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MOOD RECOGNITION AS CUSTOMER'S FEEDBACK USING FUZZY INFERENCE SYSTEM

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ABSTRACT
Within the last several years, human mood recognition has been actively explored in the computer vision research. Human mood recognition is widely applied in education, psychology and customer service management. This study has been prepared for the customer service management. Nowadays, customer service is usually conducted through a manual survey to measure the customer's satisfaction. Manual customer's satisfaction survey is subjective and the customer's response may be less accurate. The objective of this study is to develop a mood recognition prototype as customer's satisfaction feedback using fuzzy inference system and to measure its effectiveness. This study explores the recognition of domain-specific mood using a fuzzy inference system to detect three categories of mood; negative and positive and neutral with the accuracy of 78% matched based on the mouth measurement and computation. The future study focus on adding more feature points and improve rules and combine other classifiers to the fuzzy inference system for better performance.

Keywords: Customer Feedback; Customer Management Service; Fuzzy Inference System; Mood Recognition.

1. INTRODUCTION

Customer satisfaction is commonly presented in quality terms to provide feedback for certain services [1]. According to [2], customer's satisfaction is an imperative indicator of how successful a service has been provided to the customers by the organization. For the ongoing service improvement, the organizations must look into the needs and wants of their customers. There is also a positive connection between customer's satisfaction, loyalty and retention towards the organizations. Therefore, customer's satisfaction, reliability and preservation are all very important for an organization to be successful [3]. That is why customer's survey feedback is very important for every organization or customer service. Moreover, these feedback data can be categorized as either implicit or explicit [4].

The important aspect in the relation and communication between human beings is emotions, and humans can express these emotions through facial elements such as speech and facial movement [5] [6]. By understanding human facial expression, it can benefit and impact business and increase profitability by understanding and improving service productions and delivery [7].

Nowadays, customer perceptions and satisfactions can be measured with the use of advanced technology such as mood recognition system. It captured customer's face expression and translate the emotions and behaviors of customers to determine one's perceptions and satisfactions [8].

According to [9], manual survey is usually conducted to measures customer satisfaction level. However, this method has certain limitations as it is costly and the time lapse between services provided to the customer and the time survey is conducted. Asking the questions to the customers to get feedback is the greatest technique so far to find out whether your customers are satisfied or not. However, humans can lie but based on facial expressions we can detect the mood showed through the degree of expressions. This paper focuses on the human face in recognizing expression and the mouth is selected as the major aspect of facial and mood expression. Based on the mouth, the real emotion can be identified accordingly. This research aim to measure the effectiveness of mood recognition as a customer's feedback prototype using Fuzzy Inference System (FIS) and the mouth features are used to determine the emotions.

2. RELATED WORKS

Since the human face can be easily captured by any imaging sensor such as a camera, facial image processing and analysis methods are widely applied in the identification process [10]. Hence, this is good to be applied in the customer's feedback domain through facial expression recognition. From [1], it showed that that in the area of human mood detection by facial expression has been growing in the interest of improving all aspects of interactions between humans and computers. In pervasive applications in assistive environment, human's emotion detection plays a significant role [11]. Two main flows in the recent research on automatic study of facial expressions consider facial emotion detection and facial muscle action detection [12]. Sadness, Anger, Joy, Fear, Disgust or Dislike and Surprise are the commonly accepted category of emotion, as applied in human computer interaction.

Meanwhile, Fuzzy Inference is the actual process of mapping from a given input to an output using fuzzy logic. The process involves membership functions, fuzzy logic operators, and if-then rules. The benefit of this method is its simplification in evaluation of Customer Satisfaction Index (CSI) based on simple linguistic statements collected from experienced people. In automation control, data classification, decision analysis, expert system and computer vision has been successfully implemented and used widely. Due to its multi-disciplinary nature, the Fuzzy Inference System is also known as fuzzy-rule-based system, fuzzy expert system, fuzzy model, and fuzzy associative memory and fuzzy logic controller [13]. Fuzzy logic represents a good mathematical framework to deal with the uncertainty of information [14]. Figure 1 shows the Fuzzy Inference System classifier for human face emotions.

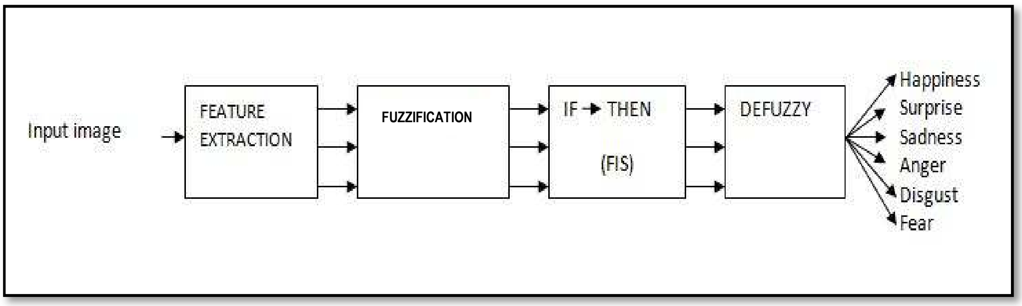

Fig.1. Fuzzy Inference System classifier

3. EXPERIMENTAL

To imply with fuzzy method, first the image analysis is needed. The most important role in image analysis is played by feature extraction [14].The input image will be processed by the extracted features. The expectation is that the set of features will extract the relevant information from input data. The aim is to perform the desired task using the reduced representation instead of the full size input. In this step, some mathematical characteristics of the extracted region such as the height and width of the mouth images are calculated and considered as features that are fed to Sugeno-type fuzzy system for the recognition as shown in

Figure 2. The Fuzzy Inference System that is proposed consists of triangular membership functions for both input and output and series of if-then rules. This system is able to detect three basic human moods which are ***Negative***, ***Positive*** and ***Neutral***.

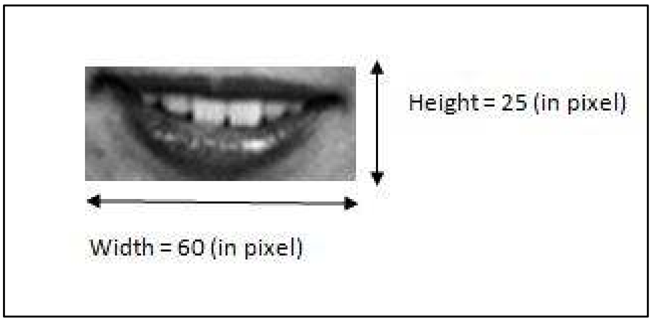

Fig.2. Height and width as the features used

a) Specify the problem and define linguistic variables

First, the problem is specified and linguistic variables are defined. This study has two linguistic values for input and one linguistic value for the output as shown in Table 1.

Table 1. Linguistic variables and range

	Variables	Linguistic value	Annotation	Numerical range
Input	Mouth_width, *w*	Short	S	0- 50
		Moderate	M	45-65
		Large	L	60-75
	Mouth_height, *h*	Low	L	0-28
		Moderate	M	24-48
		High	H	44-54
Output	Mood, *e*	Negative	NEG	> 30 %
		Neutral	NEU	50%-60%
		Positive	POS	>60%

b) Determine the fuzzy numbers

A fuzzy number can be simply defined as a set with fuzzy boundaries. The shapes of fuzzy numbers represented in this study are triangles and trapezoids. This is because these shapes often provide adequate representation of the expert knowledge and also simplifies the computational processes. Figure 3 and Figure 4 show the fuzzy numbers for the height and width of the mouth which were extracted during image analysis.

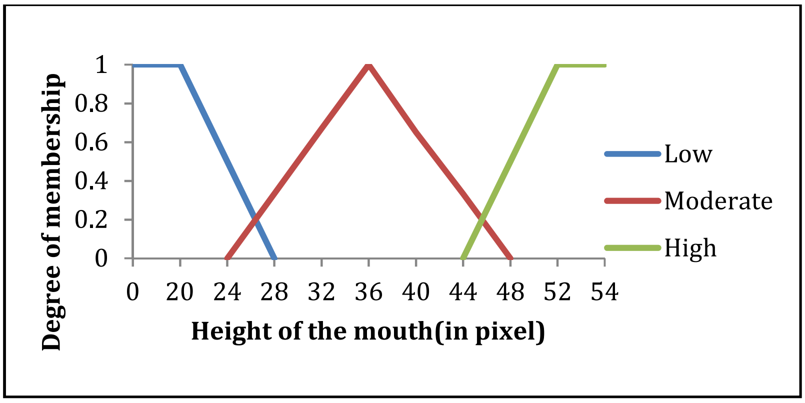

Fig.3. Fuzzy numbers of *height* of the mouth

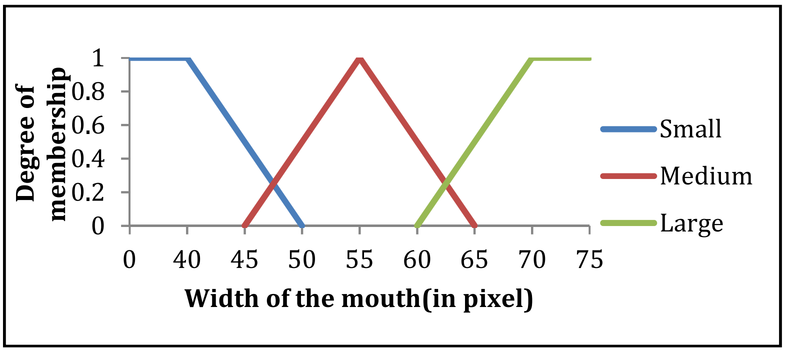

Fig.4. Fuzzy numbers of *width* of the mouth

c) Elicit and construct fuzzy rules

Next, the fuzzy rules are constructed. The rules are created from the data observation. The fuzzy rules can be defined as a conditional statement and elicit the rules as shown as in Table 2.

Table 2. Linguistic variables and range

		HEIGHT								
	AND	**LOW**	**LOW**	**LOW**	**MEDIUM**	**MEDIUM**	**MEDIUM**	**HIGH**	**HIGH**	**HIGH**
WIDTH	**SMALL**	NEU								
	MEDIUM		NEU							
	LARGE			POS						
	SMALL				NEG					
	MEDIUM					NEU				
	LARGE						POS			
	SMALL							NEG		
	MEDIUM								NEG	
	LARGE									POS

NEU: NEUTRAL, POS : POSITIVE, NEG : NEG.

- *Sugeno fuzzy inference techniques*

According to [15], there are four steps in the fuzzy process . They are the fuzzification of the of the input variables, rules evaluation, aggregation of the rule output and defuzzification. The two fuzzy inference techniques are the Mamdani and Sugeno methods. [15]added that the Sugeno methods work well with the optimization and adaptive techniques, which make it very attractive in control, particularly for the dynamic non-linear system. That is why Sugeno method was chosen to be used in this system.

i) Fuzzification

The first step is to take the crisp inputs for height of the mouth, *h* and width of the mouth, *w* and determine the degree to which these inputs belong to for each of the appropriate fuzzy numbers. The crisp input *h* correspond to the membership function **Medium,** M with the degree of 0.5 ($\mu_{(h=M)}$=0.5), and *w* correspond to the membership function **Medium**, M and **Large**, L with the degree of 0.1($\mu_{(h=M)}$=0.1) and 0.4($\mu_{(h=L)}$=0.4). In this context, by using fuzzy rules, each of the input will be fuzzified over all the membership functions. Figure 5 shows the illustration for the fuzzification process.

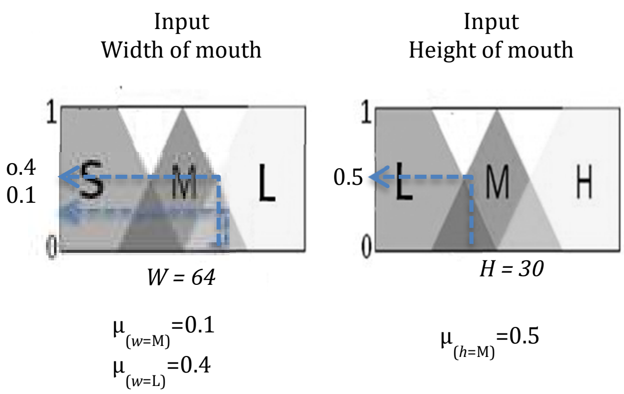

Fig.5. Fuzzification step

ii) Rule evaluation

The second step is to take the fuzzified inputs $\mu_{(w=M)}$=0.1, $\mu_{(w=L)}$=0.4, $\mu_{(h=M)}$=0.5. and apply them to the antecedents of the fuzzy rules. To evaluate the conjunction of the rule antecedents, the AND method, *min*, is used. *Min* is calculated by taking the smallest number between two numbers. Table 3 shows the construct of fuzzy rules.

Table 3. Construct Fuzzy Rules

Rule 1	**Rule 6**
IF (m_width is SMALL)	**IF (m_width is LARGE)**
AND (m_height is LOW)	**AND (m_height is MEDIUM)**
THEN (mood is NEUTRAL)	**THEN (mood is POSITIVE)**
Rule 2	**Rule 7**
IF (m_width is MEDIUM)	**IF (m_width is SMALL)**
AND (m_height is LOW)	**AND (m_height is HIGH)**
THEN (mood is NEUTRAL)	**THEN (mood is NEGATIVE)**
Rule 3	**Rule 8**
IF (m_width is LARGE)	**IF (m_width is MEDIUM)**
AND (m_height is LOW)	**AND (m_height is HIGH)**
THEN (mood is POSITIVE)	**THEN (mood is NEGATIVE)**
Rule 4	**Rule 9**
IF (m_width is SMALL)	**IF (m_width is LARGE)**
AND (m_height is MEDIUM)	**AND (m_height is HIGH)**
THEN (mood is NEGATIVE)	**THEN (mood is POSITIVE)**
Rule5	
IF (m_width is MEDIUM)	
AND (m_height is MEDIUM)	
THEN (mood is NEUTRAL)	

iii) Aggregation of the rule output

The third step, the aggregation is the process of unification of the outputs of all rules. The previous rule consequents are combined into a mathematical function. The Sugeno-style uses a fuzzy singleton to get the output. A singleton is a fuzzy number with a membership function that is unity at a single point of the universe of discourse and zero everywhere else [15]. This study uses the zero-order Sugeno fuzzy model.

iv) Defuzzification.

The last step in the fuzzy inference process is defuzzification. The input for the defuzzification process is the aggregate output fuzzy number and the output is a single number. The calculation for the defuzzification is a weighted average (WA) of all the singletons. The equation (1) shows how to get the weighted average.

$$WA = \frac{\mu(k1) \times k1 + \mu(k2) \times k2}{\mu(k1) + \mu(k2)} \quad (1)$$

where, $k1$ is the constant for fuzzy number one, and $k2$ is the constant for fuzzy number two.

4. RESULTS AND DISCUSSION

For this study, the evaluation determines how many ***Positive***, ***Negative*** and ***Neutral*** mood is recognized from the 60 testing images as shown in Figure 6. Among from the total testing images, 18 ***Negative***, 29 ***Neutral*** and 13 ***Positive*** mood has been automated recognized. Meanwhile, Figure 7 shows that from the testing images, 78% of the mood is correctly recognized based on the 60 testing images. Hence, this FIS is tolerable to be used in mood recognition for the customer's feedback purpose with future enhancement.

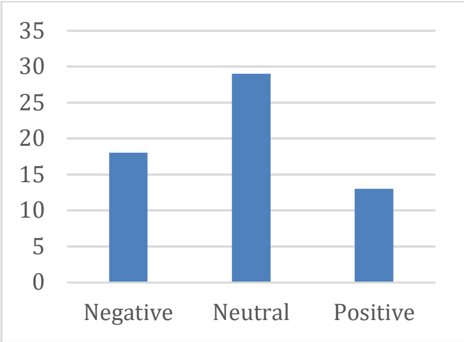

Fig.6. Total Mood Recognized

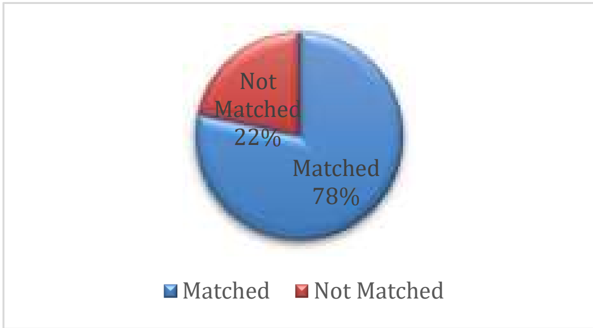

Fig.7. Total Matched Mood Recognized

5. CONCLUSION

The prototype of mood recognition system using Fuzzy Inference System and the evaluation of this algorithm is suitable to be implemented in this domain since it is known to be good in pattern matching problems. The accuracy shows a satisfactory result based on the findings. However, since this study is limited only to the height and width of the mouth, in the future, more points can be added, other than the mouth for further analysis. Moreover, this is needed to improve rules and combine other classifiers to the Fuzzy Inference System for a better performance.

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