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EVALUATION OF PHYSIOLOGICAL RESPONSE TO STRESS USING FUZZY LOGIC

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Abstract *The human stress level is rather intangible, and therefore cannot be directly measured. However, this stress can be correlated to external and/or internal factors, which are rather tangible things, such as heart rate, Systolic-Diastolic Blood Pressure, salivary α-amylase, and skin temperature. These factors measurements are provided in wide ranges and vary individually lends itself naturally to fuzzy sets and fuzzy logic. This research is aimed at assessing respondents stress level through the changes of physiological factors above over time. The subjects of this study are 10 healthy adults, aged between 23-35 years old. The measurement time divided into four periods, namely pre-stressor, stressor-I, stressor-II and post stressor period. Pauli-test and mental arithmetic test was used as stressors. Obtained data were analyzed using Fuzzy Inference System (FIS) toolbox in MATLAB. By using fuzzy inference system model, the system succeeds to predict subject stress value/index based on subject physiological value. The result showed that the changes in human factors affects human stress value/index, although the subjects stated that their stress level on the same level their physiological factors were changed during measurement, and the models showed the changes of subject stress value during different period of measurement time.*

Keywords*: stress, physiological factors, fuzzy logic, fuzzy inference system, stress value/index*

1. INTRODUCTION

Stress is tension forms of physical, psychological, emotional and mental. Form of this tension affect an individual's daily performance. Even stress can make productivity decreased, pain and mental disorders. Basically, stress is a form of tension, both physical and mental. According to Vermeulen [6], stress is anything that cause an individual to feel they are losing control. It includes anxiety and fear. Anxiety deals with imagined or unreal dangers. Fear deals with 'actual' or 'threatened' dangers. Kirschbaum and Hellhammer [5] classified stress as human body stress and cell stress, psychological stress and physical stress, as well as eustress and distress. Eustress is a psychological condition that comfortable and have a positive impact (comfortable and/or positive psychological states), and distress is uncomfortable and have a negative impact (uncomfortable and/or negative psychological states). Hans Selye [6] defined stress in physiological terms as, 'a non-specific or generalized bodily response. This response results when any demand is made on the body, whether it is an environmental condition that an individual must survive, or a demand that is being made in order to accomplish a personal goal.Every living creature had experienced stress in their life. Stress is an uncomfortable condition that is felt by individuals due to exposure to a stressor that has not been or cannot be addressed by the mechanisms of homeostasis. Physical or mental stimulation or both can be a stressor. Stimulus provided by the stress contributed to the change and growth of individuals. Humans are creatures who always respond and adapt to stress. Stress response is adaptive and protective. Homeostasis is a dynamic mechanism, because this mechanism is always related to the dynamics activities of individual that are always changing [2].

Response to stress involves several physiologic activities, among others, the activation of autonomic nervous system, the HPA axis (hypothalamic-pituitary-adrenal), and immune systems, which work in a coordinated, simultaneous, interactive and complex to avoid damage caused by stressors or stress.

When the stress response is initiated, immediate and powerful changes come about because of the activation of a particular branch of the nervous system called the autonomic nervous system (ANS). This branch is a part of SAM system, the autonomic nervous system (ANS) is the part of the body's peripheral nervous system responsible for maintaining homeostasis, or balance. Autonomic nervous system working or functioning in autonomic

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ways, simultaneously and in an unconscious state, includes the function of regulating, coordinating, and adjusting vital functions, among others, blood pressure and blood flow, body temperature, respiration, digestion, metabolism, and elimination. Autonomic nervous system is strongly influenced (strongly affected) by the emotional or psychological and also an important part of the expression associated with psychomotor behavioral aspect. Some of ANS's expressions include blushing, pallor, palpitations of heart rate, clammy hands, and dry mouth [3].

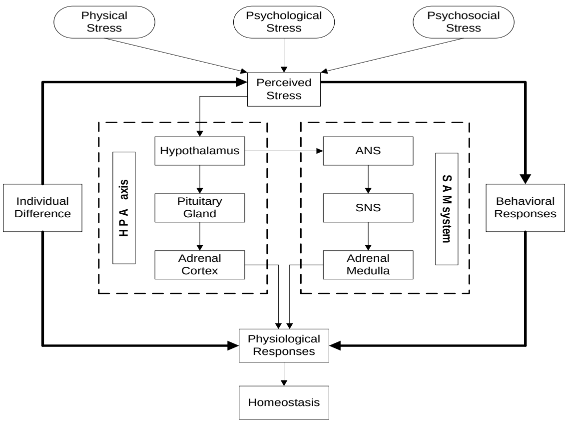

Figure 1. The pathway of stress

There are two branches of the ANS that are designed to regulate the fight-or-flight response on a constant basis. The sympathetic nervous system is the part of the ANS that is responsible for initiating the fight-or-flight response. Each time when human have a thought of danger or pain, the sympathetic nervous system initiates the fight-or-flight response to prepare the body to handle the potential danger or pain. The other branch of the autonomic nervous system is called the parasympathetic nervous system. This branch of nervous activity is designed to return the physiology to a state of homeostasis, or balance, after the threat, danger, or potential pain is no longer perceived to be imminent [1], the illustration of stress pathway inside human body is described in Fig. 1

2. STUDY RATIONALE

Understanding human stress level is something complicated. Humans in their response to stress is different for each individual. Human experience in overcoming problems / situations, individual characteristics, gender, age, physical or mental condition of the individual and the behavioral difference when the stress response itself will give variations on individual stress level. Based on that, individual's stress response systems (i.e. HPA axis and SAM system) will reacts differently from each individual to another when imposed to stressor. Therefore, the physiological responses to stress of human beings is different each other. In other word, each human bodies have different reaction in order to maintain their body system in homeostasis state when human felt threatened or in dangerous situation.

Most of human's difficult to describe their stress level in some situation, they can felt if their body is in under stress , but it’s difficult to judge their stress level, whether the stress level is on low, medium or high level. Sometimes human also describe that their stress level on the same level, even though their physiological response have different value from time to time (i.e. pre-stressor, stressor-I, stressor-II, and post-stressor). According to those facts, it is believed that there is different value/index of stress level if the physiological responses have different value each times. Further, it is important to know human stress value/index rather than merely described the stress level in the form of stress – not stress or low–medium–high by evaluate its physiological changes. Hence, the Concept of Assessment approach applied in this research is fuzzy logic computing. This research is aimed at assessing respondents’ stress degree through their blood pressure data, heart rate, skin temperature and concentration of salivary amylase. It is assumed that fuzzy logic approach against stress level correspond to stress condition of the respondents.

3. MATERIAL AND METHOD

3.1 Experimental Design

The subjects of this study are 10 healthy adults and aged between 23 and 35 years old, consisting of five males and females each. Subjects were divided into five groups each comprising two persons. Sampling data on each group performed on different days. Grouping of subjects and sampling on different days is important because of limited human resources as an observer. This experiment aims to evaluate the stress level based on physiological responses to stressors. The same experimental conditions imposed on all subjects, each subject worked on two kinds of stressors namely Pauli-Test and mental arithmetic test. Pauli-Test was given to the subjects to produce under pressure or under stress situation, and makes the subjects exhausted during experiment. After the subjects exhausted, mental arithmetic test was given to provide more stress situation for the subjects. The study was conducted in a relatively short period of time for 80 minutes and divided into four periods, which are pre-stress period, stressor I period, stressor II period, and post-stress period as shown in Fig. 2.

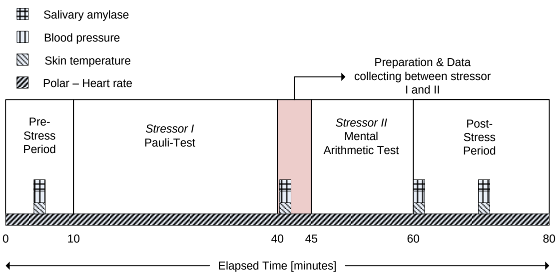

Figure 2. Experimental design

During the experiment, heart rate data was recorded continuously using Polar system. In the other hand, the concentration of salivary amylase, blood pressure, and skin temperature were obtained intermittent for each period. Firstly, the subjects instructed to wear a Polar system on their body and start recording in sitting position after instruction was given by observer. Second, the subjects were kept in a sitting position for 10 minutes and instructed to relax. In the first 5 minutes salivary amylase, blood pressure, and skin temperature were collected in the pre-stress condition. After this, the subject were tested the Pauli-Test in a sitting position for 30 minutes and salivary amylase, blood pressure, and skin temperature were collected in the end of test. They were further tested the mental arithmetic test for 15 minutes and the same data were collected after the test finished. Finally, the subjects were maintained in the sitting position for 20 minutes while post-stress salivary amylase, blood pressure, and skin temperature were collected again in the middle of post-stress period.

2.2 Experimental Tools

2.2.1 Questionnaire and Stressor

Before the stress measurement begin, each of subject was given a questionnaire. The questionnaire ask about subject's activities and stress/emotional conditions approximately one hour before the measurement. They were further asked to give their subjectivity about their stress/emotional condition in every period of measurement time (i.e. pre-stressor, stressor-I, stressor-II, and post-stressor period). In the stressor-I period, subjects were given Pauli-Test as a stimulus. The aim of this test is to create stressful conditions. On this test, subjects were instructed to do the test as fast as possible for 30 minutes. The procedure of this test are, the subject had to sum the two adjacent numbers continuously from top to bottom, starting from the upper left side, the subject only write one digit of the sum result. After this, the subjects were tested the mental arithmetic test for 15 minutes in the stressor-II period. Each subject was given 40 mental arithmetic questions, in overall all of the questions are simple mathematic operations and each question has different time limit to solved, it depends on the difficulty level of the question.

2.2.2 Polar System

In this study we use Polar RS800CX type to record subject's heart rate. This Polar system consists of (a) Polar RS800CX training computer to displays and records subject's heart rate and other exercise data during exercise and (b-1,2) Polar WearLink W.I.N.D. transmitter to sends the heart rate signal to the training computer, it's includes a connector (b-1) and strap (b-2) as shown in Fig. 3. During the experiment each subject have to wear this device properly to prevent misconnection between training computer and transmitter.

Figure 3. Polar system

2.2.3 Blood Pressure Monitor

For subject's blood pressure measurement we used OMRON HEM-6200 wrist blood pressure monitor (Fig. 4). This device used oscillometric technique in its measurement method, therefore this device requires less skill than the auscultatory technique and suitable for use by untrained staff. The OMRON Wrist BP monitor displays a measurement range of 0 to 299 mmHg for pressure readings and 40 to 180 beats/minute for pulse rates. The accuracy rate stands at ±3 mmHg for pressure and ±5 % of reading for pulse. In each period of measurement time, the subjects instructed to take their blood pressure in sitting position and are prohibited from doing any movement or speaking during blood pressure's data collecting.

Figure 4. Wrist BP monitor and Experimental setup

2.2.4 Salivary α-Amylase Monitor

Subject’s concentration of salivary α-amylase were measured using salivary amylase monitor (NIPRO Co., Ltd.). This device using non-invasive method to analyze salivary α-amylase and its displays a measurement range of 10 to 200 kIU/l for concentration of salivary α-amylase readings. The salivary amylase monitor consists of a measurement device and a strip-marker as shown in Fig. 5. The saliva is gathered with the strip-marker in Fig. 5(b), which the subject puts under his tongue for 30 s; the amylase is extracted using the measurement device in Fig. 5(a) for 30 s. The value of salivary α-amylase can be collected within 1 min, the salivary amylase data was collected four times during the experiment based on the period of measurement time. The salivary α-amylase index has the advantages of a short duration compared to other physiological indices. Clean saliva comes from under the tongue because an easily reached salivary gland is located there.

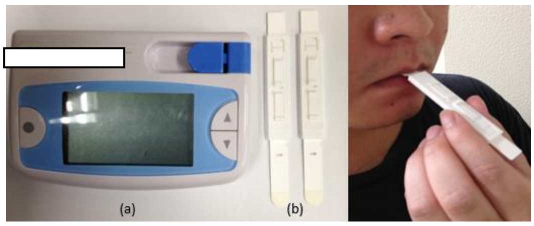

Figure 5. Salivary α-amylase monitor

2.2.5 Infrared Thermometer

Infrared thermometers measure temperature from a distance by detecting the amount of thermal electromagnetic radiation emitted from the object being measured (Fig. 6). This allows observer to accurately measure subject's skin temperatures without made contact with the subject. This thermometer displays a measurement range of -60 to 500˚C. There are four reading modes in this device, i.e. maximum, minimum, differential and average. In this study, we use average reading mode to collecting subject's skin temperature, we measure both of palm hands of the subject within range of ±12 cm between skin surface and the device.

Figure 6. Infrared thermometer

2.3 MATLAB Analysis

2.3.1 Fuzzy Inference System Analysis

Fuzzy inference system or fuzzy rule-based system is the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made, or patterns discerned. The process of fuzzy inference involves all of the pieces: membership functions, fuzzy logic operators, and if-then rules. Fuzzy inference system consists of a fuzzification interface, a rule base, a database, a decision-making unit, and a defuzzification interface described in Fig. 7.

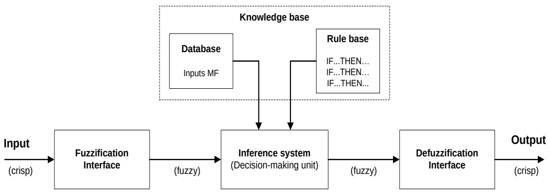

Figure 7. Fuzzy Inference system (FIS)

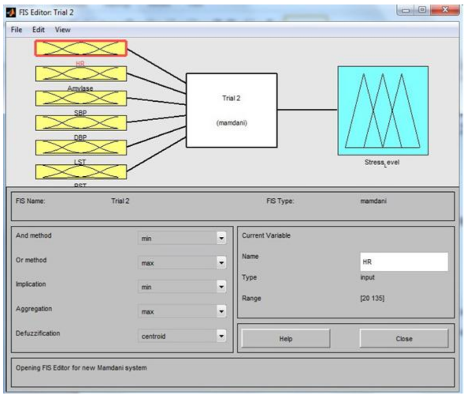

Figure 8. FIS model for stress level evaluation

In this study, MATLAB FIS Toolbox has been used as a tools to create fuzzy inference system with Mamdani-type for modeling the stress level (output) using human physiological factors namely heart rate, salivary α-amylase, blood pressure and skin temperature as input variables as shown in Fig. 8.

2.3.2 Fuzzification – Input Membership Function

The factors impact the human stress level and the stress level of different people in different ways. The amount of information presented by the various factors is enormous, thus drastically increasing the complexity of any model used to correlate the factors to the level of stress. In order to simplify the model by reducing the amount of data required to evaluate the model, we make use of fuzzy logic, where the input parameters are quantified with linguistic variables such as low, normal, and high which represent a wide range of input values. Following is a brief description of the factors used in our model and their membership function.

1. *Heart Rate (HR)*: Three heart rate ranges are identified, and categorized with fuzzy linguistic variable low (LHR) from 20-70 bpm, medium (MHR) from 45-100 bpm and high (HHR) from 84-135 bpm as shown in Fig. 9.

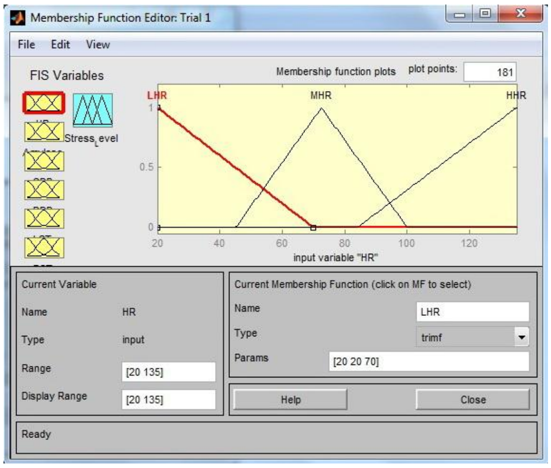

Figure 9. Heart rate membership function

2. *Salivary α-Amylase (sAA)*: sAA measurements are given in frequency ranges, and can be represented with three linguistic variables, namely low, medium and high with ranges 10-45, 30-120 and 110-200 (kU/l) respectively.
3. *Systolic Blood Pressure (SBP)*: Three linguistic variables are used to implement SBP, low (70-120), medium (90-140), and high (120-200).
4. *Diastolic Blood Pressure (DBP)*: Three linguistic variables are used to implement DBP, low (35-75), medium (65-95), and high (80-135).
5. *Skin Temperature – Left Hand (LST)*: Three linguistic variables are used to implement DBP, low (18-24 ˚C), medium (24-29.5 ˚C), and high (26.5-37 ˚C).
6. *Skin Temperature – Right Hand (RST)*: Three linguistic variables are used to implement DBP, low (18-24 ˚C), medium (24-29.5 ˚C), and high (26.5-37 ˚C).

2.3.3 Fuzzification – Output Membership Function

In this experiment, observers want to know the stress level of the subjects, whether the subjects in low, medium or high stress levels when imposed to stressor. The output of this FIS model is stress level, the stress level was mapped to values from 0 to 1 using a set of output membership function. Three linguistic variables are used to implement level of stress, low (LStress) from 0 to 0.333, medium (MStress) from 0.333 to 0.666, and high (HStress) from 0.666 to 1 as shown in Fig. 10.

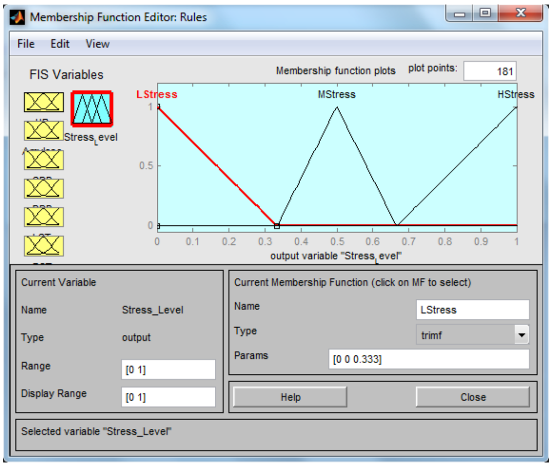

Figure 10. Stress level membership function

2.3.4 Fuzzification – Inference System

The correlation between the input and the output variables is done through a set of fuzzy rules. Each rule uses AND/OR connectors to connect various input factors with output variable. Three of 436 rules used in our model are listed below for illustration. In this study, rules were obtained from experiment's data summary (see Appendix-1). For example, rule 1 shows all the input factors which produce the low stress level. In the FIS model, rules are assigned weights. The initial weights for all rules are set to 1.

1. If (HR is MHR) and (Amylase is LsAA) and (SBP is LSBP) and (DBP is MDBP) and (LST is HLST) and (RST is HRST) then (Stress_Level is LStress) (1)
2. If (HR is HHR) and (Amylase is MsAA) and (SBP is LSBP) and (DBP is LDBP) and (LST is HLST) and (RST is HRST) then (Stress_Level is MStress) (1)
3. If (HR is HHR) and (Amylase is MsAA) and (SBP is MSBP) and (DBP is LDBP) and (LST is HLST) and (RST is HRST) then (Stress_Level is HStress) (1)

2.3.5 Defuzzification

When we try to solve a decision problem, we want the output to be a number (crisp value) and not a fuzzy set. For the stress level problem for instance, we do not want the system to tell us in which level the subject's stress level for each period (i.e. low, medium, high). What we want to know is the exactly value of the stress level. Thus, the system needs to transform the fuzzy set into a single numerical value. In this study, we used centroid of area which is one of the most popular defuzzification methods, which returns the center of the area under the fuzzy set. The output crisp value was obtained using the formula below:

$$z = \frac{\sum_{j=1}^{q} Z_j u_c(Z_j)}{\sum_{j=1}^{q} u_c(Z_j)} \qquad \text{(Eq. 1)}$$

Where, z is the output crisp value, q is the number of rules and u_c is the membership in class c at value z_j.

3. RESULT

3.1 Experiment Result

Figure 11 displays the experiment result in this study. Stress level distribution were obtained from subject's subjectivity, subjects were given the information about their stress level for each period. In this experiment's result, most of subjects have a same stress level on the different period, in the other hand the physiological responses (i.e. HR, sAA, SBP, DBP, LST and RST) of the subjects have different value on each period. For example, subject 1 stated that the stress level in pre-stressor period is low, in stressor-I is low, stressor-II is medium and in the post-stressor is low, whereas the subject's physiological responses have a different value for each period (Appendix-2). The same problem also occurred for another subjects even some of the subjects have difficulties to determine their stress level. From this condition we want to evaluate the difference of perceived stress by the subjects from period to another periods, although the subject felt the same stress level. To achieve our goals, we need to create models using fuzzy logic to make human stress level have a value or index, with stress level as an output and physiological responses to stress as inputs. Due to the nature of the human stress level that cannot be stated clearly, thus, subject's information about their stress level for each period is important to create this fuzzy model.

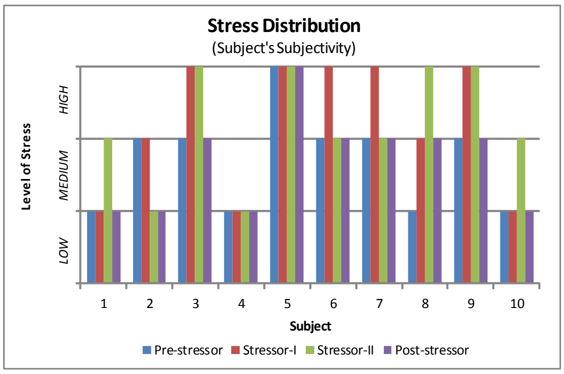

Figure 11. Stress distribution based on subject's sujectivity

3.2 Fuzzy Inference System Result

After FIS success create the model, we able to enter the value of each subject's physiological response into the model, then FIS will compute automatically the new output result in the form of value or index of stress level with range between 0 to 1. As mentioned before, we divide stress level into three levels, low (0-0.333), medium (0.333-0.666), and high (0.666-1). Figure 12 displays the stress level distribution result using fuzzy inference system's model. By using this model, we can see the variance of subject stress level on each period, not just the stress level but the stress value also obtained. For example, subject 1 have low stress level (0.272) in pre-stressor period, when the subject imposed to stressor-I the stress level still low but the stress level value is increased to 0,313. In stressor-II period, subject stress level is increased to medium level (0.462). After passed the stressor periods, subject enters the post-stressor period, where the stress level of subject still at medium level with stress level value decreased to 0.401. The fuzzy inference system's result for all subjects is described in Appendix-3.

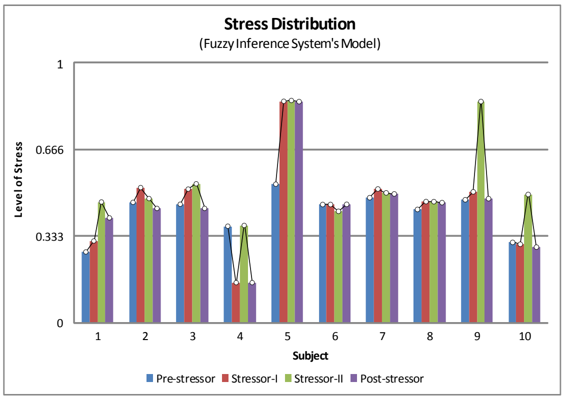

Figure 12. Stress distribution using fuzzy inference system's model

From FIS result we also know that experiment design to evaluate physiological responses to stress is shown linear correlation between measurement period and subject's stress value/index. From the graph above, most of subject stress level value/index were increased during the pre-stressor to stressor-II period, and decreased from stressor-II to post-stressor. In the other hand, it is difficult to see the stress level changes during each period if stress level is classified by verbal/binary form (i.e. 0 or 1, not stress or stress, low – medium – high).

4. DISCUSSION

The problem of stress evaluation based on the measured physiological changes in the human body is that each person manifests stress/emotion in a manner different from others. The human stress/emotion status is rather intangible, and therefore cannot be directly measured. However, this stress/emotion can be correlated to external and/or internal factors, which are rather tangible things, and hence they can be measured and analyzed.

The internal factors come from different parts of the body in several forms such as heart rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), salivary α-amylase (sAA) and skin temperature (ST). These factors' measurements are provided in wide ranges and often their impacts vary from a person to a person and for different postures for the same person. For example, a given stressor for stress measurement may putting an individual in medium stress level based on their subjectivity, while the same stressor may reveal a rather low or high stress level for another individuals. According to Zadeh [4] this kind of behavior lends itself naturally to fuzzy sets and fuzzy logic (zero and one, true and false or black and white cannot present this kind of data). As functional - biology, each parameter is part of other parameters integratedly.

By using fuzzy inference system model, the system succeeds to predict subject stress value/index based on subject physiological value. Figure 13 shows detailed comparison between subjects stress level based on their subjectivity to stress level/index using FIS model.

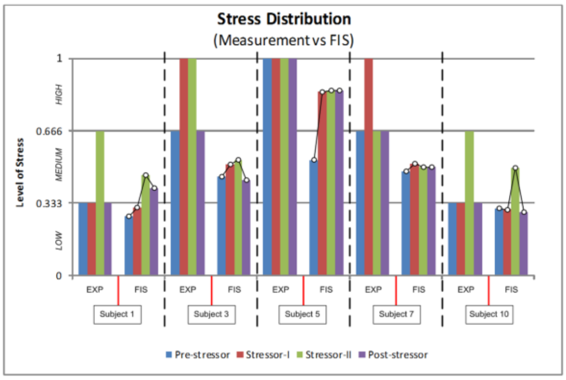

Figure 13. Stress distribution; subjectivity stress vs FIS model

Although this system provides relatively easy decision-making processing, there are some difficulties to use this FIS model. The main problem is the number of variables, in this study we used seven variables (six inputs and one output) and combined it with three membership function value for each variable (low, medium, high) to create this model. Therefore, the number of variables will generate numerous number of rules, in this case the possible combinations of rules is 3^7 = 2187 rules.

In this study, 436 rules have been used to create FIS model, there are no overlapping rules, and therefore, 436 rules out of 2187 is still acceptable. Although the number of rules is acceptable, this number is too large, it can cause the decision making process consumes a lot of time. In that case, the use of adaptive neural fuzzy inference system (ANFIS) is proposed to make better and more accurate model. Adaptive neural fuzzy inference system is the combination between FIS and artificial neural network (ANN), the difference between FIS and ANFIS is in these systems's inference system section. In FIS, we makes the rules by ourselves, it can be expert system or rule-based system. On the other hand, the ANFIS system will do self-learning to generate rules with the help of artificial neural networks system. Therefore, ANFIS will produce high speed decision-making processing in compare with FIS.

5. CONCLUSION

In this study we use a fuzzy logic inference system model to evaluate physiological responses to stress using six different measurable human factors, and the changes of the value of these physiological factor is believed affects human stress value/index. These human factors are used as input data for the system. Subjects perceived stress also necessary as output data for the system. The factors are converted into fuzzy variables and used in a set of rules to detect the stress value/index of subjects. In conclusion, the result showed that the changes in human factors affects human stress value/index, although the subjects stated that their stress level on the same level their physiological factors were changed during measurement, and the models showed the changes of subject stress value during different period of measurement time.

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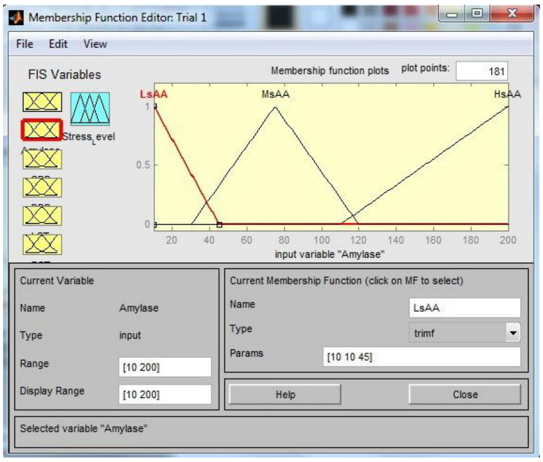
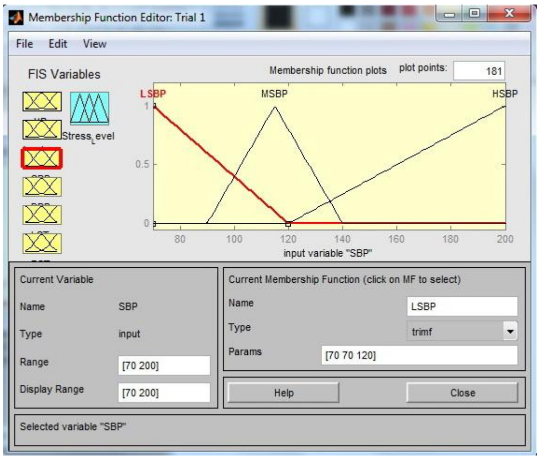
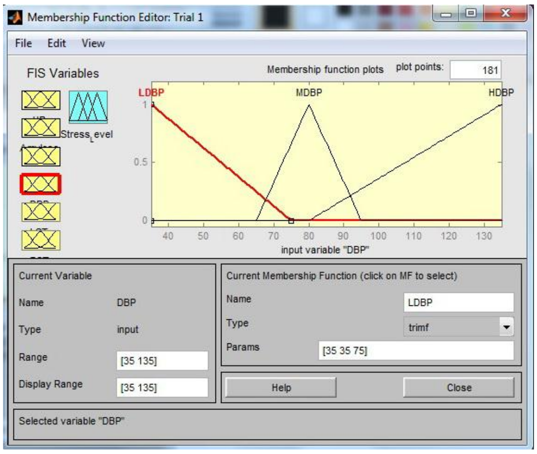
Appendix-1. Input's Membership Function



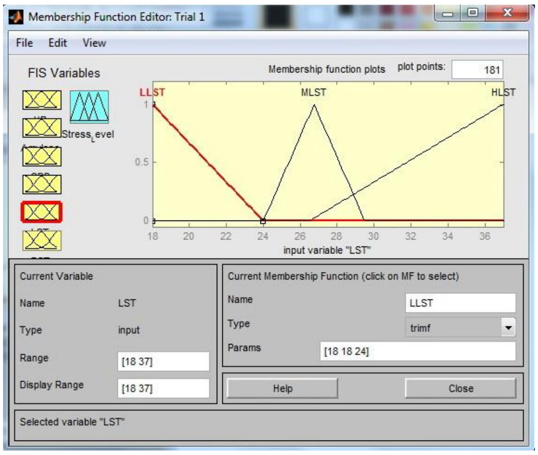
(a) salivary α-Amylase (sAA) MF



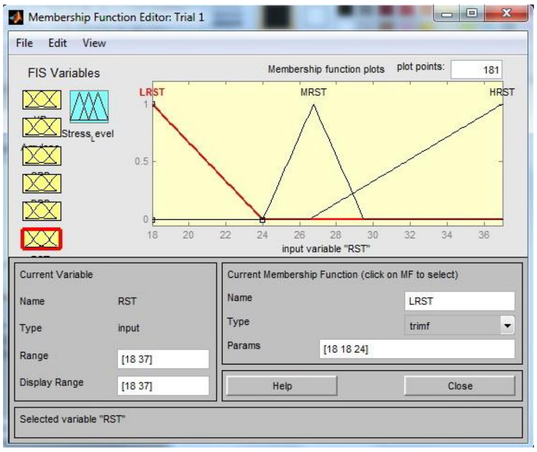
(b) Systolic blood pressure (SBP) MF



(c) Diastolic blood pressure (DBP) MF



(d) Left skin temperature (LST) MF



(e) Right skin temperature (RST) MF

Appendix-2. Experiment's Data Summary

Subject	Periods	HR	sAA	SBP	DBP	LST	RST	Perceived Stress
1	Pre	82	11	111	77	30.8	30.8	Low
	I	87	25	111	73	29	31.3	Low
	II	88	61	104	68	28.6	32.3	Medium
	Post	88	38	108	75	29.4	30.3	Low
2	Pre	93	45	104	66	27.3	27.9	Medium
	I	103	69	130	73	27.6	32.3	Medium
	II	95	48	107	72	30.8	33	Low
	Post	95	42	113	67	30.3	32.2	Low
3	Pre	96	44	110	80	27.8	28	Medium
	I	109	78	114	72	31	32.9	High
	II	102	52	121	86	29.4	31.9	High
	Post	100	41	114	73	28.1	29.8	Medium
4	Pre	78	66	109	71	25.4	24.4	Low
	I	79	54	109	56	23.3	21.3	Low
	II	75	32	110	78	24.4	24.1	Low
	Post	77	15	110	75	23.3	22.9	Low
5	Pre	75	116	113	63	30.1	28.6	High
	I	89	149	110	64	27.9	29.6	High
	II	84	162	111	82	28.6	30.3	High
	Post	77	160	80	64	27.8	29.3	High
6	Pre	79	89	95	58	33.2	33.6	Medium
	I	80	92	99	62	34.4	35.8	High
	II	79	82	103	74	32.3	33.3	Medium
	Post	76	82	99	64	32.4	33.1	Medium
7	Pre	96	51	106	71	32.9	33.8	Medium
	I	111	89	116	72	33.6	34.5	High
	II	103	54	111	64	32.1	33.2	Medium
	Post	99	46	116	72	32.6	33	Medium
8	Pre	75	46	112	72	31.2	31	Low
	I	77	57	111	90	27.9	31.3	Medium
	II	70	91	120	76	28.4	30.9	High
	Post	74	83	114	74	25.8	29.3	Medium
9	Pre	93	79	105	65	32.6	33.6	Medium
	I	104	107	105	66	33.1	34.4	High
	II	114	144	117	68	31.3	33.6	High
	Post	95	87	102	67	32.3	33.2	Medium
10	Pre	101	29	128	80	31.8	28.9	Low
	I	106	21	116	81	30.6	31.2	Low
	II	98	72	121	69	32	27	Medium
	Post	92	12	114	86	31.1	32.3	Low

Appendix-3. Fuzzy Inference System's Result Summary

Subject	Periods	HR	sAA	SBP	DBP	LST	RST	Perceived Stress	FIS Model
1	Pre	82	11	111	77	30.8	30.8	Low	0.272
	I	87	25	111	73	29	31.3	Low	0.313
	II	88	61	104	68	28.6	32.3	Medium	0.462
	Post	88	38	108	75	29.4	30.3	Low	0.401
2	Pre	93	45	104	66	27.3	27.9	Medium	0.462
	I	103	69	130	73	27.6	32.3	Medium	0.518
	II	95	48	107	72	30.8	33	Low	0.475
	Post	95	42	113	67	30.3	32.2	Low	0.44
3	Pre	96	44	110	80	27.8	28	Medium	0.453
	I	109	78	114	72	31	32.9	High	0.513
	II	102	52	121	86	29.4	31.9	High	0.533
	Post	100	41	114	73	28.1	29.8	Medium	0.44
4	Pre	78	66	109	71	25.4	24.4	Low	0.367
	I	79	54	109	56	23.3	21.3	Low	0.154
	II	75	32	110	78	24.4	24.1	Low	0.372
	Post	77	15	110	75	23.3	22.9	Low	0.154
5	Pre	75	116	113	63	30.1	28.6	High	0.532
	I	89	149	110	64	27.9	29.6	High	0.848
	II	84	162	111	82	28.6	30.3	High	0.852
	Post	77	160	80	64	27.8	29.3	High	0.85
6	Pre	79	89	95	58	33.2	33.6	Medium	0.455
	I	80	92	99	62	34.4	35.8	High	0.456
	II	79	82	103	74	32.3	33.3	Medium	0.43
	Post	76	82	99	64	32.4	33.1	Medium	0.456
7	Pre	96	51	106	71	32.9	33.8	Medium	0.479
	I	111	89	116	72	33.6	34.5	High	0.514
	II	103	54	111	64	32.1	33.2	Medium	0.5
	Post	99	46	116	72	32.6	33	Medium	0.497
8	Pre	75	46	112	72	31.2	31	Low	0.437
	I	77	57	111	90	27.9	31.3	Medium	0.467
	II	70	91	120	76	28.4	30.9	High	0.464
	Post	74	83	114	74	25.8	29.3	Medium	0.462
9	Pre	93	79	105	65	32.6	33.6	Medium	0.474
	I	104	107	105	66	33.1	34.4	High	0.503
	II	114	144	117	68	31.3	33.6	High	0.848
	Post	95	87	102	67	32.3	33.2	Medium	0.475
10	Pre	101	29	128	80	31.8	28.9	Low	0.309
	I	106	21	116	81	30.6	31.2	Low	0.303
	II	98	72	121	69	32	27	Medium	0.493
	Post	92	12	114	86	31.1	32.3	Low	0.292