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Hydroponics For Farm System

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Abstract: **Hydroponic systems offer an innovative approach to agricultural cultivation, eliminating the need for soil and maximizing resource efficiency. This study presents the design and implementation of a novel hydroponic system tailored for sustainable farming practices. The system integrates advanced nutrient delivery mechanisms, precise environmental control, and optimized plant growth parameters to enhance crop yields while minimizing resource consumption. Through a combination of hydroponic techniques such as nutrient film technique (NFT), deep water culture (DWC), and geoponics, the system provides an ideal growing environment for a wide range of crops. Additionally, the integration of smart sensors and automation technologies enables real-time monitoring and adjustment of key variables, ensuring optimal plant health and productivity. The results demonstrate the effectiveness of the hydroponic system in promoting efficient water usage, nutrient utilization, and overall crop yield, thereby offering a promising solution for sustainable agriculture in the face of increasing global food demand and environmental challenges.**

Introduction

Hydroponic systems revolutionize agriculture by enabling soilless farming, where plants grow in nutrient-rich water solutions. This method offers precise control over nutrient levels, water usage, and environmental factors, maximizing crop yield in limited spaces. Through this technology, farmers can cultivate a wide variety of plants efficiently, making it a sustainable solution for future food production

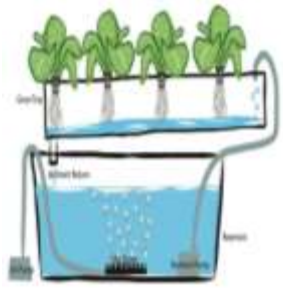
Over time, humanity has strived to maximize agricultural yield through various means such as increased energy subsidies, genetic modification, and pesticide use. However, recent decades have seen a shift towards optimizing for environmental wellness, considering factors like plant growth, shipping, and storage processes. Urban farming, leveraging high carbon dioxide levels in cities, presents a sustainable solution. Hydroponics emerges as the most efficient method for future food production, offering scalability and sustainability benefits.

A study conducted for Electrometric Innovations in Nagpur focuses on designing a hydroponic system for households and offices, emphasizing scalability and sustainability. Although scalability is limited, off-the-shelf modules are utilized to address user needs and sustainability requirements.

Understanding plant processes like light, water, and nutrients guides component selection. While optimizing light spectra can enhance growth, the focus remains on basic requirements rather than advanced growth stages. Smart farming technologies play a crucial role, automating monitoring and control of environmental factors like light intensity, TDS, and humidity. This fully automatic hydroponic system integrates into agricultural education, incorporating business skills.

Utilizing IoT for data transfer and storage, alongside a mobile app for real-time monitoring, ensures efficient maintenance and user communication. High data analytics improve accuracy over time, enhancing system performance.

Hydroponics offers numerous advantages over traditional soil-based agriculture. By excluding soil, issues related to soil-borne diseases, pests, and weeds are eliminated, reducing the need for harmful pesticides. Additionally, hydroponic systems use recalculating water, minimizing water usage and



space requirements, making them suitable for urban areas with limited cultivable land. This method also ensures a fresh and healthy yield of crops.

Fig 3.1: Generalized Hydroponic setup

Furthermore, hydroponics does not compromise the quality of fruits and flowers produced, and it allows for efficient monitoring and control of environmental parameters such as air temperature, root temperature, humidity, and TDS (total dissolved solids) through IoT technology. This monitoring and control system enables real-time data transmission and stable conditions for optimal plant growth.

Overall, hydroponics represents a sustainable and efficient farming system that addresses the challenges of modern agriculture while paving the way for smart and technology-driven farming practices.

MEHODOLOGY

Plants simply enhance themselves through the process of Photosynthesis, where they use sunlight in the presence of chlorophyll to convert carbon dioxide and water into glucose and oxygen. Chemically,

$$6CO_2 + 6H_2O \rightarrow C6H1_2O_6 + 6O_2$$

In this whole process of plant growth through the phenomenon of photosynthesis there is no requirement of soil. Neither does the chemical reaction mention it anywhere. Hereby, the proof that plant can be grown without soil. Several hydroponics tests have shown that the yields are much higher and profitable when they switch from the traditional growing through soil. Since all the nutrient rich solutions needed by plants are readily available to them in hydroponics method, they don't have to search and dig and wait through the soil anymore, therefore yielding better growth and results.

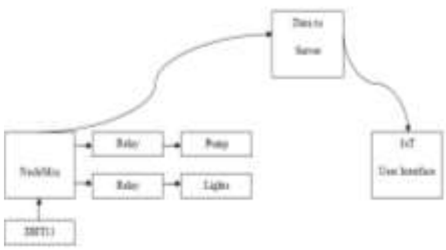


Fig Generalized Block Diagram

Hydroponics, with its efficient use of space and resources, offers a promising approach to modern agriculture. By cultivating plants without soil, hydroponic systems allow for smaller root systems, directing more energy toward leaf and stem growth. This not only maximizes plant productivity but also enables cultivation in areas previously deemed infertile. With space-saving benefits, hydroponics presents the opportunity to grow more plants in limited spaces, enhancing agricultural output.

However, the initial setup and maintenance costs of hydroponic systems can be prohibitive. Additionally, ensuring optimal plant growth requires diligent monitoring and adjustment of environmental factors such as water levels and temperature. Traditional hydroponic systems lack the intelligence to predict plant growth based on nutrient intake patterns, leading to potential nutrient deficiencies.

To address these challenges, IoT (Internet of Things) technology is being integrated into hydroponic systems. By employing sensors interfaced with microcontrollers, IoT-enabled systems can monitor water levels, temperature, and other parameters in real-time. Data is then transmitted to the cloud for remote access and analysis, enhancing efficiency and convenience in plant management.

One crucial aspect overlooked by traditional systems is the prediction of plant growth based on daily nutrient intake patterns. To address this, advanced sensors such as humiture sensors are employed to estimate temperature and humidity, providing insights into optimal growing conditions. Additionally, TDS (Total Dissolved Solids) meters measure nutrient concentration, allowing for precise nutrient management.

Automation plays a vital role in optimizing hydroponic systems. Relays are utilized to control various components such as lights and pumps, ensuring timely delivery of essential resources to plants. Submersible pumps, integral to hydroponic setups, facilitate the circulation of nutrient solutions, promoting plant growth.

Steps:

1. Keeps the time
2. Reads sensors
3. Communicates with the App
4. Turns the pump on / off for certain minutes every hour
5. Turn the lights on / off
6. Transmits data to IoT user interface

Hardware

Node MCUESP8266

The NodeMCU development board is equipped with the ESP8266 chip, which features a Tensilica Xtensa 32-bit LX106 RISC microprocessor operating at 80 to 160 MHz. The ESP8266 integrates 802.11 b/g/n HT40 Wi-Fi transceivers, allowing it to connect to Wi-Fi networks, interact with the Internet, and even set up its own network for other devices to connect directly.

Here are some key specifications and features of the NodeMCU based on ESP8266:

1. **GPIO, PWM, IIC, 1-Wire, and ADC Integratio**n: The development kit combines these functionalities into a single board.
2. **USB-TTL Support**: The board includes a USB-TTL interface for easy plug-and-play connectivity
3. **10 GPIO Pins**: Each GPIO pin can be configured for PWM, I2C, or 1-wire communication.
4. **FCC Certified Wi-Fi Module**: The Wi-Fi module is certified by the FCC (coming soon).

1. **128 KB RAM and 4 MB Flash Memory**: Sufficient resources for various applications.
2. **PCB Antenna**: An onboard antenna for wireless communication.
3. **Operating Voltage:** The Node MCU operates at 3.3V.
4. **Power Pins**: VIN (for direct supply) and three 3.3V pins (output from the voltage regulator) provide power to the ESP8266 and external components.
5. **Ground Pin**: Connects to ground.
6. **Analog Input Pin (A0)**: Allows analog measurements.
7. **Digital Pins (D0 – D8, SD2, SD3, RX, and TX)**: Used for digital I/O.
8. **SPI and SDIO Support**: SPI format transfer with adjustable timing modes and SDIO interface for SD cards.
9. **PWM Channels:** Four channels for driving digital motors and LEDs.

RELAYS

Relay Basics:
A relay is an electromechanical switch.
It opens or closes circuits based on a signal, without human intervention.
Used to control high-powered circuits with low-power signals.

Working:

Normally Closed (NC):
No voltage → No magnetic field → Armature remains in initial position (NC).
Circuit stays closed.

Normally Opened (NO):
Sufficient voltage → Magnetic field → Armature attracted.
Armature connects to normally opened pin.
External circuit behavior depends on relay configuration.

Switching Action:
Energized coil → Attracted armature → Relay switches.
De-energized coil → Armature returns to initial position.

SOFTWARE

1. PROTEUS

Proteus ISIS is a comprehensive software suite for circuit design, simulation, and PCB layout. It consists of two main components:

ISIS: Used for drawing schematics and real-time circuit simulation.

ARES: Used for PCB design, including a 3D view of the PCB layout and component placement.

2. ARDUINO IDE

- Arduino IDE stands for Integrated Development Environment.
- It's official software provided by Arduino.cc.
- Used for writing, compiling, and uploading code to Arduino modules.
- Available for MAC, Windows, and Linux.
- Runs on the Java Platform.
- Supports C and C++ languages.
- Download it from the Arduino website based on your operating system.

APPLICATION AND ADVANTAGE

Applications

- In small terraces
- Large scale farms
- Farmhouses
- Homes
- Schools

- Colleges
- Restaurants
- Gardens
- Scientific kits

Advantages

- Small size
- Compact
- Cost effective
- Doesn't require soil
- Uses less amount of water
- Good crop yield
- Harvesting time is reduced

HARVESTING CAN BE DONE QUICKLY AND MULTIPLE TIMES

RESULT AND CONCLUSION

The DHT11 sensor is used for measuring temperature and humidity, with data sent to a server via NodeMCU and Wi-Fi on the thinger.io platform. This data is stored in the platform's database and displayed on a dashboard for real-time monitoring. Information from sensors can be stored for 90 days and exported as needed.

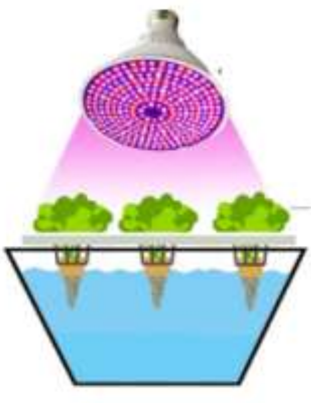


Fig: Implemented Project Model

To set up a hydroponics system, drill holes in a tube for planting cups, ensuring proper fit. Use plastic cups as plant pots, drilling holes for root access to water outside the cup. Clean clay balls in water for hydroponic use, providing nutrients and oxygen to plant roots. Create a nutrient film technique (NFT) system for water flow and oxygenation, supported by expanded clay balls as a planting medium. Connect the system using a PVC frame, powered by a 3A 12V supply for lights and a 1A water pump. Use specific hydroponic nutrients for plant growth stages and crop types. This setup optimizes nutrient delivery and oxygenation for healthy plant growth in a controlled environment.

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