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Research Article

Web-Based Solar Powered Automated Hydroponics System using WEMOS Technology

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ABSTRACT

This study aimed to develop a Web-Based Solar-Powered Automated Hydroponics System. Further, it aimed to evaluate its technical performance. The device used WeMos technology, gathering feedback from agriculturists and farmers. It used a solar panel with the following specifications Peak Power (Pmax): 100W, Open Circuit Voltage (Voc): 21.6V, Short Circuit Current (Isc): 6.1A, Maximum Power Voltage (Vmp): 18V, Maximum Power Current (Imp): 5.56A, and Temperature Coefficient: -0.45%/°C.

Agriculturists unanimously provided a perfect mean score of 5.00 across all technical aspects, indicating complete consensus and a strong endorsement of the system's capabilities. While farmers satisfaction overall mean score is 4.60. The farmers' perceptions showed slightly more variability than the agriculturists. The combined assessment from both groups was consistent with the individual results. The system's monitoring capability received the highest combined score, while report generation and ease of use received the lowest, though all scores were positive. The study underscored the capability of its Web-Based Solar-Powered Automated Hydroponics System as a promising instrument to advance modern agricultural practices and address the challenges of food production sustainably.

Based on the findings of the study and to further enhance the Web-Based Solar-Powered Automated Hydroponics System, the following recommendations for additional features may be considered Advanced-Data Analytics, Integration with IoT Sensors, Mobile Application, and Comparative Analysis.

Keywords: *Automated Hydroponics, Solar-Powered Agriculture, Smart Farming, WeMos D1 Microcontroller, Sustainable Agriculture, Hydroponic System Automation*

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Background

Nowadays farming faces many challenges. As the population grows faster, the demand for housing increases, and more farmlands are converted into residential areas. Many farmers today are also giving up on their farms due to poor prices of products and lack of financial support. Modern agriculture provides various solutions to these challenges; however, the outcome may not always be the same because of every farm's differences. Hydroponics is a method of growing plants that relies on electricity to power essential components. The integration of Internet of Things (IoT) technology with wireless microcontrollers, such as WeMos, along with a web-based platform, presents a golden opportunity to revolutionize hydroponic systems. The fusion of IoT technology with hydroponics, as demonstrated by WeMos microcontrollers, promises to make hydroponic systems more convenient and dependable, thus redefining the landscape of modern agriculture. Farmers can take advantage of these advanced technologies to gain unparalleled control and insight into farming. The potential to transform agricultural industry brings substantial benefits to farmers and consumers. In response to the growing demands to integrate technology to farming the researchers solution entitled, "Web-Based Solar-Powered Automated Hydroponics System Using WeMos Technology", is presented. This aims to empower farmers as well as small-scale vegetable growers with innovative and modern agriculture and to revolutionize farming practices.

Methods

Descriptive Research Design Methodology, which involved observation, interview, and conducting a survey is used in the study. While the system was developed using the System Development Life Cycle Iterative Model (SDLC). The Iterative Model Method is a specific implementation of the System Development Life Cycle that adheres to all SDLC phases. After completing the analysis phase, it followed by the prototype and system implementation. This ensures thorough testing was carried out to guarantee that all features worked functionally. Finally, the deployment of the fully functional system to continuously refined it based on evaluations.

Result and Discussion

The system is evaluated by farmers, agriculturists, and IT experts using ISO 25010 and 25012 standard, as seen in Figures 1 and 2. The system received an overall mean score of 4.50, interpreted as "Strongly Agree," confirming its functional suitability, performance efficiency, usability, compatibility, reliability, security, maintainability, and portability.

Based on an evaluation using ISO 25010 and ISO/IEC 25012 quality standards, the Web-Based Solar-Powered Automated Hydroponics System received strong overall user ratings, with an aggregated mean score of 4.50.

Surveys Result Tally

Respondents	Agriculturists			Farmers			All Respondents		
Technicality of the System	**M**	**SD**	**VI**	**M**	**SD**	**VI**	**M**	**SD**	**VI**
1) The integration of solar-powered technology is sustainable and can help conserve water and power or electricity consumption.	5.00	0.00	SA	4.60	0.52	SA	4.73	0.46	SA
2) The system can automatically control the water supply and the temperature in the net house.	5.00	0.00	SA	4.60	0.52	SA	4.73	0.46	SA
3) The system can monitor the pH level (Acid level), water supply, nutrient levels, water temperature, and net house temperature properly and effectively.	5.00	0.00	SA	4.80	0.42	SA	4.87	0.35	SA
4) The system can efficiently generate reports such as the pH level, water level, nutrient levels, water temperature and net house temperature.	5.00	0.00	SA	4.50	0.53	SA	4.67	0.49	SA

Respondents	Agriculturists			Farmers			All Respondents		
Technicality of the System	**M**	**SD**	**VI**	**M**	**SD**	**VI**	**M**	**SD**	**VI**
5) The system minimizes manual labor and farming workload and can help farmers save time, energy, and space.	5.00	0.00	SA	4.60	0.52	SA	4.73	0.46	SA
6) The automated system is convenient and easy to use, control, and maintain.	5.00	0.00	SA	4.50	0.53	SA	4.67	0.49	SA
Overall	**5.00**	**0.00**	**SA**	**4.60**	**0.50**	**SA**	**4.73**	**0.45**	**SA**

Figure 1.

ISO Software Quality Metrics

ISO 25010 and ISO/IEC 25012 Software Quality Metrics	Mean	SD	Verbal Interpretation
Functional suitability	4.40	0.55	Strongly Agree
Performance efficiency	4.40	0.55	Strongly Agree
Compatibility	4.80	0.45	Strongly Agree
Usability	4.80	0.45	Strongly Agree
Reliability	4.40	0.55	Strongly Agree
Security	4.40	0.55	Strongly Agree
Maintainability	4.40	0.55	Strongly Agree
Portability	4.40	0.55	Strongly Agree
Overall	**4.50**	**0.53**	**Strongly Agree**

Figure 2.

All indicators which include the system's usefulness in controlling water supply and temperature, monitoring various parameters, and saving energy, time, and power consumption consistently rated Strongly Agree, with a mean score of 4.80 and a standard deviation of 0.45. There is a strong agreement among users regarding the system's usability and effectiveness. High scores in usability and compatibility are both significant for user acceptance.

Conclusion

The assessment of the Web-Based Solar-Powered Automated Hydroponics System that utilized WeMos technology garnered an overwhelmingly positive response from both agriculturists and farmers. The respondents evaluated the system with consistent high ratings. All the criteria such as technical capabilities, functional suitability, performance efficiency, and usability, indicates its effectiveness in supporting hydroponic farming operations. But still areas for potential improvement were also identified. These are functional suitability, reliability, security, maintainability, and portability.

In conclusion, the study presented the capability of the Web-Based Solar-Powered Automated Hydroponics System as a promising instrument to advance modern agricultural practices and address the challenges of food production sustainably.

Recommendations

Based on the findings of the study, the following recommendations are hereby forwarded:

1. Advanced-Data Analytics. To further enhance the efficiency of the device, advanced data analytics features may be considered. This may allow users to access predictive insights and recommendations. This may optimize crop yields and resource utilization.
2. Integration with IoT Sensors. Another enhancement is to integrate it with a wider range of Internet of Things (IoT) sensors. Examples of these sensors are air quality sensors, humidity sensors, and pest infestations. Said sensors may be used to access real-time data. These data may be used to better understand and manage their hydroponic environments.

3. Mobile Application . Developing a mobile application that is dedicated to complementing the existing web-based interface may also be recommended to ensure convenience of use. This application will provide users with a method of accessing and managing their hydroponic systems from their smartphones or tablets.
4. Comparative Analysis. Comparison with other automated hydroponics systems is also a good recommendation in the study. The comparative analysis may highlight the strengths and areas for improvement to similar technologies developed.

These recommendations may be considered in the study to further enhance its capabilities and usability. This may also aid to increase productivity, efficiency, and sustainability in hydroponic farming operations.

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