



Drip Pipe Hydroponic Irrigation System

Dr. Ravishankar M.E, Ph.d¹, Mr.A.Gowtham², Mr.L.Jalendra³, Mr.S.Saran⁴

Department of Agricultural Engineering, Muthayammal Engineering College, Namakkal, Tamil Nadu, India¹

Department of Agricultural Engineering, Muthayammal College of Engineering, Namakkal, Tamil Nadu, India²

Publication History: Received: 25.02.2026; Revised: 20.03.2026; Accepted: 25.03.2026; Published: 28.03.2026.

ABSTRACT: Agriculture has always been the backbone of human civilization, but traditional farming methods face increasing challenges such as water scarcity, soil degradation, and limited availability of arable land. To overcome these issues, modern farming techniques like hydroponics and drip irrigation have emerged as sustainable alternatives. Hydroponics is a method of growing plants without soil, using nutrient-rich water solutions to provide essential minerals directly to the roots. Drip irrigation, on the other hand, is a precise watering technique that delivers controlled amounts of water directly to the plant base through a network of pipes and emitters. The **Drip Pipe Hydroponic Irrigation System** combines these two technologies to create an efficient and resource-conscious farming model. By integrating drip pipes into hydroponic setups, plants receive a steady supply of nutrients and moisture with minimal wastage. This system not only conserves water but also ensures uniform growth, reduces the risk of disease, and allows cultivation in areas where fertile soil is scarce. Furthermore, it supports year-round production, making it ideal for urban farming, greenhouse cultivation, and commercial agriculture.

KEYWORDS: Hydroponics, Drip irrigation, Soilless farming, Nutrient solution, Water conservation, Controlled environment agriculture, Sustainable agriculture

I. INTRODUCTION

As global food demand continues to rise, innovative solutions like the Drip Pipe Hydroponic Irrigation System play a crucial role in achieving sustainable agriculture. This project explores the design, working principles, advantages, and potential applications of the system, highlighting its importance in addressing future food security challenges. The Drip Pipe Hydroponic Irrigation System is a modern agricultural innovation that combines the principles of hydroponics and drip irrigation to create a highly efficient, sustainable, and resource-conscious farming method. Traditional agriculture faces growing challenges such as water scarcity, soil degradation, and limited availability of fertile land, while global food demand continues to rise. Hydroponics, a soil-less cultivation technique, allows plants to grow in nutrient-rich water solutions, eliminating the dependency on soil and enabling cultivation in diverse environments such as greenhouses, rooftops, and urban farms.

Drip irrigation, on the other hand, is a precise watering technique that delivers controlled amounts of water directly to the root zone through a network of pipes and emitters, minimizing evaporation and wastage. When integrated, these two methods form a system that ensures plants receive a steady supply of nutrients and moisture with maximum efficiency. The drip pipe hydroponic system not only conserves water—saving up to 70% compared to conventional irrigation—but also enhances nutrient absorption, reduces the risk of soil-borne diseases, and promotes faster plant growth with higher yields. This system is scalable, cost-effective, and adaptable, making it suitable for small-scale household farming as well as large commercial operations.

Its ability to support year-round production regardless of seasonal variations makes it particularly valuable in urban and semi-urban areas where space and soil are limited. Furthermore, the system aligns with global sustainability goals by reducing environmental impact, optimizing resource use, and contributing to food security. As agriculture continues to evolve in response to climate change and population growth, the Drip Pipe Hydroponic Irrigation System stands out as a practical and innovative solution for the future of farming.

II. EXISTING METHOD

In today's hydroponic farming, **polyethylene (PE) tubing** forms the backbone of most drip irrigation systems. This material is durable, flexible, and UV-resistant, making it ideal for greenhouse and vertical farm environments. The tubing connects to emitters that release controlled amounts of nutrient solution directly to the plant's root zone. This



ensures uniform distribution and reduces water loss compared to traditional irrigation methods. Another key advancement is the use of **smart drip valves**. These valves regulate water flow with high precision, often linked to IoT-based sensors that monitor soil moisture, pH, and electrical conductivity (EC). By adjusting irrigation automatically, they prevent overwatering and nutrient imbalances. This makes them especially valuable in precision agriculture, where consistency is critical for crops like tomatoes, cucumbers, and peppers.

III. PROPOSED METHOD

First, the hydroponic drip system must be installed properly. The system usually consists of a reservoir tank, water pump, drip pipes, emitters, and growing containers filled with media such as coco peat or perlite. The nutrient solution is stored in the tank and pumped through the drip pipes to each plant. Each plant should have its own drip emitter so that the nutrient solution is distributed evenly.

Plants in hydroponics depend completely on nutrient solutions for growth. The water in the reservoir should be mixed with the correct hydroponic nutrients containing nitrogen, phosphorus, potassium, calcium, magnesium, and trace elements. The **pH level should normally be maintained between 5.5 and 6.5**, and the **EC (electrical conductivity)** should match the requirement of the crop being grown. Proper nutrient balance ensures healthy plant growth and high yield.

In a drip hydroponic system, irrigation is controlled using a timer. The pump should deliver the nutrient solution to the plants several times a day in small quantities rather than flooding them continuously. The timing depends on factors such as plant type, temperature, humidity, and growth stage. Frequent but controlled irrigation keeps the growing medium moist without causing waterlogging.

Plants should be placed in containers or grow bags filled with suitable media like coco peat, rockwool, or perlite. The drip emitter should be positioned close to the plant root zone so that the nutrient solution reaches the roots efficiently. Good growing media helps maintain moisture while also allowing air to reach the roots.

Regular monitoring of the nutrient solution is very important. Farmers should check the pH and EC levels daily using meters. If the pH goes outside the ideal range, plants may not absorb nutrients properly. The nutrient solution in the reservoir should also be replaced periodically to maintain balanced nutrient concentrations.

Excess nutrient solution that drains from the growing containers should be properly managed. In some systems, the runoff is collected and reused after filtration (recirculating system). In other systems, the excess solution is discarded (non-recirculating system). Proper drainage prevents root diseases and salt buildup in the growing media.

Regular cleaning of pipes, emitters, and reservoirs is necessary to prevent clogging and algae growth. Filters should be installed to remove particles from the nutrient solution. Periodic flushing of the drip lines with clean water helps maintain proper flow and prevents blockage.

The nutrient reservoir should be aerated using an air pump or proper circulation to ensure enough oxygen in the solution. Oxygen is essential for root respiration and healthy plant growth. Without adequate aeration, roots may suffer from stress or disease.

Plants should be observed regularly for signs of nutrient deficiency, pests, or diseases. Early detection of problems allows quick correction of nutrient levels, irrigation timing, or environmental conditions.

IV. REVIEW RESULT AND CONCLUSION

In this proposed scheme made with pre planning, it is an economical method compared to the existing method. It provides flexibility to the user. The comparative gain that can be accomplished is the utilization of the motor in the control unit. The solar-powered grass cutter project demonstrates an innovative and eco-friendly approach to lawn maintenance by utilizing renewable energy. This system uses solar panels to convert sunlight into electrical energy, which is stored in a battery and used to drive the motors for cutting and movement. By eliminating the need for fuel or external electricity, the project reduces environmental pollution and operating costs. The integration of components such as DC motors, a control unit, and a cutting mechanism ensures efficient performance and ease of use.



REFERENCES

1. R. M. Asif, J. Arshad, M. Shakir, S. M. Noman, and A. U. Rehman, "Energy efficiency augmentation in massive MIMO systems through linear precoding schemes and power consumption modeling," *Wireless Communications and Mobile Computing*, vol. 2020, Article ID 8839088, pp. 1–13, 2020.
2. M. Boxwell, *Solar Electricity Handbook*, 2012 ed. Green Stream Publishing, 2012. ISBN: 978-1-907670-22-0.(ebook)
3. G. N. Tiwari and R. K. Mishra, *Advanced Renewable Energy Sources*. Cambridge, U.K.: RSC Publishing, Nov. 2011. ISBN: 978-1-84973-380-9.(ebook)
4. S. P. Sukhatme, *Solar Energy: Principles of Thermal Collection and Storage*. New Delhi, India: Tata McGraw-Hill, 2008.(ebook)
5. M. Schwartz, *Internet of Things with Arduino*. Birmingham, UK: Packt Publishing, 2016.(ebook)
6. C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Taylor & Francis, *Electric Power Components and Systems*, Vol.39 (8), pp.780-793, May 2011. DOI: 10.1080/15325008.2010.541746
7. C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - *Journal of Electrical Engineering*, Vol.63 (6), pp.365-372, Dec.2012. DOI: 10.2478/v10187-012-0054-2
8. C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis'- Springer, *Electrical Engineering*, Vol.93 (3), pp.167-178, September 2011. DOI 10.1007/s00202-011-0203-9
9. S.Tamilselvi, R.Prakash, C.Nagarajan, "Solar System Integrated Smart Grid Utilizing Hybrid Coot-Genetic Algorithm Optimized ANN Controller" *Iranian Journal Of Science And Technology-Transactions Of Electrical Engineering*, DOI10.1007/s40998-025-00917-z,2025
10. S.Tamilselvi, R.Prakash, C.Nagarajan, " Adaptive sliding mode control of multilevel grid-connected inverters using reinforcement learning for enhanced LVRT performance" *Electric Power Systems Research* 253 (2026) 112428, doi.org/10.1016/j.epsr.2025.112428
11. S.Thirunavukkarasu, C. Nagarajan, 2024, "Performance Investigation on OCF and SCF study in BLDC machine using FTANN Controller," *Journal of Electrical Engineering And Technology*, Volume 20, pages 2675–2688, (2025), doi.org/10.1007/s42835-024-02126-w
12. C. Nagarajan, M.Madheswaran and D.Ramasubramanian- 'Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model'- *Acta Electrotechnica et Informatica Journal* , Vol.13 (2), pp.18-31, April-June.2013, DOI: 10.2478/aei-2013-0025.
13. C.Nagarajan and M.Madheswaran - 'DSP Based Fuzzy Controller for Series Parallel Resonant converter'- *Springer, Frontiers of Electrical and Electronic Engineering*, Vol. 7(4), pp. 438-446, Dec.12. DOI 10.1007/s11460-012-0212-0.
14. C.Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- *Iranian Journal of Electrical & Electronic Engineering*, Vol.8 (3), pp.259-267, September 2012.
15. C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai.Vol.no.1, pp.190-195, Dec.2007
16. Suganthi Mullainathan, Ramesh Natarajan, "An SPSS and CNN modelling based quality assessment using ceramic materials and membrane filtration techniques", *Revista Materia (Rio J.)* Vol. 30, 2025, DOI: <https://doi.org/10.1590/1517-7076-RMAT-2024-0721>
17. M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", *Journal of Environmental Protection and Ecology*, Volume 23, Issue 2, pp: 520-530,2022
18. <https://youtu.be/X0OZ6tpZ3Mc?si=fQg2Q3sRwja2UV8E>
19. https://youtu.be/yN2G1qtbXGQ?si=_N6pgmShvJMu6lry
20. <https://youtu.be/ZiS8w-141Wc?si=-hxWEyvGtc37kt0C>
21. Anand, L., Maurya, M., Seetha, J., Nagaraju, D., Ravuri, A., & Vidhya, R. G. (2023, July). An intelligent approach to segment the liver cancer using Machine Learning Method. In 2023 4th international conference on electronics and sustainable communication systems (ICESC) (pp. 1488-1493). IEEE.
22. Rajendran, S., Sundarapandi, A. M. S., Krishnamurthy, A., & Thanarajan, T. (2022). An intelligent face recognition technology for iot-based smart city application using condition-cnn with foraging learning pso model. *International Journal of Pattern Recognition and Artificial Intelligence*, 36(14), 2256018.
23. Murugeswari, B., & Sujatha, R. (2014). Preservation of Privacy for Multiparty Computation System with Homomorphic Encryption. *International Journal of Emerging Technology and Advanced Engineering*, 4(3), 530-535.



24. Sugumar, R. (2025). Unified AI Framework for Predictive Data Engineering and Real Time Prescription and Billing Systems. *International Journal of Advanced Engineering Science and Information Technology (IJAESIT)*, 8(5), 17261.
25. Samrat, B., Thomas, P. K., Kumar, S., Benila, A., Bhardwaj, R., & Vigenesh, M. (2024, December). Industrial informatics in optimizing software-defined vehicles for logistics. In *2024 IEEE 2nd International Conference on Innovations in High Speed Communication and Signal Processing (IHCSP)* (pp. 1-9). IEEE.
26. Soundappan, S. J. (2024). AI-driven customer intelligence in enterprise lakehouse systems Sentiment Mining Governance-Aware Analytics and Real-Time Data Synchronization. *International Journal of Advanced Engineering Science and Information Technology*.
27. Rajasekar, M. (2024). AI-Powered Cyber-Secure Federated Learning on AWS for Next-Generation Digital Banking Analytics. *International Journal of Advanced Research in Computer Science & Technology (IJARCST)*, 7(3).
28. Deivendran, P., Babu, P. S., Malathi, G., Anbazhagan, K., & Kumar, R. S. (2023). Emotion Recognition for Challenged People Facial Appearance in Social using Neural Network. arXiv preprint arXiv:2305.06842.
29. Sugumar, R., & Murugeswari, B. (2016). An Efficient MChord based Authentication for Vehicular Ad-Hoc Networks.
30. Pandey, V. K., Mishra, S., Rengarajan, A., Savita, & Roomi, M. M. (2024, March). Enhancing Weather Forecasting with Machine Learning Techniques. In *International Conference on Renewable Power* (pp. 147-156). Singapore: Springer Nature Singapore.
31. Mathew, A., & Alex, H. (2025). Federated Learning for Secure Genomic Research: Privacy-Preserving AI Solutions for Precision Medicine. *Science and Technology: Developments and Applications Vol. 9*, 36-43.
32. Selvi, G. V., Anbarasan, A. B., Murthy, B. A., & Prabavathy, S. (2023). An Application Oriented Integrated Unequal Clustering Algorithm for Wireless Sensor Network. In *Underwater Vehicle Control and Communication Systems Based on Machine Learning Techniques* (pp. 140-154). CRC Press.
33. Soundappan, S. J. (2025). Next Generation AI Enabled Holistic Cognitive Platform for Secure Cloud Network Intelligence Enterprise Systems and Digital Trust Optimization. *International Journal of Computer Technology and Electronics Communication*, 8(5), 11534-11542.
34. Rajasekar, M. (2024). Real-Time Predictive DevOps Intelligence for Risk-Aware Digital Business Processes in Cloud and SAP Ecosystems. *International Journal of Advanced Research in Computer Science & Technology (IJARCST)*, 7(4), 10713-10718.
35. Jagadeesh, S., & Sugumar, R. (2017). A comparative study on artificial bee colony with modified ABC algorithm. *European Journal of Applied Sciences*, 9(5), 243-248.
36. Murugeswari, B., Sarukesi, K., & Jayakumar, C. (2010, March). An efficient method for knowledge hiding through database extension. In *2010 International Conference on Recent Trends in Information, Telecommunication and Computing* (pp. 342-344). IEEE.
37. Reddy, K. V. V. K., & Vimal, V. R. (2024, July). A novel approach on improved segmentation and classification of remote sensing images using AlexNet compared over linear discriminant analysis with improved accuracy. In *2024 Second International Conference on Advances in Information Technology (ICAIT)* (Vol. 1, pp. 1-6). IEEE.
38. Gowthami, D., & Vigenesh, M. (2024). Distributed and Lightweight Intrusion Detection for IoT: A Lightweight Pyramidal U-Net With Tri-Level Dual Inception-Based Framework. In *The Convergence of Self-Sustaining Systems With AI and IoT* (pp. 154-173). IGI Global Scientific Publishing.
39. Anand, P. V., & Anand, L. (2023, December). An Enhanced Breast Cancer Diagnosis using RESNET50. In *2023 International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICSES)* (pp. 1-5). IEEE.
40. Mathew, A. (2022). Leveraging Big Data Analytics to Power AI and ML (Machine Learning) Automation. *Educational Research (IJMCR)*, 4(5), 131-134.
41. Dhinakaran, D. (2022). Joe Prathap P. M, Selvaraj D, Arul Kumar D and Murugeswari B, " Mining Privacy-Preserving Association Rules based on Parallel Processing in Cloud Computing,". *International Journal of Engineering Trends and Technology*, 70(3), 284-294.
42. Poornima, G., & Anand, L. (2024, April). Effective Machine Learning Methods for the Detection of Pulmonary Carcinoma. In *2024 Ninth International Conference on Science Technology Engineering and Mathematics (ICONSTEM)* (pp. 1-7). IEEE.
43. Rengarajan, A., Jayakumar, C., & Sugumar, R. (2012). Optimization Of Recent Attacks Using Internet Protocol. *National Journal of System and Information Technology*, 5(1), 8.
44. Mathew, A., & Romasco, L. (2024). Forensic Investigation of Artificial Intelligence Systems. *Research Updates in Mathematics and Computer Science Vol. 4*, 154-164.
45. Vekariya, V., Kumar, S., & Rengarajan, A. (2024). A distinctive and smart agricultural knowledge-based framework using ontology. In *Sustainability in Digital Transformation Era: Driving Innovative & Growth* (pp. 207-213). CRC Press.



46. Soundappan, S. J. (2020). Big data analytics in healthcare: Applications for pandemic forecasting. *International Journal of Advanced Research in Computer Science & Technology*, 3.
47. Sugumar, R. (2024). AI-Augmented Quality Engineering for Performance Optimization and Test Orchestration in Distributed Systems. *International Journal of Science, Research and Technology*, 7(5), 12835-12846.
48. Soundappan, S. J., & Sugumar, R. (2016). Optimal knowledge extraction technique based on hybridisation of improved artificial bee colony algorithm and cuckoo search algorithm. *International Journal of Business Intelligence and Data Mining*, 11(4), 338–356.
49. Mathew, A. (2025). Ahead of the breach: Predictive threat intelligence in aviation inspired by Scattered Spider attacks. *Multidisciplinary International Journal of Research and Development (MIJRD)*, 4(6), 54–58.
50. Soundappan, S. J. (2021). DataOps: Orchestrating Reliable ML Data Pipelines. *International Journal of Research and Applied Innovations*, 4(4), 5533-5537.
51. Garg, V. K., Soundappan, S. J., & Kaur, E. M. (2020). Enhancement in intrusion detection system for WLAN using genetic algorithms. *South Asian Research Journal of Engineering and Technology*, 2(6), 62–64.
52. Anand, L., Tyagi, R., & Mehta, V. (2024, January). Food recognition using deep learning for recipe and restaurant recommendation. In *Proceedings of Eighth International Conference on Information System Design and Intelligent Applications* (pp. 269-279). Singapore: Springer Nature Singapore.
53. Kumar, A., & Anand, L. (2025). A Novel EEG-Based Deep Learning Framework for Enhancing Communication in Locked-In Syndrome Using P300 Speller and Attention Mechanisms. *KSII Transactions on Internet and Information Systems (TIIS)*, 19(11), 3841-3855.
54. Soundappan, S. J. (2022). AI-Based Fault Detection and Isolation for Reliability in Modern Power Systems. *International Journal of Research Publications in Engineering, Technology and Management (IJRPETM)*, 5(4), 7106-7110.
55. Chandra, S., Rengarajan, A., Sahoo, G. S., & Sharma, S. (2024, October). Identifying Neuronal Damage and Plasticity by Analyzing Changes in Diffusion Tensor. In *Proceedings of the 5th International Conference on Data Science, Machine Learning and Applications; Volume 2: ICDSMLA 2023, 15–16 December, Hyderabad, India (Vol. 2, p. 433)*. Springer Nature.