# Smart Gardening: A solution to your gardening issues

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**Abstract.** The technology which could make our life prosper within the walls could also help to create our own corner of nature nourish. In this project, a smart gardening system has been proposed that utilizes the concept of the Internet of Things (IoT). The main objective of this project is to optimize water usage during gardening and remotely maintain the garden. In this system, important information related to the plant, like, temperature, relative humidity, and the soil moisture is continuously recorded in a cloud-based Database. Artificial Intelligence (AI) based planning is done in regular intervals for watering the plants and provide adequate lighting in the garden area for aesthetics. The real-time sensor status can be directly monitored and controlled by the end-users of the garden through his or her smartphone using Telegram application. A plant recognition model has been introduced in this system, where a Convolutional Neural Network (CNN) [1] based deep-learning algorithm classifies the plant categories. Moreover, this model also informs the end user about the health of the plant.

**Keywords:** Smart Garden· AI planning· Plant Identification· CNN, Smart Lighting · Internet of things · Smart city.

## 1 Introduction

Maintaining the garden in itself is a very tedious and time-consuming task, on top of it watering of plants with minimal wastage has become the need of the hour to sustain energy consumption and save water. In order to experience a greater sense of aesthetics and a breath of fresh air without necessarily being a propagator, there is a need for garden digitization.

Numerous devices and networks could possibly make the hobby of gardening sustainable. Smart gardening is the best possible solution to it. With the rapidly growing popularity of the internet, multipurpose devices (laptops and smartphone) and the devices built to serve a specific purpose (say, an embedded system in a washing machine), the concept of the Internet of Things (IoT) [2] comes into the picture. IOT is a shared network of objects or things which can interact with each other via the Internet connection. In the field of business, social process, information, and communication, the things are expected to become active participants by using IOT. They need to be enabled for interacting

with the environment and communicate among themselves while exchanging and transforming the data and information sensed about the environment. It is automatically influenced by the processes that create services and trigger actions with or without human intervention.

In this context, we propose a model which could efficiently take care of a garden on its own with almost no human intervention.

The rest of the paper is organized as follows: Section 2 notes a few related works, section 3 elaborates the System design; Section 4 includes the implementation and setup and finally, Section 5 concludes with some limitations faced and the future scope for this project

## 2 Smart Garden System Design

The design of the system was done keeping in mind that the users of the smart garden may not necessarily be near the garden to take care of it, rather they can be in any part of the world. The architecture is specially built to minimize water wastage and light usage in garden area. It is of grave importance these days to conserve water, the architecture ensures optimal usage of water and light energy for the sustainability of plants. The physical layer consists of the Aeotec Multi-

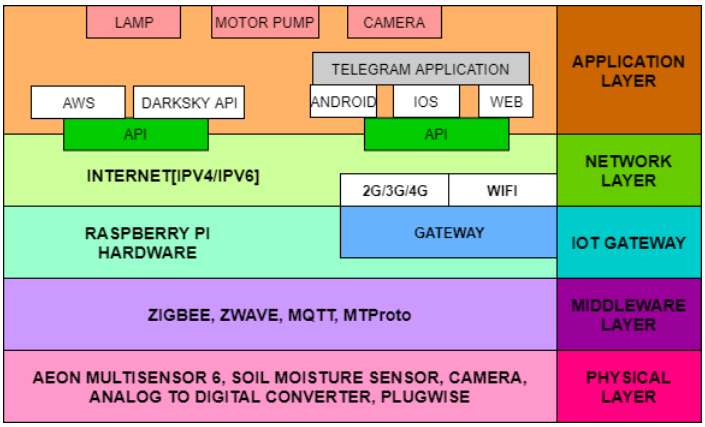


**Fig. 1.** Smart Garden System Architecture

Sensor 6 which uses Z-Wave wireless protocol to transmit temperature, relative humidity and luminescence values to the raspberry pi controller. The watering requirement for a plant can be adjusted by monitoring the soil moisture. Capacitive soil moisture sensor is used which consist of both analog and digital output pin. MQTT, a machine to machine messaging protocol is used to communicate the sensor data to the Amazon Web Service- Relational Database Repository. AI planning is done by Fast Forward planner, every 10 seconds to minimize resource wastage, regulate the watering of the plants and control the lighting in

the garden area.Telegram is a cloud-based instant messaging and voice over IP service which is used as a user level contact point to send message to the pi. The pi transmits the request to the Plugwise which in controls the motor and lamp used in the garden. Apart from this Application layer allows camera usage(phone web camera set up for demo) to capture photo based on user request.

The design is robust in the sense it is capable of handling any error both at hardware and software level. The garden is smart enough to respond to both user request and nature calls. The design is flexible and open, it can be easily integrated with other devices in future.

## 3 Smart Garden System Set-up and Implementation:

The Architecture constitutes of a small set up on a few mud trays having 2 variety of plants. AEON Multisensor 6 is calibrated using Domoticz software for temperature, humidity,luminescence and is connected to raspberry pi using Z-wave stick. For sensing the moisture, moisture sensor along with ADC [mcp3008] is used to convert the analog input to digital to be given to the raspberry pi. Two 5V submersible pump to water the plants and Lamps for lighting during low luminescence would be actuated using Plugwise. Plugwise consist of USB stick connected to the raspberry pi and Circle+ ,Circle where the appliances are connected thereby creating the Zigbee mesh network. Telegram bot application applicable both on Android phones and Web acts as a GUI platform to the user to control the pump, monitor the environmental and plant conditions. Additionally, the plant health is also monitored using Deep learning algorithm.

### 3.1 Integration of sensors and actuators with the Raspberry Pi:

The temperature, humidity, luminescence from Aeon sensor and moisture value together enables watering. The value from the moisture sensor is given to one of the analog channels on A-D converter which provides a digital input to the GPIO (General purpose input-output) pins on raspberry pi. Plugwise connects with the raspberry pi which in turn turns on and off the circle.

The decision of watering and lighting can be done by turning on and off the circle and this depends on Artificial Intelligence planning algorithm and on the user in accordance to his action on Telegram bot. Further, the data from these sensor could also be queued and published on cloud MQTT and subscriber subscribes to this data, fetches and stores back in the database on Amazon Web services.

### 3.2 Artificial Intelligence Planning Algorithm:

In order to satisfy the goal of the user, Artificial Intelligence Planning systems choose available actions to change the state of the environment to achieve goal-oriented behavior. In our proposed system, AI planning is used to plan the watering of the plants and the lighting of the surrounding.

For watering the plants, the sufficiency of the moisture level of each plant is provided as an input in the init part of the problem file. The goal is set to attain sufficient moisture level of all plants through switch on/off action of the motor pump in the domain file.Whereas for lighting, the present luminescence level of the surrounding, present state of both the lamps(on/off) is provided in the init part and the goal is to equalize the required and present luminescence level. This could be achieved by action of switching on and off the lamps included in the domain file.

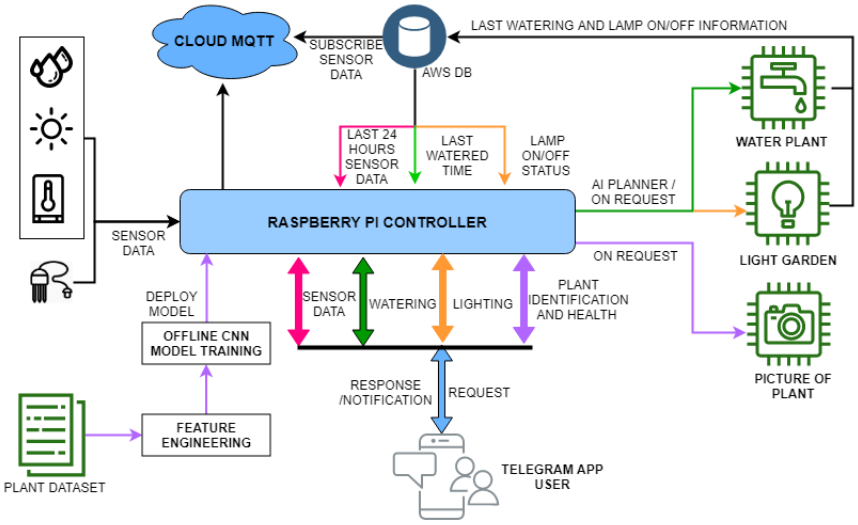


**Fig. 2.** Implementation diagram

### 3.3 Telegram Bot application:

Telegram Bot are special accounts which serve as an interface for code running on the pi. Different functionality for the user to support efficient gardening along with other smart functionality is as follows:

1. Take picture: In this, mobile is used as a webcam for the pi to capture a glimpse of the garden.
2. Water plants: When the user selects this function, the last watered time of all the plants in the database is checked. The plant is watered only if it is less than a specified time and the latest watered time is updated back to the database.
3. Lamp on/off : The lamp is turned on/off depending on the present status of the lamp in the database and thereby updated back to the DB based on the action performed.

4. Sensor Status : The user is kept updated about the current value of temperature, relative humidity, luminescence obtained from the Aeon sensor.
5. Subscribe to Garden Status : The user is provided with the graphical representation of the change in temperature and relative humidity during the day stored in the database using mqtt.
6. Local Weather : This functionality enables the user to know about the current weather situation in the locality near to the garden when he is not around.
7. Know Your Plant : This system allows the user to know about the plant name and health status, whenever the user wants. For this purpose, Convolutional Neural Network based architecture has been developed. The generated model is then deployed in the Raspberry pi. Once the end-user requests for the plant identification online, the name of the plant along with its health are reported to the user.This system allows the user to know about the plant name and health status, whenever the user wants.
8. Add a new plant : The minimum temperature, humidity and moisture threshold of the new plant could be inserted into the present plant database through this function.

## 4 Conclusions and Outlook

In this project, a rational gardening system is implemented. The system can control the water supply to the plants based on both environmental sensor data and soil moisture data. The lighting of the garden area has also been taken care off. The system boasts of efficient utilization of resources with minimal wastage. The plant health-care department has been effectively looked after by the deep-learning algorithm. Along with this, the garden can connect people from different parts of the globe, which is one of its unique selling propositions. One of the major limitations of this work was the unavailability of a movable robotic arm that could capture pictures of the garden from different viewpoints or use a single motor to water several plants. Further extension on this project would be to connect different gardens located physically apart, "Connecting Gardens for optimized learning". This project is reproducible in its entirety [git hub link].

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