Hong Kong Student Science Project Competition 2022

Team Number: JAPE254

Project Title: KIA(Keep It Alive)

Project Type: Invention

To our best knowledge and after thorough literature research, as at 30/6/2022, there ~~are/~~ are no[*] similar works.

I.   Background

Many people in Hong Kong grow plants in their home, but it would be a problem for people growing plants at home but have to travel aboard. It would save much effort if supplement of nutrient can be added automatically to the plant.

Among all the nutrients for plants to grow, the level of nitrogen, phosphorus and potassium (NPK) are measured as they are three major types of nutrients that are required by plants (Fayaz, 2016), deficiency of either of them would cause much damage to plants.

There are already well-developed smart planting systems can be found on the internet (Ji, 2015), yet they are made for large greenhouse, the scale is too large to be set in normal household of Hong Kong and not very user friendly as it needs to be run by experts.

There are also many different types of automatic watering devices in the market, there are even DIY videos to make one (Gutiérrez, 2014). However, some of them are adding water in a very low speed using pressure difference, which should not be considered as automatic ones. Some of them involve the checking of the humidity together with the addition of water, which the addition of the water is difficult to control and it might cause the soil to become water-logged. In addition, they are made for adding water only to the soil, other chemical that are necessary for the plant are not included. (Nonthaputha, 2020)

There is no device available in the market for household, which can monitor the level of nutrient and supply nutrient automatically to the soil. We would like to make a device that can effectively add in nutrients to the plant, by continuous monitoring of the nutrient level

II.   Objectives

To design a device that can supply nutrient automatically to the soil with deficient of NPK to fit Hong Kong users

III.   Methodology

Apparatus:
Electronic balance, beaker, spatula, glass rod, measuring cylinder
Chemicals:
Ammonium nitrate, sodium phosphate, potassium chloride, distilled water, soil
Materials:
Soil detector, OLED display, pumps, connecting wires, modules for detection and modules for pumps, power supply

The device involves a part to check if there is sufficient amount of nutrient in soil. And another part to add nutrient if the amount of nutrient in soil is not sufficient. Our design based on the negative feedback mechanisms to provide a relative constant environment, preventing the depletion of the nutrients to plants.

IV. Design of Invention

There are two major parts of our design.

1. Detection of the NPK level in soil

We have selected a NPK sensor for the measurement as it can provide continuous, quick and accurate data about the NPK level in soil. Together with the connection of an OLED display with programming, the NPK level will be shown on the OLED display once the sensor is inserted in soil.

2. Adjustment of NPK level of the soil

Our design also includes three pumps put in three chemical solutions, namely ammonium nitrate, sodium phosphate and potassium chloride. Each of them provides nitrogen, phosphorus and potassium to the soil respectively. There are also connecting tubes from the three solutions to the soil. If the measurement of NPK level of the soil shows that there is deficiency of any type of nutrient, the respective pumps will be activated and add the deficient chemical solution into the soil until the nutrient level return to the threshold value. Both the programming of detection and the adjustment of the fertility of the soil was done using Arduino.
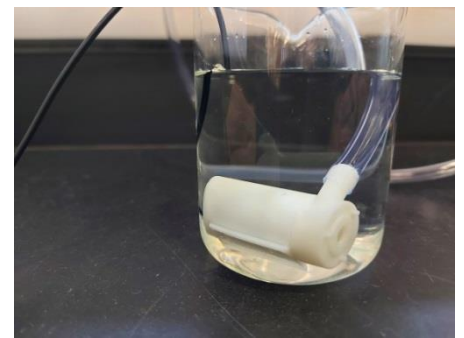
V. Application / Market Need

This device is made for families that grow plants at home but would leave home for a long period of time and for people that have no time to take care of the plants. With this device, people need not to worry that there is no one to take care their plants when they have to travel aboard or while they are busy with their work.

There are already well developed smart planting systems can be found on the internet, yet they are made for large greenhouse, the set-up is too big to be set in normal household of Hong Kong and not very user friendly as it needs to be set by experts. Our product is designed for Hong Kong household use and can be easily modified to suit different type of soil and plants by changing of the sensor or simply change the threshold, our product is much more flexible than those available in the market for large greenhouse or a big farm.

There are many different types of automatic watering devices in the market, there are even DIY videos on making one. However they are mostly for adding water only to the soil. Our design can monitor the amount of nutrient in the soil and give the soil appropriate amount of nutrient with water.

Our model aims to demonstrate how to measure the NPK level by the device and make the level to resume to the threshold level. As different type of plants have different requirement of the three nutrients, the threshold needed to be adjusted for each type of plant.

In addition to NPK, there are actually other nutrients required by the plant, like magnesium ion, one major limitation of our device is that it can only cater the need for NPK but not for other nutrients.

VI. Conclusion

A workable model of our design has been made, with the NPK level can be maintained at constant level.