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IntelliGarden: IoT for Garden Maintenance

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Abstract:- Gardening is one of the most popular and noble hobbies. But, growing and taking care of a plant is a tedious job as it requires the gardener to ensure that the plant is watered, fertilized and kept pest-free regularly. Irrigation depends on elements such as the water requirement of a plant, the water content of the soil and weather forecast. Fertilization and pest control might not be as frequent as irrigation but are essential for the survival and growth of plants. In today's busy life, it becomes tough for individuals to monitor and provide water, fertilizer and pesticides to plants. As a result, the health of plants deteriorates. Consequently, many of them dry up and die. We can eliminate this issue by incorporating Internet Of Things (IoT) and creating an automated garden-maintaining system that will water, fertilize and keep the plant pest-free without much human intervention. It will assist individuals who find it hard to take good care of their gardens due to busy lifestyles and other issues. This project aims at creating a garden maintaining system that will ensure that the basic needs of a plant are met from time to time with the least amount of human intervention possible.

Keywords:- *Internet of Things; Arduino; moisture sensor; NodeMCU; Mobile application.*

I. INTRODUCTION

Plants are as sensitive as any animal pet we have in our homes. They need meticulously calculated amounts of water, nutrition (fertilizer) and medicines (pesticides) for proper and healthy growth. Irrigation of plants largely depends on the moisture content of the soil. A little moisture indicates that the plant requires water and vice versa. Irrigation also largely depends on the weatherforecast of the area of the plantation because watering the plants/trees will not be needed if there is a high chance of heavy precipitation in the area. Fertilizers act as nutrients for plants and are equally essential as water, so the gardener must spray/ put fertilizers into the soil to replenish the depleted minerals. Similarly, spraying plants with pesticides keeps pests and diseases at bay, so it is crucial for the optimum health of a plant. Gardeners need to put in a lot of effort to maintain the overall health of the garden. It demands a lot of time and energy on the part of the gardener. This project aims to automate garden maintenance with the help of IoT. It will assist the gardener to meet the basic needs of plants regularly with the minimum human intervention. The main focus of this project will be on ‘sufficient water when needed. A soil moisture sensor will help monitor the soil moisture content which will help in the decision making regarding ‘when to water and ‘how much to water. By providing internet access to the microcontroller, we can actually get the information about any chances of precipitation which will also help in decision making. Fertilization and pest control can be done in a similar way as irrigation; only keeping a track of the dates will help with the decision of ‘when to spray. This project can be grouped into subsystems such as; power supply, relays, Arduino, NodeMCU, Soil moisture sensor and mobile app.

A. Related works

Pawar.P et. al in [1] explains that small gardens such as household gardens can be automated just like large greenhouses. Employment of humidity, light, soil moisture and temperature sensors to collect real time data can help make it a reality. The authors in [2] explain that by implementing a smart garden system with IoT, it is verified that it works by connecting various parameters ofthe soil to the cloud and controlling it via a mobile application. The developed system monitors sensor data such as humidity, temperature and ultrasonic, and controls other parameters according to requirements. For example, when the water level in the tank drops to a minimum value, the motor automatically switches on. The water level in the tank reaches its maximum value. The authors in [3] explain IoT is the interconnection of vehicles, hardware devices, software devices, and other objects. The things that work in the Internet of Things are embedded in or connected to electronics, sensors, software devices, and internet connections. The IoT allows objects to operate remotely, sensor-controlled, or connected to the Internet. Because the Internet of Things has wireless connectivity, connecting to the Internet of Things does not require manual assistance or computer interaction. In [4], the authors investigated and found that water scarcity is the country's biggest problem. Various methods are used for irrigation. Automatic water irrigation systems are designed to reduce water consumption and increase water conservation. Irrigating plants with pipes or oscillators tends to waste water. This system can be used to irrigate specific areas and helps conserve water.

B. Contribution

This project aims at incorporating technology to make the lives of people easier. We aim at incorporating IoT to solve real life problems and make the lives of modern humans smarter. This project aims to incorporate IoT and automate garden maintenance so that gardeners do not have to physically water the plant according to the moisture content of the soil or the weather forecast. It will also

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eliminate the need to fertilize big gardens physically and will keep a record of the dates so that it can automatically perform fertilizer or pesticide spraying on its own. This project will make it feasible for busy individuals to create and maintain healthy gardens.

II. SYSTEM MODEL

The working of the whole system (irrigation) is based on the sensor data received and the weather forecast. The user will be able to remotely control and monitor the whole system using a mobile app. This will ensure that users can even monitor and control the system if they are not connected to the same Wi-Fi as the system. For fertilization and pest control, the user can activate the system by switching it on; it can be done remotely with the help of the same mobile application.

The microcontroller connects to the internet and collects the precipitation forecast report, if the chances of precipitation is > 40% then the operation will be terminated or else the readings from the soil moisture sensor will be taken into consideration. The whole system will consist of a soil moisture sensor which consists of two probes that measure the volume of water in the soil. The two probes allow the electric current to pass through the soil and, according to its resistance, measure the moisture level of the soil. If the detected amount of moisture is less than 20% then the relay will turn on the motor which will in turn water the plants. Once the moisture content rises above 20%, the relay will turn off, eventually turning off the motor. This provides adequate water to the plant and also prevents over watering at the same time. The whole working process is described in Fig. 1.

The whole system can be controlled by a mobile app. The gardener can spray fertilizer and pesticides to the plants by just clicking a button on the phone. As soon as the user commands, the relay will be turned on and the motor will turn on eventually. The fertilizer or pesticide mixed with water will then be sprayed onto the plants without the user taking the pain of physically doing these jobs. The log will keep a record of the dates when fertilizers and pesticides were provided to the plant, this will help the gardener to keep record. The working process is shown in Fig. 2.

The block diagram of the system is shown in Fig. 3

A. Problem statement

Keeping in view the lifestyle of people these days, it becomes a challenge for them to water a garden regularly besides attending events in their busy schedule. Besides that, in accordance with the temperature outside and the amount of soil moisture, plants need to be watered more than once a day. It becomes impossible for people who work in offices and the garden remains unattended for most of the day. Watering the plants according to the chances of precipitation can be inconvenient for people as well. Fertilizing small gardens and keeping track is effortless, but gardeners face hardships when the area is large and consists of hundreds of plants. It becomes tough to fertilize and keep track. Like fertilization, pest control and keeping track become tedious jobs in the case of large gardens. Even if an individual is able to take care of the basic needs of plants daily physically, they still might have concerns when they travel as there would be no one available who can take care of the plants.

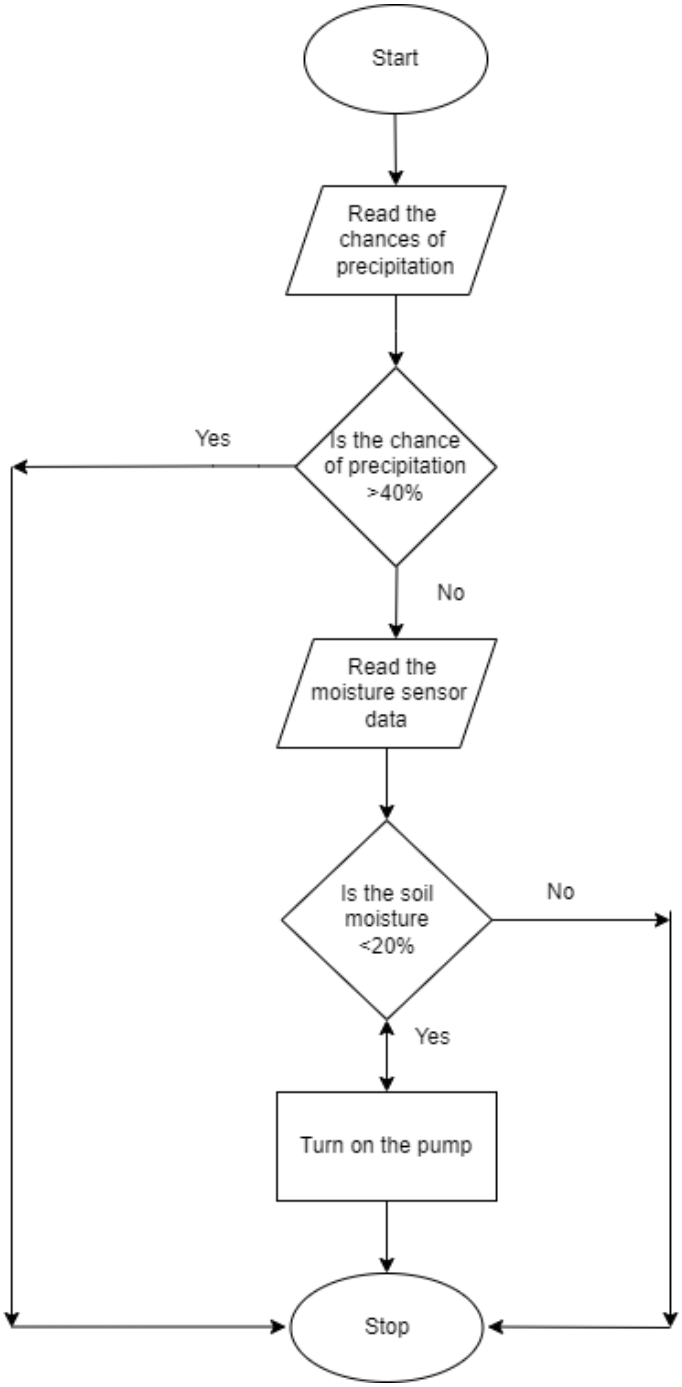

Fig.1. Flowchart explaining the irrigation process

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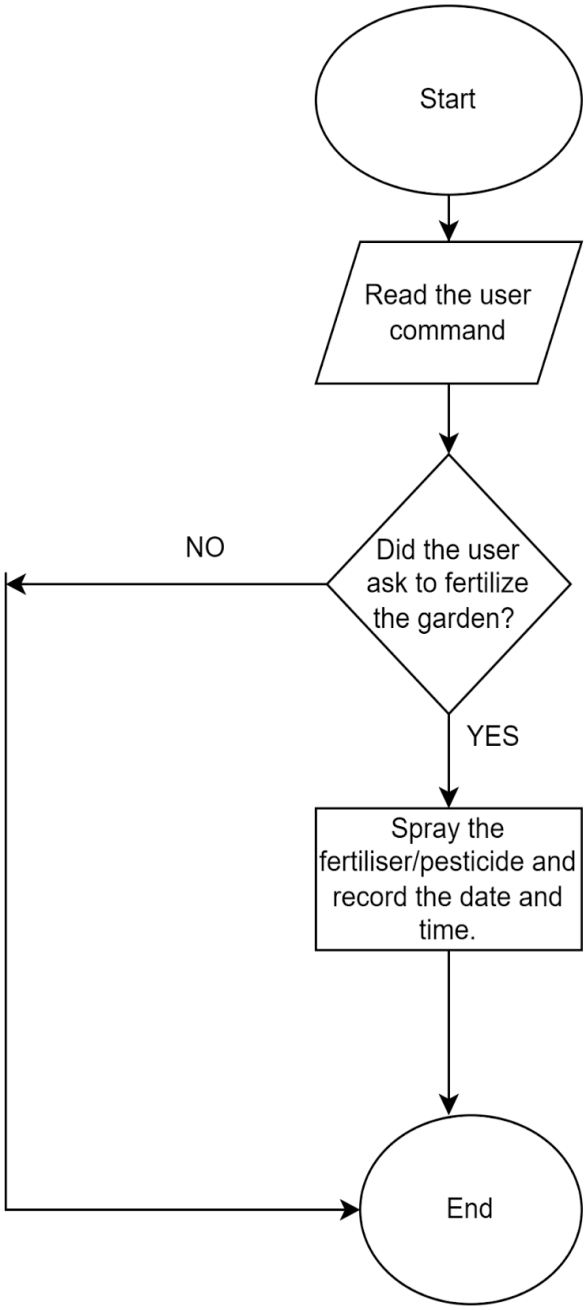

Fig.2. Flowchart explaining the fertilizer/ pesticide process

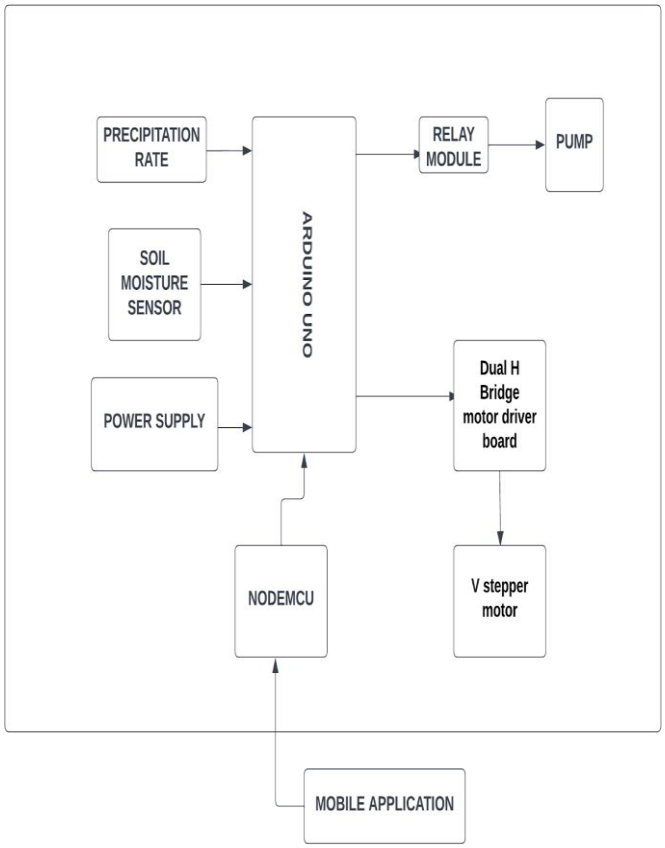

Fig.3. Block diagram of IntelliGarden

III. ARCHITECTURE OF INTELLIGARDEN

A. Hardware module

The hardware components required for the prototype are: Arduino Uno, NodeMCU, Water pump, Relay module, Soil moisture sensor, L298N Dual H Bridge motor driver board,12V stepper motor, Jumper wire, Breadboard, Pipes and other structural materials, a laptop and a mobile phone with internet connection, a power supply module.

➢ *Arduino uno:*

The microcontroller used in this project is an Arduino uno. Arduino is one of the most popular microcontroller boards for prototyping. It is based on the ATmega328P. There are 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connector, a power jack, an ICSP header, and a reset button. An arduino uno is shown in Fig. 4.

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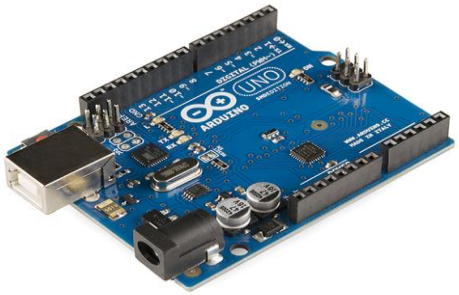

Fig.4. Arduino Uno

Fig.5. NodeMCU

Fig.6. Water pump

➢ *Node MCU:*

NodeMCU is open source firmware available for open source prototyping board designs. The name "NodeMCU" is a coined word combining "node" and "MCU" (microcontroller unit). Strictly speaking, the term "NodeMCU" refers to the firmware rather than the associated development kit. Both the firmware and the prototyping board design are open source. The firmware uses the Lua scripting language. The firmware is based on the eLua project and is based on the Espressif Non-OS SDK for ESP8266. We use many open source projects such as lua-cjson and SPIFFS. Due to resource constraints, users need to select modules relevant to their project and create firmware to suit their needs.A NodeMCU is shown in Fig.5.

➢ *Water pump:*

A 3-6 V mini submersible water pump will be used for the prototype. The Arduino board can switch the pump on/off according to the sensor inputs and conditions. A water pump is shown in Fig.7.

➢ *Soil Moisture Sensor:*

Soil moisture sensors measure the volumetric water content of soil. Direct gravimetric determination of soil-free moisture requires the sample to be taken, dried, and weighed, so soil moisture sensors can measure the soil's properties such as electrical resistivity, dielectric constant, or interaction with neutrons. It indirectly measures volumetric water content using another property. Substitute for water content. This sensor collects the humidity percentage, based on which the Arduino decides whether to turn on the pump. A soil moisture sensor is shown in Fig.7.

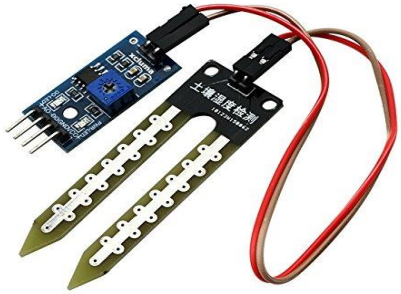

Fig.7. Soil Moisture Sensor

Fig.8. L298N H Bridge motor driver board

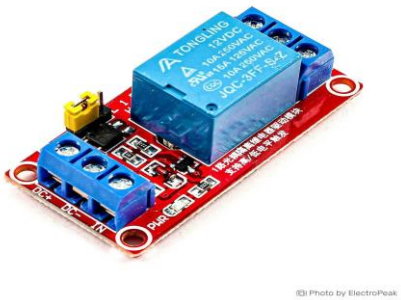

Fig.9. Relay

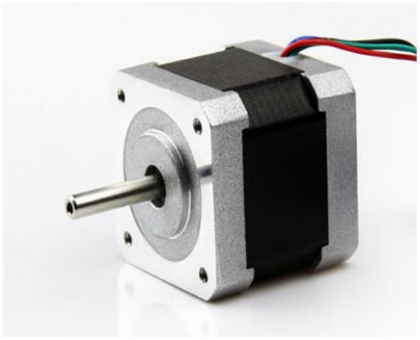

Fig.10. Stepper motor

➢ *L298N Dual H Bridge Motor Driver Board:*

This is a high voltage, high current dual full bridge driver designed for standard TTL logic levels to drive inductive loads such as relays, solenoids, DC and stepper motors. It was built into the prototype to drive a relay that controls the stepper motor, which controls the movement of the irrigation pipe.A L298N Dual H Bridge motor driver board is shown in Fig. 8.

➢ *Relay Module:*

A power relay module is an electrical switch operated by an electromagnet. The electromagnet is activated by another low power signal from the microcontroller. When activated, the electromagnet is attracted to open and close the circuit.A relay module is shown in figure 9.

➢ *12V Stepper motor:*

Stepper motors are used for precise level control. 28BYJ motors are widely used stepper motors that can be used in a variety of applications that require precise control. The specifications consist of a working voltage of 5V and a step angle of 5.625 degrees. It will be built into the prototype to move irrigation pipes so that all plants can be properly watered. A stepper motor is shown in Fig.10.

B. Software requirement

➢ *Arduino IDE:*

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus . The Arduino integrated development environment (or Arduino software (IDE)) includes a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and numerous menus. Connects to Arduino hardware for program upload and communication. A program written using the Arduino software (IDE) is called a sketch. These sketches are created in a text editor and saved with a file extension. The editor has cut/paste and find/replace functionality for text. The message area provides feedback on saving and exporting and also displays errors. The console displays text output from the Arduino software (IDE), including full error messages and other information. The bottom right corner of the window shows the configured board and serial port. Toolbar buttons let you review and upload programs, create sketches, open and save, and open the serial monitor.

➢ *Mobile application:*

This mobile app will be used to monitor the functioning of the whole system and control it when needed remotely. It will ensure that the user doesn t need to be connected to the same Wi-Fi network as the system in order to control it.

IV. ADVANTAGE OF INTELLIGARDEN

The advantages that this system will provide are as follows:

- It will save the time of busy individuals who aspire to build a garden but don t have enough time off their schedule to attend to the needs of plants.
- It will reduce the physical labor, which otherwise would have been required for the maintenance of the garden.
- It saves water as only adequate amount of water will be provided to the roots and the pump will turn off as soon as the optimum moisture is achieved.
- It will also prevent overwatering by monitoring chances of precipitation.
- It will provide smarter, efficient and fast solution to the problem that people are facing regarding maintenance of garden.

V. CONCLUSION AND FUTURE SCOPE

By incorporating IoT into garden maintenance, we aimed to reduce the time and manual labor needed to take care of the garden. Arduino Uno and NodeMCU will act as a bridge between the user and the watering system. The NodeMCU will collect the command from the user and relay it back to the arduino, the arduino in turn controlling the operation of the motors.

The area of operation of this device is not flexible but rather fixed; this issue can be saved by incorporating a mobility factor to the whole system. It would not only make the whole system mobile but also reduce cost because only one unit of the whole system will be sufficient to take care of plants at different corners of the garden. Also, sometimes, some plants require standing water for growth but a moisture sensor might not work in such cases, Bluetooth can be incorporated to carry out efficient irrigation in such cases.

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