Weather-Based Automatic Watering Device

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***Abstract*— Watering the plants is one of the most labor-intensive tasks in household activities which cause wastage of water if unexpected circumstances occur like sudden rain. For this reason, a weather-based automatic watering device was developed in this study to automatically water the plants. The device determines the soil moisture percentage and the weather conditions in the area. These data are checked by the microcontroller, whether they meet the specified conditions before sending the command to the relay which triggers the water pump. The device continuously measures soil moisture percentage and weather conditions automatically without human assistance. After conducting the series of tests, the researchers verified that the device was accurate in collecting weather information. It was able to trigger the water pump accordingly based on the detected parameters. The device will give the users the convenience of automatically watering their plants and saving water at the same time.**

Keywords—watering device; microcontroller; weather; soil moisture

I. Introduction

The Philippines has an abundant supply of water coming from its natural resources. However, due to population growth, urbanization, increasing economic activities, land-use change, and climate change, water availability is approaching its critical limit [1]. Water should be used carefully because wasting water is a social crime. There are many examples of wasting water, one of which is watering the plant when it rains in the middle of the day [2]. There is intense competition for domestic and agricultural water; therefore, the water resources are not properly utilized. The main reasons are the lack of rain, scarcity of land water reservoirs, and the unplanned use of water [3]. Plants at home are usually watered manually or through the use of sprinklers which lead to over-watering or under-watering. Aside from the wastage of water, over-watering will also increase the risk of fungus and disease and the leaching of nutrients from the soil [4].

Throughout the years, several types of research have addressed the problem of wasting water through the use of different technologies at present. A system took advantage of the popularity of the Internet of Things (IoT) technology and sensor technology wherein a fully automated system that uses a soil moisture sensor was proposed that can replace the manual watering system. This system can also monitor the amount of water in the storage tank and can notify the user. However, if the user is absent for a long period and the water storage tank is emptied, the system fails to function properly [5]. A similar study of using a soil moisture sensor and water storage tank was proposed that uses a rain sensor that notifies the user accordingly if it will rain and the system will stop [6]. Another project was the automated watering system that uses the data from the soil sensor and weather report for the prediction of rain in the immediate five days [2]. However, it includes the decision of the farmer if it will water the plant or not. Unexpected circumstances such as sudden rainfall can also contribute to a waste of water if the farmers just water their crops before the rainfall and if the weather in five days suddenly changes.

To reduce the wastage of water and the vulnerability of plants to fungus and disease, a device was developed in this study through the use of one of the most promising technologies particularly the Internet of Things. It is an adaptive watering system that controls the watering of plants by checking two parameters. The two parameters checked in this system are the moisture of the soil and the weather conditions within the day.

II. Methods

A. *Project Design and Specification*

Fig. 1 shows the block diagram of the device which consists of five parts; microcontroller, soil moisture sensor, server, and water pump. The device connects to the internet, goes to the server, and gets the necessary weather information. The soil moisture sensor detects the moisture level of the soil. The microcontroller then processes the data gathered and triggers the water pump.

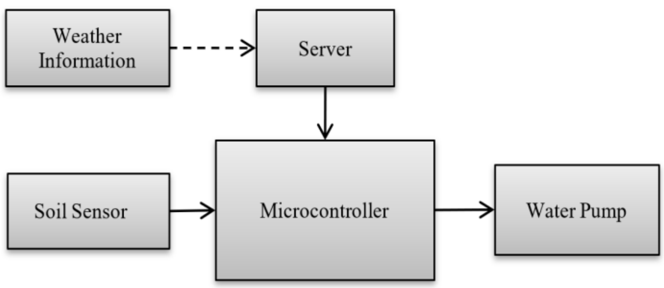

Fig. 1. The block diagram of the device.

Fig. 2 shows the interconnection of the different components of the machine. There are 5 components of the soil moisture sensor (1), Arduino MKR1000 (2), relay (3), water pump (4), and female DC jack (5). The Arduino MKR1000 microcontroller is the brain of the whole device. MKR1000 provides internet connectivity for the device. The soil moisture sensor connects to the pin A1 and 3.3V of the Arduino MKR1000. Lastly, the relay serves as a switch for the water pump and is connected to pin 13 and 5V of the Arduino MKR1000.

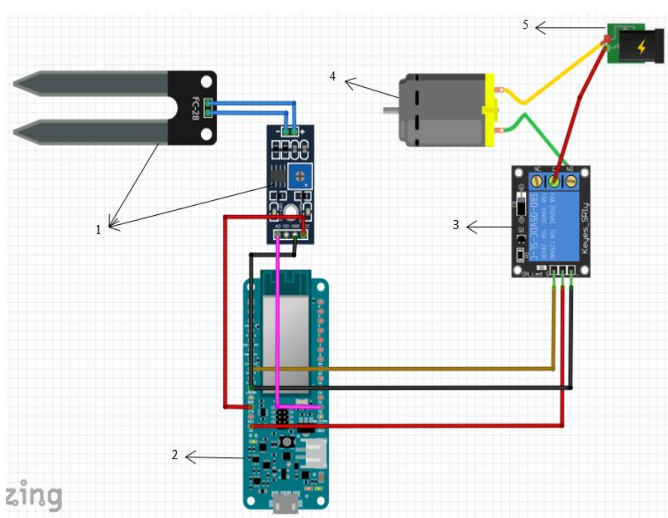

Fig. 2. The schematic diagram of the device.

B. *Flowchart of the Device*

Fig. 3 shows the flowchart of the device. First, the device connects to the internet. The initial condition of the water pump is closed. The soil moisture sensor then detects the moisture level of the soil. If the moisture of the soil is wet, the device retains its initial condition. The cycle repeats until a new soil moisture is obtained. If the moisture of the soil is already dry, the device obtains the weather update within the day in the Open Weather Map. The server indicates whether it is rain, cloudy, or clear (sunny) during that time. If one of the three input times indicates rain, the device retains its initial condition (the water pump is closed). Otherwise, the device opens the water pump for 10 minutes. After watering the plants, the system closes the water pump and delays it to 10 minutes for the soil to absorb the water. Then, the device reads the soil moisture again until it obtains a new soil moisture and the process repeats.

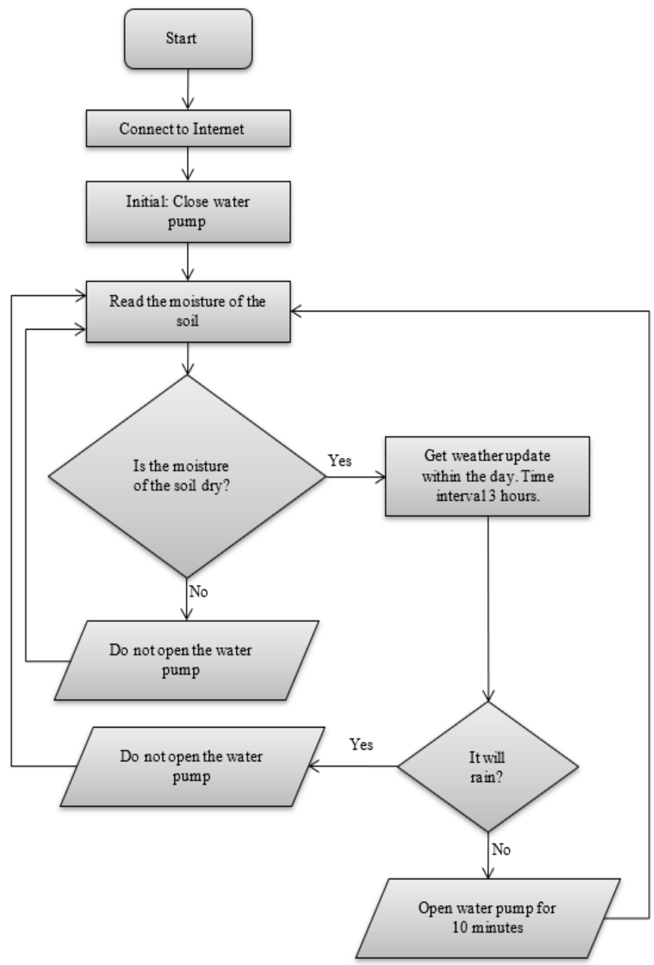

Fig. 3. The flowchart of the device.

III. Results and Discussion

The working prototype of the weather-based automatic watering system is shown in Fig. 4. The electronic components of the prototype such as microcontroller, soil moisture sensor module, and relay module were placed inside a box. The water pump and soil moisture sensor probe were connected externally to the box through a female jack.

Fig. 4. The working prototype of the weather-based automatic watering device.

TABLE I. WEATHER FORECASTING DATA

Date	Website Forecast	Device Forecast		
		Time 1	*Time 2*	*Time3*
October 31, 2019	Rain	Cloud	Rain	Rain
November 01, 2019	Rain	Cloud	Rain	Rain
November 02, 2019	Rain	Rain	Rain	Cloud
November 03, 2019	Partly Sunny	Clear	Clear	Cloud
November 04, 2019	Overcast	Clear	Cloud	Cloud
November 05, 2019	Rain	Cloud	Rain	Rain
November 06, 2019	Rain	Rain	Rain	Cloud
November 07, 2019	Overcast	Clear	Cloud	Cloud
November 08, 2019	Overcast	Cloud	Cloud	Cloud
November 09, 2019	Rain	Cloud	Rain	Rain
November 10, 2019	Rain	Cloud	Rain	Cloud
November 11, 2019	Overcast	Clear	Cloud	Cloud
November 12, 2019	Overcast	Cloud	Cloud	Cloud
November 13, 2019	Overcast	Cloud	Cloud	Cloud
November 14, 2019	Rain	Rain	Rain	Rain
November 15, 2019	Rain	Rain	Rain	Rain
November 16, 2019	Partly Sunny	Clear	Cloud	Cloud
November 17, 2019	Partly Sunny	Clear	Clear	Cloud
November 18, 2019	Rain	Rain	Rain	Rain
November 19, 2019	Rain	Cloud	Rain	Rain
November 20, 2019	Rain	Rain	Rain	Rain
November 21, 2019	Rain	Cloud	Cloud	Rain
November 22, 2019	Partly Sunny	Clear	Clear	Cloud
November 23, 2019	Sunny	Clear	Clear	Clear
November 24, 2019	Rain	Cloud	Rain	Cloud
November 25, 2019	Rain	Rain	Rain	Rain
November 26, 2019	Rain	Rain	Cloud	Rain
November 27, 2019	Rain	Rain	Rain	Rain
November 28, 2019	Overcast	Cloud	Cloud	Cloud
November 29, 2019	Overcast	Cloud	Cloud	Cloud
November 30, 2019	Overcast	Cloud	Cloud	Cloud
December 1, 2019	Overcast	Clear	Cloud	Cloud
December 2, 2019	Rain	Cloud	Rain	Rain
December 3, 2019	Overcast	Cloud	Cloud	Cloud
December 4, 2019	Rain	Rain	Rain	Rain
December 5, 2019	Rain	Rain	Rain	Rain

Table I shows the comparison of the weather forecasts based on the website www.timeanddate.com and the weather information gathered by the device from the OpenWeatherMap. The weather website is a reliable source of weather forecasts for many locations worldwide, which are provided by CustomWeather. The data are gathered from weather stations located at airports or those administered by the World Meteorological Association (WMO) and Meteorological Assimilation Data Ingest System (MADIS). The website stores the weather information from the past weeks, months, and years. It also includes the weather conditions at a certain time of the day.

Although the device gathers three weather information for the day and the weather website releases its forecast for the day, it is evident that the acquired data from the device is comparable to the data provided by the weather website. The results confirm that the accuracy of weather forecasting is improving [7] due to the advancement of satellite imagery technology.

TABLE II. DEVICE ACTION BASED ON THE PARAMETERS

Trial	Soil Moisture	Weather Condition	Excepted Action	Actual Action
1	Not dry	-----	Off	Off
2	Not dry	-----	Off	Off
3	Dry	It will rain	Off	Off
4	Dry	It will rain	Off	Off
5	Not dry	-----	Off	Off
6	Dry	It will not rain	On	On
7	Dry	It will not rain	On	On
8	Not dry	-----	Off	Off
9	Dry	It will not rain	On	On
10	Dry	It will not rain	On	On
11	Not dry	-----	Off	Off
12	Dry	It will rain	Off	Off
13	Dry	It will rain	Off	Off
14	Not dry	-----	Off	Off
15	Not dry	-----	Off	Off

The device was able to perform the expected action based on the assessment of the soil moisture sensor and the weather conditions as shown in Table II. The valuation of whether to turn on or turn off the water pump is done automatically which makes this device better than a previous study [2]. Moreover, the device does not only check the soil moisture but also the weather forecast which makes it more advanced than the study of [8-11].

IV. CONCLUSION

In this study, the accuracy of the Internet of Things resulted in correct data on whether to trigger the pump or not on the testing of the three different scenarios simulated. Also, it never transmitted false data. On another note, the integrated prototype of the Internet of Things showed satisfying results, since it accurately and simultaneously synced information with the soil moisture level and weather condition information to the system and in the automation of the whole process. Furthermore, the automation of the device showed efficiency in continuously detecting soil moisture levels and updating the weather condition information requiring no human input.

Putting the moisture sensor in an open field with different factors that are constantly changing can be crucial to the system. There can be a disconnection between the soil moisture sensor and the microcontroller, so the gathering of data will be affected. To overcome this problem, it is recommended that a wireless connection between the soil moisture sensor and the microcontroller be used. It is also recommended to have an application that updates the user on the different activities of the machine.

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