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Improve Performance of FLC for HVAC System by Fuzzy Logic

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Abstract: Rapid development in building industry has improved power demand. Sensible buildings have turn into a pattern to manage energy longings and environment ease. This is outcome in reliance of wise management. Decreasing energy utilization and to verify thermal comfort are two fundamental concerns in arranging an air-con system. They contribute basic piece of aggregate energy utilization. Studies prescribe that in areas like conference halls, indoor stadiums & auditoriums, air-con will contribute most extreme sum as seventy fifth of aggregate percent energy consumption. Management method proposed is FLC (Fuzzy Logic Controller). Usage of FLC system is grants sort out of solace to human body. A Mat Lab fuzzy tool chest is utilized wherever a fuzzy logic controller is for air-quality, artificial-lighting comfort parameters & temperature. They gave system is equipped for accomplishing energy protection inside of buildings.

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1. INTRODUCTION

Energy management consists operation and planning of production units and consumption units related to energy. Resource conservation, cost savings and climate protection are objectives, while permanent access is given to the users for the energy needed. It is inter-connected to environmental management, logistics, production management and business functions. The VDI-Guideline 4602 released a sound definition which consists the economic dimension: “energy management deals with organized and smart coordination of conversion of energy and distribution in order to meet its growing demands in a sustainable way”

1.2 ORGANIZATION INTEGRITY

It is vital to integrate management of energy to the organizational structure, so that it can be implemented. Responsibilities and interactions of decision makers must be regularized. The delegation of function and work competencies are extended to the executive worker block by top-most manager. Further, understandable coordination can guarantee the fulfillment of the work.

It is proper to establish a different organizational unit “energy management” in large-scale or energy-intensive companies. This unit should support the senior management to keep track. It will depend on the basic organizational structure, where this unit is inter-connected. With regard to a functional organization, the unit is directly between the CEO and the second hierarchical level. Under a divisional organization, there must be a central as well as sector-specific energy management units. So the different needs of the all the sectors and the interconnection between the branches along with the head office could be satisfied. Under a matrix organization, the energy management could be included like a matrix function, so most functions could be approached directly.

1.3 ENERGY PROCUREMENT

Procurement is obtaining of goods or services. Energy prices change constantly, which could significantly have an effect on the energy bill of companies. Therefore weak energy procurement can be expensive. Companies could control and decrease energy costs by following a proactive and efficient path to buy energy. At least a change of energy source could be an alternative.

1.4 PRODUCTION

Production is the action of producing output, a good or a service which has the value and the contributes for the utility of persons. This central method may be different, depending on the industry. Industrial organizations have facilities that need a lot of energy. Service organizations, do not need a lot of goods, their energy-relation is mainly on facility management or on Green IT. Therefore the energy relation has to be detected first, then optimized and evaluated.

1.5 PRODUCTION PLANNING AND CONTROL

Normally, production is an area with the largest energy use. Therefore production planning and control is very important. This deals with operational, quantitative and spatial planning and management of processes that are needed in the production of goods. The "production planner" must plan the processes so that they could operate on energy efficient ways. A strong power consumer can be moved to night. Peaks must be avoided to benefit by a unified load profile.

The impending changes with the structure of the energy production need an increasing demand of storage capacity. Production planning as well as control has to be dealt with the problem of limited storability. Theoretically there is the possibility of storing energy electrically or mechanically or chemically. Another technology is the lithium-based electrochemical storage that could be used in electric vehicles, also as an option to control power grids. The German Federal Ministry of Economics and Technology, found out that the significance of the topic, established an initiative with the goal to promote technological findings and help the quick introduction of brand-new energy storage.

1.6 MAINTENANCE

Maintenance is combination of technical and administrative actions, with supervision actions, planned to retain the item in, or restore it into a state of performing a required function. Detailed maintenance is important to help the

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energy management. So power losses and extra costs can be avoided.

Examples of ways possible to retain energy and costs:

- Defrost the fridges
- Check the barometer of cars and trucks
- Insulation of hot systems
- Improve leaks in building envelopes

MATLAB is applicable in various aspects of engineering like Electrical engineering. There are a lot of instances on these majors, although there is text or example on MATLAB in energy management. I have provided an application of energy management for buildings using MATLAB. Considering the source as fuel energy, we are required to use them carefully and it is economical and ecological challenging which is a pre- requisite for the survival and which could only be mastered with highly qualified engineers. A vital percentage of energy used is consumed in buildings that means there were considerable potential in savings and a corresponding requirement for responsible behaviors. The building sector globally uses upto 40% of primary energy and also a big amount of water requirements. Building Energy Management Systems (BEMS)is to improve the environment within the building so it may control temperature and carbon dioxide levels. BEMS is not enough due to human interference. Humans are a dynamic part of the building, and therefore they should be accounted in the control strategy. Latest trends of designing Intelligent Building Energy management Systems (IBEMS) with a Man Machine Interface which could store human's preferences to adapt the control strategy accordingly.BEMS has been developed after Energy crisis in the 70's combined with the development of computers science. These systems focus on monitoring and control of the environmental measures of the buildings and to minimize the energy consumption and costs. BEMS have become a commercial tool and is implemented in a big range of applications, especially in huge buildings.

BEMS use a control method with the following goals:

I. Obtaining flexible system which allows for maintenance of thermal, illumination, security as well as air quality inside a building.
II. Reducing energy consumption for any given load.
III. Arranging for monitoring/control system.

The above goals are achieved by use of fuzzy controller in each zone level, supervised by suitable cost functions. The description of the control method is in next parts.

System Identification is an experimental way to build models from given input-output data. This model must be able to explain the behavior of process around the operating point. The model would be constructed with assistance of the System Identification Tool in MATLAB. Aim is to provide experience in how to use system identification for the devise models.

Controller designing is used for this model. A PID controller is created from process reaction curve. Experiments are done on Boiler and Heat Exchanger. The set-up usually was operated in an open loop mode to gain process reaction curve. Process reaction curve was used for searching controller parameters. A PID controller is created by using controller parameters.

2. PROBLEM STATEMENT

The HVAC system is design by the fuzzy logic according to the base paper. In this there are two inputs E_{temp} and E_{Dtemp} . The system is not linear as compare to input and output. The system is totally based on basic data. The data is observed according to base paper. First input is E_{temp} , for the input E_{temp} range is [-3 to 3] and values are NL,NM,NS,Z,PS,PM,PL. To design the rules Gaussian waves are used.

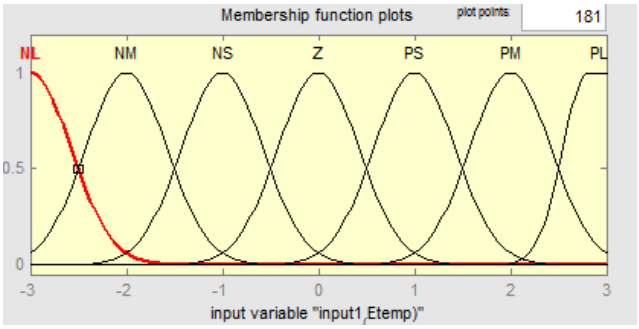

Figure 1:- Fuzzy logic rule file for input E_{temp}

The second input is E_{dtemp} and the range is [-3 to 3] for the values of NL, NM, NS, Z, PS, PM, PL. According to figure 3.2 the Gaussian wave is design for the second input which is $E_{Dtemp.}$

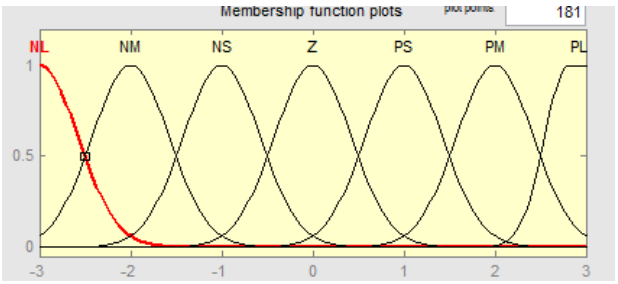

Figure 2:- Fuzzy logic rules for E_{Dtemp}

According to system, we have two inputs of the temperature. HVAC system detect the temperature of the both input temperature and then it gives the output temperature for maintain the temperature according to HVAC system. In the base paper Fuzzy logic is used, so that HVAC system can get the values of the both inputs and can give output temperature according to room/ hall temperature.

After apply fuzzy logic the output temperature is not coming exact and not in linear form .when the both the inputs given the output is not coming in linear format. That means the

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system is not following the perfect output as the input is change. We want that system perform linearly.

Main issue in the existing design is, the output temperature is not touching to the desire temperature. When the input for the E_{temp} is -1.5 and the value of the E_{dtemp} is -3 the output temperature is 11.2 .By proposed methodology we can improve the output temperature to the 11.9.

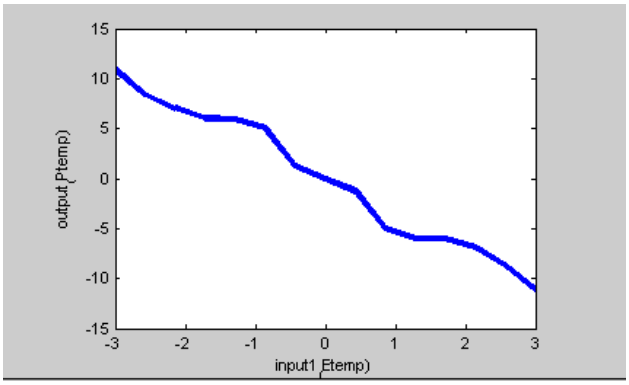

Figure 3:- Output of the HVAC system

According the existing fuzzy logic design the rules are given in table number 1.

	NL	NM	NS	Z	PS	PM	PL
NL	PL	PL	PM	PM	PS	PS	NS
NM	PL	PL	PM	PS	PS	NS	NS
NS	PM	PS	PS	PS	NS	NS	NM
Z	PM	PM	PS	Z	NS	NM	NM
PS	PM	PS	PS	NS	NS	NM	NM
PM	PS	PS	NS	NS	NM	NL	NL
PL	PS	NS	NS	NM	NM	NL	NL

Table 1:- Fuzzy logic rule file for existing design

3. PROPOSED DESIGN

For improve the performance of the output temperature, we have change fuzzy logic rules so that our system is giving the repose in linear format and the output temperature is improves from the existing design.

	NL	NM	NS	Z	PS	PM	PL
NL	PL	PL	PM	PM	PS	**Z**	NS
NM	PL	PL	PM	PS	PS	**Z**	NS
NS	PM	**PM**	PS	**Z**	NS	NS	NM
Z	PM	PM	PS	PS	NS	**NL**	NM
PS	**PL`**	PS	PS	**Z**	NS	NM	NM
PM	**PM**	PS	**Z**	NS	NM	NL	NL
PL	PS	**Z**	NS	**NS**	NM	NL	NL

Table 2:- Fuzzy logic rules for proposed design

In Table number 2 all the bold rules box are showing the changes in the rules of the proposed design. For improve the temperature of the output we change rules of the fuzzy logic with waveforms of the input. As the problem statement for the input Gaussian wave is used in input.

4. RESULTS

4.1 FLC for HVAC system

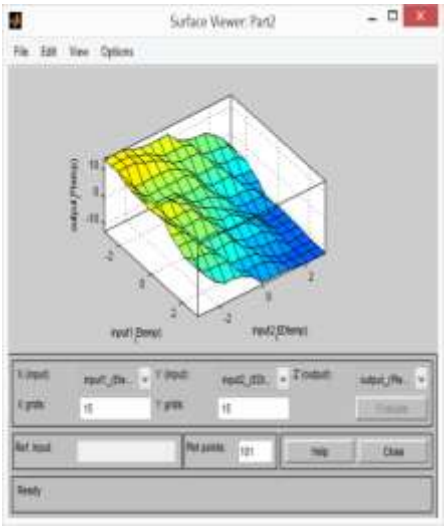

Figure 4:- FLC for HVAC system

4.2 FLC For Lighting

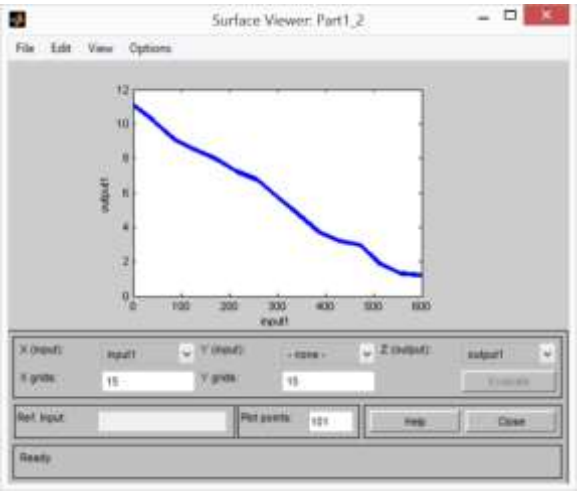

Figure 5:- FLC for Lighting

4.3 COMPARISON BETWEEN HVAC SYSTEMS

Serial Number	According to base paper	According to proposed result
1	Etemp = 0 EDtemp = 0 Ptemp = -7.93e-16	Etemp = 0 EDtemp = 0 Ptemp = 8.5e-17
2	Etemp = 1.5 EDtemp = 3 Ptemp = -12.8	Etemp = 1.5 EDtemp = 3 Ptemp = -11.9
3	Etemp = -1.5 EDtemp = -3 Ptemp = 11.2	Etemp = -1.5 EDtemp = -3 Ptemp = 11.9

4	Etemp = -3 EDtemp = -3 Ptemp = 14.1	Etemp = -3 EDtemp = -3 Ptemp = 14.1
5	Etemp = 3 EDtemp = 3 Ptemp = -13.9	Etemp = 3 EDtemp = 3 Ptemp = -12.7
6	Etemp = 2.34 EDtemp = -0.67 Ptemp = -7.45	Etemp = 2.34 EDtemp = -0.67 Ptemp = -6.52

Table 3:- Comparison in between Proposed and existing fuzzy logic rule file

According to table number 3, it is showing that the output result is more linear from the existing. Output is more linear and good as compare to existing.

5. CONCLUSION

Investigation unmistakably maps out point of interest of fuzzy logic in managing issues that are difficult to survey diagnostically however are easy to determine instinctively as far as linguistic variables. Study presented comfort index of inhabitants predictable with office consumption pattern to make shrewd call of energy management albeit fuzzy logic controller. MatLab simulation is utilized to understand composed objective. Three noteworthy systems were considered and a fuzzy controller was created for each of them. Thus building energy management with astute management will contribute enormous amount of energy reserve funds and cost. This can fabricate clients mindful appropriately to oblige insightful activities therefore.

6. FUTURE SCOPES

In the future, results can be improve by apply neural network. The neural network is a artificial intelligence which is using forgive human mind. Results can be more suitable and stable from the Fuzzy logic.

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