Development of Fuzzy Inference System for Automatic Tea Making

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***Abstract*—In this paper, a fuzzy inference system has been developed for automatic tea making process. The system takes five inputs and gives two output which determines the grade of black tea and milk tea. Specifically, the proposed system considers five important characteristics of hot tea beverage such as water temperature, sugar, milk, brewing time and tea leaves quantity for grading the standard of the drink according to the consumer's requirement. Both black tea and milk tea can be rated with a grade based on the human expert judgment which is according to the taste and aroma of the tea. This automatic tea making system can let the users choose their preferred type of tea without figuring out the complicated process to making a cup of hot tea beverage.**

***Index Terms* — Fuzzy inference system, tea grading, automatic tea maker.**

I. INTRODUCTION

Drinking tea is a popular habit of a healthy lifestyle for its significant medicinal benefits as a protective agent against cancer and cardiovascular diseases [1]. Tea has a history of thousand years as a refreshing as well as a medicinal drink. In order to ensure the complete medicinal advantages of tea to the human body, the appropriate way of making good quality tea is important. An intelligent methodology can be used to improve the grade of the tea by analyzing several parameters of the tea making process such as, water temperature, sugar content, milk content, brewing time and the tea leaves quantity. To accomplish the task, fuzzy logic system can be applied to develop a smart tea maker system to make the high quality tea that preserves the benefits of tea without losing it.

The sensory data in linguistic form was investigated by [2] for individual quality attributes of tea liquor. The method was applied for evaluation of the sensory quality of tea liquor made out of the dried crush, tear and curl (CTC) tea. Sensory scale factors assigned to each of the quality attributes such as colour and brightness, aroma, strength and briskness of tea liquors. A fuzzy ordinary regression method is proposed to develop the customer preference models [3] which are capable of addressing the two uncertainties of crispness and fuzziness of the customer preferences. An optimum fuzzy method was created in [4] where a genetic algorithm was applied to a fuzzy function which determines the amount of rice and resolves switching patterns of a heater in a cooking cycle. The proposed method controls a rice cooker by controlling the timing of heater by using a fuzzy function in a cooking operation. Neural network and fuzzy logic have been applied to consumer products in [5]. Applications of both technologies are categorized into four cases: *i*) neural networks being used to automate the task of designing and fine-tuning the membership functions of fuzzy systems *ii*) both fuzzy inference and neural network learning capabilities provided separately *iii*) neural networks work as correcting mechanisms for fuzzy systems *iv*) neural networks cascaded (serially) with fuzzy systems.

The tea withering process was simulated in [6] by using fuzzy nonlinear simulation methods in order to predict the standard of withering. The withering standard has been considered as a function of five non-interactive inputs which for a tea industry were identified as moisture content, standard of plucking, thickness of spread, period of withering and drying capacity of withering air. A set of fuzzy rules based on expert human judgment were formulated to correlate fuzzy inputs and output. A self-cleaning process was developed in [7] for stove by using fuzzy logic approach. A pyrolytic self-cleaning method for stoves includes on-line optimization with designable temperature range by fuzzy-controlling a transient state for a temperature starting value with a regulating device, to avoid a heating start up the peak with a fuzzy control step. Fuzzy c-number (FCN) and alternative fuzzy c-number (AFCN) were applied in an evaluation of Taiwan tea grades [9]. The four criteria used to evaluate tea quality which includes appearance, tincture, liquid colour and aroma. A fuzzy arithmetic average is used to obtain a fuzzy number based on these criteria and then assigned perfect, good, medium, poor or bad nearest to this fuzzy number. A two-objective particle swarm optimization (PSO) based on a weighted fuzzy neural network is used to obtain the fuzzy rules which for the taste identification of tea in [10]. A fuzzy control based tea processing method was investigated in [9] to improve the quality of tea. The multi-point detection system is used in a real-time collection of two parameters such as temperature and humidity.

Based on the above discussion it can be realized that, despite having fuzzy logic application in the tea processing system, designing fuzzy logic based automatic tea maker has