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Plant watering system – Internet of Yhings

***Abstract :** There are various issues related to agricultural processes such as the lack of a systematic watering process according to plant needs and the inability to carry out continuous monitoring processes. If users fail to water plants regularly and sufficiently, soil fertility will be reduced and plant growth will be negatively affected. In this project, an IoT-based plant watering system is developed to water plants automatically and provide continuous monitoring over the internet to increase land fertility in the use of garden land in urban life. The developed system automatically waters plants based on sensor feedback (i.e., soil moisture) and actuator activation . It also provides several environmental parameters (i.e., air humidity and temperature) for monitoring purposes. Monitoring is carried out using cloud applications , web and mobile apps . The successful system assessment shows that it fulfills its functions as required and the usability study proves that the developed system is useful for agriculture according to user opinions.*

Streszczenie.** Z procesami rolniczymi wiążą się różne kwestie, takie jak brak systematycznego procesu nawadniania zgodnie z potrzebami roślin i brak możliwości prowadzenia procesów ciągłego monitorowania. Jeśli użytkownicy nie będą regularnie i dostatecznie podlewać roślin, żyzność gleby zostanie zmniejszona i będzie to miało negatywny wpływ na wzrost roślin. W ramach tego projektu opracowano system nawadniania roślin oparty na IoT, który umożliwia automatyczne podlewanie roślin i zapewnia ciągłe monitorowanie przez Internet w celu zwiększenia żyzności gleby podczas korzystania z terenów ogrodowych w życiu miejskim. Opracowany system automatycznie podlewa rośliny w oparciu o informację zwrotną z czujnika (tj. wilgotność gleby) i aktywację siłownika. Zapewnia także kilka parametrów środowiskowych (tj. wilgotność i temperaturę powietrza) do celów monitorowania. Monitoring odbywa się za pomocą aplikacji chmurowych, webowych i mobilnych. Pozytywna ocena systemu pokazuje, że spełnia on swoje funkcje zgodnie z wymaganiami, a badanie użyteczności potwierdza, że opracowany system jest przydatny w rolnictwie w opinii użytkowników.* (System nawadniania roślin – Internet Rzeczy***)

Keyword*:* - Plant; Watering System; IoT; Censorship, Land Uses
Słowa kluczowe: system nawadniania; Internet Rzeczy; Cenzura, użytkowanie gruntów

Introduction

The Covid-19 outbreak has changed the population's habits in carrying out daily activities, the government's regulation to work from home (wfh) has made some people feel bored, so that many of the population carry out additional activities such as planting plants, both on agricultural land and in the yard.[1][2]

Agriculture is mostly done by people outside urban areas, and now this is also happening to urban residents, many people are using empty land to use as a place to grow crops, and many people are also planting plants behind their houses. But due to civilization and lack of space, many people plant plants in molds or soil, pots, and placed on the bottom of windows. Conventional planting like this relies heavily on humans, watering and providing the right amount of sunlight to maintain growth. In the busy schedule of daily life, many times people forget to water their plants and because these plants experience a lot of disturbances and the plants in the garden eventually die. [3]

Gardens require care and supervision so that the garden can be looked after, gardening is an activity that requires time for supervision rather than routinely and continuously so that the plants thrive. Some people make gardening their hobby. Plants also need to be looked after neatly so they can produce large and high quality results. However, if the plant is far from home, it makes it difficult for gardeners to look after it properly, especially during the dry season when the plant needs sufficient water. Farmers need to get help from their neighbors or relatives to look after their farms when they are far from home and this is a very complicated process. In addition, unpredictable weather changes make it difficult for existing systems to water according to the quantity of water required by plants. Furthermore, existing systems require continuous monitoring from farmers even when they are at a distance. If there is no possibility of over-watering or lack of water for the plants and so on .[4][5]

With farmers' limited time in carrying out gardening activities, a monitoring model and watering system was created using IoT by applying technology in gardening activities to help them monitor their gardens and at the same time improve their gardening process, namely watering the plants automatically based on sensor reading or apply mobile application with ON and OFF values to control the water pump . so that monitoring can be done at any time and watering of plants can be done remotely, this system is a backup for automatic plant watering systems which have low costs with sensors measuring humidity, fertility and ambient temperature as well as plant humidity. [5][6][7]

This system is basically designed for people who have gardens but have some limitations in watering them. The goal here is to develop a system that allows users to monitor their gardens based on current soil moisture, ambient temperature, weather and allows them to control the watering system remotely via smartphone.[6][7]

For this project, a prototype of this system was developed which will focus on the capabilities of a watering system that will be accessed via devices such as smartphones and computers and it is designed for outdoor plants. This system was developed using a microcontroller, namely Arduino Uno R3 and NodeMCU ESP8266 which is equipped with an IoT (*Internet of Things*) system. There are 4 *sensors* and 2 *actuators* used in this project. The first sensor is *the Soil Moisture sensor* which is used to monitor soil moisture levels. This sensor consists of an electrode or sond that is inserted into the soil to measure moisture levels. The second sensor is *the Humidity and Temperature sensor* which is used to monitor the humidity and temperature levels of the plant's surroundings. To monitor weather conditions, *Rain sensors* are used to detect the presence of rain. The final sensor is *the Ultrasonic Distance sensor* , it is used to measure the water level in the water tank used for watering plants. *The actuator* used is *a Water*

Pump , it is used to pump water for the plant watering process [7]. Next, *the DC motor* is used to drive the water pipe to water dry plants. This prototype was also developed using a Wi-Fi connection as it is highly compatible with modern electronic devices such as smartphones, tablets and laptops, making it easy to integrate with IoT applications.[7][8]

One case study (Azhar FC, Irawan B, Saputra RE., 2017) in India where farmers faced problems irrigating agricultural land because the electricity supply was cut off and supplied with low voltage [9]. If a farmer does not water the plants during this period, there may be high water and electricity waste at that time, excessive watering can also cause damage to the plants. Through this situation a system has been developed using IoT integrated with mobile. This system uses *a Temperature and Humidity sensor* combined with a Raspberry-Pi to turn the water pump ON/OFF automatically and can be controlled from a long distance. [9][10]

In 2014 a study entitled "Implementation of a Wireless Sensor Network to Monitor College Rooms as Part of the Internet of Things" [11] has begun to apply the IoT concept in its research, where in this study the researcher aims to create a healthy and comfortable college room with uses and combines sensors on nodes that are distributed equally to each level room, and all sensors are connected to a microcontroller. Apart from that, cloud computing and the Internet of things (IoT) have also been implemented in the fields of agriculture and forestry.[12]

Among the advantages of cloud computing are virtualization, it can be developed, is practical and saves. The internet of things (IoT) plays an important role in supporting the dream of realizing intensive, high-efficiency, high-quality, high-yield, technological and safe agriculture by using techniques such as photoacoustic electromagnetic sensing, "3S" technology, and laser imaging. . [13][14]

Critical applications that use IoT will also monitor water quality. Sensors measure installed water parameters to ensure adequate water supply quality and prevent accidental contamination of drinking water connected to waste disposal. This series also needs to be extended to monitor water systems in plants [15]

Precise system control irrigation is developed using wireless sensors and scheduled to function according to remote sensor data using a specific application [15]. Design a water system that uses an embedded smartphone camera and is waterproof and illuminated. The installed camera functions to take pictures and examine underground water levels according to wet or dry soil sectors, light and dark pixels are differentiated using gray scale analysis. Router nodes are used to convey important ingredients that encourage sprayers to provide water to plants automatically. [16]

Monitor and water the garden automatically. This system has watering based on weather forecasts and *a timer* . The system searches forecasts using the Forecast.io API and is flushed using a Raspberry Pi with Raspbian installed, configured with Wi-Fi access. This system provides the *GreenIQ application* to its users to select weather forecast services from lists such as Dark Sky, *Weather UnderGround* or some private weather stations collecting weather data[7][8][17][18].

Research Methods

Phase 1:

Literature Study Collecting information about the development of IoT for watering plants and preparing the criteria or measurements needed for software and hardware development

Phase 2:

In this phase the researcher will collect data from experts to determine the level of humidity and the amount of water needed for each plant, after that the data will be analyzed on the level of data requirements for the plants to be planted, then the data will be processed to enter the next stage. 3

Phase 3:

in this phase all the results of data processing will be adjusted to the design of the software and hardware that will be developed for automatic watering and will be adjusted to the level of needs of the plants, after everything is suitable then test the software and hardware whether it can be used or not, after Enter stage 4

Phase 4:

In this phase, a simulation will be carried out on the plants which will be used as a model for developing this automatic watering system.

Flow Chart

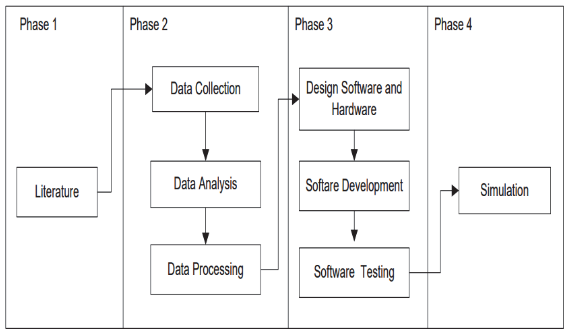

Fig 1. Design Research

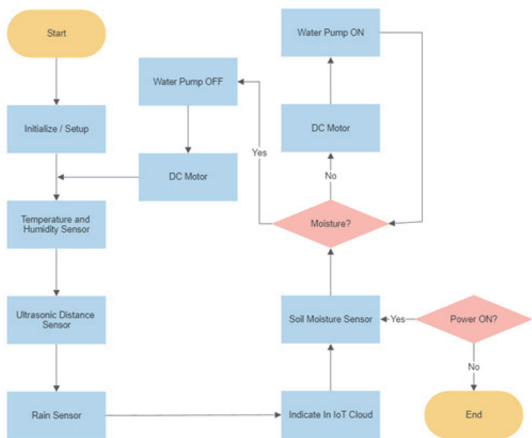

Fig 2. Flow Chart of Water System used IoT

This flow chat explains the process of creating a watering system using IoT from setting up all available devices, then testing temperature, humidity and rain, to the ON model process for use.

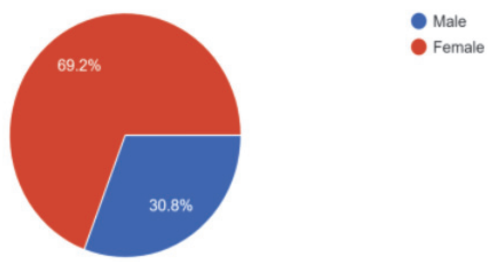

Fig 3. Respondents Based on Gender

Respondent

Based on Diagram 3, respondents aged 36-40 years (36-40 years old), the number of female and male respondents is not the same. 9 women responded simultaneously 69.2 percent and 4 simultaneously 30.8 percent. There were 13 answers from respondents consisting of lay people to this IoT-Based Plant Watering System research question.

There were 13 answers from respondents from the 6 questions given to respondents regarding the use of this watering system, and the result was that respondents strongly agreed with the use of IoT-based watering.

Results

Temperature

The temperature and humidity sensor was tested using a hair dryer. The hair dryer will emit hot air and then direct it to the temperature and humidity sensor (refer to fig 4) The air temperature and humidity readings will be displayed in the Arduino IoT Cloud Remote application (refer to Fig 5 and Fig 6)

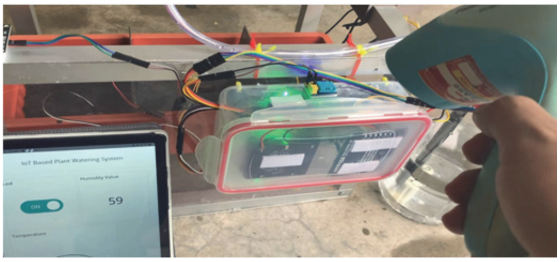

Fig 4. Temperature and Humidity Testing

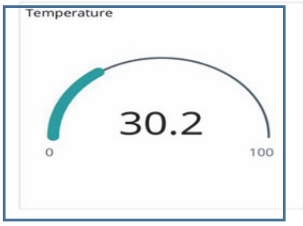

Fig 5. Temperature result

Figure 5 shows temperature readings in degree Celsius (°C) and graph form. Based on the temperature reading in the Arduino IoT Remote application, the temperature shows a reading of 30.2 °C. These temperature readings are taken using a temperature sensor and have been programmed to measure the current temperature readings on the plant. The temperature graph functions so that users can see when the ambient temperature of the plant changes

Humidity

Figure 6 shows the air humidity reading in percent form. Based on the air humidity reading on the *Arduino IoT Remote application,* it shows the reading at 80%. This air humidity reading is taken using an air humidity sensor and has been programmed to measure the current air humidity reading on the plant. If the temperature increases, the humidity percentage of the air will decrease and vice versa.

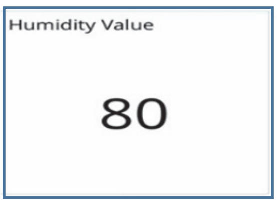

Fig 6. Humidity Result

Rain status

The rain sensor is placed at the highest part of the prototype (refer to fig 7). Rain status in the Arduino IoT Cloud Remote application will be green because the rain sensor does not detect raindrops. To test the presence of rain, a small amount of water droplets is placed on the surface of the rain sensor. Rain status in the Arduino IoT Cloud Remote application will change color from green to red indicating rain Fig 8.

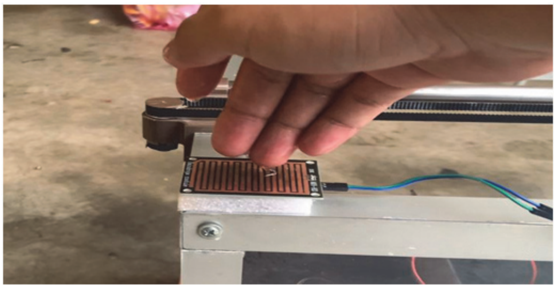

Fig 7. Rain Status Testing

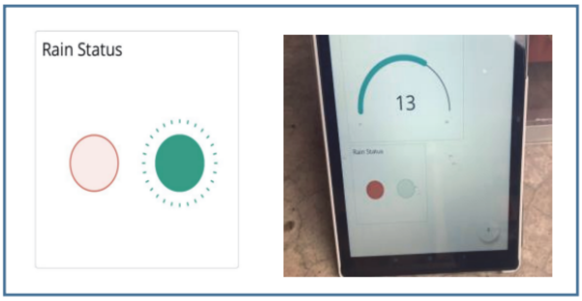

Fig 8. Rain Result

Figiure 8 shows the rain status in the *Arduino IoT Remote application* which is equipped with two different colors, namely red and green. Red indicates the rain sensor detects the presence of rain while green indicates the sensor does not detect the presence of rain. Rain status can help and make it easier for users to monitor the condition of their plants while they are away from the plants.

Watering Model Simulation

After measuring temperature, humidity and rainfall, this watering model is simulated to see the performance of this watering tool.

Fig 9. Simulation Result

Conclusion

After completing this project, what can be concluded is that the system can function perfectly and has achieved the objectives that have been set. Among the objectives stated are analyzing the specifications and needs of the plant watering system, they design and build an automatic plant watering system based on the Internet of Things, and assess the functionality of the automatic plant watering system based on the Internet of Things that is built. However, to implement it in a real environment some adjustments need to be made especially to the power supply.

Overall, this IoT-based Plant Watering System can be part of an automation system in the home. It also gives users an alternative to water their plants while away from home or garden. This web-based use gives users the opportunity to either access the service via computer or smartphone. As long as they access the correct web server IP Address, then that's when they can monitor and control their garden watering system. Apart from that, this system also makes it easy for users to monitor the temperature and humidity around the plants, the presence of rain, and the water level in the water storage tank. However, further studies need to be carried out to find out about different aspects of the system. For example, how long the system will last, how to add more sensors to it and what to do if there is a failure in the connection .

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