IoTs Smart Vertical Hydroponics with Microcontroller

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Abstract

• This research has been designed the automated control systems based on Raspberry Pi microcontroller for the vertical hydroponic systems. Technically, to control environmental factors of the vertical hydroponic greenhouse, the sensors such as Electrical Conductivity (EC), Potential of Hydrogen ion (pH), Air temperature, Relative humidity, Water temperature, and Dissolved Oxygen (DO) as well as Lighting system will install on the vertical hydroponic systems. Nevertheless, the measured value of sensors is processed by the microcontroller to monitor and control a motor, a humidifier, a water pump and a ventilator. And then, the measured value send via the wireless network to the smartphone of the farmer.
Introduction

• The vertical hydroponic is an alternative to grow vegetables for the limited space because it can also be stacked vertically to save the several times of space.

• Unsuitable environment hindrance the growth of such as labor shortage, limited of time, disease and insects.

• Therefore, this research is aiming to develop an automated control system based on Raspberry Pi microcontroller to monitor and control the factors of the environment related to the growth of the vegetables.
Objectives

• To design the automated control system for the vertical hydroponic greenhouse based on Raspberry Pi.

• To monitor and control the environment factors of the vertical hydroponic greenhouse via the smartphone such as Electrical Conductivity (EC), Potential of Hydrogen ion (pH), Air Temperature, Relative Humidity, and Water Temperature,
Overview of the Automated Control System

Sensor Interface
- Air Temperature Sensor
- Relative Humidity Sensor
- Water Temperature Sensor
- Electrical Conductivity Sensor (EC)
- pH Sensor

Microcontroller
- Serial Port Expender
- Raspberry Pi 3 Microcontroller
- Relay Board
- LCD Monitor Display

Hardware
- Water Pump
- Nutrient Solution Pump
- Lighting
- Fan
- Humidifier

IP Camera → Gateway → Cloud → Dashboard on Mobile
Overall of the vertical Hydroponic Control System

- Solar cell
- Combiner Circuit Breaker
- MPPT Solar Charger
- Battery
- 240 VAC
- The Vertical Hydroponics Greenhouse
- The Automated control System
- Cloud Server
- Router Gateway
- Personal Computer
- Smart Phone
Methodology of Research

- Design Greenhouse for the vertical hydroponics.
- Design and install the air circulation system and lighting system which the appropriate intensity to the growth of vegetables.
- Install the temperature & humidity sensor, EC sensor, and pH sensor to the Greenhouse.
- Design program of connection devices related to the growth of vegetables via the internet of things (IoTs).
- Set up the application to show the value of the sensors and observe the shape and size of vegetables via IP camera.
- Planting and controlling the factors that affect the growth of plants.
- Evaluate and summarize the automated control systems.
The Automated Control System

Condition

Light 1, Light 2
Main pump
ON 6:00 am-18:00 pm
OFF 18:00 pm-6:00 am
Fan
ON Air Temp. > 32 °C
OFF Air Temp. < 30 °C
RH
ON RH. < 50 %
OFF RH. > 60 %
A-pump, B-pump
ON Value setting
OFF Value setting

Vertical Hydroponic Control System

Air Temp.= 30.80 c RH.= 66.30 %
Water Temp.= 33.50 c
pH= 6.25
EC= 0.00 us/cm
DO= 1.67 ppm
ORP= 79.30 mv

Fan: OFF RH.: OFF
Fan-2: OFF A-Pump: OFF
B-Pump: ON Light-1: ON
Light-2: ON Main Pump: ON

Exit
The Automated Control System by Smartphone

Smartphone Display

- **Dashboard**
  - **Water**: 25.0
  - **Temperature**: 25.50
  - **Humidity**: 64.90
  - **EC**: 0.00
  - **pH**: 2.71

- **Smart Farm by TISTR**
  - **Manual**
    - Temperature
    - Humidity
    - Temperature Water
    - EC
    - pH
  - **Smart Farm by TISTR**
    - **Setup**
      - **Toroid**: 25
      - **Spin**: 30
      - **Spin**: 60
      - **Spin**: 90
      - **Scan**: 60
      - **Scan**: 30
      - **Scan**: 9
      - **Scan**: 12
      - **Scan**: 5
      - **Scan**: 8

- **Smart Farm by TISTR**
  - **Manual**

- **Smart Farm by TISTR**
  - **Manual**

- **Smart Farm by TISTR**
  - **Manual**
The Results

- The Vertical Hydroponic Greenhouse made up of Aluminum Profile: Height 180 cm. × Length 170 cm. × Width 110 cm., and cover with the white Vinyl. The automated control system composed of:
  - 240 V AC 200 Watts for the LED Lighting System
  - 240 V AC 35 Watts for the Water Pump
  - 240 V AC 65 Watts for the Ventilation Can Fan
  - 12 VDC 1.4 Amp 17 Watts for Nutrient Solution Pump
  - 12 VDC 1.5 Amp 18 Watts for Router
  - 12 VDC 1.5 Amp 18 Watts for IP Camera
  - 240 V AC 60 Watts for The Automated Control System
  - Solar Cell produce the power about 1800 watts charged in battery 12 VDC 100 Ampere × 4 unit

- The Total Power Consumption for the Vertical Hydroponic Greenhouse is 400 Watts, approximately.
The Wave Length of the Lighting System in Used

380-780nm
The Results

The First Crop for 6 Weeks

The Quantity of Vegetable is about 6 Kilogram.
The Results

The Second Crop for the another vertical Greenhouse.
Conclusion

• The Automated Control System can work smoothly on each environmental factors.
• The smart vertical hydroponic Greenhouse has been showed the good performance under the setting condition.
• To improve this system, its necessary to increase 200 Watts of lighting system and feeding CO$_2$ in order to accelerate the growth of the vegetables.
References


Thank you