IoT based Computing to Monitor Indoor Plants by using Smart Pot

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Abstract: The indoor plants are high in demand and the number of people buying indoor plants is increasing day by day. But people face a lot of problems in raising the indoor plants as taking care of these indoor plants is not easy and they even die with a cause which is difficult to predict. According to the National Gardening Association [1] people from all age groups ranging 20 and above are completely obsessed with indoor plants. It states that in the US alone the sale of indoor plants has incremented by 50% during the last three years which now stands at a value of $1.7 billion in 2019. Barometer of Trade report [2] shows the sale of indoor plants in India went up by 24.1% in a span of one year from 2016 to 2017. The market of indoor plants is increasing day by day so is the problem to take care of these plants. To raise and maintain the health of the indoor plants there are various factors that need to be monitored which include- soil moisture, sunlight, temperature, humidity, and soil pH. It is really difficult to monitor all of these factors manually. Therefore, our goal is to achieve automation [15] in taking care of the houseplants by using various components (Arduino Nano, soil moisture sensor, submersible mini water pump, ESP8266 Wi-Fi module, BH1750 sensor, DHT11 sensor, pH sensor, water level sensor, and LiPo rechargeable battery, LED light) embedded in the Smart Pot [14] and by creating a library of indoor plants with all its data points, so, that the Smart Pot works in accordance with the plant selected. It provides functionalities for automatic [5] water [7] pumping into plant soil in the right amount, sends a notification when the level of water in the storage tank [12] of the pot is low, sends a notification to put the plant in the sunlight and to brings it back, uploads data on the cloud using internet through Wi-Fi [13]. The data includes humidity, temperature, moisture, sunlight and pH value which can be seen through the android application and important notifications are sent if the value of a data point is not healthy. It also shows the overall health of the plant in its mobile interface.

Keywords: Smart Pot; indoor plants; automatic water supply; sunlight reminders; android application.

1. Introduction

According to Social Statistics 2.0, only 25% of people do not have houseplants rest come under the spectrum who nurture houseplants. The indoor plants or houseplants are proven to be good for health. The houseplants don't just produce oxygen but it also helps in curbing down the harmful toxins in the environment. Research by NASA [3] has stated that indoor plants help in removing 87% of toxins in the air in a span of 24 hours. It also states that indoor plants help in enhancing productivity and concentration by 15%. Also considered good for decreasing stress [4] levels and provides relaxation. There has been a grown awareness among people regarding these aspects. As seen the market for houseplants is exponentially increasing and a need for care to these plants is a major concern. Figure 1 shows the basic layout of the system functionality.

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The basic methodology behind the working of this process depends on the input taken from various sensors in the smart pot. The input received is analyzed and accordingly a output is carried out to maintain the health of the plant in order to make the complete process successful.

- Fetching sensor data is carried out every hour which is scheduled and controlled by the Arduino.
- The soil moisture sensor, BH1750 light sensor, temperature/ humidity sensor, pH sensor, and the water level sensor of the Smart Pot [14] runs to collect the data values.
- As soon as the data is received by the Arduino Nano it sends the data values to the cloud (ThingSpeak) by using the internet connection established with the help of the Wi-Fi module.
- The Android application in the mobile phone of the user receives or retrieves data from the cloud. The data received by the application is analyzed with the database (which is connected with the Android application) of the plant in the Smart Pot.
- If the water level in the Smart Pot is low, a notification is sent to the user about the need.
- Some plants require a few hours of sunlight but the user might forget to take it in the sun or bring it back. To help during these situations, the data received by the light sensor is compared with the requirement of the plant as per the database and accordingly the user

is notified to put the plant in the sunlight. When the right amount of lux is received for the required time the user is notified again to bring back the plant.

- Some plants require a good amount of humidity to grow well and whenever a humid environment is needed as per the analysis of data by the Android application, water [7] is automatically pumped [5] into the humidity tray.
- Water [7][8][10] into the plant is automatically pumped as per the data values received from the soil moisture sensor and analysis by the Android application considering the plant's database.
- A good pH value of the soil is also a significant factor in plant growth. A dangerous pH level is notified to the user, so, that the right action can be taken.

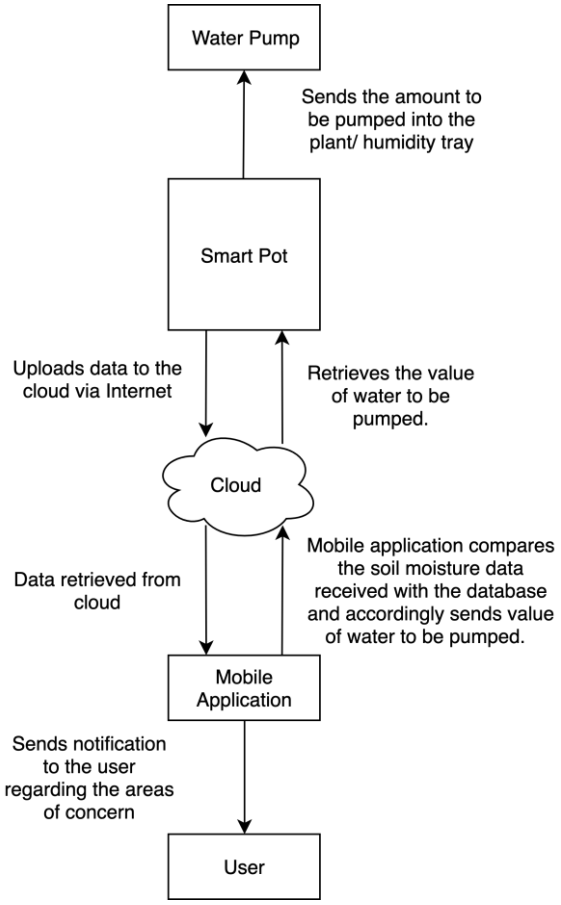

Fig.1- System Block Diagram

The entire working of the system helps in monitoring [6][9] and maintaining a healthy plant and takes away the responsibility of the people in maintaining it.

2. Working of Proposed System

The complete system works on a particular pipeline which can be broken down to multiple steps according to the various functionalities of the different parts.

2.1. Algorithm for programming Arduino System

The Arduino Nano helps in binding up the entire system together and ensures a smooth run of all the procedures. It is the place where all the sensors are controlled, data is uploaded and retrieved. The microcontroller (Arduino Nano) is programmed accordingly according to the. The microcontroller is programmed using C++ in Arduino IDE. There are multiple conditions that had were constructed in order to carry out the desired tasks in a streamlined path. The data received through various sensors is uploaded to the cloud via the internet. The various tasks which need to be carried out are received from the Android application using the cloud. The following tasks are carried out by the Arduino Nano:

- It signals all the sensors (soil moisture sensor, submersible mini water pump, BH1750 sensor, DHT11 sensor, analog pH sensor, water level sensor) to start taking in the input after an interval of every one hour.
- It notifies the user when the battery of the Smart Pot is low and needs to be put on charge.
- It connects to the internet with the help of the ESP8266 Wi-Fi module**.**
- The data is collected from the various sensors and is pushed to the cloud. ThingSpeak is used in this scenario.
- Everything is put off for an hour after the data is received and sent.
- The desired task that needs to be carried out is received from the Android application through the cloud.
- According to the amount of water that needs to be supplied to the plant (as per the data retrieved from the Android application) the water pump is signaled.
- In order to create a humid environment, the signal is passed to the water pump to supply water to the humidity tray (in accordance with the data. Retrieved from the Android application).

2.2. Development of Android Application

The android application acts as the brain of the system. One without the other will lead to failure. The android application helps if effective monitoring [6][9] and maintaining the good health of the plant by referring to the database and scheduling tasks as per the need. The communication is made with Arduino Nano with the help of the internet using the cloud as the middle layer between Arduino Nano and the android application.

Figure 2, portrays the basic layout of the android application which shows the last data retrieved and the health of the plant.

- A very basic and attractive user interface displays the data through various sensors attached to the Smart Pot. It also tells the complete health of the plant.
- It displays the water level in the Smart Pot and signals the user to replenish it when water is needed in the water tank [12].
- It notifies the user when the battery is low in the Smart Pot.
- It contains the database of all the houseplants and performs all the tasks in accordance with the required standard values.
- The android application retrieves data of all the sensors through the cloud.
- It reminds the user when to take the plant out in the sun and when to bring it back. The Smart Pot detects the lux. If too much sunlight is harmful to that particular plant, it notifies the user to keep it at a place of indirect sunlight.
- It automatically sends the amount of water [8] that needs to be pumped into the plant and the humidity tray referring to the database of the plant.
- It displays the temperature, humidity and pH level retrieved from the cloud and notifies in case any attention is required.

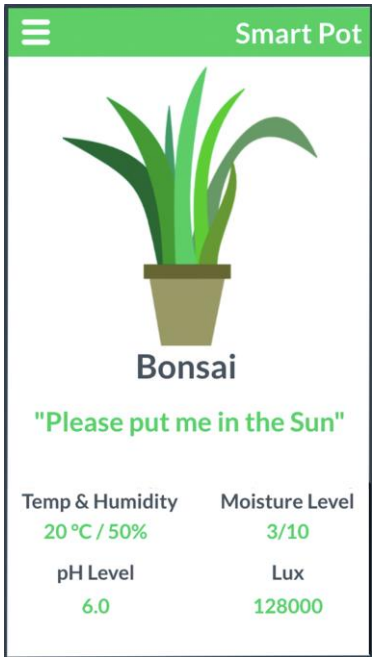

Fig. 2 – App Layout

2.3. Smart Pot

Smart Pot is the place where all the data is retrieved and send. It controls the various sensors and helps in performing various tasks to monitor and maintain the good health of the plant.

- It contains the complete set of components (Arduino Nano, soil moisture sensor, submersible mini water pump, ESP8266 Wi-Fi module, BH1750 sensor, DHT11 sensor, analog pH sensor, water level sensor, and LiPo rechargeable battery, LED light) which help in proper working of the system.
- It contains an inbuilt water tank [12] to automatically pump in water into the plant and humidity tray whenever signaled by Arduino Nano.
- It has an LED light attached which signals when the battery is low and when the Smart Pot is charging.
- A hole is constructed at the bottom of the Smart Pot to put in the power supply.
- A water pump is fixed at the center of the pot for pumping water into the soil.
- A water pump is also located at the base of the Smart Pot to fill water in the humidity tray to create an artificial humid environment.
- Arduino Nano and Wi-Fi modules are enclosed below the pot.
- Soil moisture sensor and pH sensor are fixed inside the Smart Pot.
- BH1750 and Temperature/Humidity sensor are fixed on the upper part of the Smart Pot.
- A water level sensor is fixed inside the water tank of the Smart Pot to help in monitoring the water level and to notify when water needs to be added.

2.4. Plant Dataset

As per the requirements and living conditions required for every individual houseplant. A dataset is created considering the various datapoints required in proper operations of the Smart Pot and maintaining the good health of the plant. The various data points that need to be considered for making the Smart Pot efficient include- soil moisture required, sunlight required per day, the optimum amount of lux, soil pH level, temperature, and humidity.

3. Result

The android application and Arduino Nano combined with the various sensors makes it possible for the plant to communicate with the user. It helps in curbing down the responsibility of the plant owner. So far, the Smart Pot was prototyped on a bonsai plant. It was successful in conducting the functions of uploading and retrieving the data. It carries all the tasks as stated in acting as a good monitoring [6][9] system and helping in maintaining the good health of the plant.

It helps in reducing the responsibility of the plant owners by proving automatic water supply in the right amount and constant reminders if the plant is in need. It also helps those plant owners who do not have the right knowledge to take care of the plant and might end up harming it. The Smart Pot will prevent many houseplants from dying by proper monitoring and maintaining of the houseplants. Figure 3 shows the various components which come together in producing the output stated.

Fig. 3 – Internal Components of Smartwatch

4. Future Scope

In today's world, everybody is keen to keep houseplants which provides a lot of benefits to health and moreover acts as a symbol of peace. The demand for houseplants has gradually increased with time and is still increasing at an exponential level. But houseplants demand a lot of care which becomes difficult for the working professionals and even the other people who tend to forget in taking care of their plant. Thus, this Smart Pot acts as a feasible solution to the current and future prospects. Smart Pot has made it possible for the house plants to communicate with their owners and for most of the tasks, it provides an automatic [5] solution. That day is not far away when we will be able to talk to plants as human beings with the help of computing. This Smart Pot is the stepping stone towards the future.

4. Conclusion

This paper elaborates in detail the need for Smart Pot to help in taking care of the indoor plants. The Smart Pot will provide the basic support by the use of various sensors embedded in the smart pot which in turn will improve the health of the houseplants and lower the responsibility of the owner by connecting technology with the plant's pot[15]. The gentle reminders for taking care of the houseplants will result in increasing their life span. This smart pot takes us to the new era where plants are able to communicate to their owners with the help of sensors and a mobile application.

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