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SOFT-COMPUTING TECHNIQUES BASED CONTROL OF SMART BUILDING

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Abstract: ***The building energy management systems its management and automation in buildings has vital role. These systems will play a crucial role in regular energy observation and management and so to save lots of the doable energy and value. The key purpose of the building automation market is concentrated upon higher facilitation to the user in terms of comfort at reduced operation price. Energy potency improvement will contribute to environmental protection. Therefore there are rules and rating systems created that mandates the necessity of energy observation and management in an exceedingly building. For example, the above mentioned building utilities and equipment control and automation plays an integral role in achieving the green building rating points from certifying authorities such as GRIHA and IGBC. The planned system is to regulate the active systems like lighting as well as artificial lighting (on/off & dimming control), air conditioners and safety features like fire alarm & gas alarm. In future the present plan may be enforced for the total building, i.e. various rooms or areas and so all of them may be integrated on a standard platform for observation and management of {various} instrumentation***

Keywords: about four key words separated by commas

1. INTRODUCTION

Mostly the building HVAC systems run on set schedules and while not fine grained management on in basic data. The design and implementation of detector nodes ar required for correct usage of energy on the premise of individual detection [1]. The building energy management systems ar vital to use energy with efficiency. The need for the thermal and visual comfort is raised day by day. The systems ar designed for continuous energy management for the accomplishment of the energy and value savings [2].The building may be a vital space for measurement the impact of energy usage. The wireless detector network is planned to watch and management physical parameters moreover as observation the presence of users within the rooms [3]. Building automation system presents automatic management of the conditions of interior setting. The main goal is to recognize significant savings in energy with low cost. The BAS has extended to implement information from multiple systems working on “intelligent buildings” [4]. To attain a significant reduction in energy utilization aside from the standard energy-efficiency ways, innovative technologies should be used. Therefore logicalness of customary and new energy potency choices becomes wants. To move towards the thought of property buildings, a small amount of advanced steps are required, regarding energy, water, land and material management, collectively with environmental loading, and the characteristics of the indoor and outdoor environments [5]. A building energy simulation is mentioned that primarily based|is predicated|relies} on sub hourly occupancy based management. It allows the activity models in superior lighting simulation programs [6].

Energy presents a powerful actor in our quotidian activities. Energy demand is ever increasing with population growth along with the technological growth and as a result the prices of energy will rise [28]. The rise of energy demand has brought ecological and economic problems in the modern world. According to estimation of International Energy Agency (IEA), the demand of energy in the world will dramatically increase in rate of 55% between 2005 and 2030 [1]. The balance between generation and demand in power grid will be more and more difficult to be achieved. Therefore, the energy management is considered as a major research topic for Smart Grids (SGs).

2. METHODS TO ACHIEVE PROGRESS

The implementation of the changes required to meet the drivers has largely been enabled by increasing knowledge, research and the availability of new materials and technologies, such as rapidly evolving communication systems (Drewer and Gann, 1994; Smith, 2002). It is possible to express the changing genres and aspects of buildings through the different levels shown in Figure 1, which demonstrates that as buildings have progressed there are four aspects that vary:

(1) The ways by that building operation data is gathered and passed through (intelligence);

(2) The interaction between the occupants and the building (control);

(3) The buildings physical type (materials and construction); and

(4) The methods by which building use information is collected and used to improve occupant performance (enterprise).

In different categories of building, these four methods are focussed upon and utilised to different extents. Although each method has developed over time to be more effective, the methods have largely been developed independently of each other.

3. LITERATURE REVIEW

P. Garcia-Trivino et al. [22] have studied the performance of grid-connected PV/Wind/Battery/Fuel cell HPS with PI controllers tuned by particle swarm optimization (PSO) for the inverter power control. The performance of PI controllers with offline and online PSO tuning based on ITAE index, are compared under variable environmental conditions. Kuo-Hao Chang et al. [23] have investigated the use of Monte Carlo simulation, along with simulation optimization techniques, for obtaining the optimal design of HRES in uncertain environments. Their proposed model considers the equipment installation, including PV, WT and diesel generators and the energy storage systems in each power station, and also satisfied the load demand with minimum generating cost

P. García et al. [27] proposed an ANFIS based energy management system (EMS) for a grid-connected HPS consists of WT and PV as primary energy sources, and energy storage systems (ESS) of FC system and battery. ANFIS-based supervisory control system takes the power demanded by the grid, the available renewable power, the hydrogen tank level and the SOC of the battery as inputs and determines the power that are supplied by/stored in the FC and battery. Another ANFIS-based control is also applied to the three-phase inverter, which controls the power delivered by HPS to grid by controlling the active and reactive power. Load frequency control of Multi-area power system network is acheived by ANFIS controller. The proposed controller is compared with ANN and fuzzy controller to analyse its superiority [28]. The parameters of the static synchronous compensator (STATCOM) are tuned for proper reactive power requirement and to stabilize voltatge using ANFIS based approach with disturbances in load and power generation of a wind-diesel HPS. The transient responses of HPS are compared under fixed DC link capacitor and dynamic compensation by STATCOM [29].

An academic view is given by Wang et al. (2012), agreeing that Smart Buildings are part of the next generation building industry, suggesting that they: Address both intelligence and sustainability issues by utilising computer and intelligent technologies to achieve the optimal combinations of overall comfort level and energy consumption.

Kiliccote et al. (2011) propose that Smart Buildings are self-aware and grid-aware, interacting with a smart grid whilst focusing on the real-time demand side response and an increased granularity of controls. The theme of responsiveness, adaptability and flexibility recurs in further descriptions of Smart Buildings and is a key area in which Smart Buildings can differentiate from previous generations (Cook and Das, 2007; Wang et al., 2012a, b). The use of increasing knowledge, or information to achieve the drivers for building progression is highlighted in many publications;

McGlinn et al. (2010) define Smart Buildings as "a subset of smart environments" where smart environments are "able to acquire and apply knowledge about the environment and its inhabitants in order to improve their experience in that environment" (Cook and Das, 2007). The authors acknowledge the need for information on both environment and occupants but suggests that the Smart Building should itself be an entire system rather than a collection of smaller smart environments, in order to encourage the interaction between all spaces in the building.

Sinopoli (2010) suggests that a Smart Building revolves predominantly around integration, both of the systems within the building, and the method through which the building is designed and implemented. Sinopoli also highlights the need for technology systems to be integrated horizontally, as well as vertically in order to "allow information and data about the building's operation to be used by multiple individuals occupying and managing the building". The authors believe that this approach may resemble a Smart Building, although Sinopoli does not make a distinction between Smart and Intelligent Buildings.

4. PROPOSED SYSTEM

A hybrid system is planned wherever varied sensors ar connected with the Arduino board. Gas and fireplace sensors ar connected for the emergency alert. LDR (Light Dependent Resistor) detector is connected for sensing the sunshine magnitude within the involved space or area, PIR (Passive Infrared) sensor for sensing the occupancy in the room, a magnetic reed switch door is additionally used for higher and correct detection of occupancy. LM35 detector for measurement the area temperature is additionally used. System is intended {to management|to regulate|to manage} the lightning system supported the LDR and PIR detector for on/off and dimming of sunshine and air conditioning control as per demand, autonomously. Also the system is intended to alert for gas run and fireplace with a hooter. Figure 1 shows the block diagram for sensing unit in which the main control unit is the Arduino Uno board. Basically six building block of the system are Data Acquisition Unite (Sensors), Controller Unit, Display Unit, RF Modem, Power Supply Unit. In the transmitter section the assorted sensors ar connected to the controller unit. Analog sensors are connected to the analog inputs of the controller and digital sensors are connected to other pins of controller because they provide either HIGH or LOW output. The information from varied sensors is fed to controller unit and also the information of the sensors unit and at a similar time this data is serially provided to RF Modem which wirelessly transmits this data.

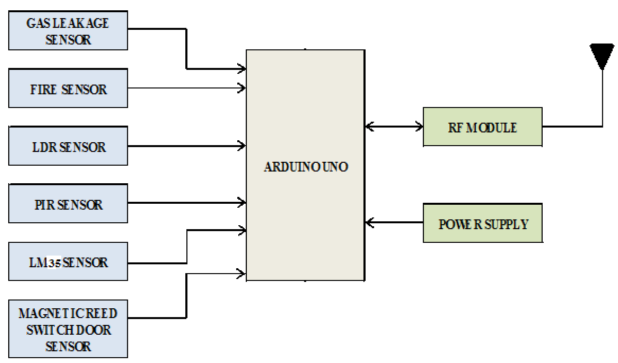

Figure 1 Block Diagram for Sensing Unit

From the literature, it is observed that previous home security models have considered some limited security concerns. Therefore one security model may be good in one situation but cannot provide the required results in other situations. To provide optimal home security solution, a new model is proposed. In this proposed model, sensors are used to detect abnormalities within the house or outside the house. There is a dedicated server for the sensors used to collect data inside the house. This server is responsible to collect information transmitted by the sensors and then analyze to detect any abnormality. Similarly, a separate server is used to process the information transmitted by sensors located outside the house. Both these servers are connected to a main server which process the information provided by these servers. Fuzzy logic is used to detect any abnormality. In case a threat is detected then main server report about the threat to concern people using internet besides setting the alarms on. Following is the graphical representation of basic logic of the proposed system:

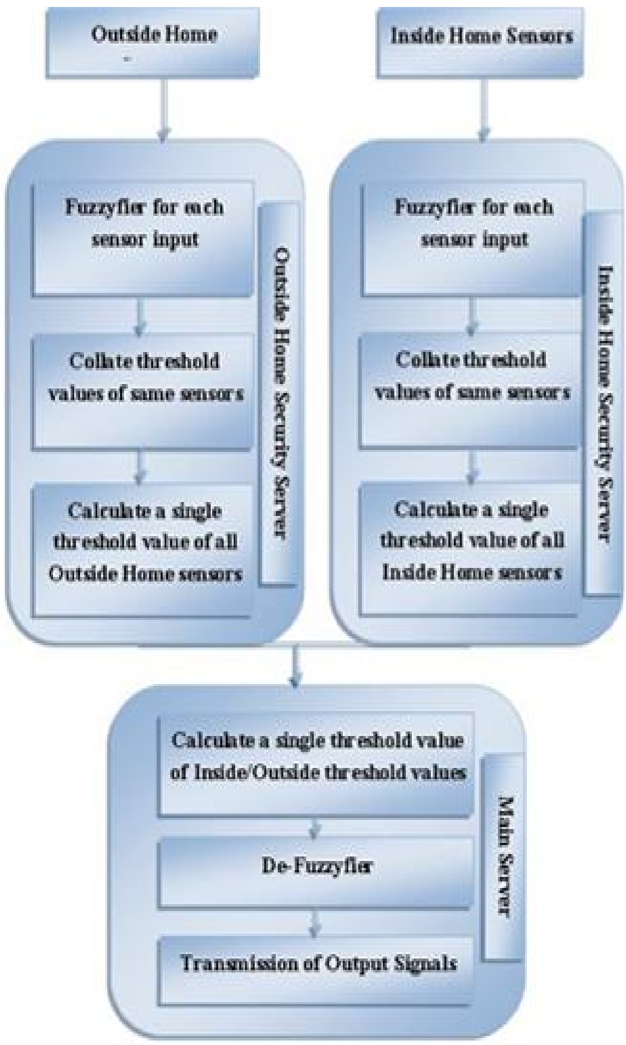

Figure 2 System Modules

In the next section we will describe the fuzzy rules of the three used Fuzzy systems (FLC1, FLC2, FLC3) then in the flowing section we will present their fuzzy rules. The implementation of the three FLC systems is done using MATLAB software. MATLAB has been used because it is extensively used in electrical engineering, and it provides a very practical MATLAB fuzzy logic toolbox [21].

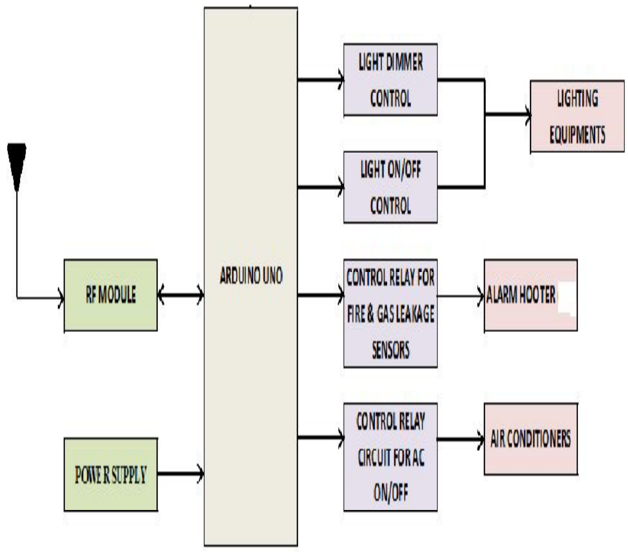

Figure 3 Block Diagram for Receiving Unit

Fuzzy Rules of FLC1 (shifting peak demand to low-demand period) We incorporated four inference rules that conclude to four IF-THEN rules, seen in Table 2. Fig. 6 shows the fuzzy inference rules. The output decision of PD-of-appliance y= 1.45, arising from the input value of the FUPDI x1 = 186 and from the input value of the Period x2 = 0.295. The output decision is represented by blue coloured areas in PD-of-appliance column. The MF "L-medium" represents the region of transition from low demand to high demand represented in Figure 2.The MF "H-medium" represents the region of transition from high demand to low demand of power.

Energy consumption on the grid peaks and troughs in daily, weekly, and seasonal cycles. As transmission facilities should be engineered to handle the height load of demand, much of their capacity is wasted during non-peak hours. An important facet of the intelligent grid is its ability to smooth the height of energy consumption and therefore improve the general capability utilization. This effectively prolongs the useful lifespan of existing transmission lines and reduces the need for costly new infrastructure. It also allows the grid to better exploit renewable energy sources that are intermittent in nature, such as wind and solar.

Figure two shows the diagram for receiving unit. In the receiver section basic building blocks of the system are Adriano Uno board, RF Modem and control circuits. This section receives knowledge|the info|the information} transmitted by the transmitter section and this knowledge is processed by the managementler unit and consistent with the detector data parameters more varied control circuits are activated. After the signal received by RF module, on the output side different outputs are given. Lightning system is controlled through the dimmer circuit as per the inputs from LDR sensor connected at the transmitter section. Air conditioner is controller with relay circuit to on/off the device. Hooter is controlled with relay circuit corresponding to inputs from gas sensor and fire sensor. The higher than explained methodology is planned to be enforced for a space in a very building for higher analysis in terms of energy and value savings.

4.1. FUZZY LOGIC CONTROLLER BASED HOME AUTOMATION

In this part, a PC based-LABVIEW was used to implement a FLC to smart home. We analyze the results of the global FLC programmed by the AG0. FLC comprise a fuzzifier, inference engine, and defuzzifier. FLC is used to reduce uncertainty in measurement of non-linear inputs variable of appliances. The input variables of the controller are: (Fuzzy Utility Power Demand Indicator (FUPDI), Fuzzy Threshold Indicator (FThI)). The controller picks up the two crisp input values, fuzzifies them in term of membership function of linguistic expressions. Then, it affects a fuzzified control signal to regulate the voltage applied to the appliance based on the settled rules and membership functions. So this mapping from input to output relies on a robust rule-based inference engine. Hence, the rule's setting depends on the expert knowledge and his logical reasoning. Finally, after the appropriate control, it deffuzzifies the outputs to crisp values. The output variables ar "Home's power demand in W (PD)" and "closing most consumed appliances (CMCA)". The fuzzy membership functions (MFs) and rules will be explained in next two sections.

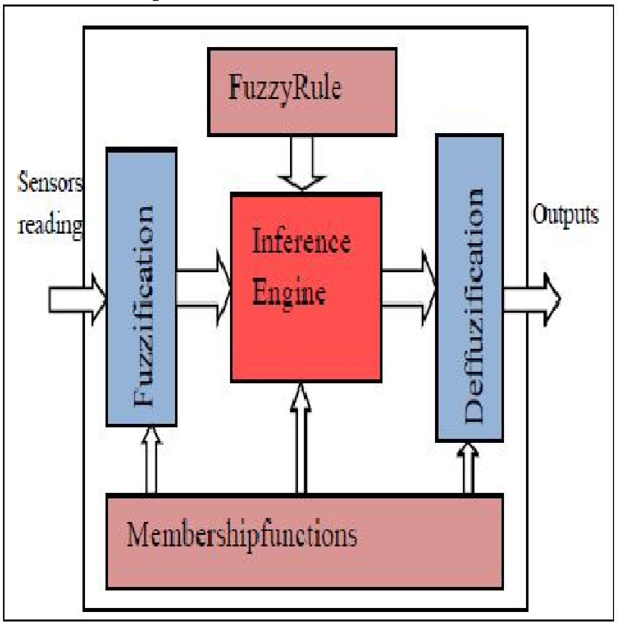

Figure 4 Fuzzy logic control system

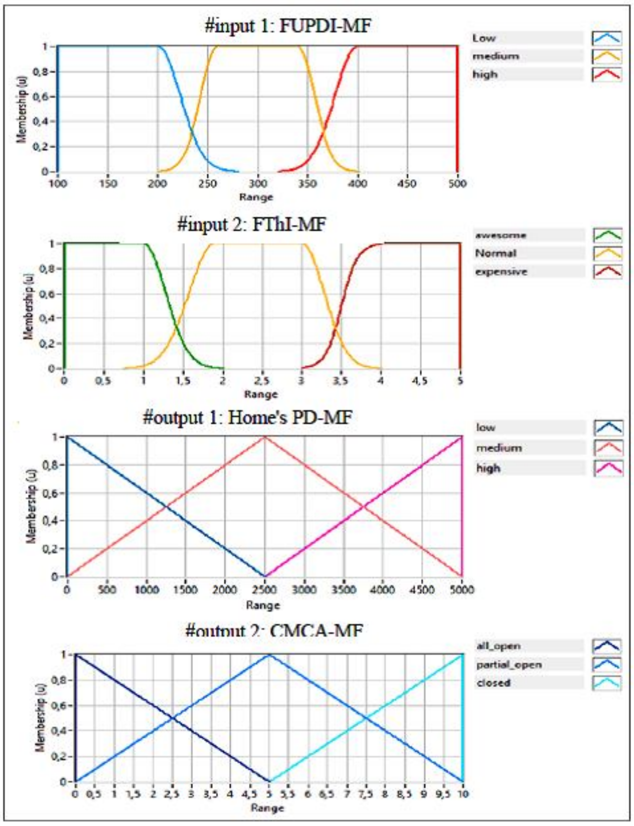

Figure 5 Fuzzy membership functions

4.2. MEMBERSHIP FUNCTIONS

In order to define linguistic rules that manage the relationship between inputs and outputs, a fuzzy membership function is needed. Each of input/output variables is divided into a range of three states. We use the GAUSSIAN (shape) MF because it is well suited to fuzzy input power demand variables. For the outputs we use the TRIANGLE shape. Figure 5 represents the MF of inputs/outputs of the fuzzy control system.

4.3. FUZZY RULES OF GLOBAL FLC

The fuzzy rules are very critical task in the development of FLC. Fuzzy rules present a helpful connection between the inputs and the outputs of the system. Fuzzy rules are a series of linguistic statements that describe how the decision is made by the fuzzy controller. The rules in the global FLC aim to show the user his present behaviour by a lighting indicator in the SM. So, when FUPDI = "High", and FThI = "Normal/Expensive" the light in the SM will be red. And in this case, AG0 sends the appropriate fuzzy control to FLC, and the latter closes the most/highest consuming appliances using the fuzzy output variable CMCA. Table 1 shows the nine fuzzy rules.

4.4 DEVELOPMENT INTERFERENCE FLC BASED LAB VIEW

An interface fuzzy was developed for control and monitoring. The software used is LABVIEW which is a graphical development environment that allows creating modular application (VI) a scalable for application design,

control, and test. The LABVIEW program has two main components:
- A Front Panel: represents the Graphical User Interface (GUI) of the FLC, which enables the user to monitor current value parameters (FUPDI and FThI),
- A Block Diagram: contains code program of FLC

The Virtual Instrument (VI) using LABVIEW was designed to accurately control in real-times. The GUI of the developed solution is shown in Figure 6. Figure 6 shows the waveform of the input/output variables of the fuzzy system. So with the variation of FUPDI and FThI, there will be significant change in the range of Home's Power Demand as well as in the number of appliances the most consumed. Moreover, we notice that the waveforms of the two output variables are opposite and it is explained in Table 1. (When the Home's PD is "High" ∈ [2500, 500], so the CMCA is all-opened ∈ [0..5]).

5. RESULTS

Rules	IF FUPDI (MW)	AND FThI	THEN PD	AND CMCA
1	Low	Awesome	High	All-opened
2	Low	Normal	High	All-opened
3	Low	Expensive	Medium	Partial-opened
4	Medium	Awesome	High	All-opened
5	Medium	Normal	Medium	P-opened
6	Medium	Expensive	Low	Closed
7	High	Awesome	Medium	P-opened
8	High	Normal	Low	Closed
9	High	Expensive	Low	Closed

Table 1 Fuzzy Rules of Global FLC

Rules	IF FUPDI (MW)	AND Period	THEN Power demand of appliance
1	Low	-	High
2	L-medium	Low-rising	Average
3	High	-	Low
4	H-medium	Low-falling	Average

Table 2 Fuzzy Rules of FLC1

Rules	IF FUPDI (MW)	AND Period	THEN Power demand of appliance
1	Low	-	Average
2	L-medium	Low-rising	High
3	High	-	Average
4	H-medium	Low-falling	Low

Table 3 Fuzzy Rules of FLC2

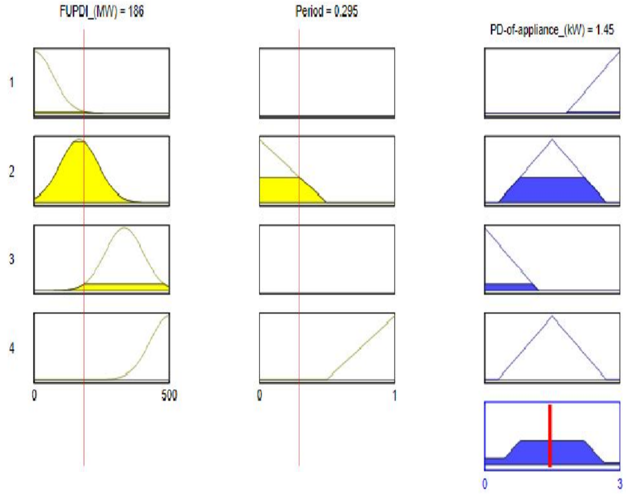

Figure 6 The inferred output of the FLC1 system

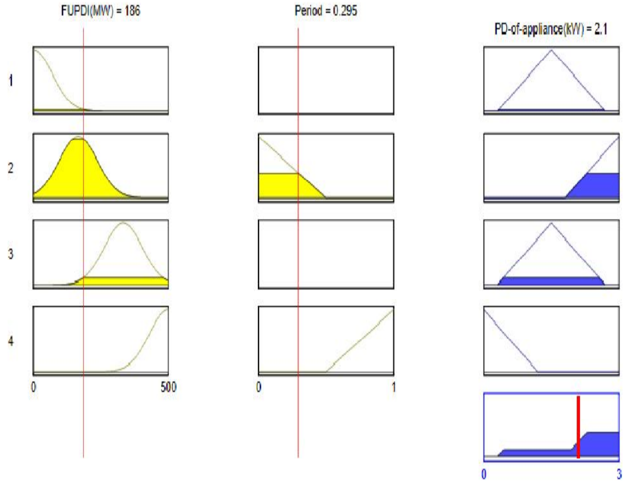

Figure 7 **I**nferred output of the FLC2 system

Rules	IF FUPDI (MW)	AND Period	THEN Power demand of appliance
1	Low	-	Average
2	L-medium	Low-rising	Low
3	High	-	Average
4	H-medium	Low-falling	High

Table 4 Fuzzy Rules of FLC3

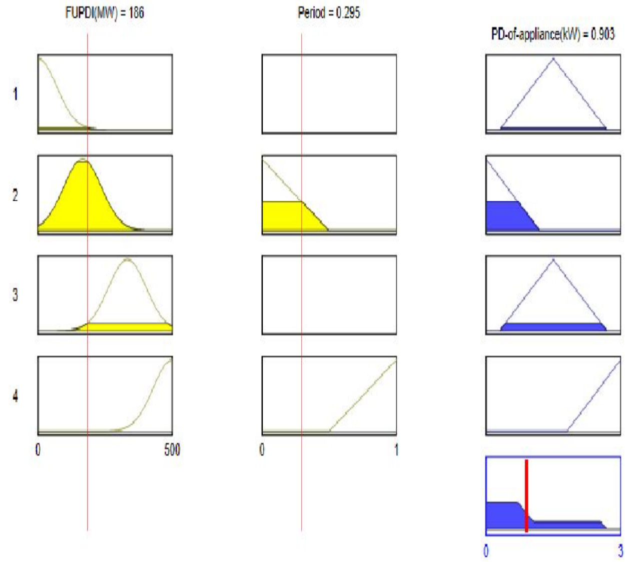

Figure 8 Inferred output of the FLC3 system

Fuzzy Rules of FLC2 (shifting peak demand to low-rising period)

For evaluation of the FLC2, we included 4 inference rules, seen in Table 3. Figure 8 shows the fuzzy inference rules.

6. CONCLUSION

A mathematical logic based mostly home security system is projected. It is observed that using this proposed concept, a better and flexible home security is provided. Proposed system inherits the properties of mathematical logic and so provides negotiator values as compare to Boolean logic bi-value outputs. Fragmentation and an absence of clarity inside the building sector can produce confusion instead of direction. Non-domestic buildings ought to aim for user comfort and satisfaction, energy reduction, resource efficiency and sustainability into the future. The definition of Smart Buildings given in this paper builds upon the foundations set by previous generations of building design, including Intelligent Buildings.

Research into Intelligent Buildings has advanced considerably since the Nineteen Eighties and sensible Buildings mix a number of the newer analysis with a a lot of holistic read of buildings. Smart Buildings are buildings which integrate and account for intelligence, enterprise, control, and materials and construction as an entire building system, with adaptability, not reactivity, at its core, in order to meet the drivers for building progression: energy and efficiency, longevity, and comfort and satisfaction. The increased amount of information available from this wider range of sources will allow these systems to become adaptable, and enable a Smart Building to prepare itself for context and change over all timescales. By contrast, Intelligent Buildings meet the drivers to building progression by focusing on intelligent systems which reactively utilize information; control, enterprise, and building materials and construction are developed largely independently of the intelligent systems.

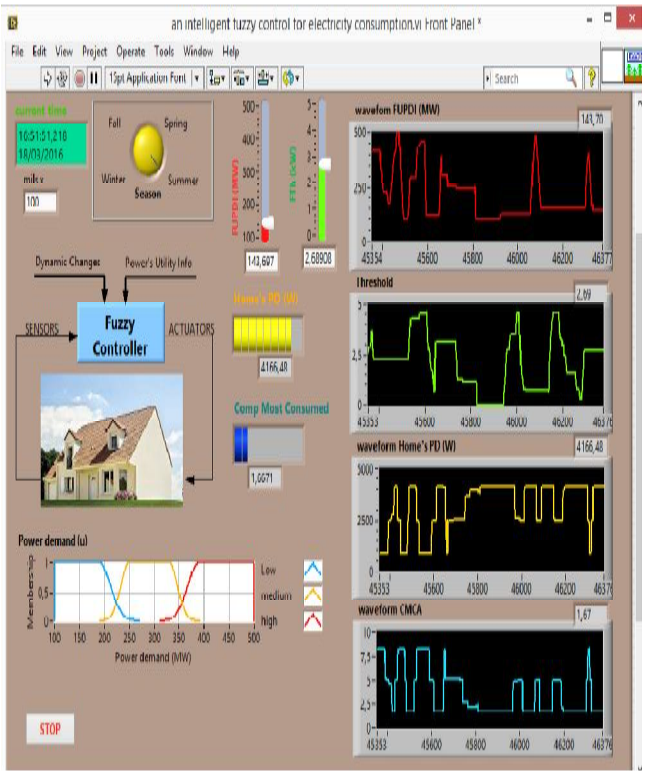

Figure 9 GUI for Fuzzy Logic Control Based MAS

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