

ABSTRAK

Sarippudin, Sarippudin, Andi. 2026. Sistem Kendali Penyiraman Presisi Zonal Tanaman Jagung Berbasis IoT Edge Computing Menggunakan Logika Fuzzy Mamdani. Skripsi, Program Studi Teknik Informatika, Fakultas Teknik dan Teknologi Kemaritiman, Universitas Maritim Raja Ali Haji. Pembimbing: (1) Nurfalinda, S.T., M.Cs., (2) Tonny Suhendra, S.T., M.Cs.

Penyiraman konvensional yang seragam belum mampu mengakomodasi variabilitas kondisi mikro-lahan, khususnya pada komoditas jagung di wilayah kepulauan dengan keterbatasan air dan energi. Penelitian ini merancang Sistem Kendali Penyiraman Presisi Zonal berbasis Internet of Things (IoT) Edge Computing menggunakan algoritma Logika Fuzzy Mamdani pada mikrokontroler ESP32. Sistem mengolah tiga variabel masukan (kelembaban tanah per zona, suhu udara, dan kelembaban udara) melalui 64 basis aturan untuk menghasilkan keputusan durasi penyiraman yang adaptif pada lima zona secara independen. Distribusi air memanfaatkan aliran gravitasi dari tandon guna meminimalkan konsumsi daya listrik. Arsitektur edge computing memastikan inferensi fuzzy dieksekusi secara lokal, sehingga sistem tetap berfungsi optimal tanpa konektivitas cloud. Validasi algoritma dilakukan dengan membandingkan keluaran mikrokontroler terhadap simulasi MATLAB menggunakan 12 sampel variasi lingkungan. Pengujian ini menghasilkan tingkat akurasi tinggi dengan nilai Root Mean Square Error (RMSE) sebesar 0,60 detik. Purwarupa ini terbukti mampu menerapkan sistem penyiraman multi-zona yang mandiri, adaptif, dan hemat energi untuk mendukung digitalisasi pertanian di Kepulauan Riau.

Kata kunci: logika fuzzy Mamdani, edge computing, IoT, penyiraman presisi zonal, aktuator gravitasi, RMSE.

ABSTRACT

Andi Sarippudin. Sarippudin, Andi. 2026. Zonal Precision Irrigation Control System for Corn Plants Based on IoT Edge Computing Using Mamdani Fuzzy Logic. Thesis, Informatics Study Program, Faculty of Engineering and Maritime Technology, Raja Ali Haji Maritime University. Supervisors: (1) Nurfalinda, S.T., M.Cs., (2) Tonny Suhendra, S.T., M.Cs.

Uniform conventional irrigation often fails to accommodate micro-field variability, particularly for corn cultivation in island regions with limited water and energy. This study designs a Zonal Precision Irrigation Control System based on Internet of Things (IoT) Edge Computing using the Mamdani Fuzzy Logic algorithm embedded in an ESP32 microcontroller. The system processes three input variables (soil moisture per zone, air temperature, and air humidity) through 64 rule bases to adaptively generate irrigation durations across five independent zones. Water distribution relies on gravity-fed flow to minimize electrical consumption. The edge computing architecture ensures the fuzzy inference runs locally, keeping the system fully operational during internet outages. The algorithm's computational accuracy was validated by comparing the microcontroller's output against a MATLAB simulation using 12 environmental samples. This evaluation demonstrated high precision with a Root Mean Square Error (RMSE) of 0.60 seconds. The developed prototype is proven capable of implementing an energy-efficient, autonomous, and adaptive multi-zone irrigation system to support agricultural digitalization.

Keywords: Mamdani fuzzy logic, edge computing, IoT, zonal precision irrigation, gravity actuator, RMSE.