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Research Article

A Smartphone Controlled Fertilizing and Plant Watering Garduino

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ABSTRACT

We know that plants require water for their survival, but all of them don't need the same amount of water. Too much or too little water both can be harmful to the plants. In the same way, fertilizing the plants are also important as most of the soils are infertile these days. The objective of this paper is to develop a robot that can tell us how much water a plant requires and water it accordingly as well as fertilize it. This robot is being controlled by a Bluetooth module, and it carries a water and fertilizer tank, a soil sensor, and a digital display. Initially, the soil is fertilized, then the soil sensor is implanted into the soil, and the moisture percentage is displayed in the digital display, accordingly, the plants are watered until the moisture content reaches 100%. This system helps in watering and fertilizing the plants properly so that the plants can thrive.

1. Introduction

Nowadays, gardening has become a day to day life practice for many people. Plants play an essential role in every individual's life. Growing vegetation requires no less than inches of water in keeping with a week. By merely looking at the environment with greenery and plants are compared to human-made creations like buildings are more effective in promoting peace from the stress [1]. Garduino takes up the responsibilities for great gardening. Due to overwatering or less watering, the plants may fall off or may even die. The soil plays a significant role during the photosynthesis of plants by producing essential nutrients like water, air, etc. for the growth of plants.

Fertilizers offer nutrients to the vegetation to boost the body and chemical nature of the soil. By using soil sensors, the moisture level of the soil is measured, and Garduino will provide the required amount of water. Once the moisture level reaches 100%, the watering is stopped with the help of a smartphone. In this competitive world, the agriculture sector seems to be a sector in which not many modern techniques are used. It is proven that the modern culture and way of living, especially in urban areas has insulated people from the environment and regular attachment with nature [2].

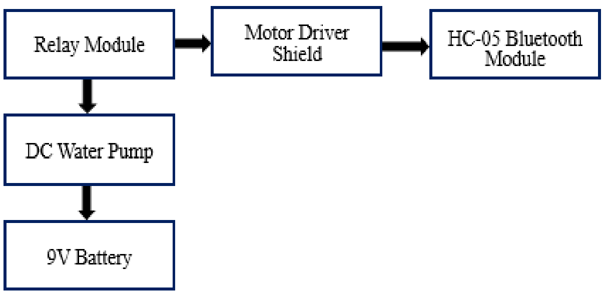

Figure 1. Functional Pattern of Garduino.

Promising developments are observed in every sector by using modern techniques like robots, IoT, etc. On the contrary, the field of agriculture faces a lot of challenges, mainly the death of farmers due to a poor harvest. The reasons might be a lack of water, pesticides, fertilizers, or some climatic conditions. So this robot can be used to monitor the appropriate amount of watering and the amount of fertilizer a Plant requires. This is a better method of watering the plants other than the drip and sprinkler water irrigation system. In drip irrigation, we

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cannot determine whether the plant has been fed with the required amount of water or not.

Moreover, it is time-consuming, and in the sprinkler irrigation system, since the water gets sprinkled randomly, all plants don't end up getting a sufficient amount of water. Therefore, this robot can be used as a guide to determine the correct amount of water a plant requires. Figure. 1 describes the schematic outline of Garduino.

The remaining parts of this paper are structured as follows: Section II provides a review of related work. The schematic and functionality of the proposed methodology and architecture of the plat watering systems explained in detail in Section III. Experimental results are presented and discussed in Section IV. Section V concludes the paper.

2. Related Works

In this section, we presented the related works and outcomes of the exiting water planting systems. A relevant model, Plant Watering Autonomous Mobile Robot designed by Heema N in 2012 [3] for watering the plants. This framework runs by appending an RFID tag, temperature and, humidity sensor accompanying with the Xbee module to all the potted plants, later the robot detects the RFID tag by reader module followed by the black path produced from the LDR sensors present and relay activates the water pump and saturates the plant. After completion, it moves to every plant and makes them moist. Suppose the water level is inadequate, then the Xbee module flings the signal to the Xbee device of the robot, and it reciprocates accordingly. This robot is very beneficial and suitable for the people sowing plants inside or outside the house.

A similar paradigm, "Solar Based Automated Plant Watering Bot for Indian agriculture scenario" implemented by H. K. Rajaguru in 2018 [4], converged on agriculture development for farmers. The robot runs mainly on sensor technology by using a soil moisture sensor, humidity sensor, and GSM Network.

The soil moisture sensor is situated on the ground level of the crop and intimates when the level of moisture drops, and GSM receives the signal, and the robot moves to the plant and waters it and stops when the humidity sensor alerts the GSM. The Withdrawal of water occurs from the backside of the robot through the tube, which is coupled to the servo motor. The readings from the sensor are exhibited in the LCD. Furthermore, an ultrasonic sensor is placed on the robot, which keeps away from the barrier. This whole operation will be performed by attaching the solar panel to the robot and provides current to the entire system. By executing this robot, the shortage of water is diminished.

An identical fashion "Autonomous robot with plant health indication" developed by Neha D. K et al. in 2017 [5] focused mainly on the well-being of the plant. The principal components used in this robot are Atmega8 microcontroller, Raspberry Pi, DHT 11 Sensor. A camera is connected to the raspberry pi such that when the robot moves to the crop, by perceiving the shade of leaves, it captures the image and scan it and discovers whether the plant has an illness or not (image processing).

The result is flashed in the LCD. Consequently, the soil sensor is accommodated in the root layer of the plant, which spots its moisture and DHT 11 sensor, which calculates the temperature and humidity of the plant. Since the farmer cannot recognize by touching or viewing the plant directly, this robot makes it comfortable for him to identify the infection and save a lot of time. Pedestrians and car drivers can react too late or in the wrong way and increase response times for vehicles and road vehicle accidents [6].

A relatable approach "Sensor Based automatic irrigation and soil pH Detection using Image processing" developed by S. Kumawat et al. in 2017 [7] concentrated on reflexive irrigation and the pH level of the soil. Raspberry Pi is the necessary element device, maneuver as a microcontroller. Soil sensor is settled in the root position of the plant. It dispatches the signal to the Raspberry Pi, thereby following the moisture level, and the irrigation system will be ON. As we studied above, The Raspberry Pi is fixed with a camera that takes the image and analyzes the pH level of the crop and formulates the farmer, whether he can grow it or not. In this technique, three soil sensors are deposited from the stem to stern, so the first two sensors identify the existence of moisture and then irrigation discontinues. If they do not recognize, the irrigation will set up. Every single one of the reports gathered from the soil sensor will be perceived to the cloud by IoT to the farmer.

The farmer can access this complete phenomenon from the mobile through the app named Semiautomatic system. As a result, the farmer can dig out the soil pH, and the devastation of crops will cease.

Onboard sensors accomplish the navigation and localization tasks along with a vision system and vision-based approaches. The robot's position self-awareness is determined by the global and local maps generated from the Global Positioning System (GPS) and onboard vision system coupled with a personal computer [8]. The nutrient nebula is expelled periodically through atomization nozzles. Several steps during plant growth including temperature, humidity, Light strength, degree of water nutrient solution, pH and EC weight, CO2 concentration, time of atomization, and the interval of atomization Time requires due attention for plant growth to flourish [9]. A smart, durable garden set with easy to restore and scale Internet- of- Things tools [10].

Another consistent model, "Microcontroller Based Automatic Plant irrigation system" originated by Bishnu. Deo K. et al. in 2017 [11] given intelligence on automatic irrigation. The appliances employed in this project are Atmega328 microcontroller, Voltage Regulator, RC filter, potentiometer, oscillator, buzzer, LCD and LED, diode and power supply along with a GSM module and the soil sensor, temperature, humidity sensor which are always placed in the root zone of the plant. GSM Module gains the data from the soil sensor when the moisture falls by the specified threshold value, and then the pump kicks off. If the supply of water is raised more than the given moisture level, the pump spontaneously cut it out. The diode endows the current, and the oscillator provides constant frequency through the complete system. This supports the farmer to stay in one corresponding area, and it performs efficiently.

3. Proposed Methodology

In this section, we presented the architecture and functionality of water plating system. This robot can be used as a guide to determine the correct amount of water a plant needs.

3.1. Fabrication of the robot:

The theoretical idea is divided into two parts.

1. Plant watering system.
2. Soil sensing system.

Various calculations are performed and taken into consideration, including load regulation, i.e., the amount of water a robot can carry, and also the torque is also taken into account so that the robot may move faster. Provision to carry two tanks of about 0.8 to 1 kg other than the components of the robot has been made so that the robot can move quickly. The robot is power- based, where power is supplied through batteries. For long life, solar panels can be used so that the batteries can be recharged. This robot's chassis has to be a little tough and very strong so that it won't break and can carry the tanks and move fast. The tanks used must be lightweight so that it doesn't affect the mobility of the robot, and the base of the robot is not damaged. The arrangements have been made so that the robot can quickly move, and the user can operate it from his smartphone. The wheels which are chosen also must be able to sustain the rough terrain in the garden.

3.2. Primary devices used for robot mobility:

The primary controller devices are controller and sensors. The principle device included in the controller is the Arduino, without which the garduino cannot be controlled. The Arduino code is dumped into the Arduino UNO board. The sensors used are soil sensor which is used to test the humidity of the soil. The Bluetooth module establishes a mode of communication between the smartphone and the garduino. The motor driver shield is used so that the DC motors or BO motors used in the robot will be powered, and the wheels attached to the motors can rotate.

A 5v relay module is used so that the pumping of water and fertilizer takes place only when the pump button is switched on in the application. If the use of the relay module is not there, then the motor will be continuously pumped as soon as the power is given. Also, there are two Arduino's used because the pins of the Arduino UNO which is used to control the robot's mobility will be used up because of the motor driver shield placed above it another Arduino UNO will be used in the soil sensing system so that the Arduino UNO when coded will be connected to the soil sensing system and the soil sensor will be used to test the humidity or the moisture content of the soil accordingly. The mobility of the robot will be controlled by an application on the smartphone.

3.3. Devices used to check the soil moisture and water the plants:

A soil sensor will be used to check the moisture level or to check how much amount of water the plant needs so that with the help of this robot, we can water accordingly. The robot must not be overweight, so that even if it goes into areas where the roadway is robust, then it must have the stability to sustain. The soil sensor, when dipped in the soil, reads the moisture level present in the soil, and the readings are shown in the LCD. According to the readings that are displayed in the LCD, the water can be given to the plant with the help of this Garduino. A DC motor pump is completely submerged in the water so that the water may be pumped until the moisture level reading shows 100% on the LCD screen.

3.4. Software used:

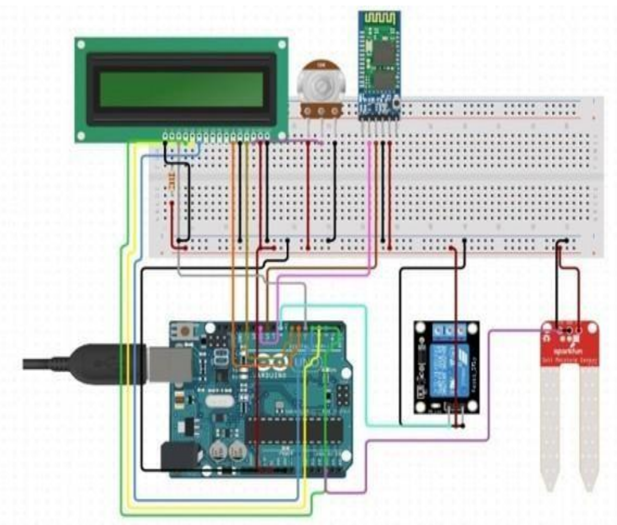

Figure **2.** Circuit Architecture.

• ***Arduino IDE:*** This software is used to interface all the components used for the robot with the microcontroller Arduino UNO.

• ***MIT APP INVENTOR:*** This is the website that does not need much coding work to be done, and the smartphone application can be designed on this website.

3.5. Working:

These above-listed components displayed in Figure. 2 are placed in the robot, and the connection between the Bluetooth module and the smartphone is established so that the mobility of the robot can be controlled in the app.

Similarly, in the soil sensing system, a soil sensor is placed so that it reads the moisture level present in the soil. Then the reading is shown on the LCD screen in terms of percentage so that the water can be supplied accordingly to the plant in the correct amounts until the reading on the LCD screen shows 100%. Figure. 3 shown below is the plant watering and fertilizing Garduino supervised from a smartphone.

A relay module of 5v is also used so that the DC motor pump will be pumping the water as soon as the button in the application is pressed. If the relay module is not used, then the water will be continuously flowing, which is total wastage. So the relay module is used to keep control of the flow of water. The Bluetooth module remains in connectivity with the smartphone. The forward, backward, left and right buttons are the options in the app which will be used to control the mobility of the robot and, the pump on and pump off buttons will be used to switch on or switch off the DC motor pump which is used to water the plants.

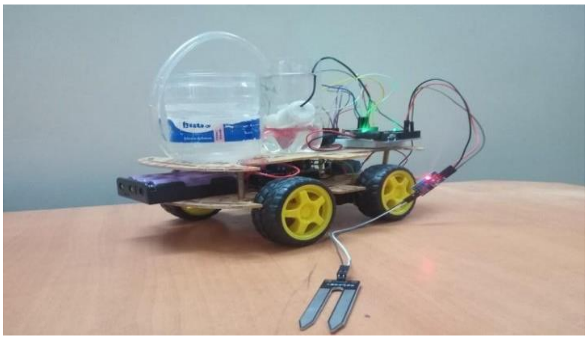

Figure 3. Plant watering and fertilizing Garduino.

The smartphone application is shown below in Figure. 4. With the help of this smartphone application, we can also supply the fertilizers to the plants by just replacing the DC motor pump to the fertilizer tank.

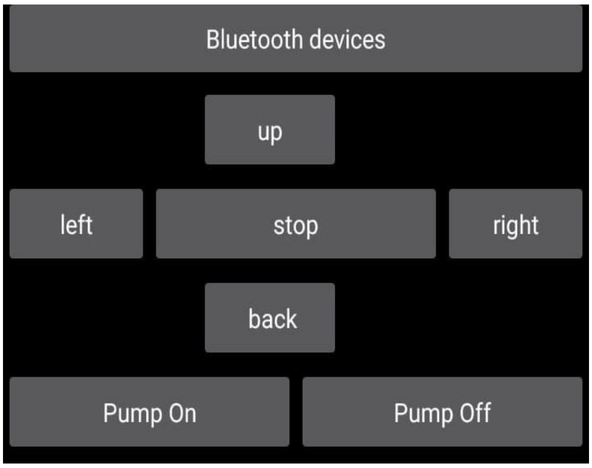

Figure 4. Mobile app operating functions.

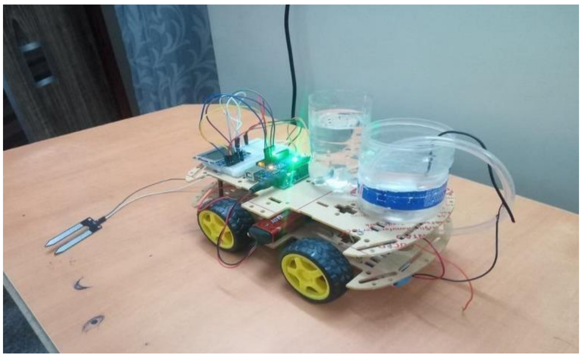

Figure 5. Robot moving left commanded from mobile.

The robot is being controlled and responded based upon the option commands given to it, as shown in the above Figure. 5, and also there was no loss of connection between the Bluetooth module in the robot and smartphone.

The app which is showing the option as Bluetooth devices will display the entire list of devices that are near us. The Bluetooth module should establish a connection with the smartphone. So the robot will function accordingly. Firstly garduino measures the soil moisture, then waters accordingly, fertilizes the soil, and saves water. Sometimes when we switch on the motor in the garden, we can see that the water goes to the plant, but not the adequate amount because as soon as the motor is on the water will flow, it may be in less amount or excess amount. In rare cases, we see that the water supplied to plants is in an appropriate quantity. So, this garduino will help us reduce this risk because if the water supplied to the plants is less or more, the plants may fade away, or they may even die.

4. Results and Discussions

The readings have been taken and tabulated, as shown in Table. 1. It tells if the moisture content in a particular plant is less, the time taken to attain 100% is more and similarly if the moisture content is more, the time taken for achieving 100% is less, so we can say that this garduino will help in determining the exact amount of water a plant needs.

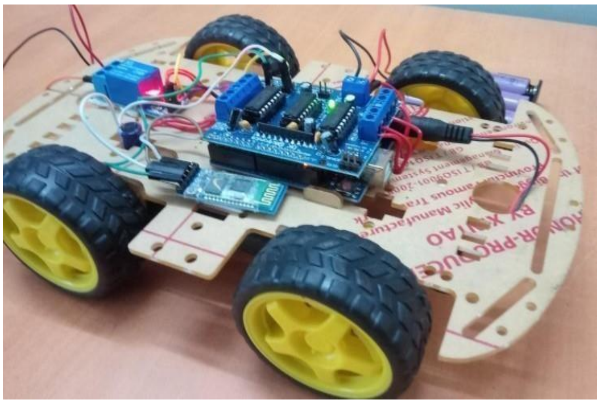

Figure 6. The Bluetooth Controlled System.

The Bluetooth module establishes a mode of communication between the smartphone and the garduino, as represented in Figure. 6. First, the DC motor pump is deposited in the water tank so that the water will be pumped into the plant. After gaining a 100 % moisture level in the soil, the DC motor pump will be removed from the water tank and kept in the fertilizer tank, and the fertilizer will be supplied to the plant.

The tank which is placed above the robot will be used to store water and fertilizer. As the robot moves towards the plant, firstly, it will check the moisture level and waters the plant and fertilizes it by placing the tube into the pot, as shown in Figure. 7. Control of the robot is very good, and there is no loss of the signal between the Bluetooth module and the smartphone. The robot was able to carry the weight of the components along with the weight of the tanks. The Bluetooth module is used to control the mobility of the robot and the relay module to pump the water and fertilizer when needed, and it is appropriately concealed on the chassis of the robot.

Figure 7. Testing the Humidity of Soil.

When the plants were watered and fertilized with the help of this robot, the plants showed good growth. The growth of the plants was not affected, and the plants did not fade away due to lack of water.

Table. 1. Simulation Parameters.

S. No	Moisture Content Present in Soil	Time Taken to Attain 100%
1	18%	1m36s
2	33%	1m10s
3	49%	57s
4	57%	44s
5	70%	30s

5. Conclusions

In this paper, we have suggested a Garduino for watering and fertilizing the plants according to their requirement. The proposed robot has been successfully built and verified. This robot avoids the wastage of water as well as spoilage of the plants due to overwatering or less watering. This can be used at home for plants or gardens for watering and fertilizing them efficiently. In the future, we'll conceive of making the Garduino automated using Wi-Fi and use a camera for identifying the healthy and non-healthy plants. Additional arrangements can be made to measure the humidity of the environment to check whether a particular plant will grow in that environment or not. Even to give warnings of rain so that the plant won't be watered or watered less. Solar panels can be installed for recharging of the batteries. By using solar panels, the robot becomes more effective. An ultrasonic sensor can be placed to avoid obstacles.

Furthermore, we can formulate it to sprinkle pesticides to plants based on Internet of things (IoT). The plants with the disease can be identified using image processing. Another sprinkler can be conjointly employed to spatter the fertilizer rather than using it directly.

Author's Note

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