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A Review of Grow-light Farming, Hydroponics, Automated Irrigation System, Smart Farming and Spectrum Led

R. Tharun[1], K.G. Padmasine[2]

[1,2]Department of Electronics and Instrumentation, Bharathiar University, Coimbatore-641046, Tamil Nadu, India

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ABSTRACT –

This system involves designing and building a self-sustaining plant habitat that can sustain plant growth indoors without relying on sunlight. The system is designed to be portable and self-contained, providing the necessary environmental conditions for plant growth, including temperature, humidity, soil moisture, and lighting. The lighting system uses LED lights to provide the necessary spectrum of light for photosynthesis, with the specific spectrum and intensity adjusted based on the plant species and growth stage. The aim is to create a self-contained and portable solution for indoor plant growth that does not require natural sunlight. Such a system could be useful for people who want to grow plants indoors but do not have access to a suitable window or outdoor space or for growing plants in environments where natural light is limited.

***Key Words*:** portable plant habitat, self-sustaining, sun-free, Indoor plant growth, autonomous agriculture, portable, spectrum LED.

1. INTRODUCTION

In recent years, there has been a growing interest in indoor and urban gardening. However, traditional gardening methods can be limited by factors such as space, sunlight, and access to water. A portable self-sustaining sun-free plant habitat offers a solution to these challenges, providing a compact and versatile way to grow plants indoors or outdoors without relying on sunlight or external energy sources.

This project aims to design and build a self-sustaining plant habitat that can provide the necessary resources for plant growth, including water and nutrients, in a compact and portable design. The habitat will be designed to support a variety of plant species and optimized to ensure maximum plant health and yield. The project will also include the development of educational materials to help users understand how to use and maintain the habitat for long-term use.

2. LITERATURE REVIEW

2.1-ROWLIGHT FARMING

1. "LED Lighting in Horticulture" by E. K. Yanagi and T. J. Blom, published in HortScience in 2019. This article provides an overview of the use of LED lights in horticulture, including the benefits and limitations of different light spectra and intensities.

- The article is a review that synthesizes current knowledge and research on the use of LED lighting in horticulture, with a focus on controlled environment agriculture (CEA) and vertical farming.
- The authors discuss the benefits of LED lighting for plant growth, such as the ability to tailor light spectra to specific crops and growth stages, reduce energy consumption, and improve yield and quality of produce.
- The article also covers some of the challenges associated with LED lighting, including high initial costs, variable product quality among manufacturers, and potential negative impacts on plant growth and human health if used improperly.
- Yanagi and Blom also provide recommendations for growers interested in implementing LED lighting systems, such as determining crop-specific light requirements, selecting appropriate LED fixtures, and monitoring plant response to light.
- The article concludes with a discussion on the future of LED lighting in horticulture, including the potential for smart lighting systems that can adjust light intensity and spectrum in real time based on plant and environmental conditions.

2. "Effects of LED Light Spectra on Tomato Seedling Growth and Nutrient Uptake" by X. Li et al., published in PLoS ONE in 2019. This study investigates the effects of different LED light spectra on tomato seedling growth and nutrient uptake, and provides insights into the optimal light conditions for tomato growth.

- The article presents a study on the effects of different LED light spectra on tomato seedling growth and nutrient uptake in a hydroponic system.
- The study found that different LED light spectra had significant effects on the growth and nutrient uptake of tomato seedlings, with blue and red light spectra promoting the highest biomass and nutrient accumulation.
- The authors suggest that the results have practical implications for the use of LED lighting in hydroponic tomato production, as optimizing the light spectra could enhance growth and nutrient quality while reducing production costs.
- The study also highlights the importance of understanding plant responses to different light spectra and the potential for further research to explore the mechanisms behind these effects.
- Overall, the article contributes to the growing body of research on the use of LED lighting in horticulture and the potential for precise control over plant growth and nutrient quality.

3. "Economic Analysis of LED Lighting Systems for Commercial Broiler Production" by J. H. Lee et al., published in Poultry Science in 2020. This study evaluates the economic feasibility of using LED lights for broiler production, and provides insights into the potential cost savings and environmental benefits of this technology.

- The study aimed to assess the economic feasibility of using LED lighting systems for broiler production.
- The results showed that the use of LED lighting systems could increase production efficiency and reduce energy costs.
- The study also found that the initial investment cost of LED lighting systems could be recouped within a reasonable timeframe.
- The authors concluded that the use of LED lighting systems in broiler production could result in economic benefits for producers.
- The study highlights the importance of evaluating the economic feasibility of new technologies in agriculture.

4. "The Potential of Light-Emitting Diodes for Sustainable Crop Production" by M. K. R. Khan et al., published in Sustainability in 2021. This review article provides a comprehensive overview of the use of LED lights in crop production, including their potential for sustainable agriculture, current limitations, and future research directions.

- The paper provides an overview of the potential of LED lighting for sustainable crop production.
- The authors discuss the benefits of using LED lighting, such as increased crop yields, energy efficiency, and reduced environmental impact.
- The study also highlights the challenges of using LED lighting, including the high initial costs and the need for careful management of light spectra and intensities.
- The authors suggest that research should focus on optimizing LED lighting systems for different crops and growing conditions.
- The paper concludes that LED lighting has the potential to play a key role in sustainable crop production.

2.2- HYDROPONICS

1. "Hydroponics: A Versatile System to Study Nutrient Allocation and Plant Responses to Nutrient Availability and Exposure to Toxic Elements" by N. Nocito and L. A. Marasco, published in Frontiers in Plant Science in 2021. This review article provides an overview of the use of hydroponics in plant research, including the benefits and limitations of different hydroponic systems.

- The study focuses on the use of hydroponics as a tool for studying plant responses to nutrient availability and exposure to toxic elements.
- The authors describe the advantages of hydroponics, including precise control over nutrient concentrations and the ability to study root development.
- The paper also discusses the limitations of hydroponics, such as the need for specialized equipment and the potential for nutrient imbalances.
- The authors provide examples of studies that have used hydroponics to investigate nutrient allocation and plant responses to toxic elements.
- The study concludes that hydroponics is a versatile system that can be used to study a wide range of plant-related topics.

2. "Hydroponic Production of Fresh Herbs and Vegetables" by C. Kubota et al., published in HortTechnology in 2019. This article discusses the use of hydroponics in the production of fresh herbs and vegetables, including the optimal nutrient solutions and environmental conditions for plant growth.

- The paper provides an overview of hydroponic production of fresh herbs and vegetables.
- The authors describe the benefits of hydroponics, such as increased yields, reduced water usage, and the ability to grow crops year-round.
- The study also highlights the challenges of hydroponic production, such as the need for specialized equipment and expertise.
- The authors provide examples of crops that are well-suited for hydroponic production, including basil, lettuce, and tomatoes.

- The paper concludes that hydroponic production of fresh herbs and vegetables has great potential for meeting the increasing demand for locally grown, fresh produce.

3. "Advances in Hydroponic Technologies for Vegetable Production: Past, Present and Future" by A. Hussain et al., published in Sustainability in 2020. This review article provides an overview of the latest advances in hydroponic technologies for vegetable production, including the use of artificial intelligence and internet of things technologies.

- This article discusses the history of hydroponic technology and its current advancements.
- The authors provide an overview of the potential of hydroponic technology for sustainable vegetable production.
- They also highlight the challenges associated with hydroponic technology and the need for further research in this area.
- The article covers several innovative hydroponic systems such as vertical farming, aquaponics, and aeroponics, and their potential for vegetable production.
- The authors also discuss the future prospects of hydroponic technology in the context of increasing population and limited arable land.

4. "Economic and Environmental Analysis of Hydroponic versus Conventional Tomato Production" by L. J. Wilkins and J. F. Godsill, published in HortTechnology in 2019. This study evaluates the economic and environmental sustainability of hydroponic tomato production compared to conventional production methods, and provides insights into the potential benefits and limitations of hydroponic systems.

1. "Economic and Environmental Analysis of Hydroponic versus Conventional Tomato Production" by L. J. Wilkins and J. F. Godsill, published in HortTechnology in 2019.

- This article presents an economic and environmental analysis of hydroponic versus conventional tomato production.
- The authors found that hydroponic production had higher costs due to the initial investment in infrastructure and equipment, but also had higher yields and lower environmental impact.
- The study also highlights the potential for hydroponic production to be more sustainable in the long term, particularly in areas where water is scarce or of poor quality.
- The article concludes that further research is needed to improve the economics of hydroponic production and optimize nutrient management.
- The findings of this study have implications for farmers, policy makers, and researchers interested in sustainable agriculture.

2.3- AUTOMATED IRRIGATION SYSTEM

1. "Automated Irrigation Systems: The Future of Agriculture" by R. B. Solanki et al., published in Journal of Agricultural Science and Technology in 2021. This review article provides an overview of the benefits and challenges of automated irrigation systems in agriculture, including the use of sensors and controllers for water management.

- This article provides an overview of automated irrigation systems and their potential to revolutionize agriculture.
- The authors discuss the benefits of automated irrigation systems, including increased efficiency, improved crop yields, and reduced water usage.
- The article also describes the various components of an automated irrigation system, such as sensors, controllers, and actuators.
- The authors highlight the importance of proper system design and maintenance for optimal performance and long-term sustainability.
- The article concludes with a discussion of the challenges and opportunities facing the widespread adoption of automated irrigation systems.

2. "Design and Implementation of a Low-Cost, Automated Irrigation System for Smallholder Agriculture" by C. A. Oppong et al., published in Agricultural Water Management in 2020. This study presents the design and implementation of a low-cost, automated irrigation system for smallholder agriculture, and evaluates its effectiveness in improving crop yield and water use efficiency.

- This article describes the design and implementation of a low-cost, automated irrigation system suitable for smallholder agriculture in developing countries.
- The system uses a solar-powered water pump, a microcontroller-based control system, and soil moisture sensors to provide efficient and reliable irrigation.
- The authors discuss the benefits of the system, including reduced labor requirements, increased crop yields, and improved water use efficiency.
- The article also presents the results of a field trial conducted in Ghana, which demonstrated the effectiveness of the system in increasing crop yields and reducing water usage.

- The findings of this study have implications for improving food security and promoting sustainable agriculture in developing countries.

3. "Irrigation Control System Using IoT" by J. K. Bhatt and P. C. Tewari, published in International Journal of Advanced Research in Computer Science and Software Engineering in 2021. This article discusses the development of an irrigation control system using internet of things (IoT) technologies, and evaluates its effectiveness in improving water management in agriculture.

- This article presents the design and implementation of an irrigation control system using the Internet of Things (IoT).
- The system uses sensors to monitor soil moisture levels, weather conditions, and water flow rates, and a microcontroller-based control system to adjust irrigation as needed.
- The authors discuss the benefits of the system, including improved crop yields, reduced water usage, and increased automation and control.
- The article also describes the architecture and software design of the system, including the use of a cloud-based platform for data analysis and visualization.
- The findings of this study have implications for the development of smart agriculture systems using IoT technology.

4. "Development of an Automated Irrigation System for Urban Agriculture using Arduino" by J. O. Adejuwon et al., published in Journal of Agricultural Engineering and Technology in 2019. This study presents the development of an automated irrigation system using Arduino microcontrollers, and evaluates its effectiveness in improving water use efficiency and crop yield in urban agriculture.

- This article describes the development of an automated irrigation system using Arduino microcontroller for urban agriculture.
- The system uses soil moisture sensors to determine when irrigation is necessary, and it can be controlled remotely through a web-based interface.
- The authors conducted a case study in Nigeria to evaluate the performance of the system and found that it was effective in maintaining soil moisture levels and improving crop yield.
- The system was found to be cost-effective and scalable, making it a viable option for small-scale urban farmers.
- The authors suggest that the use of automated irrigation systems like this can help to increase food security and reduce water wastage in urban agriculture.

2.4- SPECTRUM LED

1. "Development of an Automated Irrigation System for Urban Agriculture using Arduino" by J. O. Adejuwon et al., published in Journal of Agricultural Engineering and Technology in 2019. This review article provides an overview of the use of LED lighting for sustainable indoor agriculture, including the potential benefits and challenges of different light spectra and intensities.

- The study aims to develop an automated irrigation system using Arduino technology for urban agriculture.
- The system uses a soil moisture sensor to determine the irrigation needs of the plants.
- The system is designed to be low-cost and easy to operate, making it suitable for small-scale urban agriculture.
- The results show that the system effectively improves the water use efficiency of the plants and increases their yield compared to traditional manual irrigation methods.
- The study concludes that the automated irrigation system can be a useful tool for urban farmers to increase their productivity and reduce their water usage.

2. "The Effects of LED Light Spectrum on Plant Growth and Development: A Meta-Analysis in Controlled Environments" by M. Kim et al., published in PLoS ONE in 2020. This study conducts a meta-analysis of the effects of LED light spectrum on plant growth and development, and provides insights into the optimal light conditions for different crops.

- The study is a meta-analysis that investigates the effects of LED light spectrum on plant growth and development in controlled environments.
- The results show that different LED light spectra have significant effects on plant growth and development, such as stem length, leaf area, and dry weight.
- Blue light enhances plant growth, especially in vegetative stages, while red light promotes flowering and fruiting stages.
- The study suggests that optimizing LED light spectra can increase plant growth and development and improve the efficiency of indoor plant production.
- The study also highlights the need for further research to optimize LED light spectra for specific plant species and growth stages.

3. "Effect of LED Light Spectrum on the Growth and Nutrient Content of Lettuce and Radish Sprouts" by M. N. Tahir et al., published in Journal of Food Science and Technology in 2019. This study investigates the effects of different LED light spectra on the growth and nutrient content of lettuce and radish sprouts, and provides insights into the potential benefits of using specific light spectra for sprout production.

- The study investigates the effects of LED light spectra on the growth and nutrient content of lettuce and radish sprouts.
- The results show that red and blue LED lights significantly increase the fresh weight and dry weight of the sprouts compared to white fluorescent light.
- Red and blue LED lights also increase the nutrient content, such as phenolic compounds, flavonoids, and ascorbic acid, of the sprouts.
- The study suggests that using specific LED light spectra can improve the growth and nutrient content of sprouts, which can have potential health benefits.
- The study also highlights the need for further research to optimize LED light spectra for different sprout species and growth stages.

4. "Effects of Light-Emitting Diodes with Different Spectra on Leaf Color, Antioxidant Capacity, and Photosynthesis in Lettuce" by M. L. Jin et al., published in Journal of the American Society for Horticultural Science in 2020. This study examines the effects of LED light spectra on leaf color, antioxidant capacity, and photosynthesis in lettuce, and provides insights into the potential benefits of using specific light spectra for improving the quality and nutritional value of leafy vegetables.

- The study investigates the effects of different LED light spectra on leaf color, antioxidant capacity, and photosynthesis in lettuce.
- The results show that red and blue LED lights significantly increase the leaf color and antioxidant capacity of lettuce compared to other LED light spectra.
- Red and blue LED lights also improve the photosynthesis rate and chlorophyll content of the lettuce.
- The study suggests that using specific LED light spectra can improve the quality and yield of lettuce production.
- The study also highlights the need for further research to optimize LED light spectra for different lettuce varieties and growth stages.

2.5-SMART FARMING

1. "Automated Agriculture: A Systematic Review of Smart Farming Technologies" by A. R. A. Mohamed et al., published in Sensors in 2020. This review article provides an overview of the latest advances in smart farming technologies, including automated systems for planting, harvesting, and monitoring crop growth.

- Overview: This article provides a comprehensive review of various smart farming technologies used in automated agriculture, including IoT-based systems, drones, robotics, and AI applications.
- Methods: The authors used a systematic literature review approach to identify relevant articles from various databases, including Scopus, Web of Science, and IEEE Xplore, and then analyzed the findings.
- Key Findings: The article discusses the benefits of smart farming technologies, such as increased productivity, reduced labor costs, and improved resource management, and highlights the challenges associated with their implementation, including the high cost of technology and the need for specialized knowledge and skills.
- Implications: The article concludes by discussing the potential of smart farming technologies to revolutionize agriculture and increase food production sustainably, as well as the need for further research and development to overcome the barriers to adoption.
- Significance: This article provides a valuable resource for researchers, policymakers, and farmers interested in learning about the latest advancements in smart farming technologies and their potential to transform agriculture.

2. "Automated Systems for Soilless Crop Production: A Review" by R. T. L. de Sousa et al., published in Agronomy in 2020. This review article provides an overview of the latest advances in automated systems for soilless crop production, including hydroponics and aeroponics.

- Provides an overview of automated systems for soilless crop production, including hydroponics and aeroponics
- Discusses the advantages and challenges of using automated systems for soilless crop production, such as improved resource use efficiency and high initial investment costs
- Outlines the various components of automated systems, such as sensors, controllers, and actuators, and their roles in crop production
- Reviews recent advances in automated systems for soilless crop production, including machine learning and artificial intelligence applications
- Concludes with future research directions and potential applications of automated systems in soilless crop production

3. "Precision Agriculture: A Review of Smart Farming Technologies and Systems" by M. El-Hussein et al., published in Journal of Agricultural Science and Technology in 2021. This review article provides an overview of precision agriculture technologies and systems, including automated systems for soil and water management, crop monitoring, and yield mapping.

- Provides an overview of precision agriculture, including its definition and history
- Discusses the various smart farming technologies and systems used in precision agriculture, such as GPS, drones, and sensors
- Reviews the advantages and challenges of precision agriculture, such as improved yields and reduced environmental impact
- Outlines the key factors influencing the adoption of precision agriculture, such as economic feasibility and farmer education
- Concludes with future research directions and potential applications of precision agriculture in improving agricultural sustainability

4. "A Review of Robotics and Automation for Crop Protection Tasks in Agriculture" by A. M. Molina-Martinez et al., published in Frontiers in Robotics and AI in 2021. This review article provides an overview of the latest advances in robotics and automation for crop protection tasks, including automated systems for weed management, pest and disease control, and crop monitoring.

- Provides an overview of robotics and automation technologies for crop protection tasks, such as pesticide application and weed removal
- Discusses the advantages and challenges of using robotics and automation in crop protection tasks, such as reduced labor costs and complexity of implementation
- Outlines the various types of robotic and automation technologies, such as drones and autonomous vehicles, and their applications in crop protection
- Reviews recent advances in robotics and automation for crop protection, such as machine learning and computer vision
- Concludes with future research directions and potential applications of robotics and automation in improving crop protection and agricultural sustainability.

3. CONCLUSION

In conclusion, by combining the advantages of spectrum LED lighting, automated farming, and irrigation systems, I am initiating a project to design a portable farming system. This project aims to provide a sustainable and efficient solution to produce fresh and nutritious crops in urban areas with limited space. The implementation of these farming methods not only increases the yield and quality of crops but also reduces water usage and eliminates the need for harmful pesticides. The integration of technology in agriculture not only improves the process but also reduces labor costs and increases profitability. Overall, the use of spectrum LED lighting, automated farming, and irrigation systems can revolutionize the way we approach farming, and I am excited to contribute to this advancement through my project.

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