International Journal of Social Science Research and Review

http://ijssrr.com
editor@ijssrr.com
Volume 6, Issue 4
April, 2023
Pages: 192-200

Improving the Monitoring and Remote Control Functions of Integrated Solar Panel Agricultural Land in Bendosewu Village

Muhammad Afnan Habibi; Arya Kusumawardana; Langlang Gumilar; Muis Muhtadi; Aufa Akmal Labib; Arya Wahyu Sukma Adji

Electrical Engineering, State University of Malang, Indonesia

E-mail: afnan.habibi.ft@um.ac.id; arya.kusumawardana.ft@um.ac.id; langlang.gumilar.ft@um.ac.id; muis.muhtadi.ft@um.ac.id; aufa.akmal.2005366@um.ac.id; arya.wahyu.2005366@um.ac.id

http://dx.doi.org/10.47814/ijssrr.v6i4.1156

Abstract

The Tawang Makmur Farmers Group (KTTM) is located in Tawang Hamlet, which has a productive agricultural and plantation area of more than 75.000 ha. It has more than 30 members, led by Moh. Chilmi. Rice is the main commodity, followed by corn and wheat. Meanwhile, in plantations, cabbage, tomatoes, melons, and oranges are generally grown. Based on the results of interviews that have been carried out, the main problem faced is the selling price of rice which is unstable and tends to fall, while every year production costs are increasing. This forces farmers to have side jobs to meet their daily needs. Thus, practically farmers need a monitoring and remote control mechanism to monitor the water storage capacity and can turn on or turn off the irrigation system of agricultural land. The design of the irrigation system offered utilizes the Internet of Things (IoT) and renewable energy using solar panels as a power source. To control and monitor rice fields, a mobile application is made that contains information in the form of data on water level, humidity, and the surrounding temperature. The results of the service carried out have a good impact in reducing the operational costs of agriculture production compared to the methods used later. Furthermore, KTTM members can monitor and control the irrigation system via smartphones while doing other work or away from their farms.

Keywords: *Agriculture; IoT, Solar Energy; Solar Panels*

Introduction

Bendosewu is a village located in Talun District, Blitar Regency, East Java, Indonesia. There are five hamlets in this village, namely Bendosewu, Bendorejo, Tawang, Kalongan, and, Bakulan. One of the most significant potentials of this village is in the agricultural sector which is spread in every hamlet. The farmers of Dusun Tawang formed a farmer group called the *Kelompok Tani Tawang Makmur* (also known as KTTM) led by Mr. Moh. Chilmi. The KTTM is located in Tawang Hamlet and has a productive agricultural area of more than 75.000 ha. The site is a combination of KTTM members which was established on January 18, 2011, with more than 30 members.

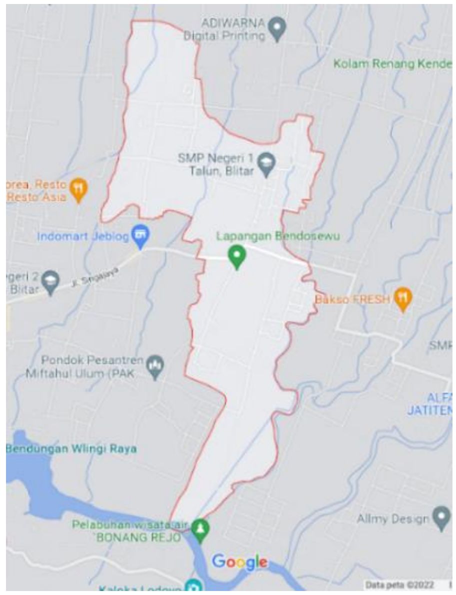

Figure 1. Location of the village of Bendosewu

Tawang hamlets is mostly an agricultural area, making the agricultural industry the main commodity. In 2022, there was a successful harvest with abundant results (source: Memontum Blitar). The agricultural industry has a positive impact on the economic sector in the region. The potential contained in KTTM agricultural land is in staple food commodities such as rice, corn, and wheat. In addition, there are vegetables and fruits such as tomatoes, cabbage, chilies, melons, and oranges.

Figure 2. Summit Members' Rice Fields

Bendosewu village has an irrigation system that drains water from the water tank alternately between hamlets to increase community yields. Even the distributed water is arranged along with the implementing a water distribution schedule. The Tawang hamlet irrigation system operates in rotation every two weeks, with the first week of the irrigation system being On and the next two weeks of the irrigation system being Off. The schedule for opening canals for the KTTM irrigation area is scheduled every Friday at 03.00 WIB. The schedule for closing the canal is on Saturday at around 17.00 WIB. The cost of using the irrigation system is between IDR 5.000.00 – IDR 7.000.00.

The problem that occurs among KTTM members is that the average income of each family head is very low because the education level of the majority of the population is also low. The net income of each farmer is IDR 15.000.00 per day. If the profit is multiplied by 4 months, which is one cycle of the rice harvest, each farmer gets IDR 1.800.000.00. Of course, the income is very small for farmers to meet the needs of their families so farmers choose to do side professions such as animal husbandry, slaughter, teaching, of entrepreneurships.

Innovation aimed at technological independence is also low. Agricultural land processing is less coordinated due to the absence of a communication platform for farmers. The government has assisted in the form of subsidized fertilizers, seeds, and agricultural equipment. In the 2017 RAPBN, the government has planned to allocate subsidies for fertilizers, seeds, and program credit interest (Heliaantoro & Juwana, 2018). However, the KTTM organization still needs innovating to increase revenue by cooperating with scholars.

The service team has mode observations on KTTM agricultural land and installed a 300 Wp solar water pump equipped with a 1200 L water tank in the previous years' service. However, it takes 45 minutes to fill the water tank from an empty water tank until is filled. To speed up the charging time of the water tank, it is necessary to increase the capacity of the solar module to speed up the charging time of the 200 Ah battery ready for use.

In addition, the purchase of seeds, fertilizers, and plant maintenance costs are quite high, thus requiring farmers to have side jobs. This condition makes it difficult for farmers to divide their time between farming and side jobs. Thus, KTTM farmers need a remote monitoring and control mechanism to help monitor the water tank water capacity and can turn On/Off the irrigation system via a smartphone. The IoT-based irrigation system was chosen because it uses an ESP32 module equipped with a Wi-Fi module so that it can communicate over the internet (Walid et al., 2022). In general, IoT-based irrigation systems are controlled through applications that out team has created. Information from the smartphone will be sent to the cloud system using firebase. The ESP32 module will fetch the data residing in firebase as a command. The order can control the water that enters the water tank and that leaves the water tank which will be distributed to agricultural land. The IoT-based irrigation system has the additional feature of being able to display how many liters of water have been accommodated in the water tank, the temperature around the water tank, and the weather at that time in Tawang hamlet which information was obtained from the BMKG. BMKG provides open-source weather information so that the data can be retrieved in real-time (Heliaantoro & Juwana, 2018).

Literature Review

At the service held in Tawang hamlet, Bendosewu, Talun, Blitar, East Java, Indonesia. This service is a refinement of the previous service that was held in the same place.

Past Devotion 1

This service is an additional innovation that is implemented from the previous service taken by the author Denis Eka Cahyani with the title "Development of Agricultural Management Information Systems Using the CodeIgniter Framework for Farmers Groups in Bendosewu Village, Blitar". The purpose of this service activity is to develop an agricultural management information system for farmer groups in Bendosewu village. The agricultural management information system provides features such as data collection on farmer members, planting, and annual yields (Cahyani et al., 2021).

Past Devotion 2

Devotion was written by Muhammad Afnan Habibi with the tittle “Design and Build an Internet of Things-Based Irrigation Water Monitoring System for Solar Water Pumps”. This service aims to create a water pump system with a voltage source coming from solar panels so that farmers do not rent diesel pumps again (Habibi et al., 2021). Integrated IoT in the system, allows farmers to monitor temperature, humidity, and water level in Stanton. However, this service is not perfect in the development of mobile applications.

Method

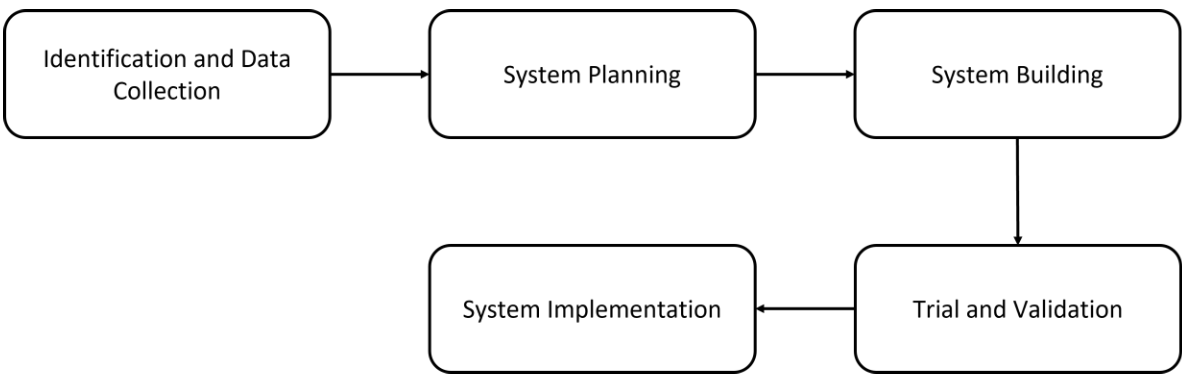

Figure 3. Flowchart Method

This community service activity was carried out for 10 months and was located in Tawang, Bendosewu, Talun, Blitar which was managed by KTTM and chaired by Mr. Moh. Chilmi. Service activities use direct mentoring and education method. In detail, the implementation of this community service activity is as follows:

1. Identification and Data Collection

This activity is carried out by observing the irrigation system and interviewing the head of the KTTM to find out the problems that are being experienced and can produce an overview at the next stage to solve the problem.

2. System Planning

The irrigation system will implement an IoT system by utilizing the ESP32 module, JSN-SE04T as a waterproof ultrasonic sensor because in its implementation it will be inserted into a water tank used to retrieve water level data (Chobir et al., 2017), DHT22 as a sensor to retrieve humidity data and temperature in the surrounding environment (Islam et al., 2016), YF-S201 is used to measure the amount of water used in the irrigation system. Figure 4 is a block diagram of the IoT water tank irrigation system working. Sensors HC-SR04 and YSF-201 send data to the ESP32 Microcontroller. The data is sent to the firebase Realtime Database using the internet network. Mobile application as a system to control and monitor data that sends and retrieves data on firebase. The command to control in the form of On/Off is received by ESP32 and will control the relay according to the command.

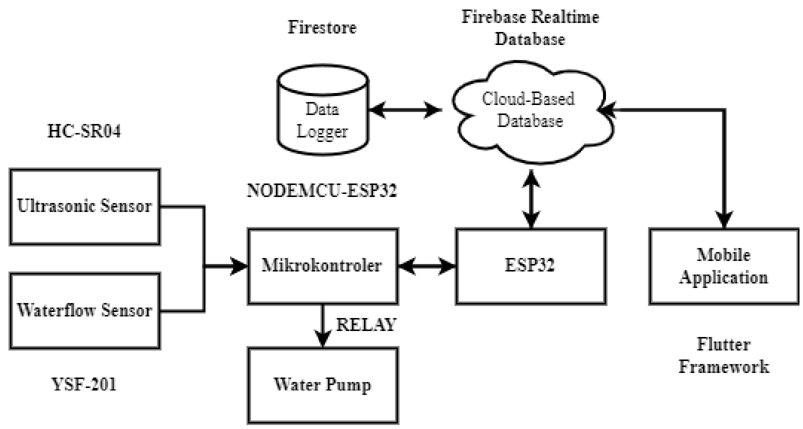

Figure 4. Block Diagram

3. System Building

In making the system is divided into two, namely hardware and software. Hardware manufacture is carried out according to the design that has been done previously. Sensors, actuators, and microcontrollers are connected via cable. In making the software, it will use cloud-based data by utilizing an internet connection via the Wi-Fi module. Firebase in a platform that is Bass (Backend as a Service). As the name implies, firebase is used to create applications or software, but focuses on the backend of the application with various services and tools that make it easier for developers to design applications. The Firebase real-time database uses JavaScript Object Nation (JSON) to store data. The authentication system allows only registered users to send and retrieve data from the database (Farizi et al., 2021). Data measurement and control off the irrigation system are connected to the application that is already installed on the farmer’s smartphone.

4. Trial and Validation

The IoT water tank irrigation system along with the applications that have been made will be tested first in order to find out whether the system is running well or not. If a system error occurs, it can immediately evaluate the system so that it can be repaired.

5. Implementation

This activity is the process of installing an IoT water tank irrigation system carried out at the location of a solar water pump that was made in the previous service. In addition, representatives of KTTM members received training using the monitoring and control application of the IoT water tank irrigation system

Results and Discussion

The results of the service of the IoT water tank irrigation system carried out in Bendosewu, Talun, Blitar. In the form of installation of an IoT water tank irrigation system, product testing, and product handover to KTTM. The products produced are IoT water tank irrigation system tools and “IoT_Tandon” Applications.

IoT Water Tank Irrigation System Installation

The installation of the IoT water tank irrigation system took place in Bendosewu Village, Talun District, Blitar, East Java, Indonesia which took place from June to August 2022, involving several

Electrical Engineering undergraduate students. This installation activity was first made as a prototype, then implemented on the IoT water tank irrigation system. The prototype consists of an ESP32 microcontroller as the brain of the system which will be connected to the internet using the Wi-Fi module already in the module. JSN-SRT04T is an ultrasonic sensor that will be used to measure the water level in the water tank. DHT22 is a sensor for detecting humidity and temperature in the environment around the water tank. YF-S201 is used to measure the amount of water used for irrigation.

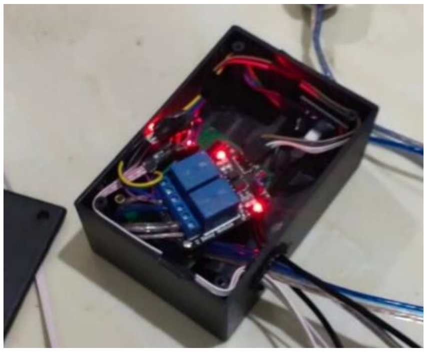

Figure 5. Product Prototype

The sensor will later send data via the internet to a cloud system located on the Firebase real-time system which can later be viewed from the user's smartphone. Realtime Firebase is an online database that can be used as a data storage medium for applications. The data is stored in JSON form and can be synchronized in real time with the users of the application (Sanad, 2019). Users can monitor the system from applications that have been made and can control the system to turn have been made and can control the system to turn On/Off the water pump and the flow of water coming out of the water tank.

After the prototype has been successfully made and passed the trial, the next step is to install the reservoir irrigation system. The installation was carried out on Tuesday, August 9, 2022, at Tawang hamlet, Bendosewu Village, Blitar Regency. The IoT reservoir irrigation system is included in an electric control box connected to a power supply that comes from a solar panel system. In the electric control box, there are supporting components for the solar panel system such as a controller, and an inverter as a system to convert the AC voltage from the battery to DC so that it can be used to power electronic equipment (Ilhami, 2018), and batteries. After installation, the irrigation system is tested and validated to ensure that the system runs properly.

Figure 6. Water Tank Electric Control Box

Testing of the IoT Water Tank Irrigation System

Testing the IoT water tank irrigation system aims to determine whether the installation of the system has worked according to its function and is running well. The voltage source is used by connecting the IoT water tank irrigation system with a 9V 1A adapter to a battery that comes from solar power. The ESP32 Wi-Fi module will connect to the installed Wi-Fi network so that the JSNS-E04T (ultrasonic sensor), and DHT22 (temperature sensor) will send data to firebase. The data in firebase will be read in the "IoT_Tandon" app. This application is also tested to control the system by pressing the On/Off button on the input Water Faucet and output Water Faucet which functions to turn On or Off the water pump to fill the water tank, and Open or Close the water tank faucet for irrigation agricultural land. There is a YF-S201 (water flow sensor) that will detect how much water is coming out of the sensor will be sent to the firebase and shown in the application.

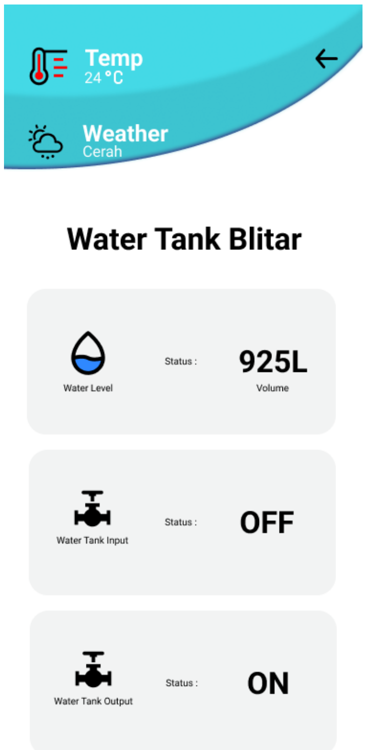

Figure 7. Water Tank System Application

Handover and Training on the Use of IoT Water Tank System Products

The handover activity and training on the use of the IoT water tank system product was carried out on August 9, 2022, at Talun District, Bendosewu, Blitar. The procession of handing over the product or service activities by the team leader, Muhammad Afnan Habibi, S.T, M.T., M.Eng to the Cooperation partner, namely the chairman of the KTTM.

Figure 8. Product Handover Process

The service team conducted education to KTTM which was directly delivered by the leader of the service team. Educational activities contain how the tools that have been installed work, how to use the "IoT_Tandon" application, and hands-on practice on how to use them. Educational activities run interactively between KTTM farmer groups and speakers.

Discussion

The service of the IoT water tank irrigation system is an improvement from the previous service in the same area. The previous service worked with KTTM farmers in the management process of KTTM members starting from member registration, adding members, and collecting data on harvests. The results of the previous service were in the from of a website as a place for recording and viewing KTTM harvest data.

The IoT water tank irrigation system enhances the results of this service by building an internet-based irrigation system so that farmers can control and monitor the water tank irrigation system using smartphone. The goal is that farmers do not have to do routine checks on their agricultural land to irrigate the land and fill water reservoirs. As such, farmers can do side jobs to get additional income which helps the economy of KTTM farmers better.

Conclusion

Community service activities that have been carried out can make it easier for farmers to monitor and control agricultural areas which automatically all information will appear on the smartphone screen and can be done simultaneously when farmers are doing side jobs. In addition, the existence of this appropriate technology cuts the cost of agricultural production that was previously based on fossil fuels into solar energy. The application of technology based on renewable energy sources also has an impact on reducing carbon emissions produced by fossil energy. It is hoped that the existence of this technology will be able to support the KTTM in obtaining quality harvests that can automatically help increase the productivity.

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