New Gen City Farming

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Abstract

Food insecurity caused by rapid population growth has pressured science and technology to advance in a faster pace to produce and maximize plant growth. The robotic technology is used in sowing, transferring plants and harvesting stages. A greenhouse farm internet of things (IoT) server works hand in hand with robotic and is capable of adjusting its functions to suit the type of crops, weather, watering amount and fertilizers.

Keywords: Food security, Maximize Plants Growth, Robotic Technology, Information Technology

1.0 Introduction

In the modern era, the population is increasing and therefore the demand of food is rising. This requires more food to be produced by agricultural sectors. However, the efficiency of food crop production is very much dependent on environmental factors. Moreover, global warming and constant weather change have affected the accuracy of planting crops based on weather conditions. Plant crops require different amount of sunlight and water. The amount of fertilizers and nutrients needed is also vary among crops. Hence, growing food crop requires constant human supervision, adequate control and it is a very time and resource consuming job.

Farming require a lot of land and normally agricultural land is in the rural areas but sometimes it may also involve land area in the cities. The New Gen Farming is an innovation method that take places in a greenhouse using the hybrid vertical farming concept associated with the latest Internet of Things (IoT) and robotics technologies. We used IoT to invent a greenhouse farm server which is capable of adjusting its functions according to the type of crops, weather, watering amount and fertilizers. The New Gen Farming provides 24 hours data collection for subsequent analysis. This invention applies IoT-based smart farming system which support industrial 4.0 in agriculture. Furthermore, the farm robot (iFarmbot) could replace farmer supervision. iFarmBot carries out its functions precisely at various levels of farming from sowing, transferring plant and harvesting. This integration of robotics and digital internet technology will serve people, plant and environment well. This will bring positive impact when farmers start to adopt this technology in their farms worldwide.

One of the major problems facing by agriculture is the loss of agricultural land. Worldwide, around three million hectares of agricultural land are lost every year due to the exposure to erosion by wind or water and the soil degradation. According to UN projections, the world's population could reach 9.15 billion by 2050, creating a 60 percent increase in demand for food (United Nation sustainable development goals - Zero Hunger, 2018). The challenge now is to produce more food with less farmland and ensuring the access to food by the most vulnerable.

Leafy greens travel an average of hundreds of miles to reach consumer's plate. Some produce lost up to 45 percent of its nutritional value along the way. Produce is bred to survive long

journey with its aesthetics, but not necessarily its flavor or its nutritional value (Plenty, 2017). Most farmlands in Malaysia are located at the outskirt of highly populated cities due to the short of space and cheaper agricultural cost. Transportation by road is used to send fresh vegetables from farm to supermarkets and this would introduce additional cost to the fresh produce. Consequently, these contributed to higher food price and affecting food security. However, this can be solved by introducing vertical farming. Despommier (2010) takes us on an incredible journey inside the vertical farm, buildings filled with fruits and vegetables that will provide local food sources for entire cities, by utilizing vertical farming in the city to grow more vegetables. The provision of food crops - from farm to table - would appear to countervail many contemporary trends in the production, processing, distribution and marketing of food in general (Buck, 1997).

New Gen Farming combines both outdoor and indoor farming as a hybrid vertical farming technology. It helps to promote optimum growth for plants. Our greenhouse has a system for the monitoring of crop field with the help of internet connected sensors as well as automating watering and fertigation systems. Unlike normal greenhouses which do not have smart and intelligent systems, our greenhouse is fully autonomous and does not require human supervision. With IoT-enabled smart system, farmers can easily track variety of environmental variables and make informed decisions. Smart farming is a necessary innovation to deal with all the challenges they face in farming (IoT in agriculture – a way towards smart farming, 2018).

In our study, New Gen Farming was designed to solve genuine problems faced by farmers with intentionally simple, economic appropriate technology and reduced manpower resources. New Gen Farming is capable of producing higher crop yields to feed increasing population and increasing environmental protection with less crops damage and fewer inputs such as water, fuel and fertilizer. The objective of our project was to develop a highly efficient farming system for optimum plant growth with good yield, reduced constant human supervision and cost by using agriculture Internet of Things (IoT) and robotics technology.

2.0 Methodology

An innovative solution New Gen Farming was designed to solve the agricultural issues with the objective to promote sustainable agriculture and achieve food security using internet of things (IoT) and robotics technology.

2.1 Materials

New Gen Farming was developed with the three main components:- robot farmer (iFarmBot), vertical farm robot and optimum growth system. The features and functionalities of each component are discussed as follows:

2.1.1 iFARMBOT

The farm robot, iFarmBot, replaces farmer supervision. iFarmBot is responsible to command the vertical farm robot to carry out its functions precisely at various levels of farming from sowing, transferring plant and harvesting. iFarmBot carries a multifunction arm which consists of seed dispenser, gripping arm with harvesting cutter. iFarmBot has a unique movement that can access to different heights of vertical farm.

2.1.2 VERTICAL FARM ROBOT

Vertical farm robot consists of soil dispenser and smart tray system. Soil dispenser can dispense soil of precise amount automatically to each row of seedling trays. Smart tray system uses pulley system with precise positioning of the tray. It uses motor with high power gearing to move heavy loads of plants with tray sensing.

2.1.3 OPTIMUM GROWTH SYSTEM

A smart IoT greenhouse for farming consists of a farm server and four smart farm working components which are smart roof, watering system, fertigation system and lighting system. It is equipped with sensors (light, humidity, temperature, soil moisture and vision) for automating watering, fertigation and lighting systems.

2.2 Method

2.2.1 *Smart IoT Greenhouse with A Farm Server*

The farm server was operated by Raspberry Pi 3 and Arduino Uno using Node-red IoT Programming and Sketch Programming. Raspberry Pi 3 was used as an internet connected farm server with satellite weather monitoring system for farm management analysis to manage crop yield better, cheaper and efficiently. Node-red IoT Programming analyzed weather and make adjustment accordingly. This system uses Open Weather Map for precise prediction of rain, humidity, UV levels, air pollution and agricultural parameters. The data were analyzed and fed into the smart control components via Arduino. Smart IoT greenhouse provides 24/7 visibility of soil and crop health, water and energy consumption. Farmer can access all the data and settings via a single Web application dashboard.

2.2.2 *Four smart working components of Optimum Growth System*

2.2.2.1 **Smart Roof** was built with variables filters intensity. The optical properties of the greenhouse roof can be adjusted according to the amount of sunlight based on Open Weather Map. The motorized switchable filters provide optimum growing condition according to the needs of the crops.

2.2.2.2 **Watering System** uses Open Weather Map to have precise prediction of rain, temperature and humidity. The amount of water needed depends on the types of crop and weather condition. This system uses sprinklers or water drip technology to reduce water wastage. It controls the sprinklers according to Open Weather Map with the monitoring feedback from the soil, humidity, and temperature sensors. It can collect the rain water for optimum farm water distribution.

2.2.2.3 **Fertigation System** is the application of fertilizer with irrigation water. Drip irrigation applies fertilizer slowly, directly to the soil around the crop. It uses camera with IBM Watson Vision sensing to monitor the leaves, plant, size and colour. The application of fertilizer is based on the crop growth rate. This helps to avoid wastage of fertilizer and increase crop yield in an efficient way.

2.2.2.4 **Lighting System was built to** allow crops to keep growing with sunlight and LED lights that offer outstanding uniformity and superior intensity of light as much as 16 hours a day. Smart lighting system can change the colour of the LED lights to suit different stages of the crops. It controls the lighting system according to the monitoring feedback from the light sensors. The LED lights will turn on even during the day according to weather condition with Open Weather Map.

3.0 Results and Discussion

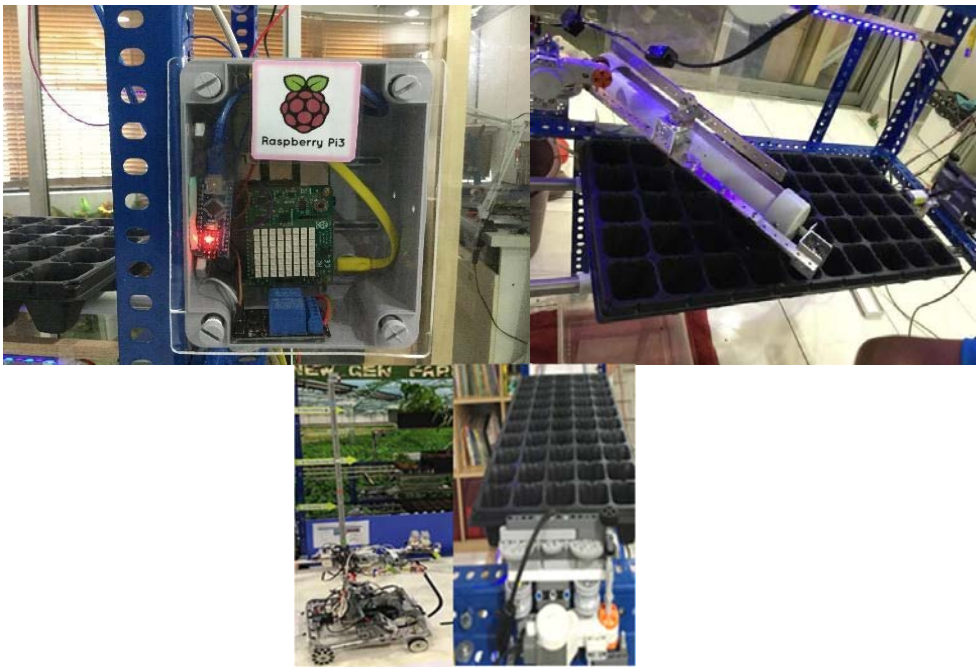

Figure 1: NEW GEN FARMING - Farm Server, Soil Dispenser, Smart Tray and iFarmBot

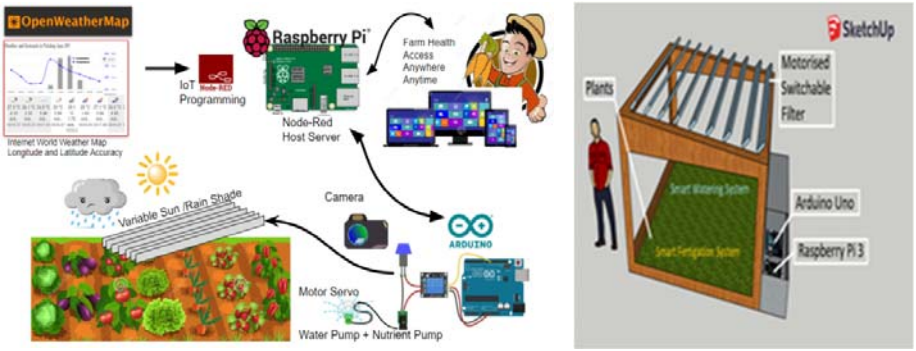

Figure 2: The New Gen Farming System Flow Chart and 3D System

In this study, the New Gen Farming system is potentially useful for unlimited vertical farming expansion. No additional human resource required since it is using robotic technology and Internet of things (IoT). The greenhouse smart roof is capable to adjust according to the weather and local conditions. Vision sensing is used for precise plant growth monitoring. Farmer could apply artificial intelligence for data analysis and control the farm remotely via internet. In addition, our project uses robot technology for sowing, transferring plants and harvesting. The New Gen Farming provides optimum plants growth and good yield while reducing constant human supervision and cost with precise farming by using agriculture Internet of Things (IoT) technology.

4.0 Conclusion

Our project grows vegetables faster, with less water usage and electricity. By using hybrid vertical farming combine with weather optimum growth system, this system is potentially useful to promote sustainable agriculture and achieve food security using IoT and robotics technology. It could provide fresh local produce to communities.

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