| Volume 02 | Issue 04 | September 2026| ISSN: 3139-1737

International Journal of Advances and Applications in Convergent Studies & Transdisciplinary (IJ-AACST)

Bridging Disciplines, Bridging Knowledge

Aligned with the Vision of NEP 2020 and UGC Guidelines

Website: https://aacstij.org || Email: journaleditor@aacstij.org

An Integrated Cloud–IoT–WSN Framework for Reinforcement Learning-Based Smart Irrigation: A Comprehensive Review and Future Directions

DOI: https://doi.org/10.5281/zenodo.22337949

Mithilesh M. Wasu[1]*, Dr. Kishor M. Dhole[2], Sagar A. Durge[3]

*Corresponding Author: [1]Research Scholar, Dept. of Electronics and Computer Science, PGTD, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, Maharashtra, India.

ORCID: https://orcid.org/0009-0002-3406-8604 *mithileshwasu546@gmail.com*

ORCID: https://orcid.org/0009-0005-6544-6649

[2]Associate Professor, Dept. of Computer Science, Seth Kesarimal Porwal College, Kamptee, Dist. Nagpur, Maharashtra, India.

km.phd108@gmail.com

ORCID: https://orcid.org/0009-0006-9587-2398

[3]Research Scholar, Dept. of Electronics and Computer Science, PGTD, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, Maharashtra, India.

sagardurge40@gmail.com

ABSTRACT

Smart irrigation has emerged as an important application of precision agriculture for improving water-use efficiency, crop productivity, and sustainable agricultural management. This paper reviews the evolution of irrigation systems from conventional and sensor-based approaches to intelligent systems integrating Wireless Sensor Networks (WSNs), Internet of Things (IoT), cloud computing, Artificial Intelligence (AI), and Reinforcement Learning (RL). Particular emphasis is placed on RL-based irrigation because irrigation scheduling is inherently a sequential decision-making problem influenced by dynamic soil, weather, and crop conditions. The review examines conventional Machine Learning, Deep Learning, and RL approaches, including Q-Learning, Deep Q-Networks (DQN), and Proximal Policy Optimization (PPO), and analyzes their advantages and limitations for autonomous irrigation. Finally, emerging directions such as Edge AI, Explainable AI, Federated Learning, Multi-Agent RL, Digital Twins, and multi-objective optimization are discussed. The review highlights the potential of integrated RL-enabled architectures to support adaptive, autonomous, and sustainable irrigation management.

KEYWORDS: Smart Irrigation; Reinforcement Learning; Wireless Sensor Networks; Internet of Things; Cloud Computing; Deep Reinforcement Learning; Precision Agriculture; Sustainable Water Management.