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Home Energy Management System for Dynamic Loads using Mamdani Fuzzy Logic Approach

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Abstract: HEMS (home energy management systems) are controllers that manage and coordinate a home's generation, storage, and loads. These controllers are becoming increasingly important. To ensure that distributed energy penetration continues to grow resources are appropriately utilized and the process is not disrupted within the grid[1]. An approach to hems design based on behavioural control approaches is discussed in this paper which do not require accurate models or forecasts and are particularly responsive to changing situations, in this study. In this study, the role of the customer as well as the micro grid in intelligent demand management is demonstrated using MATLAB 2018 Fuzzy tool.[3]

Keywords: Home Energy Management System, Fuzzy Logic, Microgrid, Membership Function.

I. INTRODUCTION

With the introduction of new technology for human comfort, customer demand is growing day by day. The rising demand is quickly depleting resources and raising tariffs. The spontaneous the smart grid, as opposed to the traditional grid, has a different structure [2]. With its effective scheme, it is quickly garnering recognition. Smart grid implementation necessitates a comprehensive communication strategy and an organized a tactic for control the smart home controls are discussed in this study. The electric power grid has been built on the premise of centralised generation and control, unidirectional power flow through transmission and distribution networks to loads, and little or no energy storage for over a century [5]. The goal of this system is to create a smart controller that uses the fuzzy logic controller technique to regulate household appliances. To create a fuzzy logic controller, the MATLAB Fuzzy logic Toolbox is used. Fuzzification, a knowledge base, and a controller are the four main components of the Fuzzy Logic controller [2]. A defuzzification interface, and an inference engine the efficacy of the system is influenced by each component. The regulated system's behaviour and the fuzzy controller. A measurement of inputs is performed at the fuzzification interface. And a transformation that transforms input data into output data appropriate linguistic factors are used to mimic human decision-making. Fuzzy logic relies on fuzzy inference rules and fuzzy implication operators to produce outcomes [1]. The knowledge base contains information on information required for language control rules and the Fuzzification and defuzzification information During the real control action is a defuzzification interface retrieved from the fuzzy inference engine's results [6][7].

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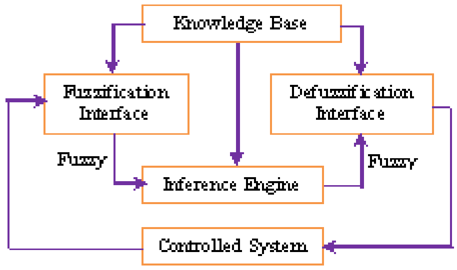

Fig. 1.1: Basic configuration of fuzzy logic controller

II. PROPOSED METHODOLOGY

2.1. Fuzzy Logic Controller Design

FLC is a computing technique based on "degrees of truth" rather than the traditional "true or untrue" (1 or 0), a boolean logic generally used by modern computers. The fuzzy mamdani approach is used in this investigation. The max-min approach is another name for the Mamdani fuzzy method. Abraham Mamdani was the first to make it in 1975 and due to its simplicity, this strategy is frequently utilized and More easily comprehended by the human intellect [9]. A Mamdani Fuzzy Inference System is a fuzzy inference system developed by Mamdani [10-12]. (Mamdani-FIS) being soft computing paradigm that allows for approximation with computation reasoning. It comes to the conclusion that using a set of fuzzy if-then rules, known facts can be executed even with non-linear mapping from an input space to an output space [3].In this work, 8(eight) appliances are investigated drawing heavy currents but of necessity and luxury in the present times. They are listed as below:-

1. Air conditioner
2. Washing machine
3. Refrigerator
4. Exhaust fan
5. Geyser
6. Microwave oven
7. Cooler
8. Water heater

2.2. Developed Fuzzy Model of Air Conditioner

The starting procedure is the first step that must be implemented. This method is used to calculate the magnitude of the fuzzy number distribution and the range for each fuzzy class. The membership function input and output, as well as the rules table, are employed in the fuzzy logic controller to obtain the results [8]. System input and output controller the membership function is a curve that determines how the values of two variables interact. A set of fuzzy variables certain territories are assigned membership values ranging from 0 to 1 [1].

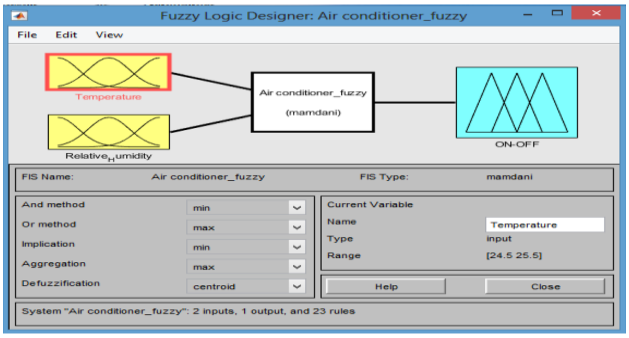

Fig 2.1: Developed Air Conditioner Module

Fig 2.1 represents developed air conditioner module, it has 2 inputs and 1 output.

The 2 inputs are temperature and relative humidity and output is ON-OFF.

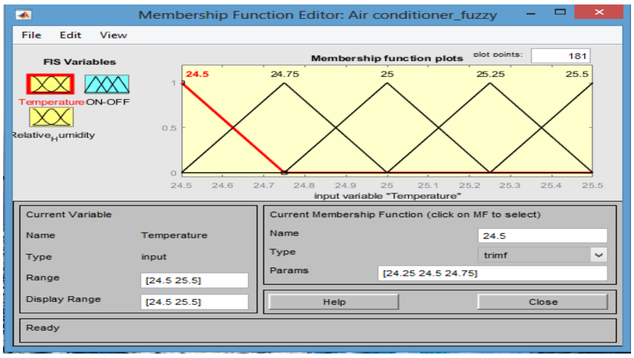

Fig 2.2: Membership Function of Temperature

Fig 2.2 represents membership function of temperature as a input .

It has 5 descriptors

1. 24.5 it has a range of [24.25 24.5 24.75]
2. 24.75 it has a range of [24.5 24.75 25]
3. 25 it has a range of [24.75 25 25.25]
4. 25.25 it has a range of [25 25.25 25.5]
5. 25.5 it has a range of [25.25 25.5 25.75]

Figure 2.3 represents membership function of relative humidity. It has 9 descriptors

1. 25 it has a range of [20 25 30]
2. 30 it has a range of[25 30 35]
3. 35 it has a range of[30 35 40]
4. 40 it has a range of [35 40 45]
5. 45 it has a range of [40 45 50]
6. 50 it has a range of [45 50 55]
7. 55 it has a range of [50 55 60]
8. 60 it has a range of [55 60 65]
9. 65 it has a range of[60 65 70]

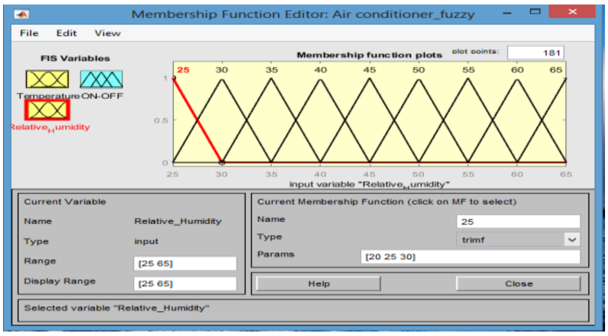

Fig 2.3: Membership function of relative humidity

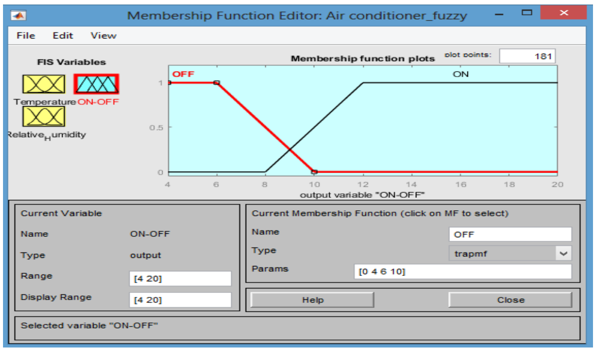

Fig 2.4: Membership Function of On-Off

Fig 2.4 represents membership function of ON-OFF.

It has 2 descriptors

1. OFF it has a range of [0 4 6 10]
2. ON it has a range of [8 12 20 24]

Fig 2.5 represents rule editor for air conditioner. This system contains 23 rules that cover for the 2 inputs and 1 output membership functions as shown in Figure 2.5.

There is a combination of temperature and relative humidity in order to control the room temperature according to the designed room temperature. The examples of the rules are shown as below:

1. If temperature is 24.5 and relative humidity is 25 then ON-OFF is OFF
2. If temperature is 24.5 and relative humidity is 35 then ON-OFF is OFF
3. If temperature is 24.5 and relative humidity is 45 then ON-OFF is OFF
4. If temperature is 24.5 and relative humidity is 55 then ON-OFF is OFF

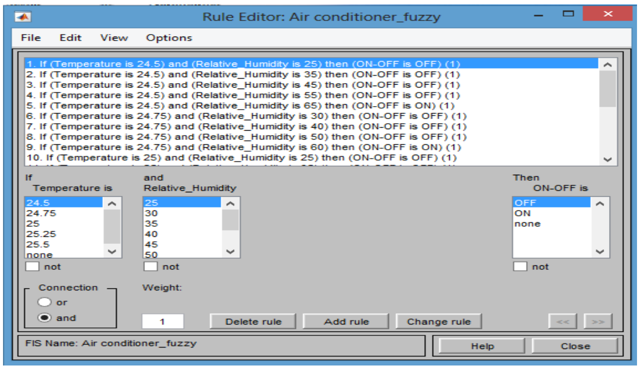

Fig 2.5: Rule Editor for Air Conditioner

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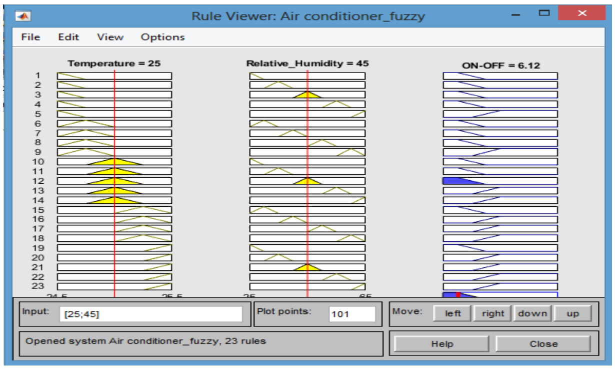
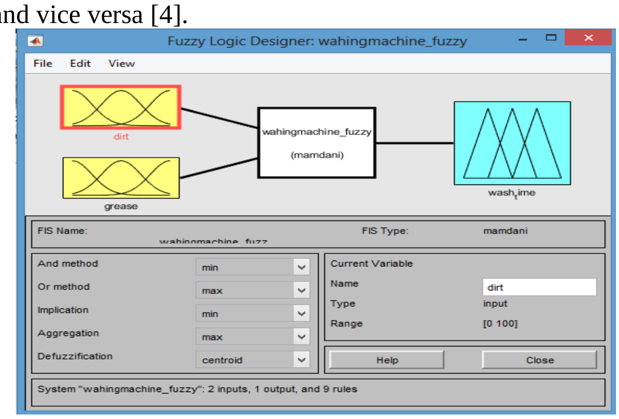


Fig 2.6: Rule viewer in MATLAB

After adding rules to the system, the result can be obtained from 'Rule Viewer' in MATLAB FIS tools as shown in Figure 2.6

2.3. Developed fuzzy model of washing machine

Here a controller is designed to determine the wash time of a domestic washing machine. Assuming the input is dirt and grease on cloths. Using 3 descriptors for input variables and 5 descriptors for output variables. Derive the set of rules for controller action and defuzzification. The design should be supported by figure wherever possible. Show that if the cloths are solid to a large degree the wash time will b more and vice versa [4].



.Fig 2.7: Developed Washing Machine Module

Fig 2.7 represents developed washing machine module, it has 2 inputs and 1 output. Dirt and grease are the 2 inputs and output is wash time

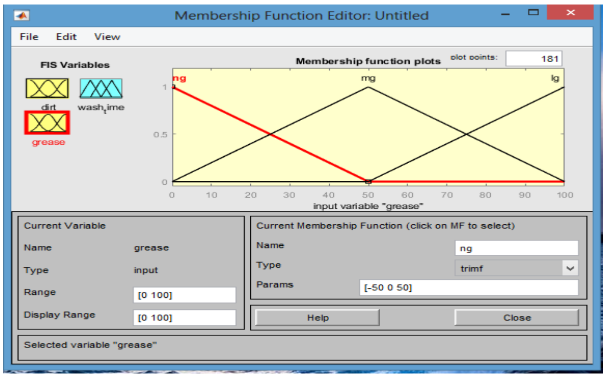


Fig 2.8: Membership Function of Dirt

Fig 5.8 represents membership function of dirt input.
It has 3 descriptors

1. Short dirt has a range of [-50 0 50]
2. Medium dirt has a range of [0 50 100]
3. Large dirt has a range of [50 100 150]

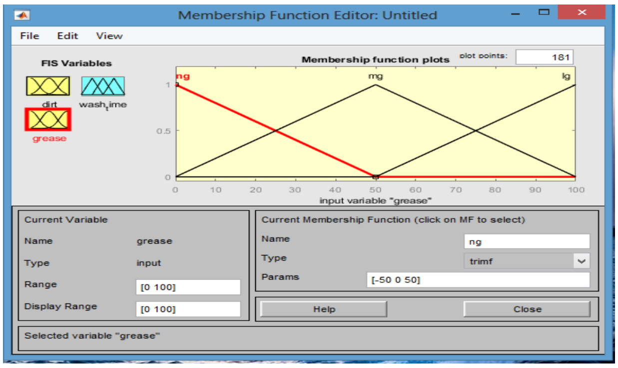


Fig 2.9: Membership Function of Grease

Fig 2.9 represents membership function of grease
It has 3 descriptors

1. No grease has a range of [-50 0 50]
2. Medium grease has a range of [0 50 100]
3. Large grease has a range of [50 100 150]

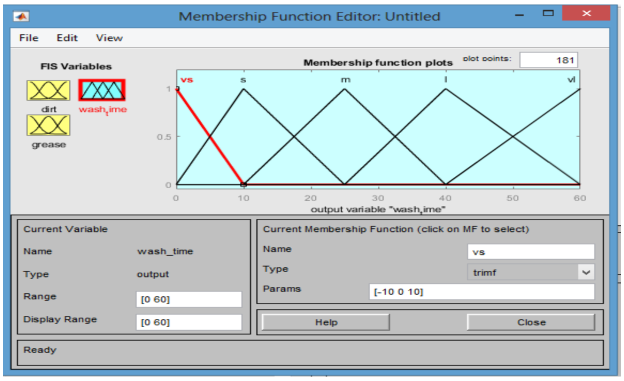


Fig 2.10: Membership Function of Wash Time

Fig 2.10 represents membership function of wash time.
It has 5 descriptors

1. Very short has a range of [-10 0 10]
2. Short has a range of [0 10 25]
3. Medium has a range of [10 25 40]
4. Large has a range of [25 40 60]
5. Very large has a range of [40 60 70]

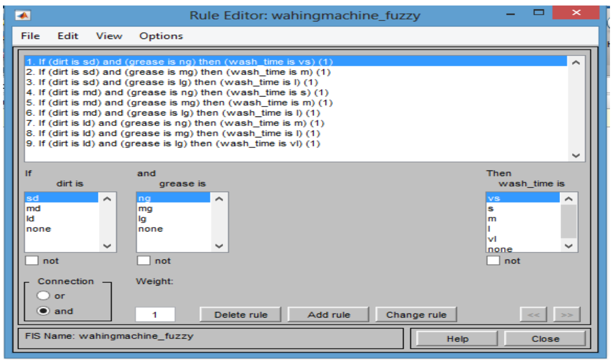


Fig 2.11: Rule Editor for Washing Machine

Fig 2.11 represents rule editor for washing machine. This system contains 9 rules that cover for the 2 inputs and 1 output membership functions.
There is a combination of dirt and grease in order to control the wash time. The examples of the rules are shown as below:

1.If dirt is SD and grease is NG wash time is VS
2.If dirt is SD and grease is MG wash time is M

Fig 2.12: Rule viewer in MATLAB

After adding rules to the system, the result can be obtained from 'Rule Viewer' in MATLAB FIS tools as shown in Figure 2.12

2.4. Developed Fuzzy Model of Refrigerator

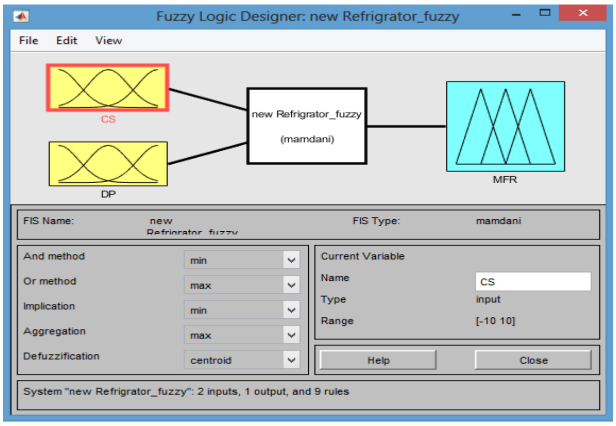


Fig 2.13: Developed Refrigerator Module

Fig 2.13 represents developed refrigerator module, it has 2 inputs and 1 output. Compressed speed and delivery pressure are inputs and mass flow is 1 output.

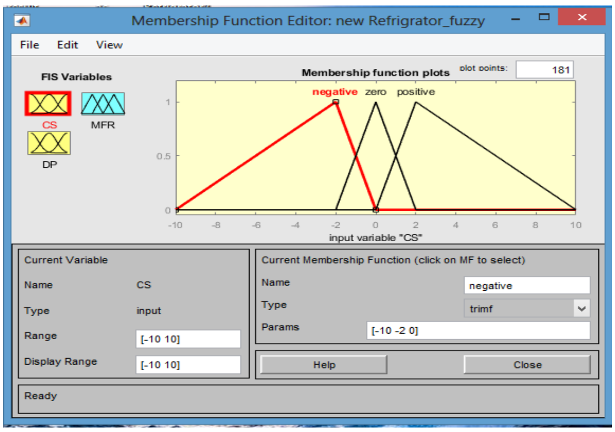


Fig 2.14: Membership Function of Compressor Speed

Fig 2.14 represents membership function of compressed speed It has 3 descriptors

1. Negative has a range of[-10 -2 0]
2. Zero has a range of [-2 0 2]
3. Positive has a range of [0 2 10]

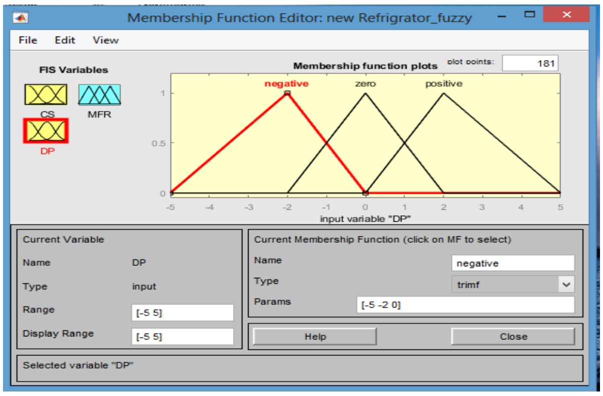


Fig 2.15: Membership function of delivery pressure

Fig 2.15 represents membership function of delivery pressure.
It has 3 descriptors

1. Negative has a range of [-5 -2 0]
2. Zero has a range of[-2 0 2]
3. Positive has a range of[0 2 5]

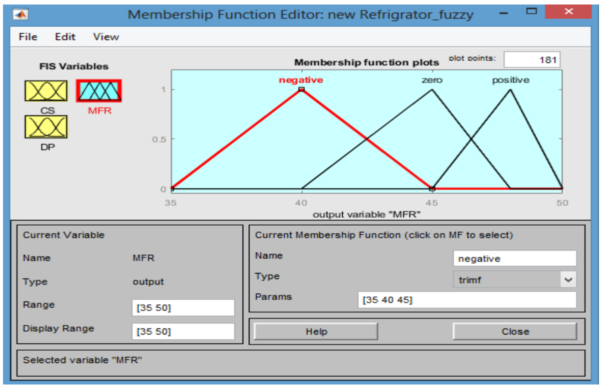


Fig 2.16: Membership function of mass flow rate

Fig 2.16 represents membership function of mass flow rate.
It has 3 descriptors

1. Negative has a range of[35 40 45]
2. Zero has a range of[40 45 48]
3. Positive has a range of[45 48 50]

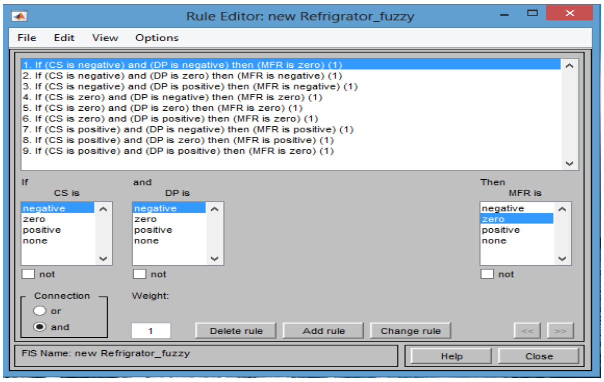


Figure 2.17: Rule editor in MATLAB

Fig 2.17 represents rule editor for refrigerator. This system contains 9 rules that cover for the 2 inputs and 1 output membership functions. There is a combination of CS and DP in order to control the MFR . The examples of the rules are shown as below:

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1.If CS is negative and DP is negative than MFR is zero
2.If CS is negative and DP is zero than MFR is negative.

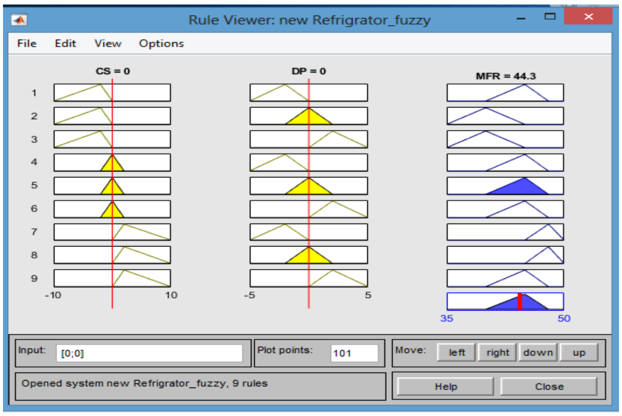

Figure 2.18: Rule viewer in MATALB

After adding rules to the system, the result can be obtained from ‘Rule Viewer’ in MATLAB FIS tools as shown in Figure 2.18.

2.5. Developed fuzzy model of exhaust fan

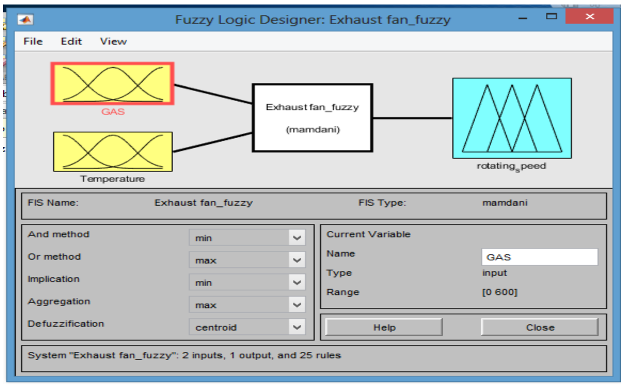

Fig 2.19: Developed exhaust fan module

Fig 2.19 represents developed exhaust fan module, it has 2 inputs and 1 output. Gas and temperature are 2 inputs and rotating speed is output.

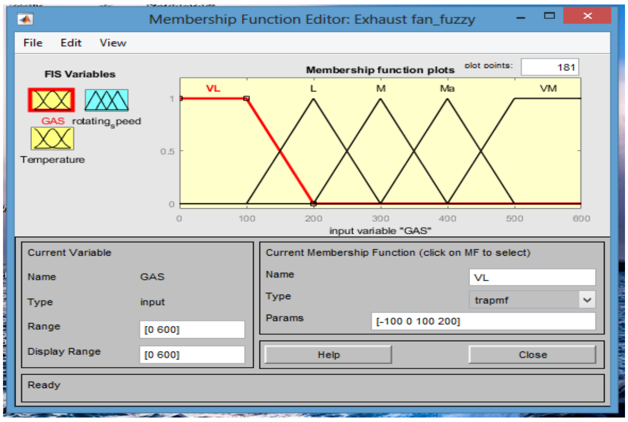

Fig 2.20: Membership function of gas

Fig 2.20 represents membership function of gas.
It has 5 descriptors
1.VL has a range of[-100 0 100 200]
2.L has a range of[100 200 300]
3.M has a range of[200 300 400]
4.Ma has a range of[300 400 500]
5.VM has a range of[400 500 600 1000]

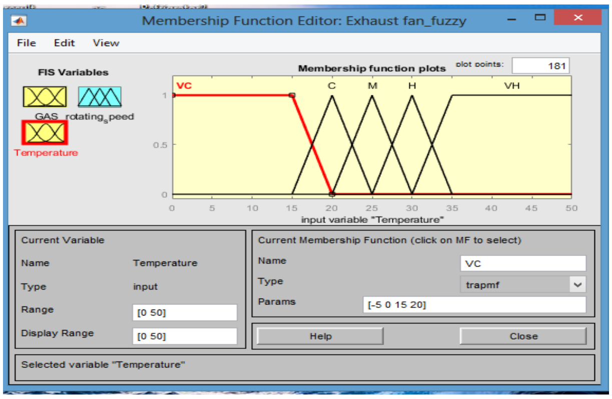

Fig 2.21: Membership function of temperature

Fig 2.21 represents membership function of temperature.
It has 5 descriptors
1.VC has a range of[-5 0 15 20]
2.C has a range of[15 20 25]
3.M has a range of[20 25 30]
4.H has a range of[25 30 35]
5.VH has a range of[30 35 50 55]

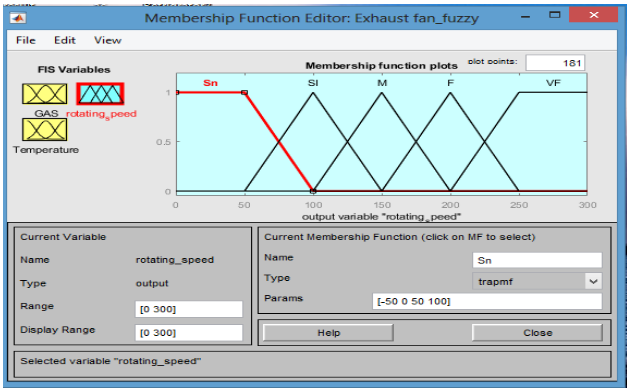

Fig 2.22: Membership function of rotating speed

Fig 2.22 represents membership function of rotating speed.
It has 5 descriptors

1. Sn has a range of[-50 0 50 100]
2. Sl has a range of[50 100 150]
3. M has a range of[100 150 200]
4. F has a range of[120 200 250]
5. VF has a range of[200 250 300 400]

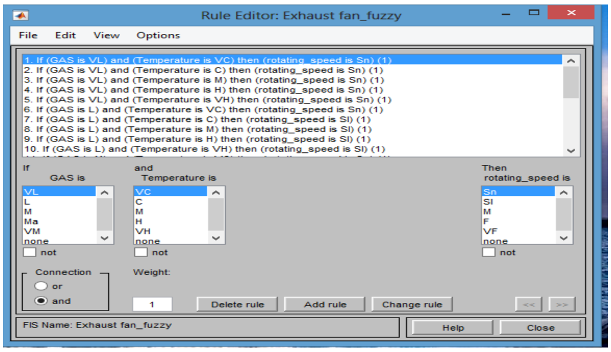

Fig 2.23: Rule editor in MATLAB

Fig 2.23 represents rule editor for exhaust fan. This system contains 25 rules that cover for the 2 inputs and 1 output membership functions [13-17].

There is a combination of gas and temperature in order to control the rotating speed . The examples of the rules are shown as below:

1.If gas is VL and temperature is VC then rotating Speed is Sn

2.If gas is L and temperature is M then rotating speed is Sn

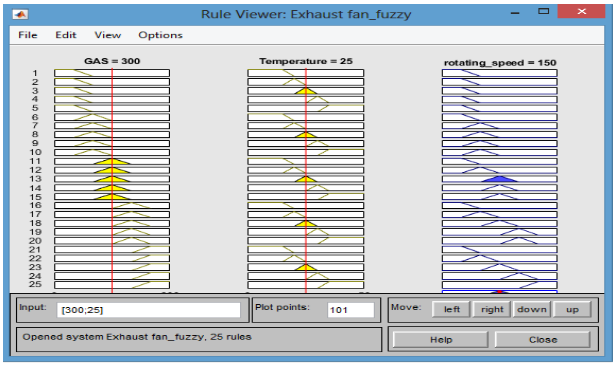

Fig 2.24: Rule viewer in MATLAB

After adding rules to the system, the result can be obtained from 'Rule Viewer' in MATLAB FIS tools as shown in Figure 2.24.

2.6. Developed fuzzy model of geyser

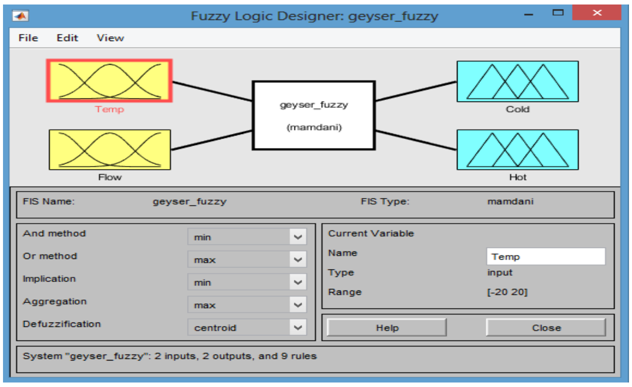

Fig 2.25: Developed geyser module

Fig 2.25 represents developed geyser module, it has 2 inputs and 2 outputs. Temperature and flow are 2 inputs and cold and hot are 2 outputs.

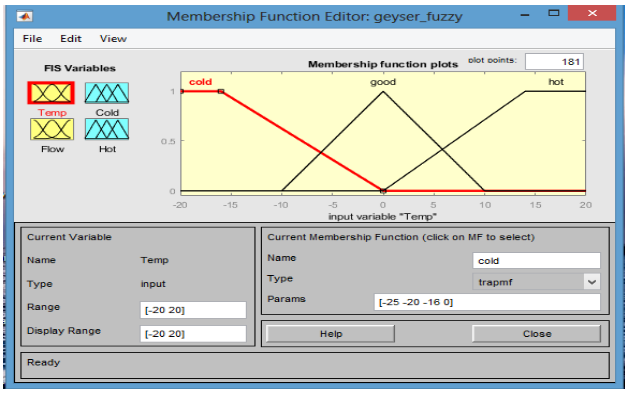

Fig 2.26: Membership function of temperature

Fig 2.26 represents membership function of temperature. It has 3 descriptors

1. Cold has a range of[-25 -20 -16 0]
2. Good has a range of [-10 0 5]
3. Hot has a range of[0 12 20 25]

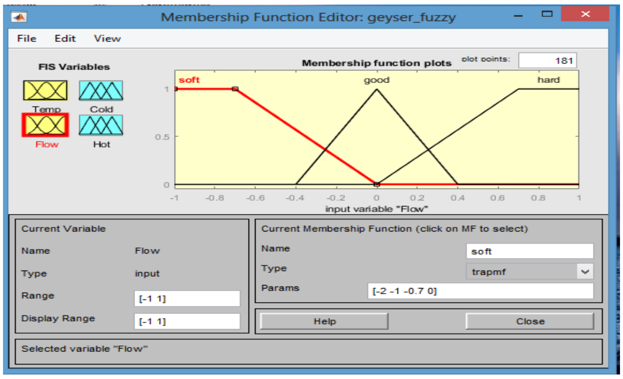

Fig 2.27: Membership function of flow

Fig 2.27 represents membership function flow input. It has 3 descriptors

1. Soft has a range of[-2 -1 -0.7 0]
2. Good has a range of[-0.4 0 0.4]
3. Hard has a range of[0 0.7 1 2]

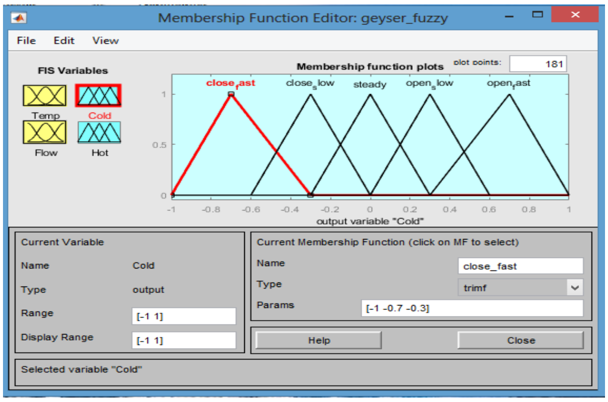

Fig 2.28: membership function of cold

Fig 2.28 represents membership function of cold input. It has 5 descriptors

1. Close fast has a range of[-1 -0.7 -0.3]
2. Close slow has a range of[-0.6 -0.3 0]
3. Steady has a range of[-0.3 0 0.3]
4. Open slow has a range of[0 0.3 0.6]
5. Open fast has a range of[0.3 0.7 1]

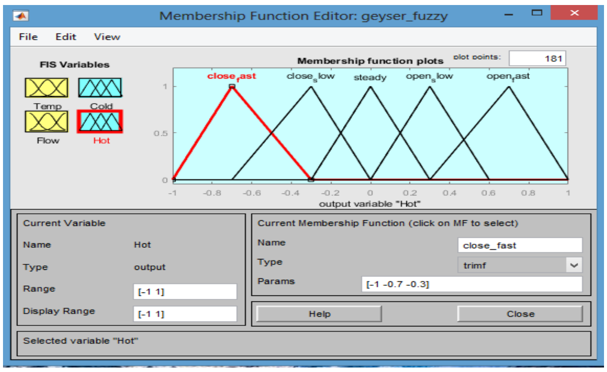

Fig 2.29: Membership function of hot

Fig 2.29 represents membership function of hot input. It has 5 descriptors

1. Close fast has a range of[-1 -0.7 -0.3]
2. Close slow has a range of[-0.6 -0.3 0]
3. Steady has a range of[-0.3 0 0.3]

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4. Open slow has a range of[0 0.3 0.6]
5. Open fast has a range of[0.3 0.7 1]

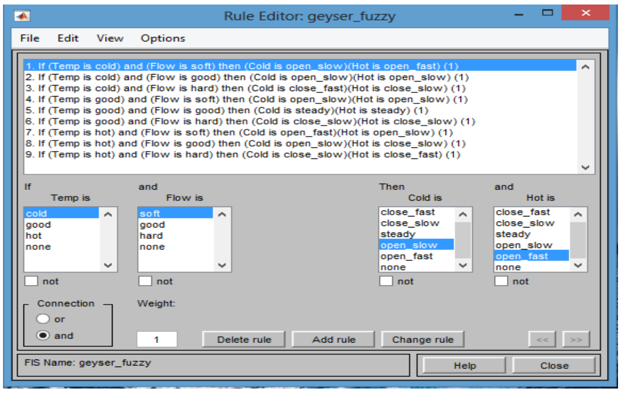

Fig 2.30: Rule editor in MATLAB

Fig 2.30 represents rule editor for geyser. This system contains 9 rules that cover for the 2 inputs and 2 output membership functions .
There is a combination of temperature and flow in order to control water temperature . The examples of the rules are shown as below:

1. If temp. is cold and flow is soft then cold is open slow , hot is open fast
2. If temp. is good and flow is soft then cold is open slow , hot is open slow

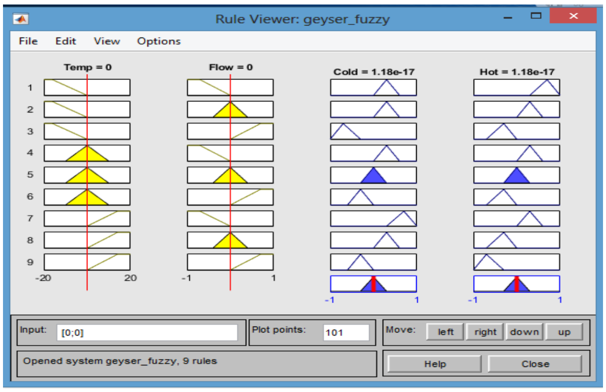

Fig 2.31: Rule viewer in MATALAB

After adding rules to the system, the result can be obtained from ‘Rule Viewer’ in MATLAB FIS tools as shown in Figure 2.31.

2.7. Developed fuzzy model of microwave oven

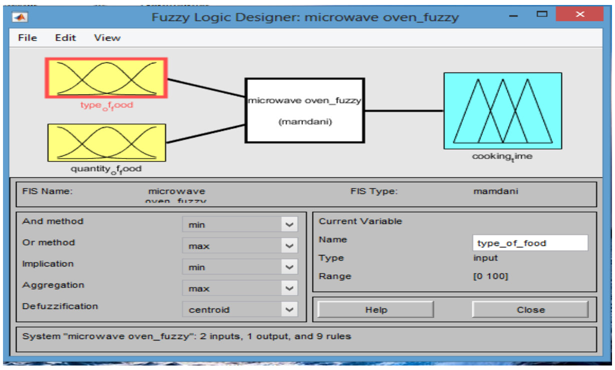

Fig 2.32: Developed microwave oven module

Fig 2.32 represents developed microwave oven module, it has 2 inputs and 1 output. Type of food and quantity of food are the 2 inputs and cooking time is the output

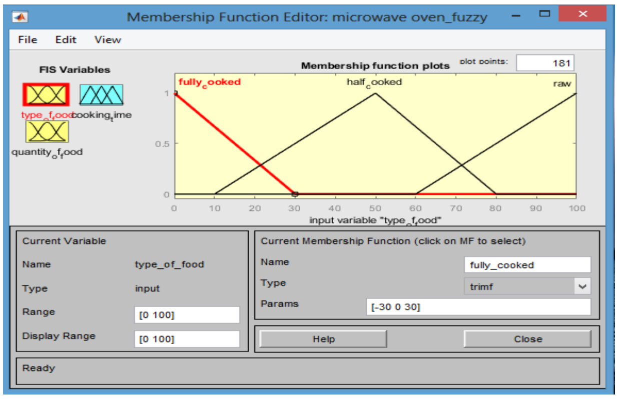

Fig 2.33: Membership function of type of food

Fig 2.33 represents membership function of type of food
It has 3 descriptors

1. Fully cooked has a range of[-30 0 30]
2. Half cooked has a range of[10 50 80]
3. Raw has a range of[60 100 125]

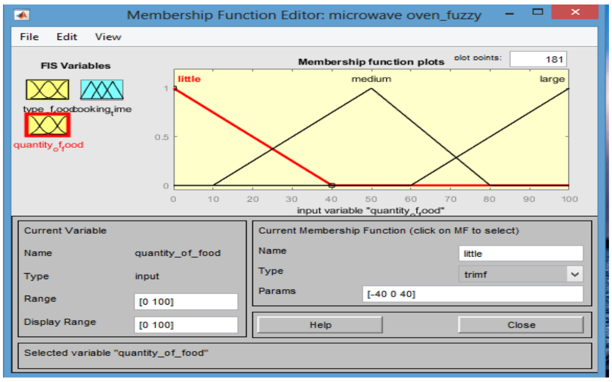

Fig 2.34: Membership function of quality of food

Fig 2.34 represents membership function of quantity of food
It has 3 descriptors

1. Little has a range of[-40 0 40]
2. Medium has a range of[10 50 80]
3. Large has a range of[80 100 150]

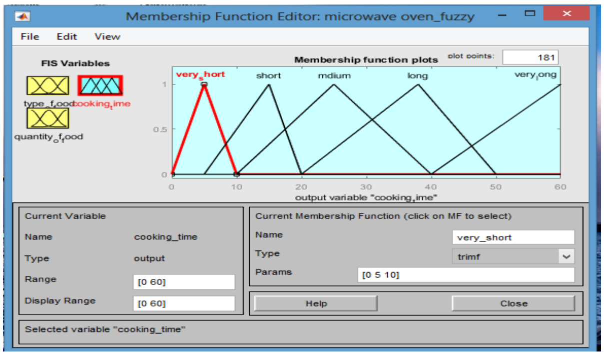

Fig 2.35: Membership function of cooking time

Fig 2.35 represents membership function of cooking time
It has 5 descriptors

1. VS has a range of[0 5 10]
2. S has a range of[5 15 20]
3. M has a range of[10 25 40]
4. L has a range of[20 40 50]
5. VL has a range of[40 60 70]

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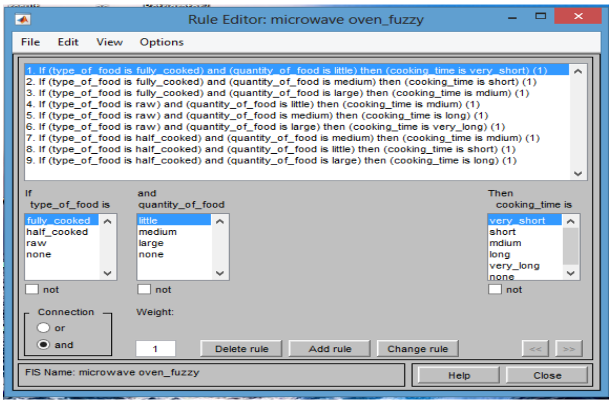

Fig 2.36: Rule editor in MATLAB

Fig 2.36 represents rule editor for microwave oven. This system contains 9 rules that cover for the 2 inputs and 1 output membership functions .

There is a combination of type of food and quantity of food in order to control the cooking time . The examples of the rules are shown as below:

1. If type of food is fully cooked and quantity of food is little then cooking time is very short
2. If type of food is raw and quantity of food is little then cooking time medium

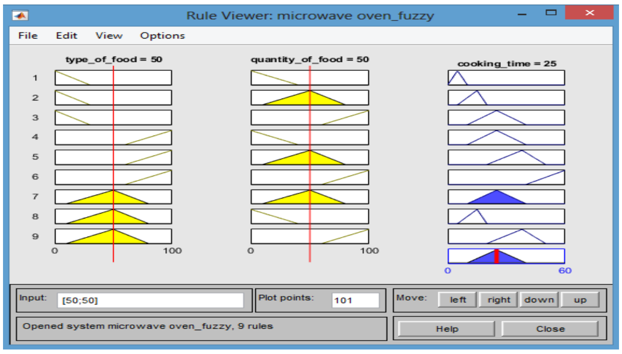

Fig 2.37: Rule viewer in MATALB

After adding rules to the system, the result can be obtained from ‘Rule Viewer’ in MATLAB FIS tools as shown in Figure 2.37.

2.8. Developed fuzzy model of cooler

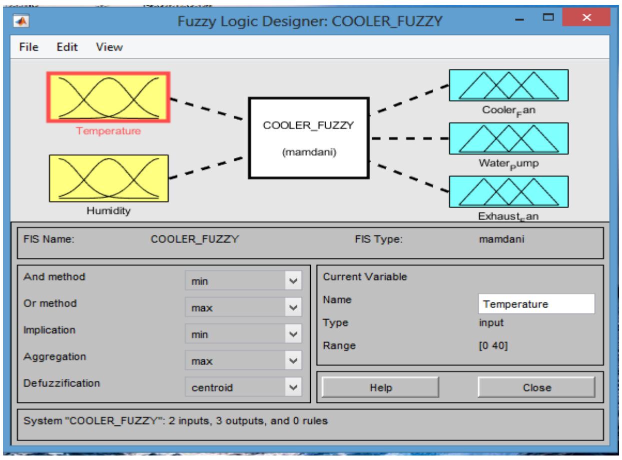

Fig 2.38: Developed cooler module

Fig 2.38 represents developed cooler module, it has 2 inputs and 3 outputs. Temperature and humidity are 2 inputs and cooler fan, exhaust fan, water temp. are 3 outputs.

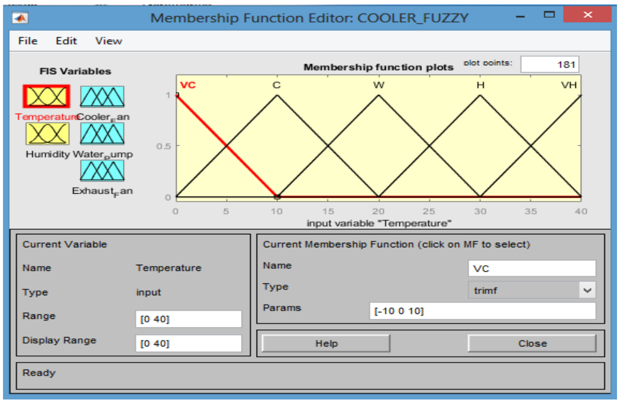

Fig 2.39: Membership function of temperature

Fig 2.39 represents membership function of temperature It has 5 descriptors

1. VC has a range of[-10 0 10]
2. C has a range of[0 10 20]
3. W has a range of[10 20 30]
4. H has a range of[20 30 40]
5. VH has a range of[30 40 50]

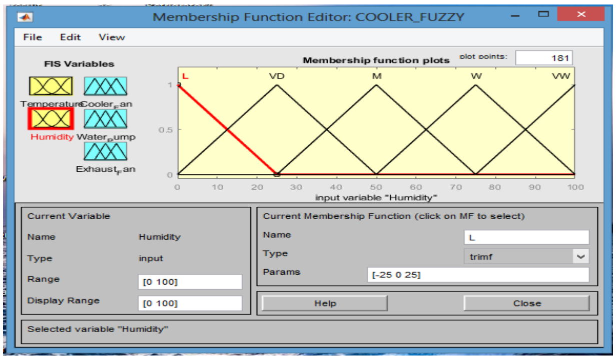

Fig 2.40: Membership function of humidity

Fig 2.40 represents membership function of humidity. It has 5 descriptors

1. L has a range of[-25 0 25]
2. VD has a range of[0 25 50]
3. M has a range of[25 50 75]
4. W has a range of[50 75 100]
5. VW has a range of[75 100 125]

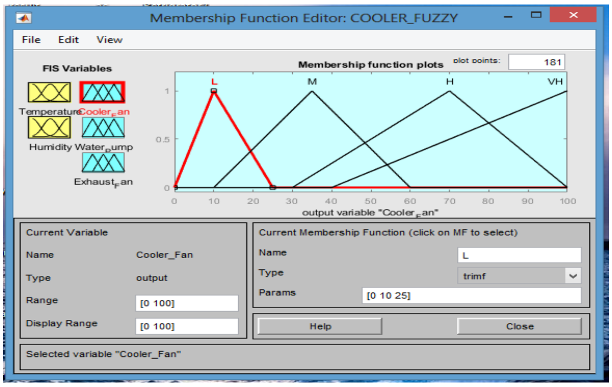

Fig 2.41: Membership function of cooler fan

Fig 2.41 represents membership function of cooler fan. It has 4 descriptors

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1.L has a range of[0 10 25]
2.M has a range of[10 30 50]
3.H has a range of[30 70 100]
4.VH has a range of[40 100 125]

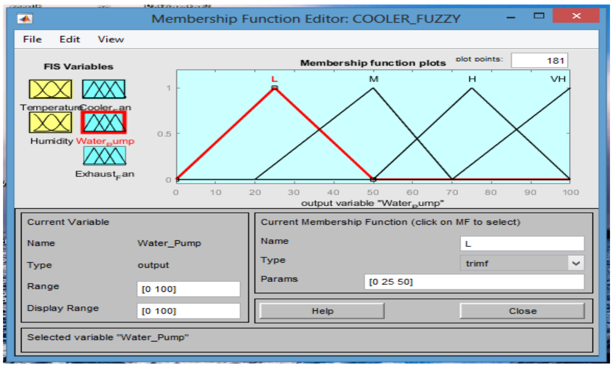

Fig 2.42: Membership function of water pump

Fig 2.42 represents membership function of water pump. It has 4 descriptors

1. L has a range of[0 25 50]
2. M has a range of[20 50 70]
3. H has a range of[50 75 100]
4. VH has a range of[70 100 125]

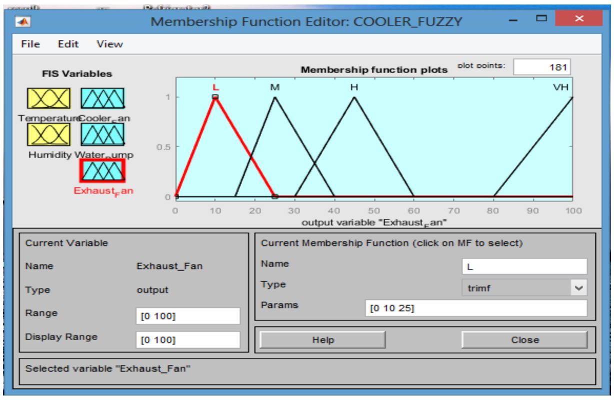

Fig 2.43: Membership function of exhaust fan

Fig 2.43 represents membership function of exhaust fan. It has 4 descriptors

1. L has a range of[0 10 25]
2. M has a range of[15 25 40]
3. H has a range of[30 45 60]
4. VH has a range of[60 100 125]

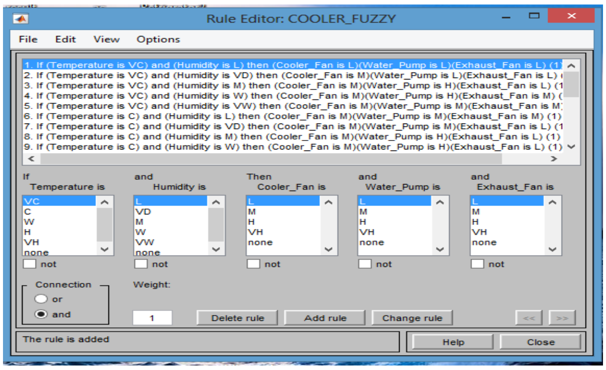

Fig 2.44: Rule editor in MATALB

Fig 2.44 represents rule editor for cooler. This system contains 25 rules that cover for the 2 inputs and 3 outputs membership functions .

There is a combination of temperature and humidity in order to control the cooler fan, water pump and exhaust fan. The examples of the rules are shown as below:

1. If temp. is VC and humidity is L then cooler fan is L, water pump is L, exhaust fan is L
2. If temp. is C and humidity is W then cooler fan is M, water pump is H, exhaust fan is L

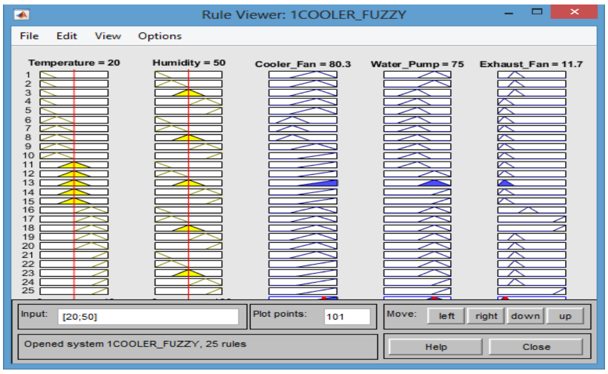

Fig 2.45: Rule viewer in MATLAB

After adding rules to the system, the result can be obtained from 'Rule Viewer' in MATLAB FIS tools as shown in Figure 2.45.

2.9. Developed Fuzzy Model of Water Heater

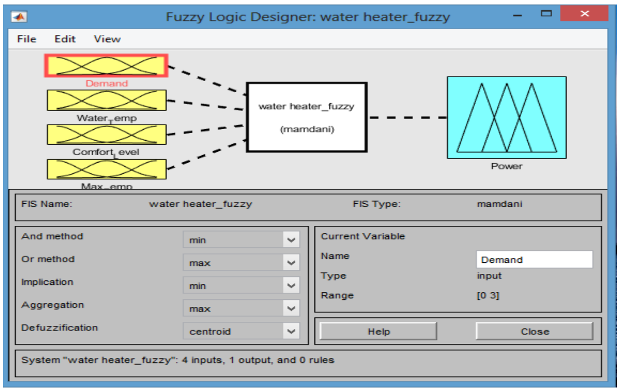

Fig 2.46: Developed water heater module

Fig 2.46 represents developed water heater module, it has 4 inputs and 1 output. Demand , water temp, comfort level and max temp are the inputs and power is output.

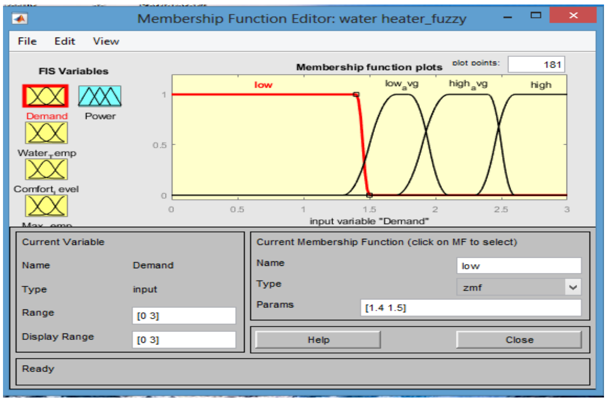

Fig 2.47: Membership function of demand

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Fig 2.47 represents membership function of demand input
It has 4 descriptors

1. Low has a range of[1.4 1.5]
2. Low avg has a range of[1.4 1.5 1.8 2]
3. High avg has a range of[1.8 2 2.4 2.5]
4. High has a range of[2.4 2.5]

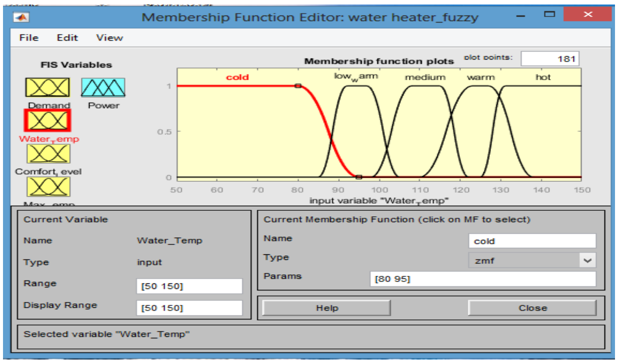

Fig 2.48: Membership function of water temperature

Fig 2.48 represents membership function of water temperature
It has 5 descriptors

1. Cold has a range of [80 95]
2. Low warm has a range of [85 90 98 102]
3. Medium has a range of [98 102 118 120]
4. Warm has a range of [110 120 128 138]
5. Hot has a range of [128 132]

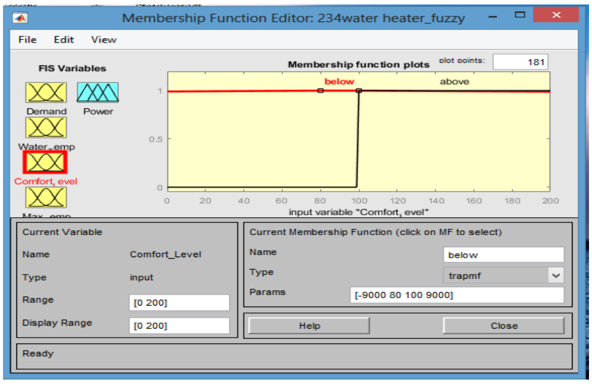

Fig 2.49: Membership function of comfort level

Fig 2.49 represents membership function of comfort level
It has 2 descriptors

1. Below has a range of [-9000 80 100 9000]
2. Above has a range of [100 100 200 9000]

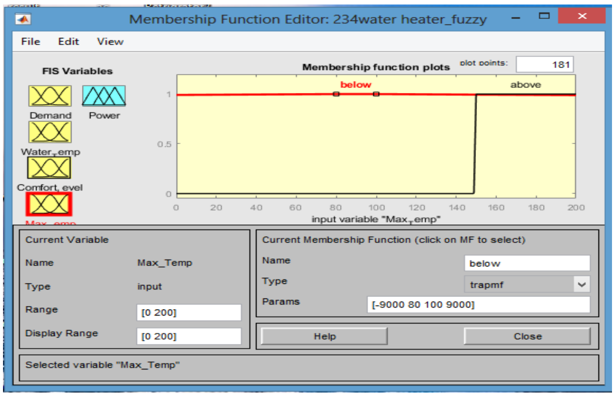

Fig 2.50: Membership function of maximum temperature

Fig 2.50 represents membership function of maximum temperature. It has 2 descriptors

1. Below has a range of [-9000 80 100 9000]
2. Above has a range of [150 150 200 9000]

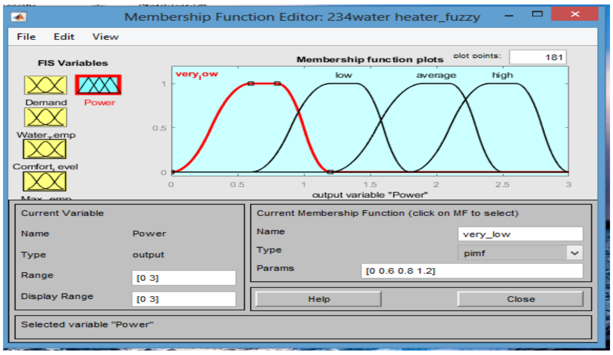

Fig 2.51: Membership function of power

Fig 2.51 represents membership function of power
It has 4 descriptors

1. Very low has a range of [0 0.5 0.8 1.2]
2. Low has a range of [0.8 1 1.4 1.7]
3. Average [1.2 1.7 2.3 2.5]
4. High [1.7 2.3 2.7 3]

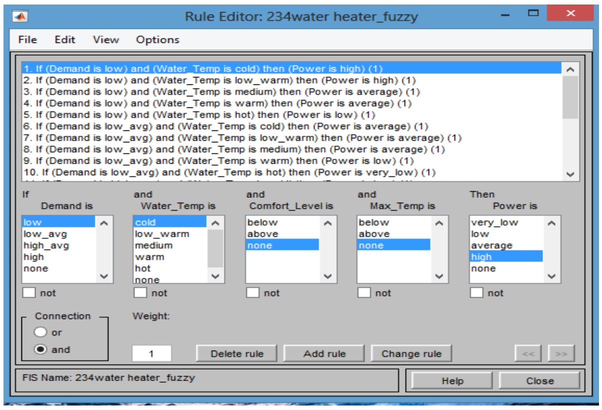

Fig 2.52: -Rule editor in MATLAB

Fig 2.52 represents rule editor for water heater. This system contains 22 rules that cover for the 4 inputs and 1 output membership functions.
The examples of the rules are shown as below:

1. If demand is low and water temp. is cold then power is high
2. If demand is low_avg and water temp. is hot then power is very low

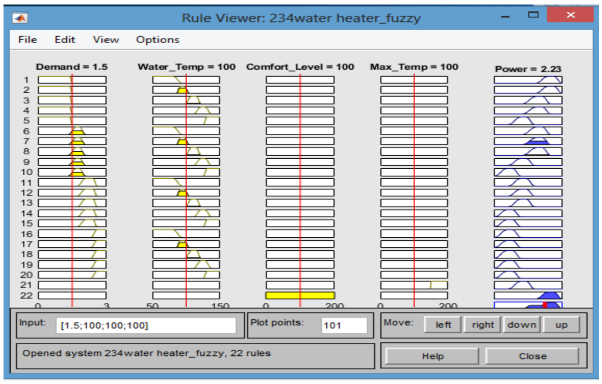

Fig 2.53: Rule viewer in MATLAB

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After adding rules to the system, the result can be obtained from 'Rule Viewer' in MATLAB FIS tools as shown in Figure 2.53

III. SIMULATION AND RESULTS

The selection of these 8 gadgets was done, as they are necessary and on demand in almost every home for luxury as well as necessity. All being heavy loads drawing appreciable amount of current, needs a proper attention while designing as well, when in use demanding safety and minimal electricity charges. GUI studies makes it possible to highlight the use of fuzzy logic controllers using parametric variations.

Table 1. Gives results of various types of dynamic loads

S.NO.	Type of load	Parameters	Measured value
1.	**Air conditioner**	a. Relative humidity b. Temperature	45/kg 25°C
2.	**Washing machine**	a. Grease b. Dirt	50API SC-CC 50 KN/m³
3.	**Refrigerator**	a. Delivery pressure b. Compressor speed	3Mpa 0RPM
4.	**Exhaust fan**	a. Temperature b. Gas	25°C 100Kpa
5.	**Geyser**	a. Temperature b. Flow	0°C 0cms
6.	**Microwave oven**	a. Quantity of food b. Type of food	50pu 50pu
7.	**Cooler**	a. Temperature b. Humidity	20°C 50/kg
8.	**Water heater**	a. Demand b. Water temperature	1.5 J 100°C

3.1 Simulation Result of Air Conditioner

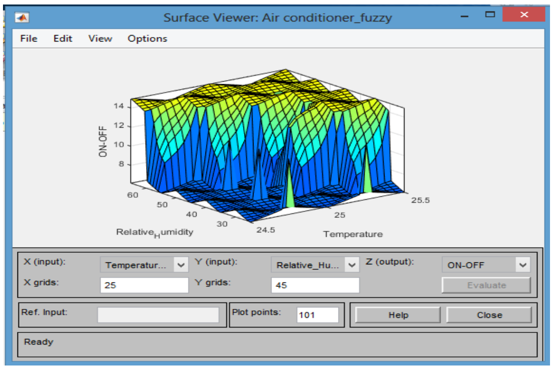

Fig 3.1: Surface Viewer in MATLAB for Air Conditioner

The temperature, relative humidity, and ON-OFF plot are all represented in figure 3.1. The temperature is shown by the x-axis, the relative humidity is represented by the y-axis, and the ON-OFF is represented by the z-axis.
In this temperature is 25°C and relative humidity is 45/kg.

3.2 Simulation Result of Washing Machine

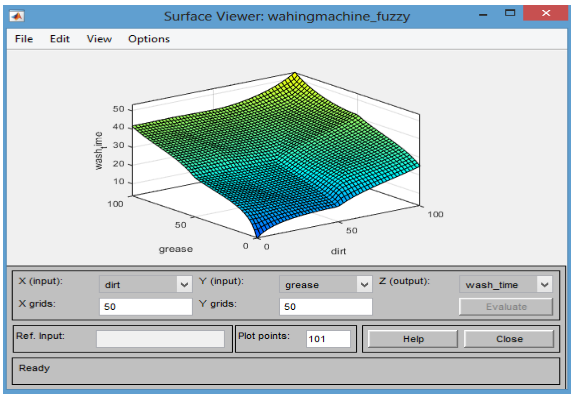

Fig 3.2: Surface Viewer in MATLAB for Washing Machine

The grease, dirt, and wash time plot is shown in figure 3.2. Figure 3.2 shows the x-axis representing dirt, the y-axis representing grease, and the z-axis representing wash time.
Dirt has a 50 KN/m^3 , while grease has a 50 API SC-CC

3.3 Simulation Result of Refrigerator

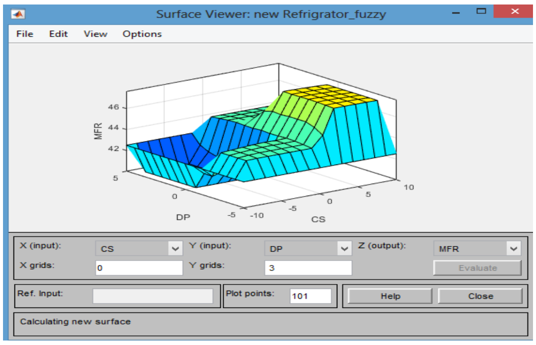

Fig 3.3: Surface Viewer in MATLAB for Refrigrator

The Compressor speed, Delivery Pressure, and Mass Flow Rate plots are shown in Figure 3.3. In fig. 3.3, the x-axis indicates Compressor Speed, the y-axis represents Delivery Pressure, and the z-axis represents Mass Flow Rate.
In this case, the Compressor Speed is 0 rpm and the Delivery Pressure is 3 pa.

3.4 Simulation Result of Exhaust Fan

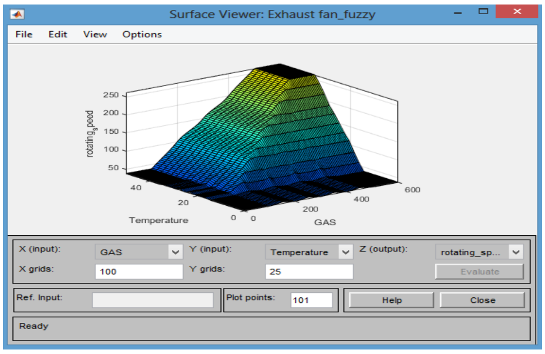

Fig 3.4: Surface viewer in MATLAB for Exhaust Fan

The plot of gas, temperature, and rotating speed is shown in figure 3.4. The x-axis in figure 3.4 represents the gas, the y-axis represents temperature, and the z-axis represents spinning speed. This gas has a pressure of 100 Kpa and a temperature of 25 °C.

3.5 Simulation Result of Geyser

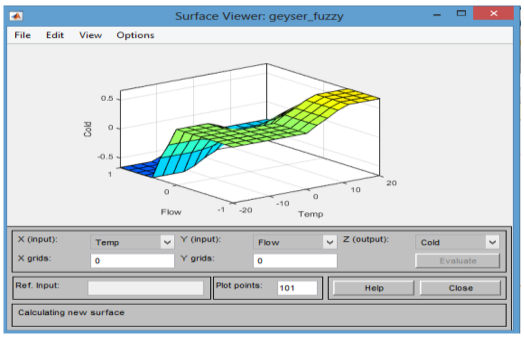

Fig 3.5: Surface viewer in MATLAB for Geyser

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The temperature, flow, and cold plots are shown in Figure 3.5. In fig. 3.5, the x-axis represents temperature, the y-axis represents flow, and the z-axis represents cold. The temperature is 0 °C and the flow is 0 cms in this case.

3.6 Simulation Result of Microwave Oven

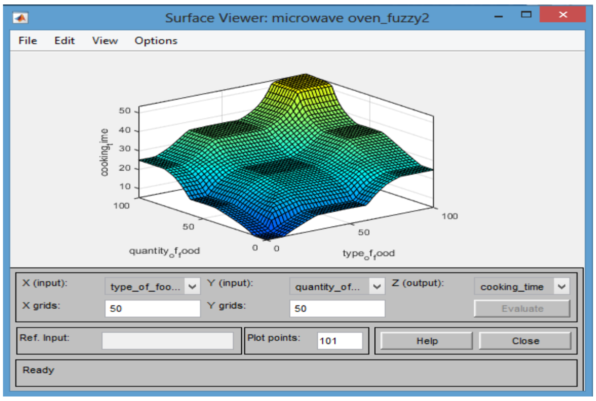

Fig 3.6: Surface viewer in MATLAB for Microwave Oven

The type of food, quantity of food, and cooking time are plotted in figure 3.6. The x-axis represents the type of food, the y-axis represents the quantity of food, and the z-axis represents the cooking time in Figure 3.6. In this type of food is 50 pu and quantity of food is 50 pu.

3.7 Simulation Result of Cooler

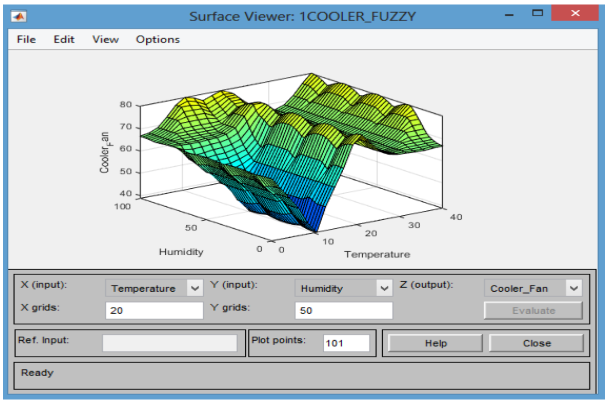

Fig 3.7: Surface viewer in MATLAB for Cooler

The temperature, humidity, and cooler fan plot are shown in figure 3.7. In fig. 3.7, the x-axis represents temperature, the y-axis represents relative humidity, and the z-axis represents the cooler fan. In this temperature is 20°C and humidity is 50/kg.

3.8 Simulation Result of Water Heater

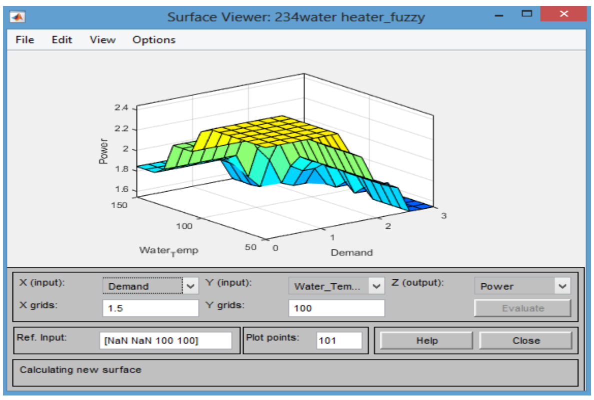

Fig 3.8: Surface viewer in MATLAB for Water Heater

The demand, water temperature, and power plot are shown in figure 3.8. In Figure 3.8, the x-axis represents demand, the y-axis represents water temperature, and the z-axis represents power. In this case, the demand is 1.5 J and the water temperature is 100 °C.

IV. CONCLUSION

Based on the findings done in this work, it is obvious that the usage of fuzzy logic controllers (FLC) in everyday life is becoming increasingly complex, and it will be possible soon to use them to a wide variety of applications. Using fuzzy on all smart home devices, according to tests, aids in detecting the amount of these gadgets. The expenditures paid as a result of using appliances that exceed the minimal specifications may also help and force in coming times to adopt FLC in near future more rigorously.

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