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IoT Empowered Harvest : Advancing NFT Hydroponics with Smart Agricultural Automation

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ABSTRACT

For every nation, farmers play the most essential role and that is to feed the population. In the urban areas there is lack of open green space for farming and even if the land is available it is infertile for plants to grow on them. Problems faced in urban areas farms are due to the toxic elements let in the soil. The sources of toxic metals and effluents in urban soils are mainly from emissions from industries, automobiles, industrial as well as domestic sewage. In urban areas, people are busy in their work which leads them to buy pesticide and chemically treated food which in injurious to health and they are unable to grow organic vegetable at home due to deficit of space, time and un-fertile soil.

Hydroponics is the method of cultivating plants without soil. Water with oxygen and required minerals acts as the cultivation medthod. Smart Hydroponic Farming using the NFT Method helps the farmer to stay connected to their farm anytime and anywhere. This hydroponic system requires special attention to several parameters such as the water temperature, water level, acidity (pH), and the concentration of the nutrient (EC/PPM). We first monitor and collect information from NFT Hydroponic farmer and then systematically evaluate and analyze them. Unfortunately, it is still controlled by using the conventional way (human), for example in controlling the concentrations of nutrient has to be done at least once a day, so much time is wasted. In addressing these issues, we need a system that can be applied and used easily.

We built a hydroponic monitoring and automation system that can monitored using sensors connected to the Arduino Uno microcontrollerm, Wi-Fi module ESP8266 and Raspberry Pi 2 Model B microcomputers as the webserver with the concept Internet of Things, in which each block hydroponic farming can communicate with the webserver (broker). Web used as the interface of the system that allows user to monitor and control the NFT hydroponic farming. The

NFT hydroponic web interface management systems using a responsive web framework, such as Bootstrap for the front-end, JQuery and JavaScript libraries. The result shows that this system helps farmers to increase the effectivity and efficiency on monitoring and controlling NFT Hydroponic Farm.
Keywords: Hydroponic farming, nutrient film technique, internet-of things, urban farming, Arduino Uno microcontrollerm, Wi-Fi module ESP8266 and Raspberry Pi 2 Model B

I. INTRODUCTION

Hydroponicsis a technique of growing different varieties of plants or vegetables without using the medium of soil (Soil-less Medium) but using mineral or nutrient solutions mixed with water and on the technique of hydroponic system used, the plant's roots are dipped in water streams or misted with the nutrient mixed water solution in a way such that the plant can absorb the elements it needs for its growth cycle. In this project the aim is automating the process of hydroponics systems using ESP32S Microcontroller along with different sensors and high-power devices. Our system is based on automating the hydroponics system.

The Manual Hydroponics System using NFT

This NFT method is used for developing green leafy plants with short heights. It's called as Nutrient Film Technique because a thin and constricted flow of water moves over the channel and the nutrient stream forms thin film at the bottom.

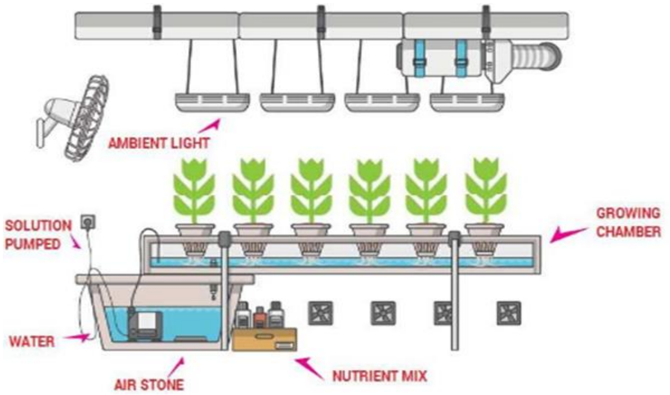


Figure 1: 1Manual Hydroponics System

The channels are kept slopping for the nutrient film to easily flow. Plants are first grown in the nursery and transplanted into the channels. To transplant into the channels net pots are mostly used along with a bit of growing medium to hold the toots in place at the beginning. One can design NFT system in many ways but there are few components that every system should have:

- Reservoir: Here the water is blended with nutrients in proper proportion before providing to the plants. It is placed beneath the water channels and water is siphoned upwards to the channels.
- Air Pump: It is utilized to aerate the water in other words to oxygenate it in the reservoir with a steady wind flow output.
- Air Stone: It has a miniaturized pore design which stimulates the developing solution as it oxygenates and circulates the nutrients.
- Water Pump: Water pump is essentially used to transfer water from the source of water to the repository whenever water in the reservoir goes underneath some specific level and also to pump water from the reservoir to the water channel to feed the plants.
- Net Pots: These are utilized to advance bigger and healthier roots. It is easy to maintain cleanliness of the net pots. This container makes it easier to snatch, lift and relocation of the plants.

II. METHODS AND MATERIAL

Farmers can use an IoT-based system and a mobile application as part of the Smart Agriculture System. On the hardware side, we have an Internet of Things-based system that measures numerous metrics such as soil moisture, temperature, and humidity. An android app for farmers is included in the software section. We created an Android app that is connected to the hardware system via IoT and alerts the farmer so that he or she may monitor the live status of temperature, humidity, and other field factors at any time using the app.

IoT SYSTEM

Temperature-Humidity (DHT11), Soil moisture, and other parameters are monitored using an IoT-based system (soil moisture sensor). The IoT system's circuit diagram is shown in the diagram below.

1. Temperature and Humidity sensor (DHT11)
The DHT11 is a basic digital temperature and humidity sensor with a modest price tag. It measures the ambient air with a capacitive humidity sensor and a thermistor and outputs a digital signal on the data pin. It is simple to use, but data collection takes careful scheduling.
To find dew point, dew point=(C-(100-H)/5) Where,
C=temperature value in degree Celsius
H=Humidity value

2. Soil Moisture Sensor
A soil moisture sensor is a device used to determine the volumetric water content of soil. The sensor uses other soil indirectly detect volumetric water content without removing moisture. Because environmental factors like as soil type, temperature, and conductivity might affect the outcome, it must be calibrated. properties like as electrical resistance or conductance, dielectric constant, and interaction with other neutrons to indirectly detect volumetric water content without removing moisture. Because environmental factors like as soil type, temperature, and conductivity might affect the outcome, it must be calibrated.

3. NodeMCU
NodeMCU is an open-source firmware. The firmware as well as the prototyping board designs are both free sources [10]. The firmware was created using the Espressif Non-OS SDK for ESP8266 and is based on the eLua project. It makes use of a number of open-source projects, including lua-cjson and SPIFFS. Users must select the components important to their project and construct a firmware tailored to their needs due to resource limits.
A circuit board that functions as a dual in-line package (DIP) that merges a USB controller with a smaller surface-mounted board housing the MCU and antenna is commonly used as prototype hardware. The design was based on the ESP8266s ESP-12 module, which is a Wi-Fi SoC with a Tensilica Xtensa LX106 core that is frequently used in IoT applications.
These sensors collect data such as temperature, humidity, and moisture level from the farms and send it to the Node MCU, where the data is stored (ESP8266). Node MCU is a Lua- based open-source firmware and development board designed specifically for IoT applications. It consists of firmware that runs on Espressif Systems' ESP8266 Wi-Fi SoC and hardware that is based on the ESP-12 module. The values from the sensors are kept in the Node MCU's connection to the IoT analytics platform service ThingSpea

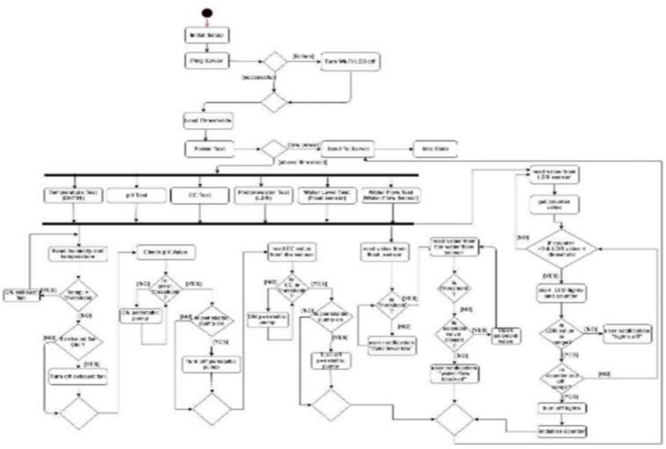
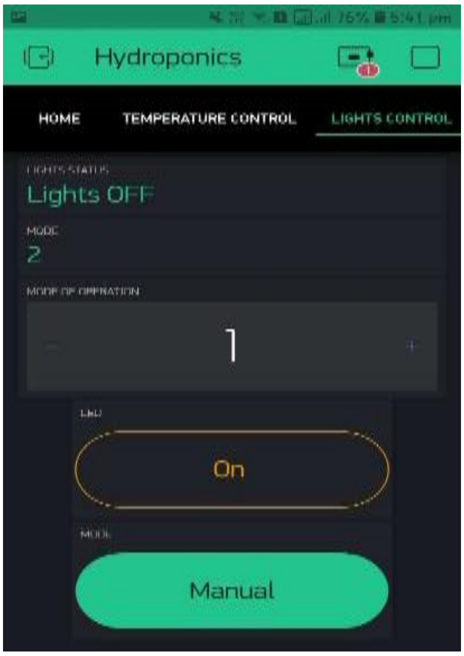


Figure 3 : System Activity Diagram

III. RESULTS AND DISCUSSION

In our automated Hydroponics System using ESP32S all the sensors were interfaced successfully. There were four modules created they are Environment control Module, Nutrient Dispel System, Lighting System and water Cycle system were implemented along with user interface in the form of website and app.

Figure 4 : HydroponicsSystem Prototype with Lettuce



Plants Grown

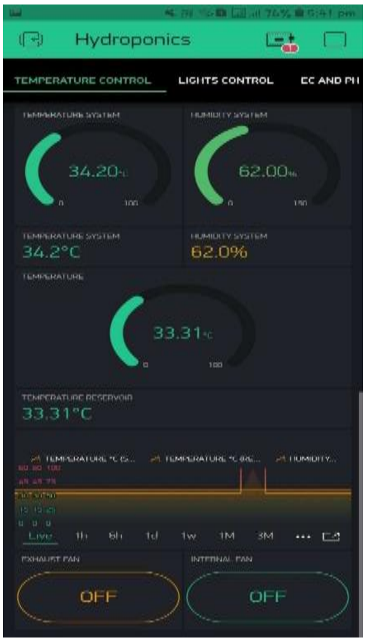


Figure 5 : User Interface

Figure 6 : User App

IV. CONCLUSION

This research was focussed on interfacing and integrating all the functions of the Hydroponics system together using the ESP32 microcontroller which is easily available at an affordable price. The hydroponics system uses NFT (Nutrient film technique to grow the plants and all the functions of the system can be controlled remotely using wi-fi enabled ESP32. All the sensors were interfaced successfully and the data collected from the sensors can be viewed on the user app and based on the data displayed the user can take appropriate actions without manually being present at the prototype. The user app was developed using Blynk IOT platform and the ESP32 microcontroller was programmed using Arduino IDE.

The cost of the project is including the cost of the prototype is rupees 28,808 and is the cheapest in the market as it has only one microcontroller chip and all the sensors are integrated and can be controlled via an app which has simple user interface.

This project can also be scaled for large farm lands without any changes in hardware and software and the setup of the project is simple.

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