APPLICATION OF FUZZY LOGIC IN MICROCONTROLLER-BASED AUTOMATIC IRRIGATION SYSTEMS

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ABSTRACT

Fuzzy logic is an effective method for handling uncertainty and imprecise data in decision-making processes, particularly in sensor-based automation systems. This study aims to design and implement an automatic water pump control system based on fuzzy logic, using temperature and soil moisture as input variables. Temperature data is obtained from a DHT11 sensor, while soil moisture is measured using a resistive moisture sensor. The values from both sensors are converted into linguistic variables through a fuzzification process, categorized into three sets: temperature (cold, normal, hot) and moisture (wet, normal, dry). The Mamdani fuzzy inference method is applied using nine predefined rules to determine the pump speed (fast, medium, slow). These rules represent the logical relationships between input conditions and system responses based on expert knowledge. The final decision is derived through a defuzzification process to produce a precise output (crisp output). Testing results show that the fuzzy logic-based control system can provide adaptive and reliable responses to environmental changes. For example, when the temperature reaches 33 °C and soil moisture is 450, the pump operates at a fast rate (19 seconds); when the temperature is 25 °C and soil moisture is 860, the pump operates at a medium rate (10,03 seconds); and when the temperature is 27 °C and soil moisture is 780, the pump operates at a slow rate (17,9 seconds). This demonstrates that fuzzy logic is an intelligent and efficient approach for automatic irrigation systems.

Keywords: *Fuzzy Logic, Temperature, Soil Moisture, Automation.*