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Durian Tree Watering System Uses IoT and Solar Energy

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Abstract: When the dry season approaches, durian growers are especially concerned when the soil of the durian plantation dries up quickly. As a result, by proposing a Durian Tree Irrigation System, this project can fix the problem. To address the problem of rapidly drying soil, IoT and solar energy were developed. To communicate with the irrigation system, the ESP2866 utilized a controller system. The scope of the study was decided before the design was created to ensure that the prototypes produced can meet the objectives that were set. This project's goal is to ensure that this irrigation system can be controlled using an energy-efficient wireless concept. The Blynk app is used on a smartphone to control the watering system and monitor soil moisture conditions. Users merely need to open the system in their smartphone to adjust the sensor's sensitivity and the state of the watering. The project will also employ solar energy, which will save the gardeners money and eliminate the need for the gardeners to bring power into the garden, which is tough to maintain if there are any problems. The project is primarily concerned with a watering control system linked to an EPS2866 via a wireless network. To connect the system, a wireless router is used. Therefore, it can be concluded that the study successfully developed a system that addresses the problem of fast-drying soil in durian plantations.

Keywords: Solar Energy, Watering, Moisture, Wireless

1. Introduction

Durian also known as the "king of tropical fruits" is one of the most economically important tropical fruits grown in Southeast Asia. Hailing from Peninsular Malaysia and Borneo, its spread has spread to Sri Lanka, Northern Australia, and Hawaii (Honsho et al., 2004). The main producers and exporters of durian are Thailand, Malaysia, and Indonesia while other countries in the region such as the Philippines and Vietnam produce durian for domestic consumption (O'Gara et al., 2004).

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In general, the durian fruit season in Peninsular Malaysia is not similar in the growing area because it is influenced by the monsoon season, dry season, and changes in wet to dry weather conditions in certain places (Chung, 2011). Changes from wet and dry spells in monsoon weather systems are caused by sunlight that triggers land-sea temperature changes (Huffman et al., 1997). For durian, the rise and fall of production trends are highly related to changing climatic conditions. Kukal and Irmak. S (2018) revealed that crop yield variation may be due to factors such as technology, genetics, soil, farm management and practices, fertilizers and climate. Among these variables, yield performance is heavily influenced by climate change as it is a major driver in agricultural production.

1.1 Necessity for Smart Watering System

Water is one of the basic requirements for durian crops from air and soil. Water requirements are one of the main factors to increase tree growth and durian fruit production. With effective water management, production, yield can be increased by 50 percent (Shaheen, 2017). In agriculture and horticulture, especially crops that need water is very important because crops cannot live and grow well if the water on the soil does not suit the needs of crops. Water scarcity at present has become an urgent issue for global attention (Shaheen, 2017).

To ensure secure agricultural water resources such as through the construction of small dams; increase the capacity of reservoirs, build tube wells and increase the efficiency of water distribution through pump replacement, promote minimal water consumption by using drip irrigation systems and mist blowers as well as stagnant rainwater. Due to high start -up costs, smallholders are unable to make the installation and use of drip irrigation systems (Wesonga et al., 2014).

1.2 IoT application in Watering System

The rapid development and implementation of smart technologies and IoT (Internet of Things) has made possible various possibilities in technological advancement for various aspects of life (Nižetić et al., 2020). IoT is one of the techniques that can be used to control electrical equipment. This technology provides a virtual view of the devices that generate the real environment. Controlling electrical equipment using IoT is a system that uses computers or mobile devices to control basic office functions and features automatically over the internet from anywhere around the world (Nawawi, 2014)

One of the methods that has been developed is the Durian tree watering system using the Internet of Things (IoT) and solar energy (Sundawati et al., 2012). The system can control online for the purpose of watering crops. However, the Durian King tree crop monitoring system using the existing IoT relies on the internet and this system cannot work if the internet network has problems (Sundawati et al., 2012).

1.3 Solar Powered in Watering System

Solar panels consist of solar cells made up of semiconductor materials that can directly convert sunlight into electricity. Often also use the term photovoltaic (Effendi & Yusran, 2018). Solar cells basically consist of p-n junctions that function similarly to diodes. Theoretically, when sunlight is emitted to the surface of a solar cell, the energy carried by this sunlight will be absorbed by electrons at the positive -negative junction to move from positive to negative diodes and then flow outward through cables attached to solar cells. (Effendi & Yusran, 2018)

2. Methodology

In this chapter, it will explain the project methodology. This chapter is the part where it is used as a reference by researchers to design, collect and analyze information. This chapter also discusses how the procedure is used from the initial stage of development of "Durian Tree Irrigation System Using IoT and Solar Energy" which includes the planning phase, analysis stage and requirements, design stage, development stage and testing until the final stage. This methodology can help researchers understand in more depth about the determination of appropriate methods to be used in the study. Thus, the project can be produced without any problems by following the order of the model to be used.

2.1 Research Design

Project design is a method or technique used throughout the development process of a project (Jin, 2010). The selection of project design is very important in ensuring that the project development can run smoothly. This project uses the Prototype Development Model design because it has a systematic process.

Prototype Development Model is a system development method given to users for testing (Jin, 2010). Comments received from users will be used to improve the prototype so that a complete system can be produced. This prototype development model has six phases, namely:

i. Requirements data collection and analysis
ii. Fast design
iii. Build a prototype
iv. Ratings with users
v. Product improvements
vi. Develop a product

2.2 Research Procedure

To produce a good product, the choice of methodology is important. The prototype development model was chosen as the model for developing the product. Prototype development models can help developers detect errors that occur in advance. In addition, this model can also collect user feedback to detect weaknesses in prototype development and improve those weaknesses to produce good and quality products.

2.2.1 Needs Collection and Analysis Phase

The needs collection and analysis phase include the collection of data and information on prototype development needs. The information collected was analyzed for the purpose of prototype development. Data and information collection will also spark ideas in the production of prototypes for Durian Tree Irrigation System Using IoT and Solar Energy with devices such as ESP8266 microcontroller, Blynk Application, Solar Panel, High Pressure Water Pump and Solar Charger Controller. Among the main analyzes that have been given attention are:

i. Set and list objective:

After the need in monitor durian tree crops from water requirements, three objectives were selected to determine the prototype design to be designed. The three objectives that have been selected are:

a) Designing a water pump control device in the form of a durian tree watering system using IoT and solar energy to facilitate gardeners.
b) Develop a system that can use natural energy sources, namely Solar Energy.
c) Test the functionality of durian tree watering system using IoT and Solar Energy.

ii. Determining the Scope of the Study

The scope of the study must be determined before the design is made to ensure that the production of prototypes can meet the objectives that have been set. The scope of the study that has been set includes Durian Tree Irrigation System Using IoT and Solar Energy which uses Blynk application as IoT application.

iii. Problem statement

The importance of the development process of Durian Tree Watering System Using IoT and Solar Energy is very important to monitor the process of watering durian trees in terms of watering frequency and automatic handling. The development of this system can help the production of quality crops and ensure the watering process is not disrupted.

iv. Design Suitability

The thing that needs to be emphasized in the production of product design is the design features that are appropriate for the system to be built. Among the features that need to be emphasized in the production of the design is the simplicity of form, waterproof and user-friendly interface so that it is easy to use. This can help monitor their durian trees well and effectively.

v. Cost

The cost of building a Durian Tree Watering System Using IoT and Solar Energy is affordable so that consumers can afford it and can help them undergo the process of watering durian trees more efficiently.

2.2.2 Quick Design Phase

Once the need to develop the system has been identified, the second phase that will be able to be carried out is the rapid design phase. This phase is able to identify the inputs and outputs of the system which aims to provide a concise overview with a simple design to the user. Figure 1 shows the schematic circuit for Durian Tree Watering System Using IoT and Solar Energy consists of ESP8266 microcontroller, battery, Solar Panel, High Pressure Water Pump and Solar Charger Controller.

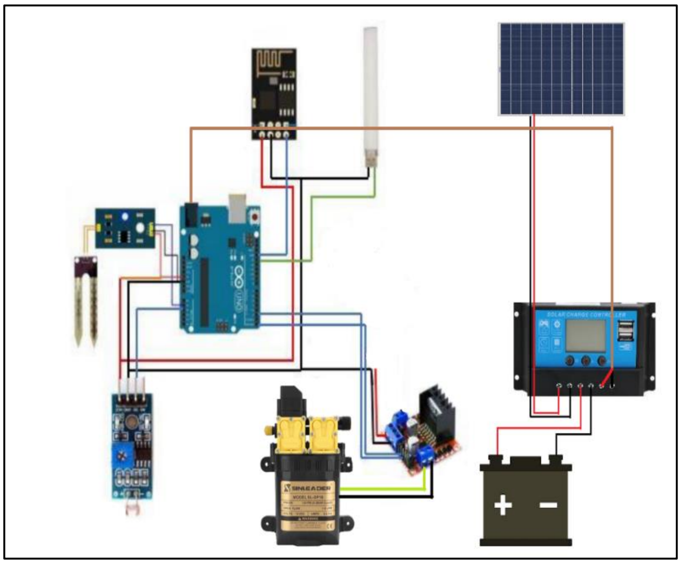


Figure 1: Schematic circuit of durian tree watering system using IoT and solar energy

2.2.3 Prototype Building Phase

In this phase, a prototype will be built based on information that has been gathered from the rapid design phase. The construction of this first prototype will provide an overview of this prototype to the user so that the user can make an initial assessment of the design of the prototype model produced. There are several system devices housed in the box to ensure that the system equipment is always in a safe condition. Among the equipment housed in the control box are batteries, ESP8266 and Solar Charger Controller as in Figure 2.

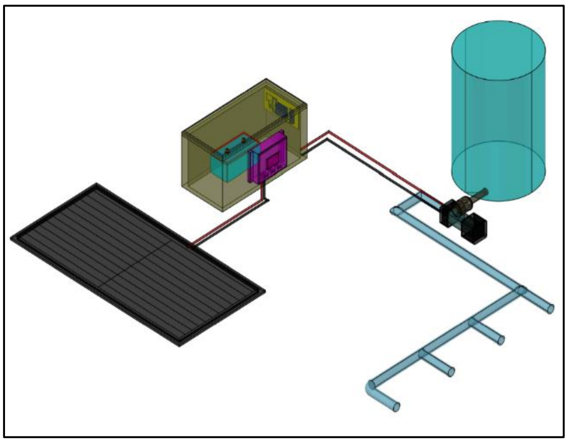


Figure 2: Prototype model of durian tree watering system using IoT and Solar Energy

2.2.4 Evaluation Phase with Experts

Next is the evaluation phase with experts where experts can provide comments or opinions on the prototype model that has been built. Feedback from experts consisted of the advantages and disadvantages of the prototype that had been built. The lack of prototypes will be ameliorated by fixing weaknesses in terms of controls consisting of the ESP8266 and Solar Charger Controller and hardware such as control boxes. Next, the user will re-evaluate and test the prototype to see if the rebuilt prototype can work better. This process will be repeated if there are still deficiencies in the prototype that has been rebuilt.

2.2.5 Prototype Improvement Phase

At this prototype improvement phase, the prototype is improved based on comments or feedback from experts to ensure the production of a good product is to meet the set objectives. The feedback results received from experts are composed in terms of functionality and prototype design.

2.2.6 Product Development and Testing Phase

The last phase is the phase of product development and testing. In this phase, the development and testing of durian tree irrigation systems using real IoT will be carried out. durian tree watering system using IoT is carried out based on the improvement of the prototype that has been built. Two designs are built in this phase which are:

a) Development of circuit design
b) Blynk application design development

Circuit design development is carried out for the purpose of testing the functionality of devices such as ESP8266 Module, Solar Charger Controller, and solar panels when the devices are connected. Development of the Blynk application design will be carried out for the purpose of ensuring that the Blynk application can communicate with the ESP 8266 to carry out control over the IoT.

2.3 Research Instrument

The Durian tree watering system using IoT includes three elements, namely (1) input, (2) process, and (3) output. The input consists of two sensors, namely the humidity sensor, and the readings from the sensor are processed by the ESP8266 and ESP8266 Module, then the data is sent to the Blynk application as shown in Figure 3.

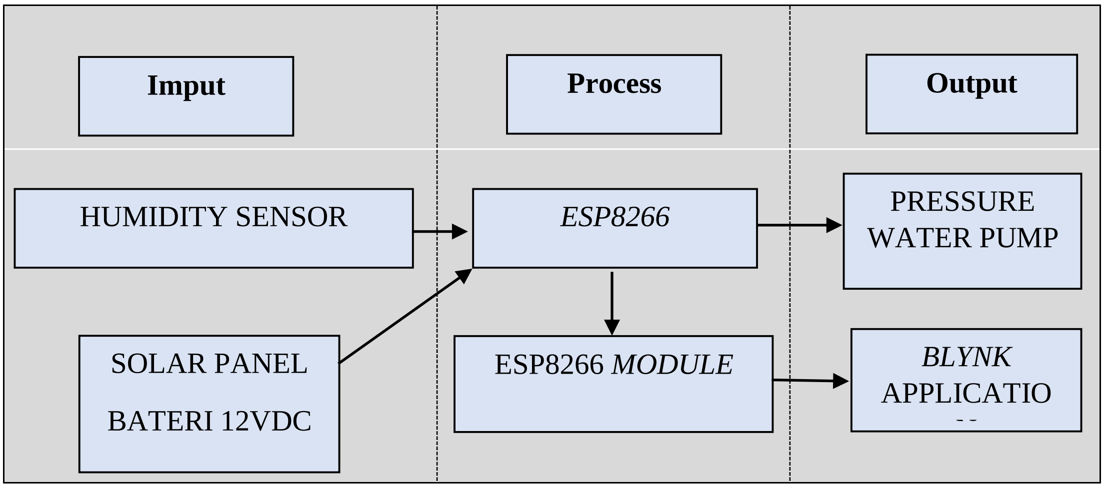


Figure 3: Block Diagram of Durian Tree Watering System Using IoT and Solar Energy

3. Results and Discussion

The results and discussion section presents data and analysis of the study, from the experiment that has been conducted to the Durian Tree Watering System Uses IoT and Solar Energy.

3.1 Results

a) Microcontroller ESP8266

The circuit developed has the main device that controls the entire operation of the durian tree watering system using this IoT is the ESP8266 microcontroller. This microcontroller is pre-programmed using Arduino IDE software. The test was performed on the ESP8266 by measuring the voltage value at the 3.3 V power supply leg on pin 3V3 ESP 8266. This test was performed using a multimeter by placing the positive leg on pin 3V3 ESP 8266 and the negative leg on the earth leg i.e., pin Gnd on ESP8266. The results are in Table 1.

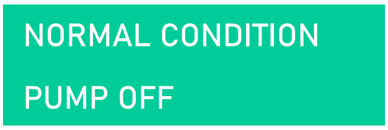
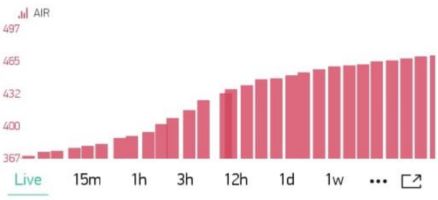
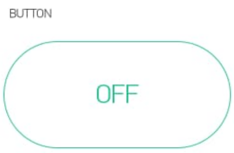
Table 1: Results of power supply testing on ESP8266

Pin ESP8266	Voltage (V)
3 V	3.3
3 V	3.3
3 V	3.3

b) Moisture sensor

Humidity sensor readings will be received by the ESP8266 and will then be displayed on the Blynk app. The history of soil moisture readings can also be seen on the graph in the Blynk app. The ESP 8266 has been programmed for Blynk to notify on a smartphone if a humidity reading of more than 1000 gauges indicates DRY soil. While for NORMAL soil level 600 gauge up to 1000 gauge and for WET soil is below 600-gauge reading. The operation as in Table 2.

Table 2: Operation of the humidity sensor and the display on the Blynk application

Moisture Sesnsor Operation	Explanation
	1. Moisture sensors planted in plants
	2. Humidity readings shown on the Blynk application
	3. Notification of ground conditions shown on the LCD on the Blynk Application.
	4. Historical graph of soil moisture readings on the Blynk application
	5. Button placed on the Blynk app to make it easier for bypass users to turn on the water pump manually by simply pressing the ON/OFF button

c) Solar Charger Controller

Solar Charger Controller is used in durian tree watering system using IoT to charge the battery which is the power supply for this watering system. The Solar Charger Controller used was connected to a 50 W solar panel and sent a supply to the ESP8266 and the Water Pump Motor to carry out the next operation. Table 3 shows the solar charger controller operation.

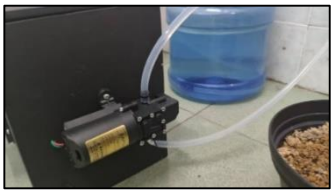
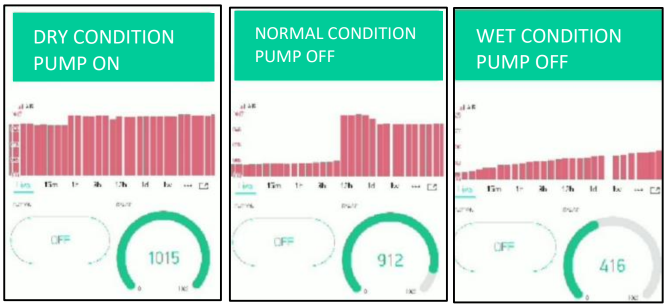
Table 3: Solar Charger Controller operation

Solar Charger Controller Operation	Explanation
	1. Connecting the Solar Panel to the Solar Charger Controller and further to the 12 VDC Battery.
	2. The 12 VDC supply from the Solar Charger Controller is sent to the DC Step Down before entering the ESP8266 Microcontroller.
	3. The LCD display on the Solar Charger Controller shows no presence of photovoltaic as a source of solar energy.
	4. The LCD display on the Solar Charger Controller shows the presence of photovoltaic as a source of solar energy.

d) Water Pump Irrigation System

To control the watering process, the ESP8266 has been programmed to use an Arduino IDE so that Blynk notifies the smartphone if a humidity reading of more than 1000 gauges indicates DRY soil. While for NORMAL soil level, 600 gauge up to 1000 gauge, and for WET soil is below 600-gauge reading. The watering process will only occur when the humidity sensor is at the KEIRNG level i.e., when the gauge reading exceeds 1000. Table 5 shows the crop watering operation and analysis of each crop soil moisture level.

Table 5: Irrigation System Operation

Watering System Operation	Explanation
	1. Placement of humidity sensors on three levels from the right DRY, NORMAL, and WET.
	2. Connection of the water pump to the system that is the input from the water source and the output of the pump to the durian plant.
	3. Watering is done into bottles because the soil conditions have been set according to the stage
	4. The display that will come out on the Blynk app shows the presence of moisture by stage and the graph shows the humidity situation directly.

3.2 Discussions

Overall, the Durian Tree Irrigation System Project Using IoT and Solar Energy has been successfully developed through a process of testing and evaluation. The testing process is carried out on all devices used in the Durian Tree Watering System Using IoT and Solar Energy. The developed system has gone through an evaluation process to ensure that the developed project meets the specified specifications. In addition, the developed project can identify weaknesses that can be improved in the future. Some possible weaknesses could include technical issues with the IoT devices or solar panels, inefficiencies in the water delivery system, or challenges with data management and analysis. It's important to address these weaknesses through continued testing and development to ensure the system is as effective and efficient as possible. However, there are lots of advantages to using this project which can increase efficiency. The use of IoT technology and solar energy can make the irrigation system more efficient by automating the watering process and reducing energy costs. Then it can maintain sustainability the use of solar energy and IoT technology is a sustainable approach to agriculture that can reduce the carbon footprint and environmental impact of the irrigation process. Other than that, using this system project can improve cost savings. The use of solar energy can help reduce energy costs, while the precise water delivery system can reduce water waste, leading to cost savings over time. Overall, the Durian Tree Irrigation System Project using IoT, and solar energy has the potential to make a positive impact on the cultivation of Durian trees and contribute to sustainable agriculture practices and meet the goals of the study.

4. Conclusion

Overall, the durian tree watering system using IoT, and solar energy can function as expected and can meet the objectives that have been set. The humidity sensor works fine and sends data to the ESP8266 to display humidity readings on the Blynk app. The Notification function on the Blynk can also work well to keep users aware of soil moisture readings. durian tree watering system using IoT can help users to monitor their durian tree watering system as well as reduce additional production costs to carry out durian tree planting.

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