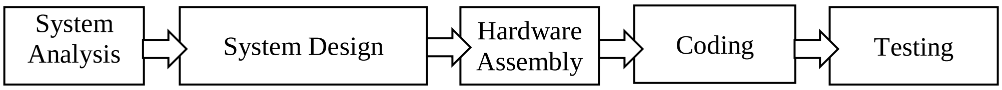

Figure 1. Stages in The Waterfall Method

From figure 1, it can be described as follows:

- System Analysis
  This stage aims to analyze the system requirements, in this case, the researcher conducts a literature study, interviews, and observations of the existing system.
- Design Stage
  The system design designed in this research is to make a system design
- Hardware Assembly
  Hardware assembly is done by combining Arduino Uno with several sensors and electronic components and ESP 8266 as a data sender to the server.
- Coding
  The Arduino and ESP 8266 coding/coding system use the Arduino Idea Toll with the C++ programming language and the website coding system is built with CodeIgniter using JavaScript, PHP, and Html programming languages in terms of code implementation and editing using the Sublime Text editor tools.
- Testing
  At this stage, testing of the compatibility and functionality of the system is carried out to review whether the system is running according to the concept and plan.

System Planning

The design of the tool system is made to simplify and assist in the process of making tools. The design of the tool can be seen in the image below.

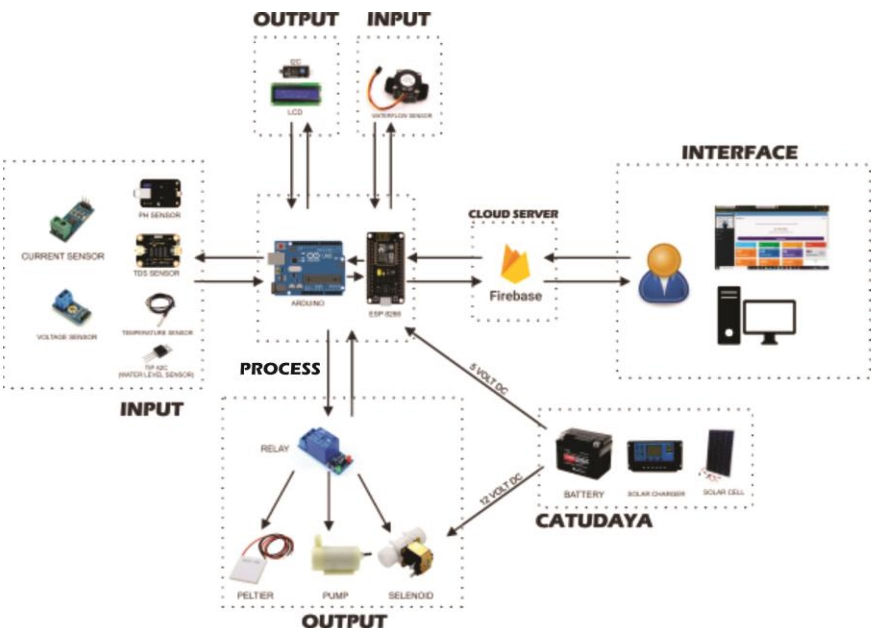

Figure 2. System Flow Design

After the system design has been completed, the next step is hardware design. The hardware design includes input, process, and output that are combined into a single unit that is structured into a tool that can monitor important data on hydroponics and control it.

The hardware design uses Arduino Uno as a sensor reader and an ESP8266 wifi module as a sensor data sender to the webserver. The website software design uses the Codeigniter framework as a monitoring application as well as controlling sensor data.

Tool testing is carried out with 2 types of testing, namely technical testing, and effectiveness testing. This test aims to obtain observational data and the accuracy of the tools made.

RESULTS AND DISCUSSION

The testing of this research was conducted at the University of KH A. Wahab Hasbullah Jombang. Jl Garuda No. 9 Tambakberas Jombang.

Implementation Results

The results of the implementation of the tool design system are hydroponic planting equipment that is controlled by various sensors in an integrated manner and works automatically. The shape of the design can be seen in Figure 3.

Figure 3. Tool Implementation

Tool Assembly Results (Hardware)

The results of assembling the tool are placed in a box, on the front, there is an LCD panel and a solar cell control panel, on the inside, it contains several modules including Arduino, relays, and others. On the back consists of a terminal port that is used to connect to various sensors. The results of assembling the tool can be seen in Figure 4.

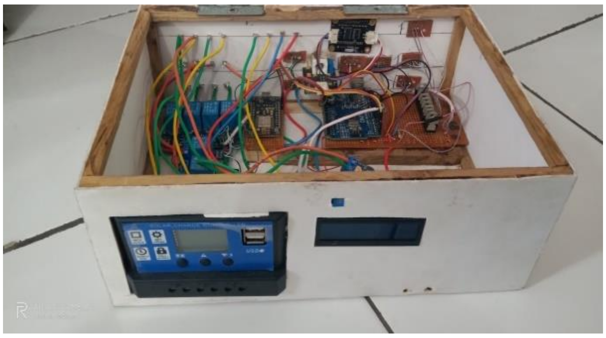

Figure 4. Hydroponic Equipment

Website Based Application Results

The result of making a website application for monitoring and controlling important hydroponic data. The display when the website application is first accessed in the form of a login page. This page is used as a security system to limit interested users to avoid confusion in the process of detecting plant needs, data leakage, and abuse of authority (Ravida & Santoso, 2020). The login display form can be seen in Figure 5.

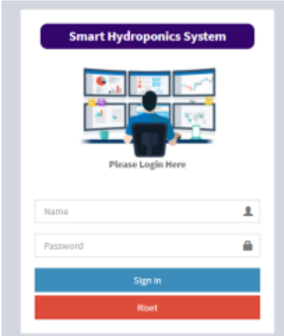

Figure 5. Login Form

Dashboard Menu

After the user has successfully logged in, they are then taken to the dashboard view. This page displays several menus and important hydroponic data displayed in real-time from various sensors. This page also contains a tool navigation system to control sensors and other equipment as needed. The dashboard page display form can be seen in Figure 6.

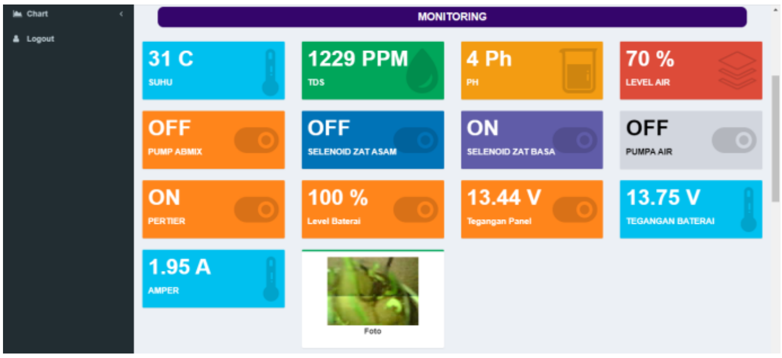

Figure 6. Real-time Data Monitoring Dashboard

The data displayed on the dashboard page is real-time data taken from firebase which is sent from ESP8266 every 5 seconds.

On the dashboard page, apart from displaying data in real-time, this page is also used to control through configuring the threshold values for each sensor. Among them are the threshold value of TDS, the minimum and maximum values of the pH of the water, the maximum temperature value in the water, and the minimum value of the water level. This configuration is used as a reference for the automation of the hydroponic system according to the type of plant.

Figure 7. Sensor Control Data Configuration

Data Menu

The data menu page displays historical data stored in the database in the form of tables and is categorized in the form of a sub-menus. The types of data that can be viewed include TDS data, Ph, Temperature, Water Level, battery level, and photos of plant conditions.

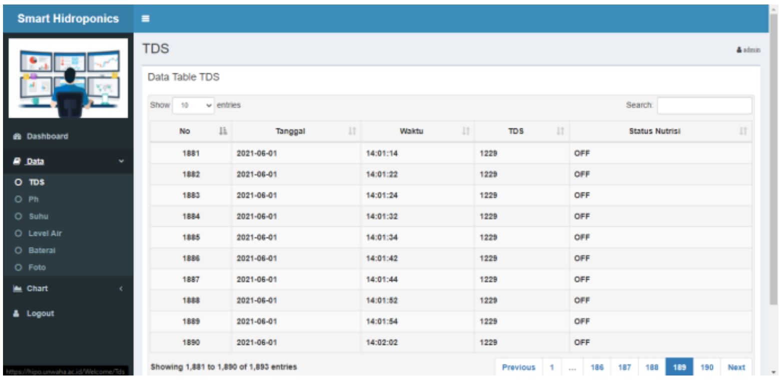

Figure 8. TDS Data Display

Menu Chart

The chart menu page displays the data stored in the database in the form of a chart. The data displayed on the chart is filtered by month and year.

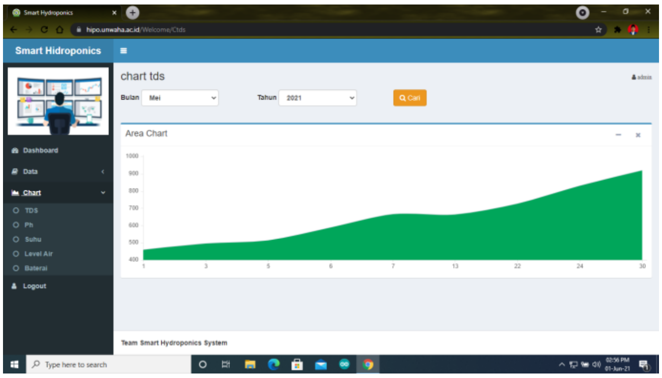

Figure 9. TDS Chart

Test Result

TDS Sensor

The TDS control test can be seen in the following table:

Table 1 TDS Test Results

TDS (PPM)	Nutrition Pump	Value the condition of the website	Status
205	ON	TDS<600	Good
310	ON	TDS<600	Good
480	ON	TDS<600	Good
590	ON	TDS<600	Good
605	OFF	TDS<600	Good
708	OFF	TDS<600	Good
850	OFF	TDS<600	Good

The results of the TDS test in the table above are running well, that is, if the condition value given on the website is greater than the TDS value, the nutrient pump is on and otherwise it will be off.
The TDS control test can be seen in table 2.

Table 2 Ph Test Results

Ph	Acid Pump	Base Pump	The max and min value of the website	Status
5	OFF	ON	Ph<6 & Ph >7	Good
6	OFF	OFF	Ph<6 & Ph >7	Good
7	OFF	OFF	Ph<6 & Ph >7	Good
8	ON	OFF	Ph<6 & Ph >7	Good
9	ON	OFF	Ph<6 & Ph >7	Good

The results of the pH test in the table above are running well. The min and max values from the website determine whether the pump is off or on.

Temperature and Peltier Sensor
Temperature control testing can be seen in the following table.

Table 3 Temperature Test Results.

Temperature (C)	Peltier	Code of Value From Website	Status
27	OFF	Temperature > 30	Good
29	OFF	Temperature > 30	Good
30	OFF	Temperature > 30	Good
31	ON	Temperature > 30	Good
33	ON	Temperature > 30	Good

The results of the pH test in the table above are running well. If the temperature value is below 30 degrees, then Peltier (coolant) is on, if 30 degrees and above, then Peltier is off. Temperature is one of the parameters for whether or not a plant grows well (Nahdi et al., 2019).

Water Level Sensor
The water level control test can be seen in the following table.

Table 4 Water Level Test Results

Water Level (%)	Water pump	Condition Value From Website	Status
40	ON	LA < 60	Good
50	ON	LA < 60	Good
60	OFF	LA < 60	Good
70	OFF	LA < 60	Good
80	OFF	LA < 60	Good

The results of the water level test in the table above are running well. If the water level value is below 60% then the water pump is on, otherwise, the water pump is off.

Function Testing
The results of functional testing can be seen in the table below.

Table 5 Functional Test Results

NO	Function	Status	
		Good job	Not Working
1	Table data records	✓	-
2	Chart data records	✓	-
3	Realtime data	✓	-
4	The set data control value	✓	-

The data interface display on the website consists of real-time data, control data value sets, data record tables, and data record charts. The test results of the four interfaces show that these features work well. This can be seen from the working of the data interface through the smart hydroponic system website.

Table 6 Results of Effectiveness Testing

NO	Variable	Manual	IoT
1	Data Storage	0 time	Realtime
2	Provision of Nutrition (Fertilizer)	Manual (with the help of farmers)	Automatic (without farmer assistance)
3	Water controller	Manual (with the help of farmers)	Automatic (without farmer assistance)

NO	Variable	Manual	IoT
4	Temperature controller	Manual (with the help of farmers)	Automatic (without farmer assistance)

The test results in table 6 show that the tool built in this final project works automatically and is stored reliably every 5 seconds.

CONCLUSION

In the results of this final study, the author concludes that the design of tools and systems has been successfully realized by combining hardware and software to obtain three main processes, namely input, process, and output. The way the tool works is that the input from the sensor is then processed by Arduino Uno and sent to the ESP8266 to be processed while sending data to firebase and read by the website in the form of real-time data output, tables, and charts. Testing is done by 2 ways of testing, namely functional and effectiveness testing. The results of both tests worked well.

SUGGESTION

The results of the design of this smart hydroponic system found several shortcomings in the system. The author suggests for further development to test how long the effectiveness of this tool can work properly and the addition of a video feature of growth from planting to harvesting.

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