INTELLIGENT PLANT AUTOMATION SYSTEM

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Abstract— *As the World Population increases day by day, and we are exploiting each and every resource by using them on a daily basis. As best example we destroy Trees and Agricultural lands for our own benefits and this causes reduction in the natural food production and result in less Rain fall which also increases the Carbon content in the air, most prominently we are not using the Solar Power efficiently (even in the tropical countries), we aware of Water Management but we are not implementing it everywhere. On the other hand due to petrochemical, industrial revolution the agricultural industry has kept hike in the production but providing a lavish price in return as of soil pollution, environmental hazards, health issues, and more significantly the problems in food production system. To deal with the above mentioned problems and to bring back the conventional agriculture we need a system and for the same above said issues we have proposed a system named Ecobot, a completely stand alone device for Automating the complete Plant Seeding, Watering, and Monitoring constantly with various Sensors for Maintaining the Health of the Plants and Vegetables. Thus, the proposed solution is dealt in-depth in the full paper.*

Keywords—Exploit Solar Power; Water Management; Plant Seeding; Watering System; Plant Monitoring; Polluting soil; Automated system

1. INTRODUCTION

The Population Growth and Usage of natural resources are increasing day by day, this lead us to take some stance against the Environment by exploiting the Natural Resources, Health, and the Production System itself by these destructive measure. We have evident that the temperature in our country is fluctuating and rainfall ratio is varying abnormally and this situation is considered to be consistent and carbon content in the atmosphere is increased. To deal with these Massive problems the prevention and self-responsibility of the individual is important.

Ecobot is developed to tackle each and every above mentioned problem completely.

Globally we have 70% of Water in which only 2.5% are utilizable, the remaining are saline ocean waters. In that 2.5% only 1% is easily available remaining are in the form of glaciers or snow fields. So it is important to preserve and reuse waters as much as we can and use them fruitfully to make sure we utilize each and every water droplet usefully. To make this happen water should be properly handled and preserved in a systematic way, for this Rain water harvesting and Smart Water Preservation system must be implemented. Our proposed system Ecobot provides mechanism for these solutions.

Ecobot is an open source farm in which the users can learn and develop their own models for their respective fields; however we would have certain standard models to do so. It's a type of farming machine in which the seeds are planted, monitored, and watered automatically. Most importantly without any inorganic fertilizers, it is completely organic. After the full growth period of a plant, a mail or message will be generated and sent to the user automatically indicating the vegetable or fruit is ready for cultivation.

This idea has been proposed to utilize the natural resources by some systematic mechanisms and to produce something constructive and beneficial to the society as well the environment, by this we can reuse our own household waters in proper way, preserve rain waters and these preservations can be done using solar energy by customizing solar panel to the system. This system can be installed in our backyard/ terrace or where ever you find place to grow your own plants based on the convenient of the individual.

2. LITERATURE SURVEY

A study has been made on some of the journals published, more relevant to the subject taken under consideration, with the description of each paper as follows.

As in the implementation of the Farmbot [1] they have used microprocessor, microcontroller, drivers, shields, water pump, vacuum pump, sensors, stepper motors, and battery. They are too expensive and the schemes like water preservation are not used in it, but it provides a detailed procedure for conventional farming by using the latest technologies coupled with powerful hardware and smooth software.

The plant automation system [2] will be used only for watering of the plants based on their respective classes, but that is not enough to maintain their health with the changing environment and temperature so it uses the database and records stored in it to understand about the plants and waters them on that basis. But it is limited to watering of the plants based on their classes nothing more than that and we cannot perform actions outside of this system.

The other systems which are used for food production are destructive but they are producing foods in large scale, the point is they are cultivating plants for production in larger areas and the result of production is high but the investments, cost, accessories used are too expensive for every person afford.

3. PROPOSED SYSTEM

The system primarily consists of a bed of soil, the place where the plants are going to seeded automatically. It consists of three dimensional procedures X, Y, Z zones separately in which these operations are carried out by the stepper motors and powered by the motor driver 298n which is controlled by Adruino mega2560t.(primary board)

The secondary board consists of four sensors for temperature, rainfall, soil and flow control respectively which is controlled by a WI-FI module implemented in our system.

The water pump, vacuum pump, team of relays and switches will be used to control the system; solar panel is included to supply power for the battery (12v and 5 amps).

The separate water tank is built and used to water the plants similarly rain water harvesting procedure and waste water recycling mechanisms are also implemented and connected to the water tank from waste household water.

The communication is executed between the user and the system via WI-FI module connected to the web interface and Plants are handled individually by the help of sensor readings.

1. Arduino Uno & Arduino Mega2560T:

The two microcontrollers with the same functionality is embedded with the system and Adruino Mega 250T which differ from other controllers having more number of ports. The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino Mega 2560T is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

2. Stepper Motors:

Stepper motor (part no: STEPMOT-1) is a four phase, unipolar, permanent magnet motor. It comes with a standard size, 200-steps-per-revolution, NEMA 17 (1.7 in. square footprint, 5 mm shaft diameter), 12 V motor. This motor is a permanent motor just like the other motors work. About the Mosaic stepper, it is a typical high resolution motor which requires a full revolution 200 steps, while each step turns the shaft only 1.8° for a full step, or 0.9° in half-stepping mode.

3. Motor Driver298N:

This is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motor**s**. This driver has two options to enable or disable the device independently via the input signals.

4. Water flow sensor:

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When **water** flows through the rotor, rotor starts to roll. The speed of the rotor changes with different rate of flow. We have provided a comprehensive line of water flow sensors in with different diameters.

5. Temperature sensor:

A temperature sensor is a device, typically acts as a thermocouple that provides temperature measurements through an electrical signal. A thermocouple (T/C) is made from two dissimilar metals that generate electrical voltage in direct proportion to changes in temperature.

6. Rain sensor:

The rain sensor module is a tool for rain detection purpose. It will act as a switch when rain drops fall on raining board. It is also used for measuring rainfall intensity. The analog output is used in detection of rain drops from the amount of rainfall.

7. Soil sensor:

The Soil Moisture Sensor uses capacitance to measure the water content of soil (by measuring the dielectric permittivity of the soil, which is a function of the water content). This rugged sensor is simply inserted into the soil which is to be tested, and the volumetric water content of the soil is reported in percentage format.

8. Battery:

The system is powered by a lead acid battery with the capacity of 12v and 5amps. The battery can be charged directly from the wall socket through a power adapter, to convert from AC to DC. To step-down the voltage we are using a power convertor and recharger with diodes to charge the battery. This battery will be active whenever the system starts its functionality. The schematic diagram of the system has been provided in the figure *fig1*

9. Vacuum pump:

A vacuum pump is a device that removes gas molecules from a sealed volume in order to leave behind a partial vacuum. It operates in 4watts power supplied from battery and it is extremely low power consumable system. In order to seed the plants in the bed the vacuum pump will be turned on; once the bed is reached, the vacuum will be turned off leaving behind the seed in the bed.

10. Water pump:

A centrifugal water pump uses a rotating impeller to move water into the pump and pressurize the discharge flow. Standard, trash, and submersible models are the three different alternatives to provide centrifugal water pumps. All liquids can be pumped using centrifugal water pumps, even liquid with low viscosity.

4. WORKING PRINCIPLE

Ecobot is an open source fully automated faming machine used to grow plants in the backyard or at the rooftop of the house or even in the industrial area. Thus the proposed system will be completely running on the solar power charged battery which will perform seeding of the plants and complete watering for the plants at 24*7 monitoring until the date where the plant is fully matured and ready to be used. The system has seed mounter placed in the bed which holds the seeds. Initially the bed will be divided into horizontal and vertical columns in which the meeting points of those will be recorded and that will be provided as the input to the microcontrollers. The actions performed are, the microcontroller will give the command to the stepper motor to move to the designated location after the completion of the movement the seed injector will take the seed from the seed mounter and will inject it into the soil by the help of the vacuum pump which will hold the seed till it is injected into the soil, for each seed this procedure will be repeated. After the completion of the seeding procedures the plants or seeds need to be watered. To water the plants the water pump is used. The water pump is controlled by the microcontroller and the water will be measured using the flow sensor. This allows watering each plant in the bed and helps in plant healthy growth.

The system provides smart water preservation system which holds waste water management, water utilization, and rain water harvesting. Watering the plants using the nozzles helps in water management in the same time watering is done proficiently for the plants.

The proposed system also hold sensors to measure the temperature, rainfall, soil which contributes actively to maintain the health of the plants and based on the reading the watering of plants is also done.

1. Open source application, scalable, efficient, and fully documented.
2. Fully automated and 24*7 monitoring system.
3. The size of the system is Scalable and implemented from the backyard/terrace to an industrial operation.
4. Unlimited Farming design ideas and possibilities provided.
5. Ability to plant in any available space layout.
6. Uses the Big Data techniques and analysis for the smart way of farming.
7. Ability to optimize operations such as Watering, Spraying, and Seeding.
8. Smart water preservation system is used for efficient water utilization.

Primarily the system consists of bed mounted tracks with functional stepper motors embedded within the tracks. This set up helps in movement of the system in X direction, the input fetched from the user will be transferred through the wi-fi module, from which they send the signals to the adruino to implement the necessary actions as per the instructions given by the user. The input from the user will be sent as signals by the microcontroller and it signals to the motor driver (l298n) and that signal will be transferred to the Nema stepper motors. Then the motors will move the feeding system to perform various actions in the bed. And each of them is controlled separately.

The sensors will be operated based on the necessity and it provides most important real world information about the climate, soil moisture, water flow, temperature based on the database is generated. The generated database acts as source of information for watering the plants and seeds accordingly. And each plant is totally different from the others based on it

The operation is very simple as a 3D printer and the full working mechanism is based on it. The axis defines the path for the system to move to the desired location in the bed to carry out the action. The system can operate in any area and carry out its operation on it. The proposed system is coded in a fashion such that minimum water is used but maximum output is extracted, for these sensor readings are also used. The Soil Moisture sensor, Rain sensor, temperature sensor gives the reading of the values separately which are combined to perform actions. For example: If the intensity of the rain is low then automatically the reading of the Moisture sensor will be looked up and otherwise there won't be any changes in the watering system of the plants. If the intensity of the rain is moderate the watering of the plants will be on hold for one or two times based on the reading. If the intensity of the rain is heavy then the watering system for the day will be on hold for 12 or 24 hours process. On the other hand the solar power is utilized because the whole operation will be performed by using a 12v 2amps battery which can be easily charged in tropical countries like India. The Rain water harvesting schemes and smart water preservation system combined with waste water management makes this system as an Intelligent watering system on the whole

5. EXPERIMENTAL RESULTS

A comparative study has been made on the accuracy, performance, and the actions performed by it on the whole as a single independent system. The Adruino controls the whole functioning of the system with the help of stepper motors, sensors, and pump which is powered by the

battery. This system will generate the result as per the user's instruction. The command from the user will be from the integrated website used for it and the instructions are received by the Wi-Fi module placed in the Adruino to receive signals. Once the signals are received the operational control can also be translated to the user. The user can select the vegetables from the list of vegetables and the rest will be implemented and performed by the Ecobot. In case of failure the system will send mail or message to the user regarding the failure of the system, each and individual problem will be identified separately and mentioned in the mail to the user. It is an open source platform, safe and valuable for the money we invest in this system. Anyone can use it and collaborate with the system and organization.

S.No.	Name of the vegetable	Temperature (Fahrenheit)		Fertilizer type	pH level (0 to 14)	Watering
		Germination	Growth			
1.	Broccoli	50 - 85	60 - 65	Heavy feeder	6.0 – 7.5	Average
2.	Carrot	45 - 85	60 - 65	Light feeder	5.5 – 6.5	Average
3.	Celery	60 - 70	60 - 65	Heavy feeder	6.0 – 7.0	Heavy
4.	Potato	60 - 65	50 - 65	Light feeder	5.0 – 6.0	Heavy
5.	Cabbage	45 - 95	60 - 65	Heavy feeder	6.0 – 7.5	Heavy
6.	Onion	50 - 85	55 - 75	Light feeder	6.0 – 7.5	Average
7.	Tomato	60 - 85	70 - 75	Light feeder	5.5 – 6.5	Average
8.	Peas	40 – 70	60 - 65	Light feeder	5.5 – 6.8	Heavy

Fig 1: Description of the vegetables with their individual values for providing the Database from which the system fetches the values and operates on it.

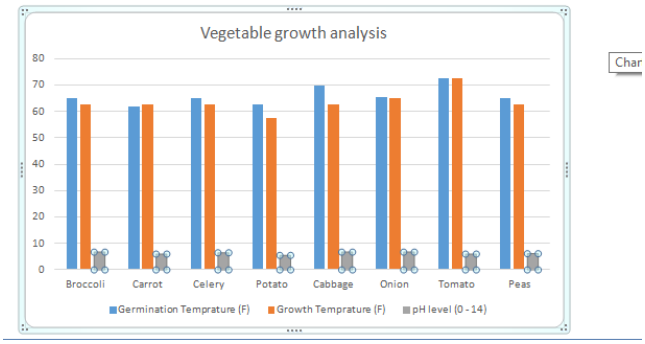

Fig 2: Describes the values after the plantation of the plants, the Growth Temperature and PH values are specified with Germination Temperature.

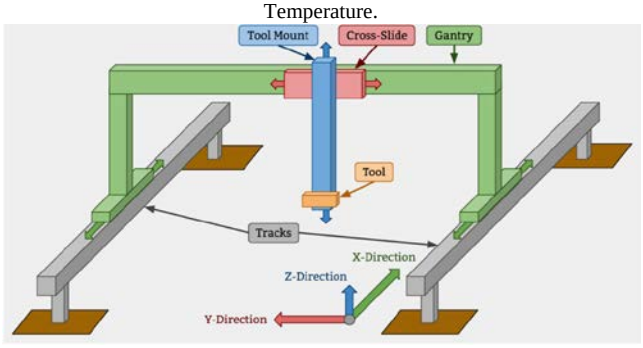

Fig 3: This specifies the X, Y, Z modules operation in which it acts as a big sized 3D printer, and placement of Tool mount, Tools, Seed injector, Watering nozzle along with track specification.

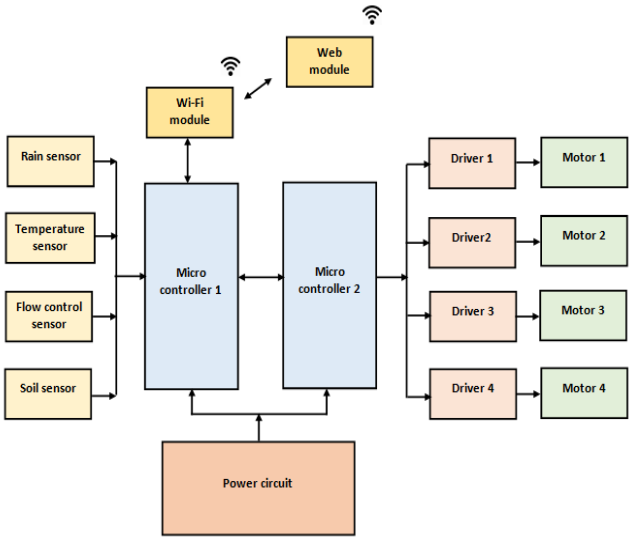

Fig 4: The picture depicts the working procedure of the system in which the whole functionality of the system is visualized and performed in action. The web module used by the user will give the instruction and the Wi-Fi module placed on the arduino will receive the signal and gives instruction to perform the actions and the Stepper motors, sensors, pumps and drivers will be operated based on the instruction provided by the microcontroller and this whole setup is powered by a single 12v battery charged using a 12v Ac to Dc converter.

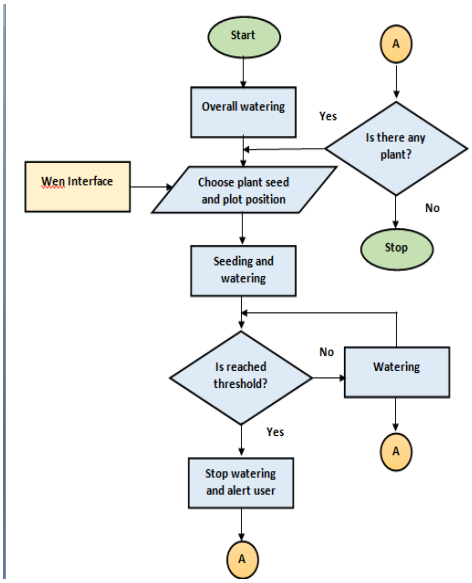

Fig 6: As given in the Flow chart the system boots up, the training modules are booted up and the procedure continues the instructions from the user are received and the actions are performed based on it. Once the

plant is chosen the seeding procedure takes place after that watering is done as a continuous process for that day after that it continues for every day until the day where the plant is fully grown.

6. FUTURE ENHANCEMENTS

The proposed system ECOBOT designed is made to operate only on the backyard and at the roof top of the user's building. But the system should be able to get operated on larger areas such as Government Building, Bus stands, Airport areas, Railway stations etc since the operations, actions, and functionalities are the same, the system implementation at larger square feet will be enhanced in future with more reasonable price. The plants which are to be grown will be the same under any circumstances, the only changes would be done are mechanical changes like extension of the area; we need more powerful motors with higher battery capacities. We provide an open source environment and forum for everybody to collaborate and improve it, so that we can save a large amount of water from wasting and use the solar energy to a maximum extent. Plant as many trees as possible, this paves the way to create a pollution free environment without chemicals and without damaging the food system at a very comparative price.

7. CONCLUSION

The ECOBOT is to help the people to grow plants in their own Backyard or at the Rooftop by completely automated device with strong interface, simple and easy procedures to operate it. This can provide solution to waste water treatments, water preservation, water utilization and usage of solar power completely to create a organic vegetables for our own usage and benefiting the Environment around us. The ECOBOT has been designed with utmost care to ensure the usability and easy access of all features by the user. Research in progress includes the pi-camera module, for the real time navigation and accessing the plants with more accuracy, it improves the overall performance of the Ecobot for enhancing user experience by creating extensive and intractable website for the user comfort and thus improving the overall product.

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