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Decision Making Via Demand Forecasting In The Building Structures For Energy Management Through Multi-Agents

[1]Shobhna Singh, [2]Prachi

[1]Mtech Student , Department of CSE & IT, ITM University,Gurgaon
[2]Associate Profesoor, Department of CSE & IT, ITM University,Gurgaon

***Abstract*: Energy management is one of the primary concerns in the building structures due to increasing demand of energy day by day. This paper proposes a decision making system to cover-up the giant demands of electricity. To achieve our objective, a multi-agent system is used in which different agents will handle different duties. These agents comprises of software and sensors. The intelligent systems composed of two main components: perceptron and actuators. Perceptron perceives simulations from the environment and acutators perform the action on the stimuli. The multi agent system is used for cost reduction, utilization of renewable energy resources, check on green house gases, etc. As a result, the demand forecasting through multi agents will help in managing the resources and effectively utilizing the energy sources.**

***Keywords:* BEMS, Demand Forecasting, Multi-Agent System (MAS), Intelligent Sytems**

I. INTRODUCTION

Rapid exhaustion of fossil assets and climatic dangers throughout the world during the last two decades redirected the specialists and researchers to find out new methodologies for energy effectiveness and manageability.

To handle this circumstance with constrained time and assets, demand side management (DSM) can be used. DSM relies on upon splendid mechanized structures for their energy effectiveness and supportability for future trend. The advantages of these structures incorporate high power proficiency, expanded solace and ecologically well disposal. A multi-agent system (M.A.S.) is a computerized system composed of multiple interacting intelligent agents within an environment. In artificial intelligence, an intelligent agent (IA) is an autonomous entity which observes through sensors and acts upon an environment using actuators (i.e. it is an agent) and directs its activity towards achieving goals. Intelligent agents may also learn or use knowledge to achieve their goals. Each agent works toward its individual goal to achieve it completely. This type of working in an artificial environment for the economic purpose gives birth to a new era of distributed problem solving which merges the advancement in Information and Technology. This same concept is being proposed to manage the energy in the building structures so that the capacity, production, renewable energy sources, etc can be enhanced successfully.

The building business is a developing energy client, as pretty nearly 90% [1] of the populace invests the majority of their time in structures, subsequently expending around 40 – 45 % of the general energy [2-3]. The yearly rising rate is 1.5 - 1.9 % recorded for energy utilization, alongside 1% top interest increment of framework system [2][4][5]. In this way, huge potential exists to lessen building energy request at lessened expenses with exceptional yields. The capacity of the insightful building administration framework is to screen, control and streamline building administrations, for example, warming and cooling, visualization, air quality, stickiness, etc. It is clear that, the change of the indoor environment solace requests, expanded energy utilization. To maintain the balance between the tenant's solace necessities and power utilization, smart productive structures are required. In other words, we can say that to attain extraordinary comfort and power proficiency, a viable control framework ought to be created. The tenants living quality and wellbeing are indispensable for understanding the control method of heat, visual and air quality comforts framework. In this way, dealing with the power accessibility and guaranteeing the agreeable exploitation of outdoor environment control are in disagreement with each other. The components impacting the two clashing targets are client tendency, sensor position, and precision and variable open air atmosphere conditions. In a building framework, various systems for comfort control have been proposed. Prescient control model with climate forecasts coupled with the energy reducing capability of HVAC framework were developed in past [6-8] Visual comfort control with a fuzzy rationale controller was also proposed in literature [9]. Researchers also proposed a strong control for wind streaming rate [10] and fuzzy view control machine for air quality control [11].

A. Multi-Agent System:

MAS is an aggregation of networked agents or controllers to achieve some global objectives by coordination and communication among the agents.

Characteristics of MAS:

- Autonomous: The agents in the MAS system are autonomous in nature, i.e. least partially dependent.
- Transparent: No agent is aware about any other agent working in the system i.e. not a single agent know about the global view of the problem
- Decentralized: Not a single agent is assigned to control the network; all agents do their work in an independent mode.

These characteristics of the MAS make it a better option for the distributed problem solving technique. Here, the main job or problem is divided among the agents and their collaborated results make a proper output of the system [12]. Just take an example of sensor network at a public area where each sensor has its own processing power, battery and memory to take the action upon receiving the stimuli. If one of the sensors fail then whole network will get an alert for something wrong. In this case, sensors work as the perceptron or receiver of the stimuli and the action taken by the system through the machine is called as actuator.

B. Demand- forecasting:

Most basic operation of Building Energy Management Systems (BEMS) is Demand Forecasting (DF), which permits the BEMS to know the required amount of power, ahead of time. This paper depicts MAS implementation of the Demand Forecasting System for a BEMS. The objective of the MAS Demand Forecasting system is to forecast BEMS user's energy needs at different areas. To carry out this task, the BEMS uses different Agents and team up with alternate techniques to guarantee BEMS solidness. DF agent tasks include:

- DF - Historical Control Agent (DF-HcA): This agent chooses what verifiable information will be used as a part of system retraining.
- DF – Smart Meter Control Agent (DF-McA): This agent is in charge of guaranteeing that smart meters are sending energy utilization information accurately.
- DF – Smart Home/House Data Control Agent (DF-DcA): These agents synchronize with the DF-McA to checks the significance of the acquired data, and account this data to the pre-processing representative.
- DF – Data Preprocessing Agent (DF-DpA): These agents are liable for institutionalizing the information stored into the database, and for detecting and solving would-be irregularities.
- DF – Forecasting Agent (DF-FoA): These agents are in charge of initiating demand forecasting in harmony with a common clock controlled by the DF system.
- DF – Retraining Control Agent (DF-ReA): This agent is in allegedly involved in controlling when the forecasting architectural model needs to be retrained.
- DF – New Smart Home/House Control Agent (DF-NcA): These agents are responsible for reporting new client consolidations to alternate operators. In addition to this, they also delete nonusers of BEMS services [13].

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C. Building Energy Management System (BEMS):

BEMS is most commonly used in large projects with wide mechanical, Heating-Ventilation & air conditioning (HVAC), electrical and plumbing frameworks. Frameworks connected to a BEMS normally uses 40% of a building's energy utilization; if lighting is incorporated, this number approaches to 70%. BEMS framework is a basic part to oversee energy request. BEMS is analyzed using different simulation tools [18] and simulation results proved that the cyber enabled BEMS (CEBEMS) model for BEMS is most beneficial. Therefore, it can be readily implemented in various buildings such as food restaurants, office building and many more.

II. PROPOSED WORK

Here the concept of artificial neural network (ANN) is used in which neurons (the basic and functional elements of network) are trained by using the previous data sets and then neuron testing is done. The multi-layer back propagation algorithm for supervised learning of neuron is used in which after training in the testing phase, the threshold value of neuron is matched with the value of network. If it is equal to or greater than that of network's value then the system is working fine, if it is not then the training of the network is not done properly.

Similarly, the various agents are trained and tested against the environmental stimuli. As discussed earlier, various agents are used for the specific purpose on their own such as, DF-HcA, DF-McA, DF-DcA, DF-DpA, DF-FoA, DF-ReA, DF-NcA and DF-EcA. Here each agent will perform its own functioning and without knowing the global functioning of the system.

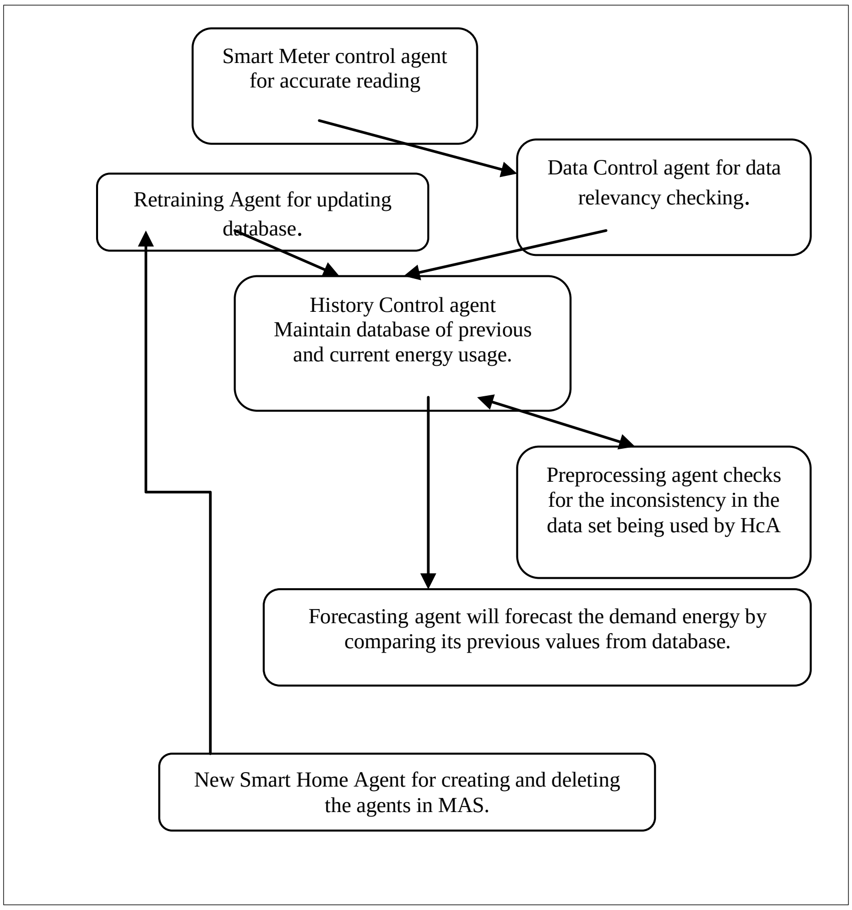

Fig.1 Demand Forecasting MAS for BEMS

Figure1 demonstrates the MAS system for demand forecast of energy in the BEMS with the help of many agents. This work is implemented in MATLAB in order to provide the graphical user interface (GUI) to the working of the system.

Here, the old data set is being feed into the system database. It checks the need of energy for particular number of hours on the day and month that are feed into the system by the user from its end. The DF in BEMS became the need of current hour because the present sources of energy will exhaust soon and to make them available for the upcoming generation it is necessary to have control. This can be done by the smart energy management of the buildings. Also, this helps in reducing the problem of long electricity cuts and emission of green house gases. However, some researchers can argue that we have many better options available today to tackle this problem such as wind energy, solar energy, bio-gas and many more then why to use it. However, authors in [13-14] have already answered this question.

III. IMPLEMENTATION

In the previous section, we have already discussed about the workflow of the proposed work. As shown in figure 2 this work is implemented on the MATLAB.

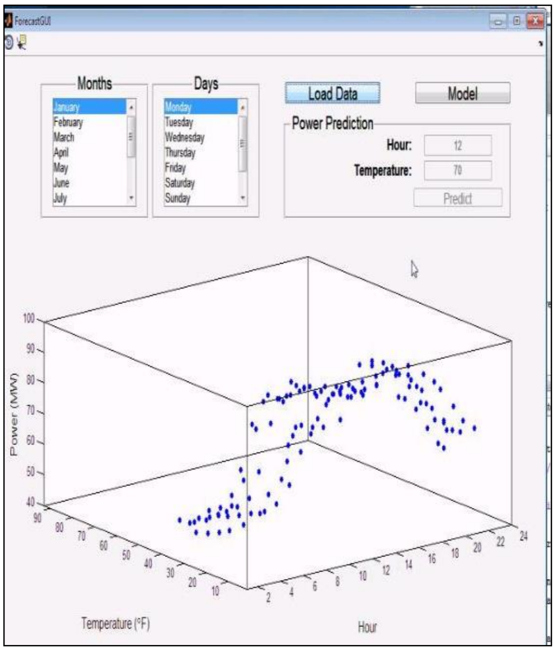

Fig.2 Mapping the data on the graphs to study

Here the X-axis is shown by Hour, Y-axis by Temperature and Z-axis by Power. The time is measured in the unit of hours, temperature is measured in degree Fahrenheit and power in MegaWatt. The Figure 3 shows the surface view of these data points. Loading of dataset into system is the training step of the neuron.

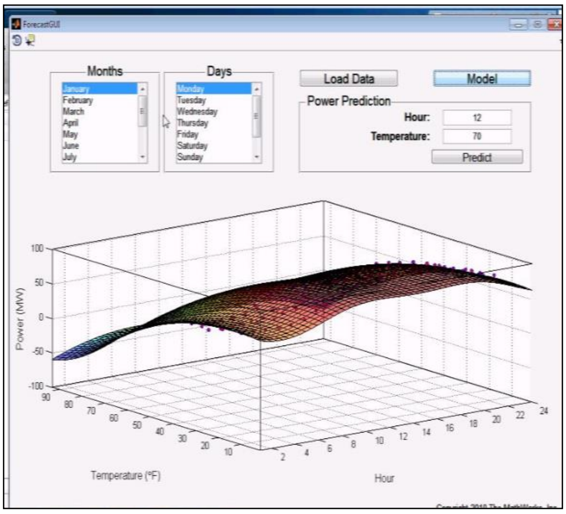

Fig.3 Surface view of data points

Upto Figure 3 data is loaded and the data points are made available in two different models. First model is shown in form of simple graph and the other one is shown in form of the surface view.

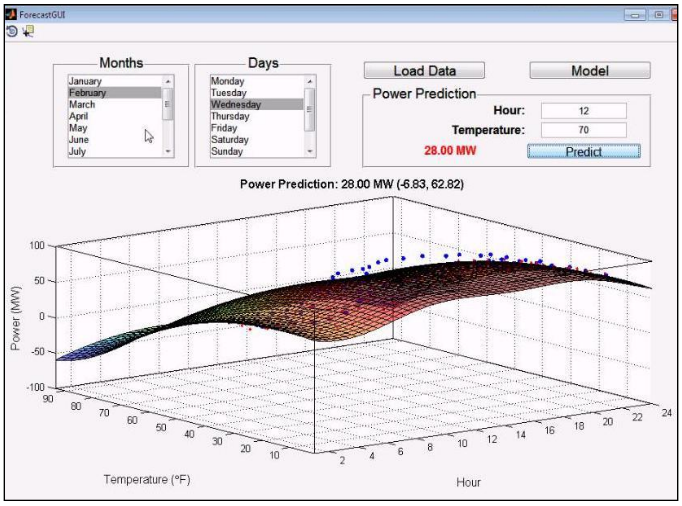

Fig.4 The forecast graph.

Now, check for the energy requirement prediction. Here, the user is supposed to fulfill the entries in the power prediction panel of the GUI. Figure 4 has two options, one is the number of hours and another is the temperature during that hour. The DF agent will use other agents of MAS and forecast the requirement on the basis of above stated information. Whenever there is an update in the database then the updating agent will perform its duty to update the datasets.

The difference between the surface inclinations can be seen easily by comparing Figure 3 and Figure 4. Here, first prediction is for the month of February on Wednesday when the time is 12 hour and the temperature is 70 degree Fahrenheit. The prediction shows that there is a decline on that day for that particular hour.

VI. CONCLUSION

The decision making using demand forecasting for BEMS is proving to be a boon for the future generations. In this paper, the DF for BEMS has been studied and implemented. The MAS system comprises of various agents. Each agent performs its own function. This type of scenario will provide better results by mingling up with new IT techniques. Proposed system shows a ray of hope for the power sector industries and smart home techniques. Simulation results clearly show that it foretells the need of energy. Predicted amount of energy can be less or more as compared to its previous use. This will help in managing the limited resources.

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