

ABSTRACT

Lengkeng cultivation in confined environments such as rooftops faces challenges in efficient water management due to environmental dynamics and specific plant requirements. Conventional irrigation systems are often ineffective and result in wasteful use of resources. This study aims to design, build, and test a precision irrigation system that integrates the Internet of Things (IoT) for monitoring and Machine Learning for intelligent and automated watering decisions. The system uses an ESP32 microcontroller connected to soil moisture sensors, air temperature and humidity sensors, rainfall sensors, and wind speed sensors to collect data that can be monitored via the Blynk app. Two Machine Learning models with Random Forest algorithms were developed: one classification model for weather prediction (rain/no rain) and one regression model for determining irrigation duration. These models were trained and evaluated using actual data collected from the field. The test results showed good model performance. The classification model for weather prediction achieved an overall accuracy of approximately 0.73 (73%), precision of 0.82 for the 'Rain' class, and recall of 0.96 for the 'No Rain' class. This demonstrates the model's ability to reliably detect non-rain conditions, while the high precision on the 'Rain' class helps avoid unnecessary irrigation. Meanwhile, the regression model for determining irrigation duration achieved a Mean Squared Error (MSE) of 43.72 seconds² and a coefficient of determination (R^2) of 0.89. These results indicate that the model is capable of learning patterns from environmental parameters and converting them into precise and reliable irrigation duration estimates. The integration of IoT and Machine Learning has proven successful in creating a smart and efficient irrigation system, capable of optimizing water usage and supporting sustainable urban agriculture in challenging environments.

Keywords: Precision Irrigation, Internet of Things, Machine Learning, Random Forest, Lengkeng Tree, ESP32.