Optimizing Plant Growth in Small-Scale Home Farming through IoT and Data Analytics: A Comparative Study by increasing the Container Size and Plant Quantity

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ABSTRACT

The arid Gulf region's mostly desert terrain and dry climate make it a challenging environment for plant development. Very few plant species are able to withstand these kinds of conditions, and those that do are typically inappropriate for human consumption. To overcome this issue, the project's objective is to design and construct an indoor vertical hydroponic system that is weather-independent. It takes up less room because this clever method makes it easier to produce common crops fit for human consumption in homes. After a thorough analysis of several vertical hydroponic systems—considering things like cost, power consumption, and interior automation compatibility—the system's architecture was developed. Acting as the core processing unit of the system, In order to operate every component and reduce the need for human involvement, a microcontroller interfaces with a variety of sensors. Remote access to the system's parameters is made possible by a graphical user interface that uses an open Internet of Things (IoT) platform to display and store data. With little assistance from the user, the system effectively maintains ideal growing conditions for plants. By monitoring and evaluating each component's responsiveness through the Internet of Things platform, the system's functionality was verified. In the height of summer, the system consumed 120.59 kWh in the absence of air conditioning control and 230.59 kWh in its presence; these figures translated into operating expenses of 13.26 and 25.36, correspondingly. In total, the system moved about 104 thousand liters of nutrient-rich solution with a monthly usage of 8–10 L of water. Customers may use this hydroponic system to remotely monitor parameters without the need for lab equipment, and they can get real-time notifications when adverse conditions arise. Furthermore, the system provides an abundance of data that is vital for plant scientists, improving their comprehension of the relationship between important aspects of hydroponic systems and plant growth. The technology under consideration has two applications: it can be used to automate labor-intensive maintenance tasks and optimize indoor farming systems quantitatively. The monitoring system may also assist higher-level decision-making procedures as data comes in. With the help of creative and sustainable indoor farming methods, the people of the Gulf region will have a good chance of meeting their food needs.

Keywords: Gulf region, hydroponic system, indoor farming, IoT, data analytics, plant growth optimization, sustainable agriculture, smart sensors, microcontroller, remote monitoring.

1. INTRODUCTION

To meet food demands, crop production must increase in step with the global population, which is predicted to reach 9.3 billion by 2050. But a variety of challenges, such as unpredictable weather patterns, a scarcity of water, and a lack of arable land, have an impact on traditional agricultural production methods. Modern farming methods have therefore gained popularity, most notably vertical hydroponic growing. Vertical hydroponic farming is a hybrid of hydroponic and vertical farming that use state-of-the-art research to boost productivity. It has been demonstrated that hydroponic gardening, which involves growing plants in water rather than soil, is effective in maintaining essential nutrients, minerals, and pH levels within predefined ranges. Numerous hydroponic methods can meet the need for efficient plant development, including such as aeroponic, deep flow, wick, drip, and nutrition film technology (NFT) systems. Modern hydroponic systems are automated, making it feasible to farm indoors without a lot of area and with exact control over growth conditions. Automatic vertical hydroponic systems, which enable a range of crops to be grown in houses to fit local demands, have the potential to transform the food production industry.

The Gulf countries, whose populations are growing quickly, need to find a solution to increase local agricultural production in order to reduce their dependency on imports and ensure food security. Currently, 90% of these countries' food and water needs are imported, making agriculture a critical strategic sector. Because to their sparsely forested area, dry climate, infrequent rainfall, scarcity of groundwater, and high rates of evaporation, countries such as India rely heavily on imports to meet their nutritional needs. Though the proportion of arable land has increased slightly over time, just 6% of India's land area is suitable for cultivation. The demand for vegetables in the local market is enormous, which emphasizes the necessity for creative solutions like vertical hydroponic systems to deal with these problems in agriculture.

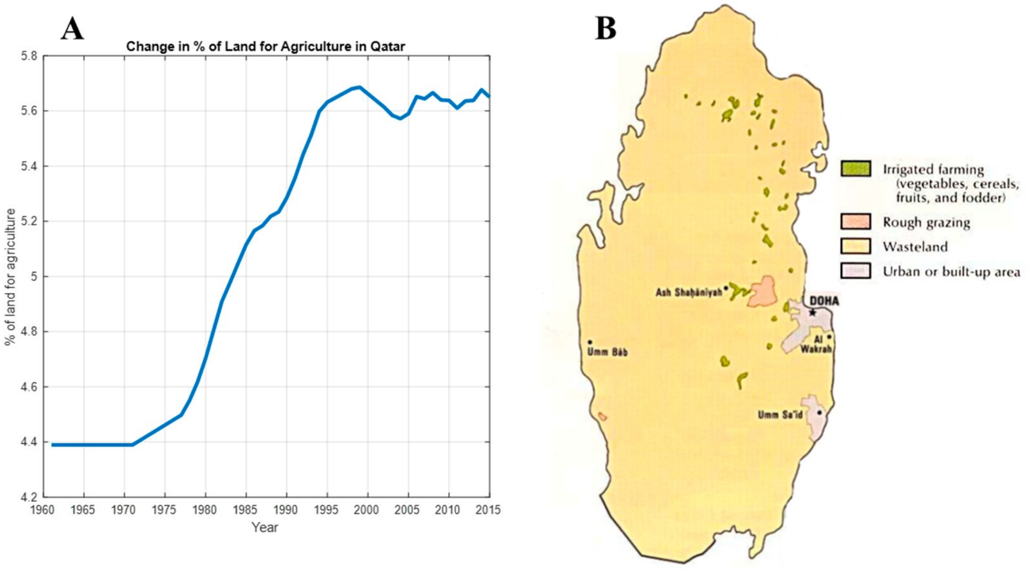


Figure 1. (**A**) Change in % of land for agriculture in india; (**B**) distribution of agricultural land

in india.

The goal of the India National Food Security Program (QNFSP) is to increase food security and self-sufficiency in food production by utilizing technology and advanced agricultural practices. With an emphasis on resource conservation and efficient use, this approach seeks to guarantee a high level of crop productivity all year round. The administration responded to obstacles, especially following a blockade, by putting strong measures in place to meet local food demand and attain total self-sufficiency. Notably, a local business called Baladna was able to effectively cover 95% of the nation's dairy goods and reach foreign markets with the help of the government.

A greater emphasis was placed on improving agricultural and aquacultural methods because, historically, 85% of India's vegetables were imported. By 2023, the QNFSP wants to see a significant rise in self-sufficiency, from 10% to 60%. The creation of a contemporary indoor agricultural system—one that makes use of hydroponic technology, in particular—becomes essential in order to achieve these objectives. By using India's experience as a case study, this paper aims to increase awareness of the critical role hydroponic systems play in encouraging sustainable agriculture and achieving food self-sufficiency. The goal is to enable residents to grow their own food in the comfort of their own homes, saving a great deal of space and money by doing away with the need for expensive greenhouse farms.

The design, execution, and evaluation of hydroponic systems are the subject of numerous research in the literature, each of which provides a different perspective. Some concentrate on particular areas, including wireless control or nutrient solutions, while others incorporate IoT platforms for remote monitoring. Nevertheless, a complete solution that takes into account power consumption and cost-effectiveness while monitoring and controlling a variety of hydroponic elements for indoor applications is still unattainable. This study fills this vacuum by providing a thorough, step-by-step account of the planning and execution of an affordable indoor hydroponic monitoring and control system that is based on the Internet of Things and is vertically automated.

Detailed design steps, a method for calibrating different sensors, a full Internet of Things solution that can be used in personal areas, and a foundation for future study toward a sustainable solution in the harsh Gulf climate are some of this work's major accomplishments. This study offers comprehensive insights into system components, cost analysis, and power usage. It is the first large-scale vertical hydroponic system installation in the Gulf region. The system's versatility and affordability make it ideal for personal farming, and its real-time monitoring features enable remote observation and action via mobile applications and web interfaces. The implemented system is discussed, a comparison with alternative systems is made, and potential future research areas are discussed in the paper's conclusion.

2. MATERIALS AND METHODS

The block diagram of the automated vertical hydroponic system includes the following six crucial parts: the online database, Wi-Fi module, vertical hydroponic structure, power meter, sensing and control system, and main power supply (Figure 2). Any smart device with an IoT platform may easily monitor every sensor built into the vertical hydroponic system. Continuous monitoring of the system's power usage is ensured by a specialized power meter module, which boosts the system's effectiveness and permits large-scale extension. In the sections that follow, each element of the block diagram will be covered in detail.

It is essential to keep certain factors, such as pH, electric conductivity (EC), ambient temperature, and water container level, within predetermined ranges in each hydroponic system. An automatic hydroponic system that works well should be able to maintain these parameters on its own without assistance from the operator. The microcontroller is connected to a number of sensors to track various hydroponic system parameters. Control over artificial lighting, water pumps, and dosing pumps—which add pH and nutrients to the water—is delegated to a panel electromechanical relay. The ESP 8266 Wi-Fi module then wirelessly transmits all of the data collected by the central microcontroller circuit to the Thingspeak web database. Information about the sensors and materials utilized in the study is included in Supplementary Table S1.

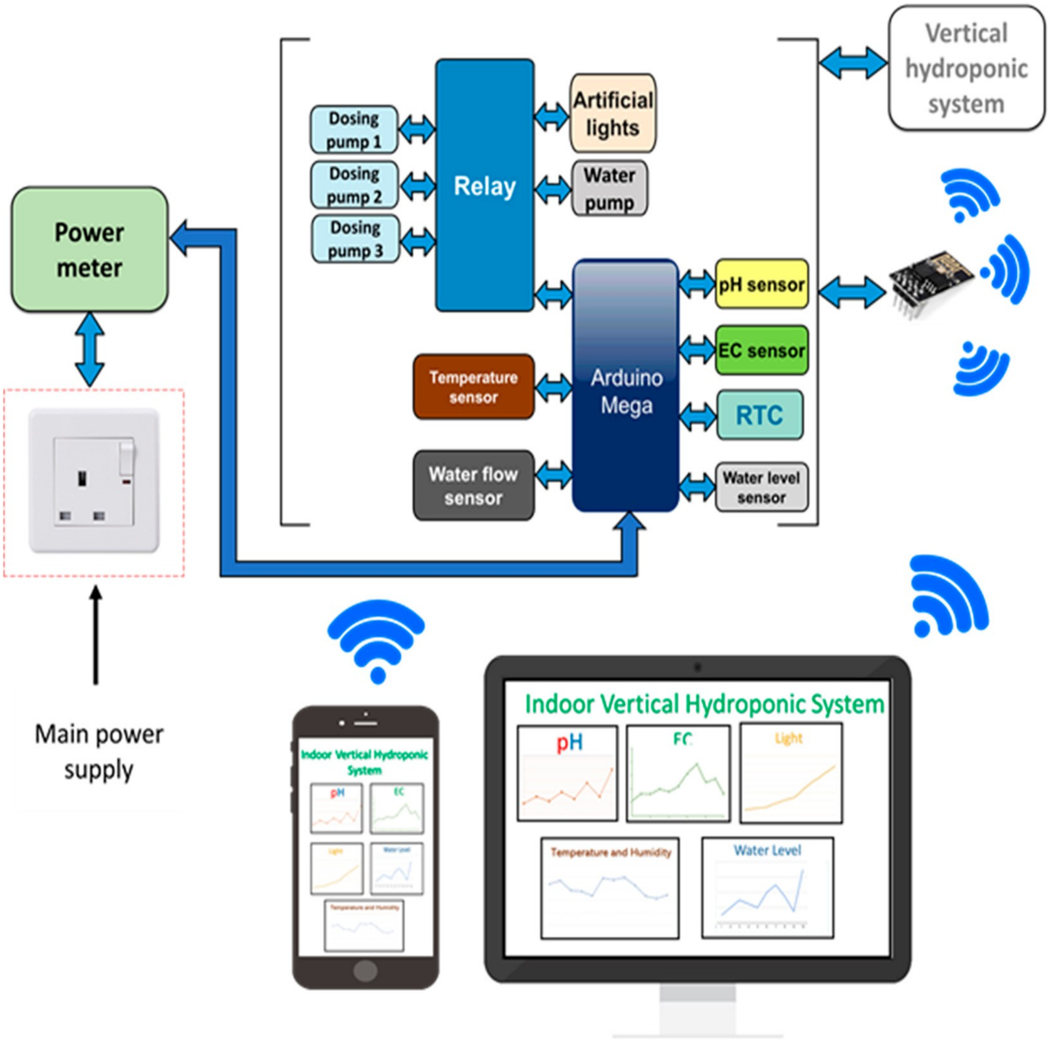


Figure 2. Block diagram of the designed system.

2.1. *NFT Structure and Essential Components*

Given its comparative advantages over alternative systems, the vertical Nutrient Film Technique (NFT) hydroponic system was selected for this study's hydroponic setup [44]. In particular, the three-shelf arrangement of the vertical NFT system produced by the Koray Company (Guangdong, China) [45] made it the preferred option. Four 63 mm (0.063 m) diameter polyvinyl chloride (PVC) pipes fit into each shelf. The pipes also have nine 32 mm (0.032 m) diameter planting holes in each pipe. The vertical NFT hydroponic system's overall measurements are 96 cm (L), 50 cm (W), and 90 cm (H) (Figure 3). The prefabricated PVC system was purchased off-the-shelf to speed up the development process, but because the specs are known, it can be produced and built locally, saving a substantial amount of money. Hydroponic pipes, a nutrient container, a water pump, artificial lighting, and solutions for pH and nutrition adjustments are all included in a typical hydroponic system. The ideal effectiveness of the hydroponic system is contingent upon the meticulous selection of the fertilizer container, water pump, and artificial lighting. This section describes how to choose artificial lighting, nutrients, and pH adjustment solutions in addition to the right size for the nutrient container and water pumps.

Figure 3. Vertical NFT hydroponic structure assembled and connected to the monitoring and control system.

2.1.1. Nutrients' Container

The nutrient solution fed to the vertical NFT system is stored in the nutrient container, and in this closed system, any excess solution is returned to it. Since it is forbidden to utilize reactive elements like metal, plastic makes the perfect container material. To stop algae from growing, the container should also obstruct light [46]. The size of the container must be big enough to accommodate the necessary volume of solution, which is decided by the total number of plants in the system. A minimum of 5 gallons (18.9271 L) is advised for 40–50 plants, and for every extra 20–25 plants, an additional gallon (3.78541 L) is suggested [46]. The 50 plants, 25 plants, 25 plants, and 8 plants are the groupings into which these plants are divided. Two more gallons (7.57082 L) are needed by each of the second and third groups, while the first group needs five gallons (18.9271 L). Eight of the final eight plants use eight quarters of a gallon of water (1.21133 L). The determined total container size is 27.70921 L, or 7.32 gallons. Thirty percent of the 28 liter (8.4 liter) is added to account for possible water losses from plant use and evaporation, making the total volume inside the container 37 liters. The 46 L container size that was chosen allows for more room for air exposure at the top.

Water Pump

The water pump must be sized properly to provide a steady and adequate flow of water throughout the system. Because submersible pumps work well in tiny systems with a capacity of no more than 1200 gallons, they were selected for this particular design. The three main parts in the sizing process were figuring out how many gallons per hour (GPH) the pump would need, measuring the hydroponic system's head height, and evaluating the water pump datasheet to confirm the pump's appropriateness [47]. The needed GPH, as shown in Supplementary Table S2, takes into consideration a 15–30% efficiency loss for the pump. Equation (3) was used to get the total GPH while taking into account the NFT system's demand of 4-6 GPH per dip, an average flow rate of 5, and a worst-case efficiency loss of 30%.

The head height distance was determined to be 66.5 cm (0.665 m), which is the distance between the water's surface and the point where nutrient water enters the NFT vertical system. The right pump should have the power to raise the water to a height of at least 0.665 meters and be able to deliver at least 456 liters per hour. The system's criteria were met by the SUNSUN Submersible Water Pump (Chennai, India) [48], which could pump 600 LPH and reach a maximum height of 1.3 m. As a result, it was chosen for this investigation. Interestingly, this pump runs quietly, which is an essential attribute for indoor systems [48].

2.1.3. Artificial Lights

The process of photosynthesis depends heavily on lighting, and any lack of light might impede the growth of plants [49]. Particularly, plants absorb photosynthetically active radiation (PAR), or visible light with a wavelength between 400 and 700 nm. The right spectrum of light is essential for healthy growth; flowering plants require higher levels of red and blue light, whereas non-flowering plants can survive on high levels of red light alone [50].

Using three lights for each of the three NFT system tiers, this design made use of LED lights from Koray Company (Guangdong, China) [45]. In the investigation, two different kinds of LED lights—6K3R4 and K6 (Guangdong, China) [45]—were used; their respective functions are listed in Supplementary Table S3. Leafy vegetables can be grown in 6K3R4 because of its high red light intensity, as seen by the light spectrum (Supplementary Figure S1). K6, on the other hand, is the best light color for flowering plants due to its strong blue and red light intensity. LEDs should ideally run for 16 hours a day [51], and in this setup, the lighting was managed by a relay that was managed by the central microcontroller.

.Nutrients and pH

A total of seventeen components are essential to the whole development of plants. These components were given to the plants in the hydroponic system as a nutrient solution. But, it is crucial to provide the nutrients within the range that each plant requires because adding too much could seriously harm the plants. Electrical conductivity (EC) was continuously measured to guarantee the proper nutritional concentration. Furthermore, a constant watch was kept on the nutrient solution's pH level, which is thought to be essential for plant growth. The Atlas Scientific pH Kit 0–14 pH sensor (Long Island City, NY, USA) was used for real-time pH measurement [52], and the Atlas Scientific Conductivity Kit K 1.0–5200,000 µS/cm sensor (Long Island City, NY, USA) was used for EC measurement [53]. For the hydroponic system, the ideal pH range is 5.0 to 7.5. Plant health may suffer if this range is departed from because it increases the possibility of toxicity or nutrient shortages. Supplementary Table S4 provides an overview of acceptable EC and pH values for various plant species. It is best to lower the EC range while growing plants from stems until the plant develops a sizable root system [54].

Fox Farm (Samoa, CA, USA) provided the fertilizer solution used to hydrate the plants [55, 56]. With three percent nitrogen, two percent phosphorus, and six percent potassium—elements critical to plant growth—this solution contains all 17 essential elements in a single container [55]. pH up and down solutions from the General Hydroponics Company (Santa Rosa, CA, USA) were used to change the pH concentration in the nutrient solution [56].

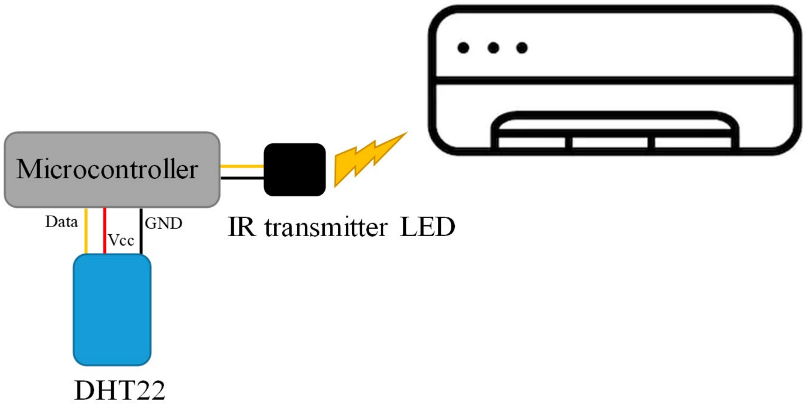


Figure 4. Block diagram of AC controlling subsystem.

2.1.4. Power Consumption Monitoring Subsystem

To reduce the system's overall operating costs, it is imperative to monitor and regulate power use. A power meter that was devised and constructed was used to precisely measure the power, voltage, and current consumed by the system. There are two ports on the power meter: input and output. A 240 V AC supply is connected to the input, and the hydroponic system (load) is connected to the output. This meter is equipped with an Arduino Nano (Somerville, MA, USA) microcontroller, an AC/DC converter (HLK-PM12; Shenzhen, China), a voltage sensor (ZMPT101B; Guangzhou, China), a current sensor (ACS712; Worcester, MA, USA), and a current sensor for precise measurement of the loads' current and voltage consumption. Supplementary Table S1 contains more information. To determine the overall power usage, all of the gathered data were sent to the central microcontroller (Figure 5).

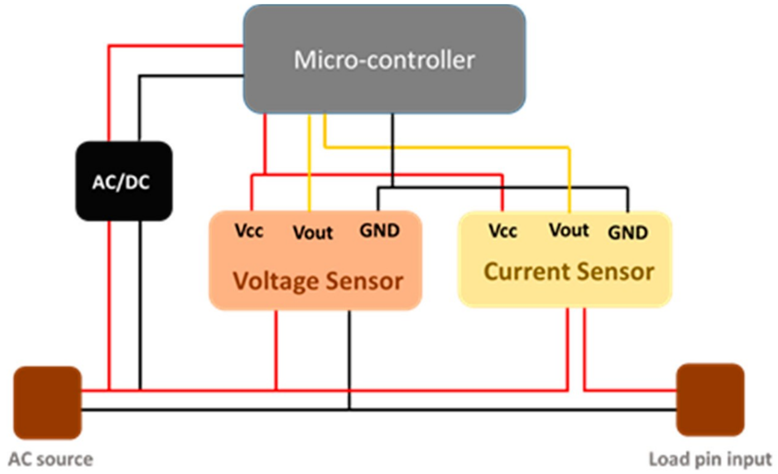


Figure 5. The block diagram of the power meter.

The air conditioner's power consumption was monitored using a commercial power meter that was digitalized for data analysis and storage. The cooling capacity of a 2-ton air conditioner is calculated by dividing its power consumption by the Energy Efficiency Ratio (EER), which comes out to be 7.034 kW. A two-ton air conditioner with an EER of 2.7 and a 3-star rating uses 2.6 kW of energy on average. The two separate parts of the air conditioner are the compressor, which is outside, and the evaporator, which is inside. The evaporator uses a lot less power than the compressor. When the goal temperature is attained, the compressor unit turns off. It only operates when the inside temperature increases above the predetermined point.1.56 kWh of energy are used for each hour of operation, assuming that the compressor unit runs for 60% of the total running period. However, the overall monthly consumption is determined by the daily usage behavior. In India, the air conditioner typically runs from May to September for extended periods of time, and from March (18–27 °C) to May (26–39 °C) and September (28–39 °C) to November (20–30 °C) for a few hours each day [65]. Since the hydroponic system was placed in a room where the occupants usually control the air conditioning, it was unclear how the hydroponic system would affect regular consumption and usage. Utilization information for the air conditioner was noted in order to investigate this.both on a monthly average and when it was fueled by the hydroponic system. This comparison was done to determine whether the hydroponic system made a substantial difference in the power usage.

2.2. *Nutrition and pH Controlling System*

The dosage pumps were all housed in a specially made box. To make it easier to connect the electric cables from the dosing pumps to the relay and microcontroller, the back of the box has three holes. Supplementary Figure S3 shows the dosing pump holding box, as well as the nutrient and pH controlling system. Figure 6 shows the detailed schematic of the entire system.

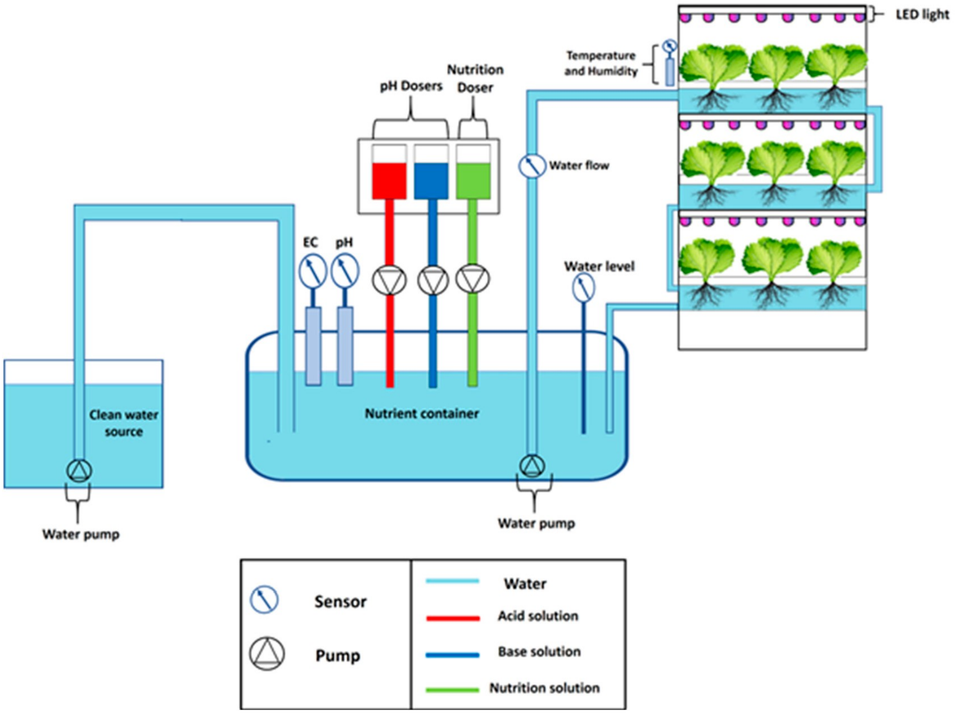


Figure 6. Schematic diagram of the complete system.

2.3. *Internet of Things (IoT) Platform*

The Internet of Things (IoT) makes it simpler to gather and store data from numerous devices using a web server by connecting the system to the internet. Consumers can view this data online at any time and from any location using a computer or smartphone [43]. In this study, sensor readings comprising pH, electrical conductivity (EC), water level, humidity, temperature, and power consumption data were sent to a web server via a Wi-Fi module, namely the ESP8266 (Shanghai, China) [43]. Sensor data is collected by the microcontroller and transferred to Thingspeak, an open-source IoT platform, using the Wi-Fi module [42]. Thingspeak is a fantastic choice for a vertical hydroponic system indoors since it's not just anopen-source solution, but it also enables the execution of algorithms on the supplied data and data visualization using MATLAB. The framework makes it easy to apply common machine learning techniques and deep learning, providing a potential future direction for this work. Additionally, Thingspeak offers eight fields, meaning that without paying a subscription price, eight different system metrics can be shown in real-time. The free version of the channel is updated every 20 seconds, which is suitable for our application. Additionally, there are several Android apps that can be easily configured to watch the channel on mobile devices, eliminating the need to continuously check in with a web browser to access system settings. As a result, a Thingspeak-based system is regarded as a wise decision.for developing an affordable solution with solid IoT platform features. More analysis and future machine learning-based research will be substantially aided by the platform's ability to export previous data in CSV format.

3. TESTING AND VALIDATION

Before being used, a number of sensors that were included in the system design were calibrated.

The system's complete circuit diagram, shown in Figure 7, shows how all of the sensors and AC appliances are connected to one another. This covers the power meter and AC controller subsystems. As indicated in Supplementary Table S1, two different Arduino models—the Arduino Mega (Somerville, MA, USA) and Arduino Nano (Somerville, MA, USA)—were used. Data is transmitted to the master Arduino Mega over serial communication by both the power meter, which uses an Arduino Nano, and the AC controller, which is based around the Arduino Mega. Figure 8 explains the overall automatic hydroponic system's working principle based on sensor data.Electronic Sensor Testing

3.1.1. EC and pH Sensor

By connecting the EC and pH sensors to the Arduino Mega (Somerville, MA, USA) microcontroller, they were tested and calibrated. Calibration required adhering to the guidelines provided by the manufacturer. Calibration of the EC sensor was carried out using dry, low, and high EC solutions of different EC levels, showing very accurate findings (see Figure S4). Precise findings were also obtained when the pH sensor was calibrated using fluids with varying pH levels. It is essential for plants to grow healthily to maintain the proper amounts of EC and pH.

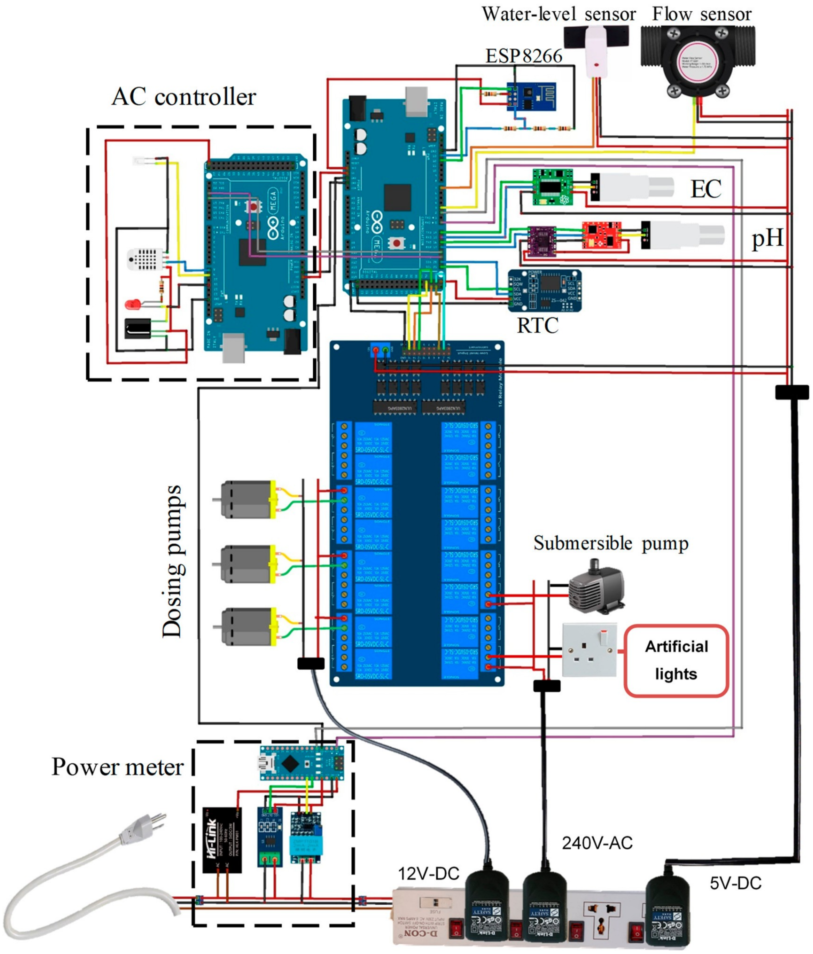


Figure 7. Overall circuit diagram of the system.

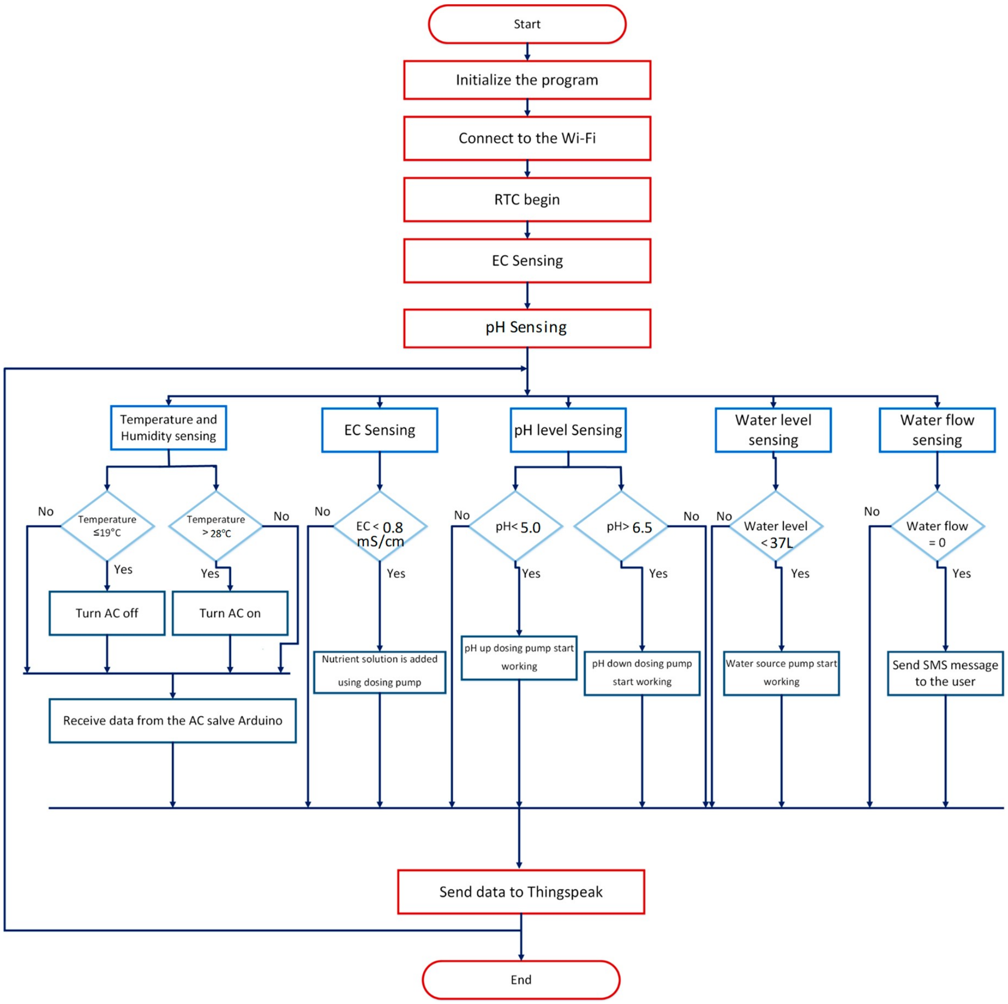


Figure 8. Flowchart of the automatic hydroponic system.

4. RESULTS

After the sensors and other modules were calibrated and tested, the full indoor vertical hydroponic system was used and tested. Figure 3 illustrates that the initial cultivation was carried out indoors, and Supplementary Video S1 provides details on the operation of the system. Next, lettuce, tomato, cucumber, coriander, capsicum, strawberry, chilli seeds, and mint stems were added to the vertical hydroponic system. This section uses the IoT interface of the Thingspeak mobile application and website to demonstrate the functionality of the system. It also includes a visualisation of plant development, a study of electricity and water usage, and a comparison between the proposed system and other research and commercial activities.

4.1. *IoT Based Web and Mobile Interface*

The system's purpose was to gather sensor data, store it in a central microcontroller, and transmit it to an Internet of Things platform. An IoT platform can store, analyse, and present data to a user via a mobile application or a private or public web interface. A computer or smartphone can be used to view the online interface at any time, and a straightforward and simply accessible mobile application is also available. A sample Thingspeak web interface is displayed in Figure 9. The mobile application (Figure 10A) can display data for a shorter period of time with the most recent data point highlighted, while the Thingspeak web interface can display data for several days at a time..

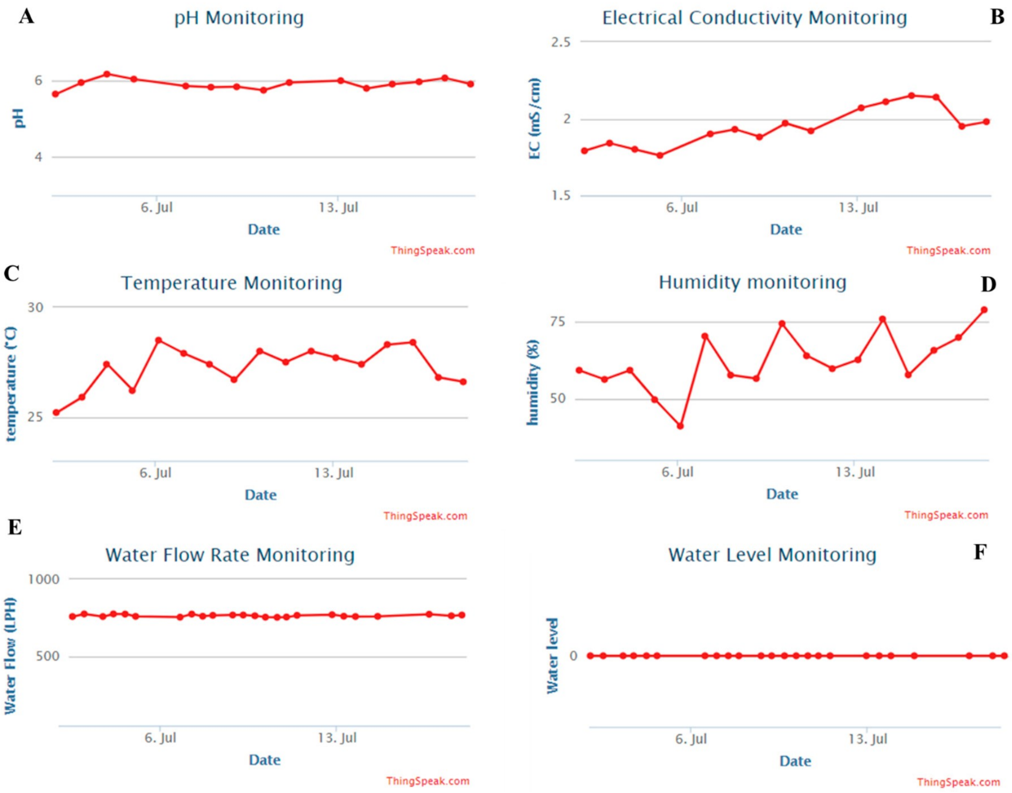
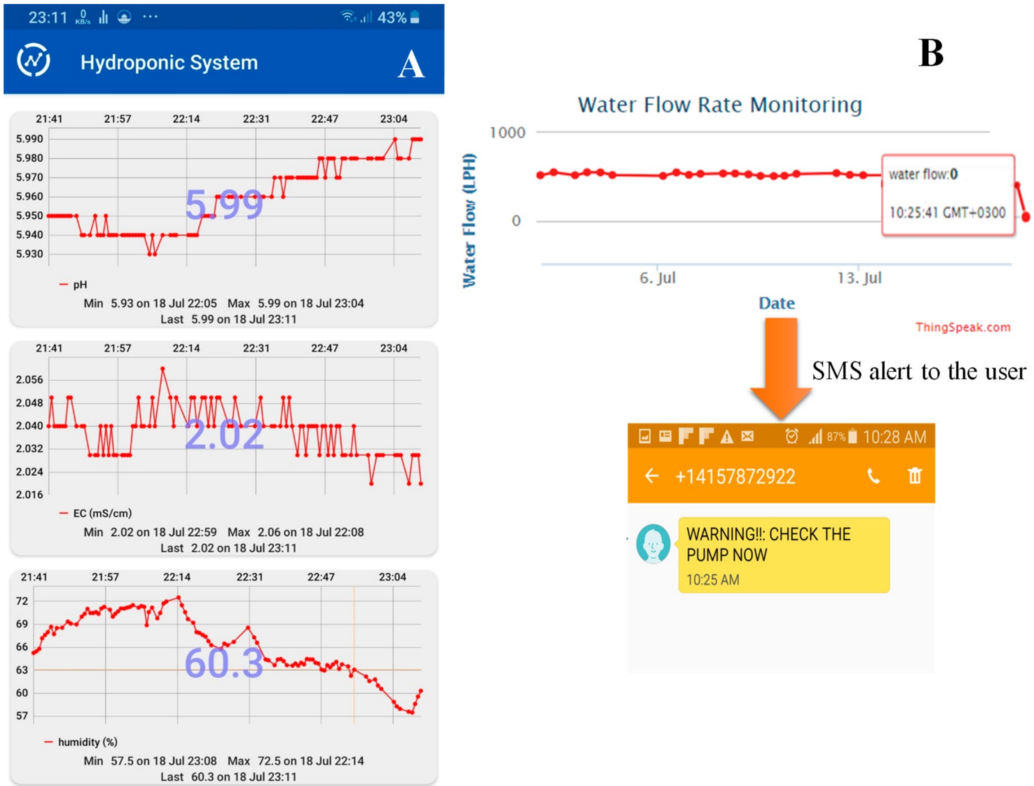


Figure 9. Sample graphs of the Thingspeak Web-interface of IoT platform: (**A**) pH, (**B**) EC,
(**C**) Temperature, (**D**) Humidity, (**E**) Water flow rate, and (**F**) Water level monitoring.

As seen in Figure 9, the automated system as a whole was successful in maintaining a consistent environment that was favorable to the plants' growth. The system was successful in maintaining the pH and EC within the specified range, as shown in Figure 9, and it was in charge of managing any deviation from the range, as shown by the flowchart in Figure 8. Similarly, the temperature in the area was maintained at a level that was beneficial for the plants thanks to the automatic AC control module.

4.2. *Alerting the User When an Intervention Is Required*

A text-messaging alerting system has been successfully implemented when user engagement is required. The pump, which moves the nutrient solution from the nutrition tank into the system, is one of the primary components of an automated hydroponic system that must run continuously. As a result, within a few hours, the plants will dry out and eventually die from any pump problem. As a result, in the event that the main pump broke down—which is detected by the water flow sensor—a short message service (SMS) massage was sent to the user's phone whenever the water flow through it was zero liters. To report the issue and arrange for a pump inspection, it is submitted via Thingspeak and an outside website (the IFTTT website). As shown in Figure 10B, the user receives an instant notification when the water flow sensor measurement is 0 L.



Min 5.93 on 18 Jul 22:05 Max 5.99 on 18 Jul 23:04
Last 5.99 on 18 Jul 23:11

Min 2.02 on 18 Jul 22:59 Max 2.06 on 18 Jul 22:08
Last 2.02 on 18 Jul 23:11

Min 57.5 on 18 Jul 23:08 Max 72.5 on 18 Jul 22:14
Last 60.3 on 18 Jul 23:11

WARNING!!: CHECK THE PUMP NOW
10:25 AM

Figure 10. The hydroponic system's mobile application interface (A) and the SMS alert that is sent to the user when the pump breaks (B).

4.3. Power Consumption of the Overall System

The development of a power-efficient method for the ongoing monitoring and management of the hydroponic system was one of the paper's main contributions. Continuous power monitoring of the entire system was required to do this. The system ran in two modes: Other modules with artificial light, and Other modules. When artificial light and other modules were turned on, the system used 247 watts; when the lights were off, only about 10 watts were used. With the air conditioner off, Table 1 shows the system's monthly electricity consumption of 120.59 kWh. The monthly cost of power use is 13.26 QAR. Nevertheless, this cost did not account for the two-ton air conditioner, which the system regulates to keep the room temperature within the designated range.

The daily variance in air conditioner usage during regular use and while the temperature was controlled by the hydroponic system is shown in Figure 11. It is clear that the hydroponic system caused the AC unit's overall usage to increase and its monthly consumption to climb from 656 kWh to 766 kWh. Nonetheless, there was a 110 kWh monthly increase because of the hydroponic system, according to a two-month research in which the AC was utilized for the hydroponic system one month and for regular use the next. 12.1 QAR is the additional expense resulting from the hydroponic system's regulation of the air conditioner. Consequently, the total monthly cost of the system—which accounts for the higher use of the air conditioner—is 25.36 QAR.

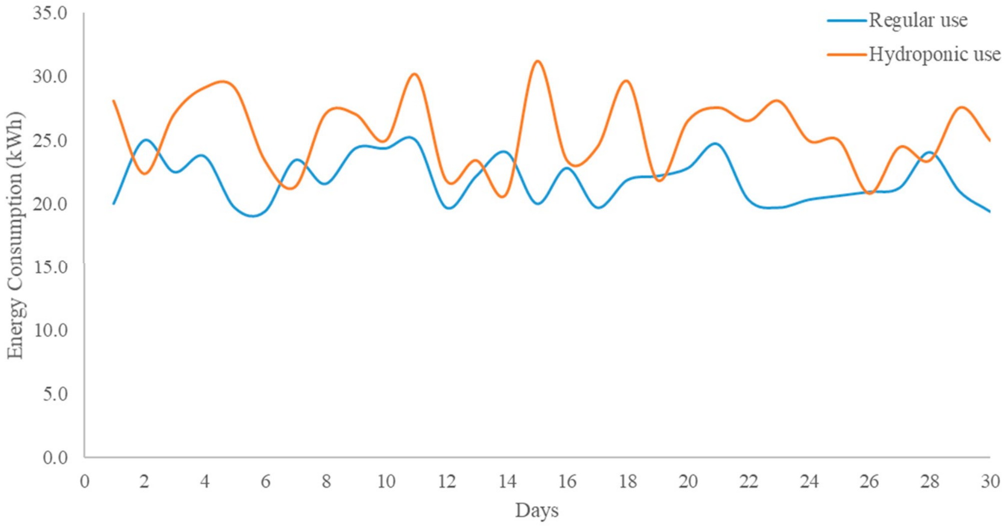


Figure 11. The hydroponic system's daily energy consumption as compared to regular use.

Water Consumption and Volume Circulation per Month

With daily water circulation, it was found that the hydroponic system moved about 103.9 k gallons of nutritional solution during the month. After accounting for plant use and evaporation, a monthly water usage of 8–10 L was achieved with a weekly replenishment of about two liters of fresh water. The growth of several plants in the hydroponic system is shown in Figure 12. In addition to growing organic vegetables in the living room, kids now like using the system since they get to plant seeds and see them grow.

Figure 12. An overview of the hydroponic system used to grow a variety of plants from seeds and stems.

5. DISCUSSION

The key components of a hydroponic system are accurate environmental control and effective fertilizer and water delivery to promote healthy plant growth. This study describes how to automate a vertical hydroponic system at a reasonable cost using an Internet of Things platform. After assembling the basic structural design and conducting a comparative analysis of prices, efficacy, and suitability for building in a small indoor area, the design of the vertical hydroponic system was chosen. The meticulously crafted essential components for an automated system served as a guide for the selection of necessary parts. Among the important system parameters that were examined and determined were the ideal temperature, light wavelength, pH, EC, and water volume. After that, the online and mobile applications forThe Thingspeak IoT platform provided an easy-to-use user interface and presented these metrics with simplicity. These parameters are visible to users, and in the case of a pump failure, the system is set up to send SMS messages. Machine learning algorithms could be developed using the CSV format data extraction functionality of the IoT platform. Large-scale data creation from the automated system improves its control performance and can be used to train both deep learning and traditional learning algorithms. This paper establishes the foundation for multiple possible follow-up studies. It's surprising how few feasibility studies there are in this sector that contrast indoor and outdoor plantings. Furthermore, it makes it feasible to compare the growth of hydroponically grown plants, organic plants, and field plants.through this wireless system.be kept an eye on, making it possible to analyze plant development in depth. In conclusion, the Arab world now has a suitable indoor plant substitute thanks to this affordably priced automated vertical hydroponic system. Its cost is further decreased by using locally accessible resources. If these technologies are widely used in homes, they may lessen reliance on imports and satisfy the demand for fresh green veggies locally.

6. CONCLUSIONS

The precise control of environmental factors and efficient delivery of nutrients and water to ensure healthy plant growth are the essential elements of a hydroponic system. This study presents the use of an Internet of Things platform to automate a vertical hydroponic system at a reasonable cost. The vertical hydroponic system design was selected after a comparative analysis of costs, effectiveness, and appropriateness for construction in a small indoor area led to the assembly of the basic structure design. The selection of required components was guided by carefully designed important elements for an automated system. The optimal temperature, light wavelength, pH, EC, and water volume were among the significant system parameters that were analyzed and calculated. Following that, the mobile app and web version of the The Thingspeak IoT platform displayed these metrics with ease and offered a user interface that was simple to use. Users can view these metrics, and the system is configured to send SMS notifications in the event of a pump breakdown. The IoT platform's data extraction feature in CSV format holds potential for the development of machine learning algorithms. The automated system's control performance is enhanced by the system's large data production, which may be utilized to train deep learning and classical learning algorithms. This work lays the groundwork for several potential follow-up investigations. Surprisingly, there aren't many feasibility studies that compare indoor and outdoor plantings in this field. Additionally, the comparative growth of field plants, hydroponically produced plants, and organic plants is made possible by this wireless platform.be monitored, enabling a comprehensive analysis of plant development. In conclusion, this reasonably priced automated vertical hydroponic system offers the Arab world a desirable indoor plant substitute. Using resources that are readily available locally further reduces its cost. These technologies could reduce dependency on imports and meet local demand for fresh green vegetables if they become widely used in households.

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