Implementation of Novel Semi-Supervised Machine Learning Model into Autonomous Irrigation Network Optimized for Power Self-Sufficiency

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Agricultural irrigation wastage, especially from inefficient infrastructure in developing nations, is among the leading causes of the global water shortage epidemic, which affects an estimated 2.8 billion people worldwide. In this project, a three-component cloudless internet-of-things (IoT)-based irrigation network was designed and constructed to affordably integrate into existing irrigation infrastructure and approach zero water wastage while maintaining crops at a perceived healthy threshold. A Raspberry Pi-based electrical circuit of sensors and drone was constructed to collect environmental data and extract brightness-adjusted HSV crop color using k-means clustering-based computer vision algorithms. A semi-supervised approach was used to train a bidirectional Recurrent Neural Network, which enabled long-term and working memory analysis within hidden layers for time-sensitive outputs. The resulting predicted irrigation volume was executed by an Arduino Nano-based irrigation micropiece to dynamically adjust the water flow to each crop for individualized irrigation. Induction from water flow through irrigation pipes generated current, yielding complete and scalable power self-sufficiency at an excess margin of 25.8%. Empirical data collection reflected a 68.8% increase in irrigation effectiveness for crop growth. Model testing on various African nation crop yields and corresponding satellite images (n=10,301) reflected an accuracy rate of 89.1% and a binary classification success of 96.0% after a single growth cycle. The ability to cost-effectively integrate into existing irrigation infrastructure and minimize irrigation resource wastage enables the constructed network to be a viable solution to mitigate the negative impacts of water scarcity on agriculture yields.

Awards Won:

First Award of $5,000

Craig R. Barrett Award for Innovation

U.S. Agency for International Development: Second Award Agriculture and Food Security