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Application of Internet of Things (IoT) Technology Automatic Plant Watering Using Arduino Program on Corn Plants of Sadar Tani Farmers Group

Mimmy Sari Syah Putri[*1], Saib Suwilo[1], Aghni Syahmarani[1], Putri Cahaya Situmorang[2], Alberto Tondang[3],

[1]*Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, Indonesia*
[2]*Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, Indonesia*
[3]*Faculty of Computer Science and Information Technology, Universitas Sumatera Utara, Medan, Indonesia*
[*]Corresponding Author: mimmysarisyah@usu.ac.id

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ABSTRACT

The technology of the Internet of Things (IoT) is advancing and being implemented in a variety of sectors, including agriculture. The Sadar Tani farmer group's automatic plant watering system for maize plants is the focus of this research, which investigates the application of IoT technology. The primary controller of this system is an Arduino device, which is connected to a communication module and soil moisture sensor to transmit data in real-time. The water pump is automatically activated to irrigate the plants until the humidity level returns to normal when the soil moisture level falls below the specified limit. This implementation has yielded enhanced corn plant health, reduced farmer workload, and increased water use efficiency. Furthermore, this system enables the remote surveillance of crop conditions, which offers supplementary advantages in the management of larger agricultural lands. As a result, the implementation of IoT technology offers a viable solution to the issue of watering plants on expansive agricultural land, in addition to promoting precision agriculture that is more environmentally favorable and sustainable. This research has the potential to serve as a reference for future development in the application of similar technology to other crops and the enhancement of features to optimize agricultural yields.

Keyword: Internet of Things, Sustainable agriculture, Sensor, Automatic Plant Watering, Arduino

1. Introduction

The integration of Internet of Things (IoT) technologies in precision agriculture offers transformative potential for improving crop yields and optimizing resource use [1]. By leveraging IoT devices such as sensors and drones, farmers can gather real-time data on various environmental parameters, which, when combined with machine learning algorithms, can significantly enhance decision-making processes in agriculture [2]. This approach not only aids in predicting crop yields but also in managing resources more efficiently, ultimately leading to increased agricultural productivity.

Some of the roles of IoT Applications in Precision Agriculture

- Data Collection and Monitoring: IoT devices, including sensors and drones, are employed to collect data on crop health, temperature, humidity, and soil moisture. This data is crucial for making informed decisions regarding pest control, fertilization, and irrigation, thereby improving crop yields.

- Disease Detection and Crop Selection: Machine learning algorithms, such as convolutional neural networks and Random Forest, are used to detect crop diseases and recommend suitable crops based on soil and meteorological data. This helps in preventing crop diseases and selecting crops that are more likely to thrive in given conditions, thus maximizing yield.
- Smart Farming Systems: IoT-based smart farming systems monitor crop fields using sensors to measure light, temperature, humidity, and soil moisture. These systems can automate irrigation processes, ensuring optimal water use and improving crop growth.

Technologies that play a role in Improving Crop Yields with IoT and Machine Learning

- Yield Prediction Models: Advanced models like PEnsemble 4 integrate IoT data with machine learning to predict crop yields accurately. These models use comprehensive datasets, including soil attributes and weather conditions, to forecast yields and detect crop stress and diseases, thereby enhancing decision-making in farming operations.
- Resource Optimization: IoT systems can recommend the appropriate quantity of water and fertilizers needed, based on real-time soil nutrient analysis. This prevents the overuse of resources, maintaining soil fertility and improving crop yields.
- Deep Learning Integration: The use of deep learning algorithms in conjunction with IoT data allows for sophisticated analysis of agricultural data, aiding in tasks such as yield prediction and disease detection. This integration enhances the precision and efficiency of agricultural practices.

While the integration of IoT in precision agriculture presents numerous benefits, it also poses challenges such as the need for significant initial investment, data privacy concerns, and the requirement for technical expertise to manage and interpret the data [3]. However, the potential for IoT and AI technologies to revolutionize agricultural practices by improving efficiency, sustainability, and productivity is immense. The ongoing research and development in this field aim to address these challenges and harness the full potential of these technologies for sustainable farming practices [4]. IoT applications in precision agriculture hold significant promise for enhancing crop yields and optimizing resource use. By providing real-time data and enabling data-driven decision-making, these technologies can transform traditional farming practices into more efficient and sustainable operations [5]. However, addressing the associated challenges will be crucial to fully realizing the benefits of IoT in agriculture.

The Awareness Farmer Group need suitable technologies to enhance the efficiency of plant irrigation. The significance of this lies in the fact that the productivity of farmers' maize crops is heavily influenced by the caliber and amount of water supplied.

One of the top issues that needs to be addressed is the automated provision of water that meets the specific requirements of plants. Thus, this service also incorporates the Sustainable Development Goals (SDGs) target in goal 2, specifically Zero Hunger, aligning with the objective of utilizing this automated irrigation tool to enhance food security and advance sustainable agriculture [6]. Partners' problems necessitate practical solutions. The remedies that will be provided as a result of this community service activity are:

1. Offer automated irrigation systems for plants.
2. Provide training and familiarize individuals with the tool's usage.

2. Method

The activity implementation team conducts inspections of the destination area and engages in discussions to gain a comprehensive understanding of the most pressing issues currently affecting the partner environment. This evaluation approach facilitates the activity implementation team's comprehension of issues, fostering a mutually beneficial relationship between the team and the general public as a provider of activities.

The community service activities are organized into multiple stages, including:

a) The initial survey involves examining partner locations to gather information about any issues that arise with partners, in order to identify and implement remedies.
b) Tool making at this stage involves the assembly of necessary components such as sensors, LCD displays, MCU boards, and connector cables.
c) Providing training and socialization to farmer groups on the proper usage and assembly of tools.
d) Assessment and surveillance. At this step, the implementation team will assess the impact of utilizing the tools on the growth of maize plants as facilitated by the system.

2.1 Flowchart

The procedure for creating this automated irrigation device is illustrated in the subsequent flowchart.

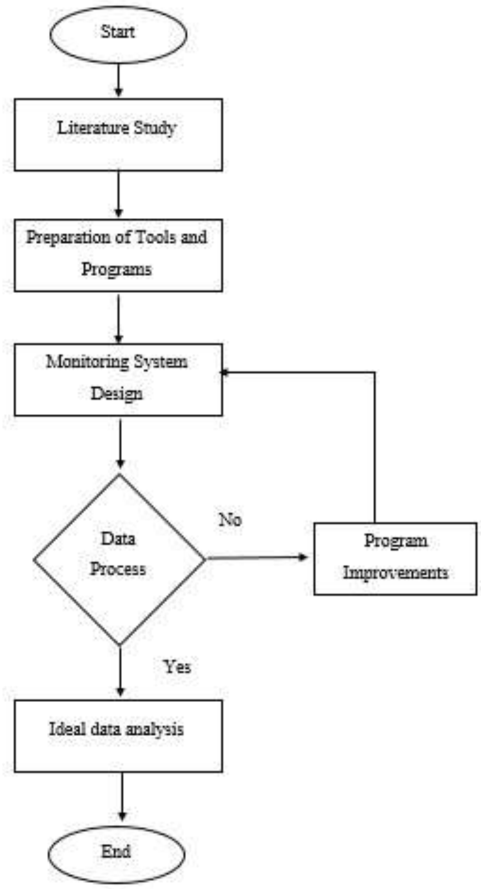

Figure 1. Flowchart

2.2. Tools and Materials

The research incorporates the Arduino UNO and esp32 microcontrollers as its main components [7]. The reason for employing these two microcontrollers is that the pH-4502c sensor offers a higher level of stability and precision compared to the ESP32. The ESP32 is utilized solely as a data transmitter, with the Arduino UNO processing the data and the ESP32 transmitting it via WiFi. The temperature sensor employs a DS18B20, an I2C 16x2 LCD display, and an AC to DC adapter as a power supply for the monitoring system.

Table 1. Tools and Materials

No	Tools and Materials	Procedure
1	Soil Moisture sensors	Measure the level of moisture in the soil
2	Humidity sensors (DHT11)	Measure the current ambient temperature
3	Temperatur sensors (DS1820)	Measure the temperature of the water in the reservoir
4	LCD Display 16 x 2	To present or showcase information
5	Arduino	As an operator of electronic components with software control
6	Relay	Switch
7	ESP8266	As an electronic circuit controller with integrated WIFI and Bluetooth capabilities
8	Pump motor	Facilitates the transfer of water from the reservoir to the plants

Figure 2. Materials

Figure 3. Appearance of the instrument after assembly.

3. Result and Discussion

3.1 Time and place of the event

Date and time: Thursday - Saturday, 20 - 22st June 2024. Location: Yard of Narumonda Village Head Office. Participants: 30 participants

3.2 Implementation of activities

a. Overview of IoT and Arduino Technology: This section provides a concise explanation of the fundamental principles of IoT technology and its application in irrigation systems. Overview of the primary elements of the system, including the soil moisture sensor, Arduino microcontroller, and actuators for the irrigation system.

b. Device Installation and Setup: Installing soil moisture sensors in corn growing zones. The Arduino microcontroller is configured to regulate watering depending on input from sensors.

c. Conduct a test and demonstration of automated irrigation utilizing IoT devices that have been installed.

d. Training and Discussion: Provide explicit instruction to farmer group members on the operation and maintenance of the system. Analysis of the advantages, difficulties, and prospects for the advancement of Internet of Things (IoT) systems in the field of agriculture.

Figure 4. Training by the team

Figure 5. IoT that has been fully assembled

4. Conclusions

The conclusions obtained from this service activity are:

1. Community service activities that have been carried out have received extraordinary and enthusiastic responses from members of farmer groups and local village officials.
2. Increasing people's understanding and expectations of agricultural technology which is increasingly advanced and can help them in farming.

The suggestion from the service implementation team is that in the future, with greater funding and intervention from the regional government, automatic sprinklers can be made on a large scale and can be used by every member of the farmer group.

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