Proceedings of Research Exhibition in Mathematics and Computer Sciences 2025 (REMACS 8.0)
e-ISSN: 3093-7930

ADAPTIVE FUZZY LOGIC SYSTEM FOR MICROWAVE COOKING OPTIMIZATION

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Abstract

This study presents the development of an Adaptive Fuzzy Logic Control System for optimizing microwave cooking. Conventional microwave ovens typically rely on fixed settings that do not account for food variability. To address these issues, fuzzy logic was incorporated to dynamically adjust cooking parameter, specifically cooking time based on three input variables doneness level, quantity of food and initial temperature. The model uses a Mamdani type fuzzy inference system to produce accurate results that require overlapping membership functions and 27 rules in the form of IF THEN rules to determine the appropriate cooking time. The system's flexibility enables it to learn and adapt over time through human engagement, resulting in enhanced customisation and energy efficiency. The model was implemented and simulated using MATLAB, demonstrating consistent, high-quality cooking results with reduced energy usage. This invention highlights how intelligent control systems can improve the sustainability, efficiency, and precision of home appliances.

Keywords: *Adaptive fuzzy logic, microwave cooking optimization, Mamdani inference system, intelligent appliances, energy efficiency*

1. Results / Findings

Microwave ovens often operate on rigid presets that ignore variations in food texture, quantity and temperature resulting in uneven cooking and excessive power usage. This study aims to develop an adaptive fuzzy logic system that dynamically adjusts cooking time based on real-time input conditions. The system considers three key factors doneness level, food quantity and temperature. The objective is to optimize microwave performance for better consistency, personalization and energy savings especially in home setting where user preference and food diversity vary significantly.

2. Methodology

The fuzzy logic system was built using a Mamdani inference model consisting of fuzzification, rule evaluation and defuzzification stages. Input variables doneness level, quantity and temperature were mapped using triangular membership functions and cooking time was categorized as short, medium or long. A total of 27 IT-THEN rules constructed to handle all input conditions. MATLAB's Fuzzy Logic Toolbox was employed for modelling and testing. Simulations involved altering input values and observing the resulting cooking time. Rule viewers, control surfaces and membership editors were utilized to verify system behavior and manual calculations using the centroid method validated the defuzzified outputs.

3. Results / Findings

The adaptive system effectively responded to variations in food conditions by adjusting cooking time accordingly. For example, input values of doneness level=65, quantity=60 and temperature=59 resulted in cooking time of approximately 30 seconds, aligning with medium doneness. Simulations demonstrated consistent output generation and adaptability across different cases. The fuzzy logic model successfully improved the reliability and quality of microwave cooking outcomes while reducing energy use. The control surface visualizations confirmed the system's ability to generalize across multiple input interactions.

4. Novelty of Research / Product / Project

The proposed system introduces adaptive intelligence into microwave ovens using fuzzy logic principes, which is still limited in current consumer appliances. Unlike conventional models with fixed timers, this system dynamically tailors cooking time to match the actual food condition and user preference. Its learning potential further enhances personalization over time. By simulating the system in MATLAB, this research proves the feasibility of integrating AI based control in low-cost home appliances to improve both performance and sustainability. This innovation contributes to the development of smart kitchen technologies aligned with modern energy efficiency goals.

5. Conclusion or Future Work

The project successfully implements a fuzzy logic-based microwave controller that optimizes cooking time using a real time input variable. Future work may involve integrating sensors for live data capture, real world prototype development and expanding to broader food types and user interfaces for commercial application.

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