Self-Sustaining Planter with Disease Detection

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Abstract - *Self-Sustaining Planter Pot revolves around the concept of automating all processes and tasks, such as watering plants and protecting them from extreme weather conditions. This saves a lot of labor and time for the owner and keeps the plant alive and healthy. It also addresses the idea of collecting real-time data on soil moisture and light intensity in a mobile application and adds the ability to control the movement of plant pots manually and automatically. Evidence of disease on the leaves of the plant can further help the proper care of the plant.*

***Key Words*: Automation, Blynk, ESP-32, Sensors, Yolov5**

1. INTRODUCTION

The limitations of traditional Plant pot introduce the advantages of the concept of self-sustaining planter. The ability of the planter to sense the change in the environment variables like light and moisture in the soil helps in reducing lots of human effort to keep the plant healthy. The planter can also move from point A to point B for a fixed interval of time and then come back to point A. All the action occurring in the planter are being controlled through the microprocessor. The movement of the pot can be both manual and automatic, and it can be controlled through the mobile application. Communication between system and application helps in capturing of real time data coming through the sensors and taking required action accordingly. The disease detection on the leaf was made possible using the dataset containing the images of various healthy and unhealthy leaves of different plants and Roboflow was used to make annotation on the images for processing it under yolov5. A total of 2500 images were annotated and was classified into 38 classes.

2. Literature Survey

For the various cons and limitations found in the traditional plant pot system, we looked for various papers and took the ideas and objectives into consideration. An embedded system that grows plants of specific plant species that can accurately monitor and control greenhouse parameters 24 hours a day, 7 days a week to maximize production of throughout the growing season of the crop[1]. Our project differs in that it is a simple, easy-to-install microcontroller-based circuit for monitoring ornamental plants in households. In[2] the idea of a wireless sensor node for greenhouse monitoring by integrating the with Sensinode Ltd's sensor platform is discussed. There are three commercially available sensors that can measure the four climatic variables. Wireless sensor networks (WSNs) can form a useful part of automation system architecture in modern greenhouses. Wireless communication to collect measurements and communicate between the centralized controller and the actuator in different parts of the greenhouse can also be used. [7] discuss the study of plant growth that underlies Design and the development of prototype automatic flowerpots. In our work, we used three key elements of the study: water, nitrogen, and temperature as key criteria for developing a prototype automated flowerpot. These three elements need to be fully automated for this prototype to reach its goal of helping people build gardens with less attention.

3. Block Diagram and Working Principle

There are 6 key features of the planter pot i.e., Movement, Light control, Soil Moisture, Water Station Control, Blynk Application and disease detection on the leaf. The architecture is shown in figure 1. The Movement of the pot can be manual and automatic, and this feature can be controlled the application. In manual movement, the user gets to decide whether to take the plant forward or backward. In automatic, the pot moves from point A to point B for fixed time and then stays there for a fixed time and then come back to the starting position.

The light control of the pot is completely based on the data coming from the sensors i.e., LDR sensor[6]. It is made up of semiconductor material which high resistance up to 10 k ohm which is also called dark resistance. Semiconductor material used is cadmium Sulphide or CdS. LDR sensor module has an onboard variable resistor or trim point, this variable resistor is a 10k preset. It is used to set the sensitivity of this LDR sensor. The preset knob is used to adjust the sensitivity of the light intensity detection. Under applied voltage (3.3V), when there is light, the current flowing through the LDR is called the photocurrent, and the ratio of the applied voltage to the LDR is called the bright resistance, which is usually indicated by "100LX". Under the same applied voltage, the current flowing through the LDR is called a dark current when there is no light. The ratio of the applied voltage to the dark current is called the dark resistance, which is usually indicated by "0 LX". When a light level of 1000 lux (bright light) is directed towards it, the resistance is about 40 (ohms). When a light level of 10 lux (very low light level) is directed towards it, the resistance value raised dramatically to 10.43Kohms and thus based on light intensity value it gives output to microcontroller and then the decision is made whether to switch on or off the artificial light. When no light is detected, the application informs the status to the user and the artificial light is turned on. And if light has been detected, the application shows the status to the user and the artificial light get turned off.

The Soil moisture feature of the pot gets implemented from the data coming from the soil moisture sensor. The readings of soil moisture levels are in percentage volume (ratio of water to soil volume). We are using resistive soil moisture sensor because of accuracy factor. The resistive soil moisture sensor consists of mainly two components: The probes and the module. Module has built in potentiometer to set the threshold which will be compared by the LM393 comparator[6]. The soil moisture sensor consists of two probes which are put in the soil in which one probe functions as cathode and other is anode. Anode is connected to the +5Volt supply through series resistance of 10K ohm and second plate is connected directly to the ground. These probes allow the current to pass through the soil and based on volumetric water content it gives resistance value. The module on the basis of resistance value produces analog output (A0) gives us a value from 0 to 1023. We got analog readings between 483-505 when soil was wet and got reading of 1023 when soil was dry. The analog output signal is further fed digitalized by LM393 comparator and output made available at digital pins. According to the data coming from the soil moisture sensor, the decision is being taken whether the soil is wet or dry and thus the status is displayed on to the application for the user to monitor.

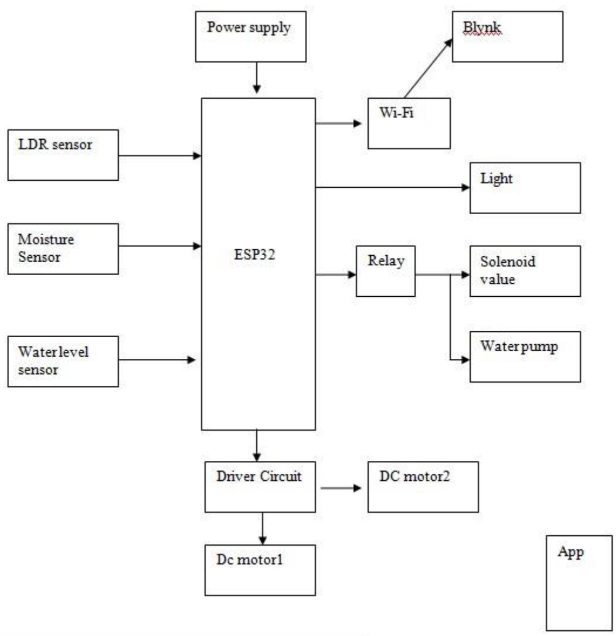

Fig -1: Smart Plant Pot Architecture

ESP32-WROOM-32[5] is a low cost, very low power system on a chip microcontroller that has integrated wi-fi and dual mode Bluetooth (BL and BLE). ESP32 series is created and developed by Espressif Systems. ESP 32 with Xtensa 32-bit dual core LX6 microprocessor is implemented in the project. It has ultra-low power co-processor which allows ESP to do ADC converting and other computation even when microcontroller is in deep sleep. It has 6 Analog pins that are used for taking analog inputs from sensors and use ADC chip to convert received analog values to digital from. It has 6 PWM pins which coverts digital signal to analog is used for giving desired analog inputs to our controllers like LED, motor which required analog inputs. ESP 32 has clock speed of 240 MHz for faster execution. It has flash memory of about 4 Mb for storing information when the power suddenly turned off. It has SRAM for storage and instruction purpose of 520 kb which is higher than that of Arduino Uno. Water Station Control feature of the pot gets implemented using the water station. When the soil is dry as reported by soil moisture sensor, the water station waters the plant and maintains the water level of pot. As soon as the soil is detected wet, the water station stops the process. The water in the water station is controlled by some external supply such as tap water etc. The working of Blynk Application revolves around the idea of keeping every process simple and easy. The application provides the user with real time data and also help them with controlling the movement of the pot i.e., automatic and manual. The real time status of soil artificial light can be observed through the application.

4. Working of Plant Disease Detection

To train the machine learning algorithm for disease detection in plant, the data was taken from the Kaggle dataset named "New Plant disease dataset" [3]. It comprises of large number of augmented images which are classified into 38 different classes. Roboflow was used to annotate the images and to produce the label corresponding to each image. This annotated data was fed to yolov5 object detection algorithm and the model was trained for various weights. Upon seeing the best output, the corresponding weight was selected. While training the yolov5 model the first step was to import necessary libraries such as CV2, numpy, pandas and matplotlib. Google drive was also connected to save the output of the trained model. The data was plotted to verify whether the received images were correct or not. Cloning of Github repository of yolov5 is done to import the necessary files for running the model[4]. Training was started by defining the required parameters for 400 epochs using yolo5n.pt weights. Results were saved in the runs folder under the name best.pt (This is default name yolov5 uses). The best.pt file was copied to drive for future use. Now, detect.py was run by giving the appropriate arguments and a number of images were tested for detection. Some of results are shown in fig 2-6:

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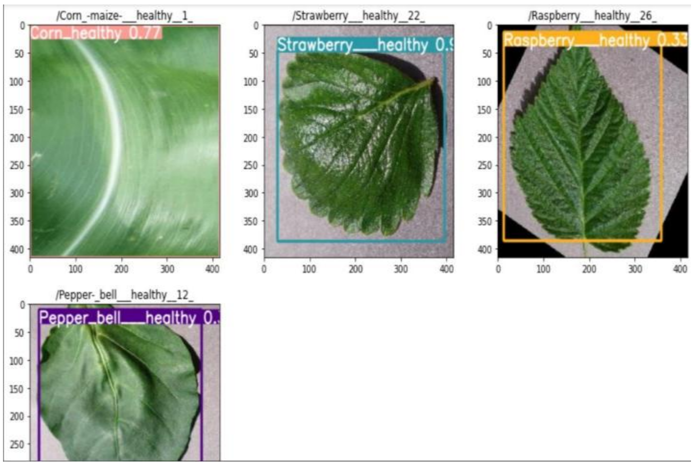

Fig -2: Disease Detection output

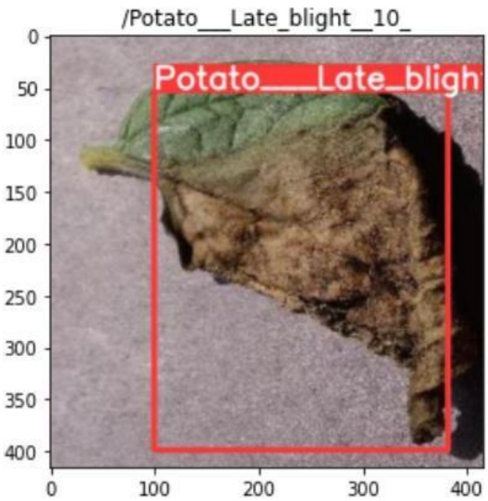

Fig -3: Disease Detection output

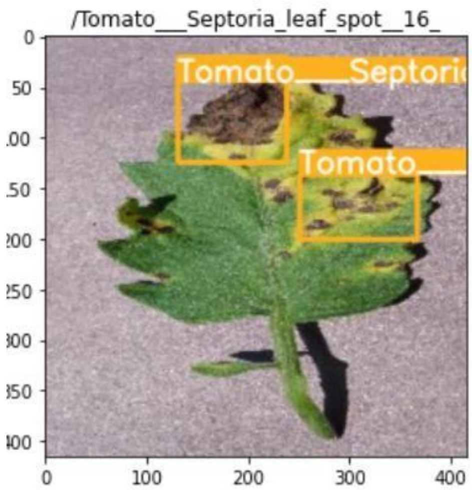

Fig -4: Disease Detection output

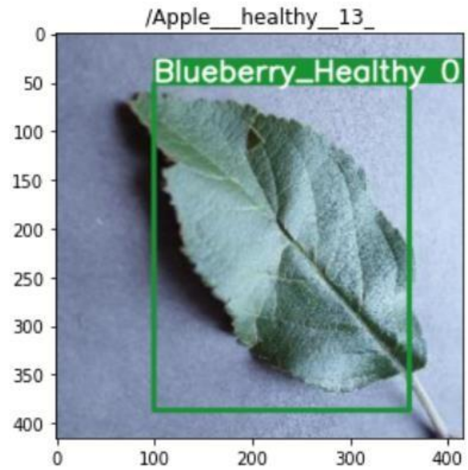

Fig -5: Disease Detection output

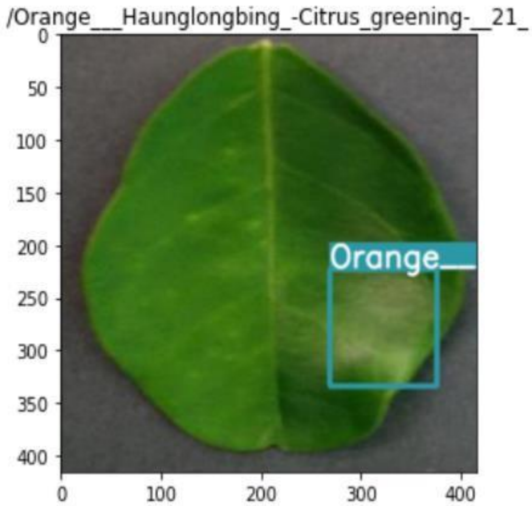

Fig -6: Disease Detection output

5. Smart Plant Pot Architecture

The architecture can be divided into 2 parts i.e., hardware and software. Figure 7 shows the connection diagram of hardware system.

In the hardware section, the following tools were used:

- Power Supply(12V)
- ESP-32 microcontroller
- Soil Moisture Sensor and Comparator circuit
- LDR Sensor and LEDs
- Water level Sensor and Pump
- Water Station and Solenoid valve
- L293D Motor driver

- 2 DC Motors(12V)
- 2 Channel Relay and Voltage Regulator(5V)

In the software section, the following tools were used:

- Blynk(legacy)
- Android Application
- Arduino IDE
- Library: Blynk, Wifi.h
- Board- ESP 32 Dev Module
- Python libraries– Pandas, Matplotlib, CV2, NumPy etc.

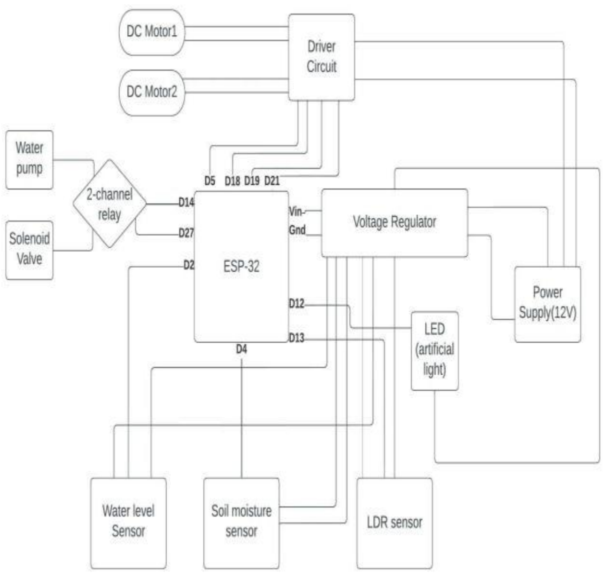

Fig -7: Connection Diagram of Hardware System

6. Results and Discussions

The 6 features implemented in the Self-Sustaining Planter which includes Movement, Light control, Soil Moisture, Water Station Control, Blynk Application and disease detection on the leaf were tested. The Plant pot was able to remove the limitations of the traditional plant and thus was able to automate various activities which can simplify the lives of the people. The following images illustrated the features of the Planter pot and the features of the blynk application.

Fig -8: Manual and Automatic movement through Blynk

7. CONCLUSIONS

The idea revolves around automating all the process which can result in saving time and effort. Through this proper nourishment and growth can be monitored. Implementation will result in high yield and growth of the plant. In future this project can be used by people bearing antique or expensive plants and want to take extensive care of them, so our model can achieve this by completely automating the process.

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