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Load Prioritization with Suspicion Assessment Based Inspection [SAI] Algorithm

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Abstract: ***Smart metering technology has been undergoing innovations nowadays. The proposed project is to design a smart meter having machine learning capabilities so as to prioritize load according to time. The system can be divided into three segments based on the operations fulfilled. Firstly, the machine learning part, deploying Suspicion Assessment Based Inspection [SAI] Algorithm, sets up the priorities of load. This can be accomplished in Python programming and can be fed to Smart Meter. The Smart Meter design in MATLAB can be considered as the second part. The output from Smart Meter containing prioritizing section including circuit breakers can be considered as the final section. There is higher as well as lower priority points that are switched on and off with different timings.***

Keywords: Load Prioritization, Machine Learning, Smart Meter, Suspicion Assessment Based Inspection [SAI] Algorithm

1. Introduction

Smart metering and application of machine learning, or even artificial intelligence, in real time electrical creation, distribution and levying charges has been witnessed across the globe irrespective of developed or developing countries. Machine learning (ML) models have been extensively made use of in the sculpting, strategy and extrapolation in energy systems. Throughout the former double decades, there has been a histrionic upsurge in the encroachment and solicitation of countless types of ML facsimiles for energy systems [2].

An energy system is an assemblage of systematized fundamentals intended for the tenacity of fabrication, regulation and/or revolution of energy [5,8]. Energy systems could unite amalgamations of mechanical, chemical, thermal, as well as electromagnetical constituents, casing an eclectic array of energy groupings counting all renewables and substitutions [1,7,11]. The improvement of energy systems is fronting precarious decision-making responsibilities to mollify abundant tough and conflicting purposes bearing in mind functional enactment, adeptness, financial encumbrance, environmental sway, etc. [9].

Whether it is a commercial scenario or household one more probable consideration is gained by the business locations when taking limited supply cases. All households are taken into similar status when a load shedding is employed in any area. People who have to eliminate this predicament have to depend on alternate sources like generators or inverters in their houses in order to avoid breaks in power supply; there can be infants or elderly or people who cannot keep themselves away from light sources or air circulation in rooms. So here through this paper a trial is made to handle such situations using a machine learning and distribution of power with respect to assigned priorities to loads. Two level of prioritization analysis approach can be made use of: one at the usage point and another at the distribution point.

Paper here tries to explain what had it been designed and how it was made into reality, what was obtained towards the end and how can it be upgraded or made better and finally to see if it can help towards further learning with respect to real time exploitation.

2. System Design

The system of load prioritization had its own dependence on completed works by renown researchers and made use of it with proper foresight towards the final result intended to meet. Here priority numbering and ranking approach has been considered for end users as well as distributing agencies; thereby helping the circuit breakings at both the levels.

End users or households have their appliances and different rooms assigned with corresponding priority numbers along with its time linked onlooker. For example, lights are not always necessarily given top priority as they are only required to illuminate a dark area. So with their respective uses, priority standards are defined ahead and those are made use of.

Again the distributers will have a priority listing which is connected to primacy like elderly, patients or infants and even working-at-home people.

Machine Learning is made use of at this point of linkage between distributers as well as end users; both levels will implement their own control and circuit-breaking. Python Programming is made use to implement this and the output of which is sent to the smart meters installed which will compare and analyses from its level of working to give proper signals for achieving adequate approach of circuit breaking at both levels.

According to priority ranking and time and climatic situations predetermined as well as loaded for machine learning, distributing points will interrupt the power supply or partially allow or fully allow power consumption during a period of power supply shortage or load problems owing to the significance of the power supply for such consumers. Figure below shows the block diagram of the system.

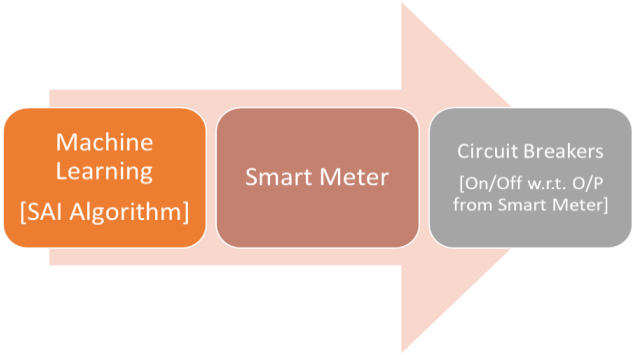

Figure 1: System Design - Block Diagram

The end-using point will also be having a circuit breaking scenario as instructed by smart meters depending on whether it is necessary to see if light sources or cooling or heating systems are necessary when comparing to fed time and climatic setting.

3. System Implementation

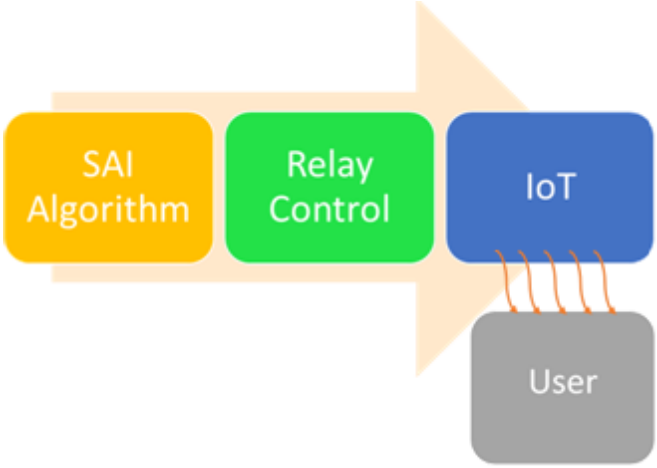

Figure 2: System Implementation - Block Diagram

The block IoT here shows usage of an IoT linking can also be achieved with the Python code. The site address is specified in the code so as to display the data required so that the user can get the load priority data through internet. Here the code part implements Internet of Things [IoT] technology that helps the user to know about the status of load priority through Thingspeak site.

3.1 Machine Learning Using Python

Suspicion Assessment Based Inspection [SAI] Algorithm was used to apply the machine learning here for achieve an easier, more easily trackable approach for attaining what it was intended to do through machine learning. The exact approach for the algorithm is in fact Binary Tree Based Inspection Strategy which is executed to attain the necessary machine learning intended to achieve. The handlers are queried by a binary tree-based inspection stratagem which contains a binary tree that was erected in accordance with allocated end-user priorities. The inspection mandate of the nodules on the binary tree is also dogged by the priority allocations and experimental outputs gave some considerably fair outcomes that support the choice of SAI algorithm in executing the prioritization of loads [12].

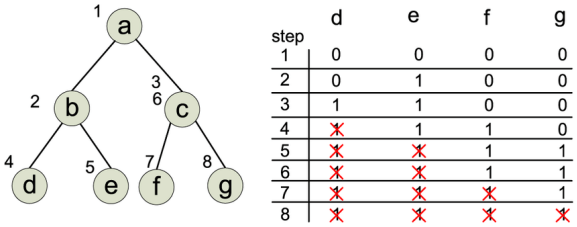

Figure 3: Dynamic Binary-Tree-Based Inspection [12]

The diagram above shows the realization of accepted algorithm by the team of researchers Z. Xiao, Y. Xiao and D.H.C Du, whose learning on SAI algorithm gave a real time possibility of the same.

3.2 Smart Meter

A simulation which was studied and conducted by N. H. Azmi and his co-researchers on three phase energy meters by using MATLAB / Simulink Software to scrutinize the enactment of the altered natures of loads has been adapted here as the base of the smart energy meter. The recital of the energy meter method can be perceived comprehensive in the simulation upshot [6].

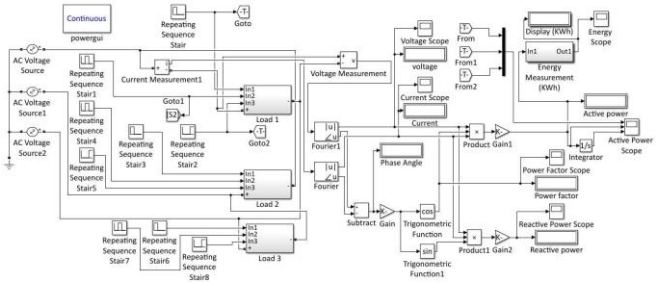

Figure 4: Three Phase Energy Meter Circuit [6]

The various parts shown in Figure 4 is the complete models of three phase energy meter, a fail-proof one adopted from [6], delivered the energy ingesting of all possible types of loads that maybe used. Here are numerous blocks that convoluted in this coordination as presented beneath:

Power Factor block: The maneuver and intention of the power factor is completed under this section; the finalizing of power factor is done from the dissimilarity in phase angles of voltage and current.

Voltage block: This segment yields the assessment of voltage from the load associated.

Current block: It is produces the value of current from the supply and load connected.

Load block: This part encloses of superlative switch that is associated in series with the load. Task of the idyllic switch in this section is to simulate the power intake of the load and correspondingly this switch wrought concurrently of all phase.

Energy measurement block: It has to work in order to parade the energy consumption for altered types of load and this chunk renovates the value of energy shaped from Watt (W) to Kilowatt (kW).

3.3 Priority Implementation

As the execution has been done on double levels, priorities defined will have its part of influence on the other stage; minimum load with higher priority, minimum load with medium priority and lower priorities are all defined. The KW of power to be distributed when at times become lesser than the load connected to the system, distributers are compelled for analyzing load priorities among the users and distribute the available energy among the most needed and maintaining certain basic loads of overall connections [3].
Studies conducted by S. I. Ahmed, S. Rauf and N. Khan on load prioritization have provided a supportive stance towards this project implementation. Below are the two particular outcomes of their learning which shows variations on the circuit loads of low and high priorities respectively [10].

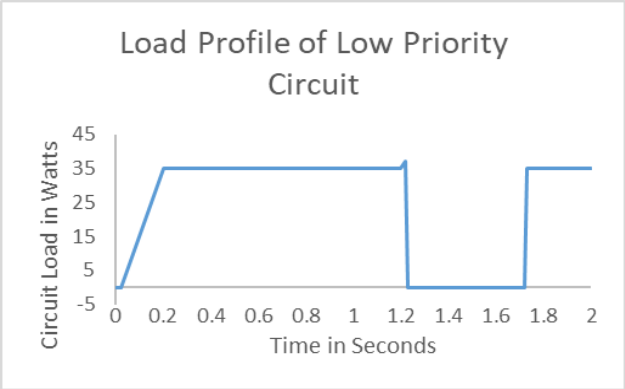

Figure 5: LP Circuit Load

From the simulation outcome of the LP circuit, which is shown above, as learned by S. I. Ahmed and others, it became evdient that at a time instance 1.2 second, the load current surpasses its already identified numbers, the smart meter initiates a disconnection of power supply to load thereby making the current flow to 0. At LP circuit a break of 0.5 seconds, from 1.2 seconds to 1.7 seconds followed by re-establishment of normal supply can be evident which later works in a normal manner [10].

The simulation scenario depicted below will interpret HP case in the same consumer load and there has been visible difference regarding the same. Here the point were load is exceeding the highest limit of 35 watts is at instance of 0.5 seconds. It is here during which smart meter inititates a stoppage to power supply to the load through a number of circuit breakers. Later after a considerbale delay of 0.5 seconds, between 0.5 seconds and 1 seconds, again the energy is being delivered. After that the load gets the supply as normal and there has no evdient variations identified throughout the later periods till observed outcomes for 2 seconds [10].

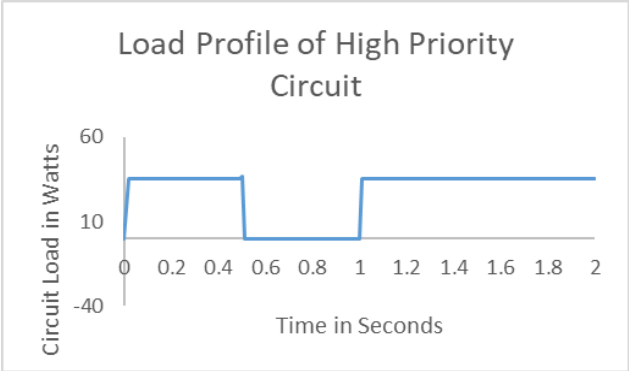

Figure 6: HP Circuit Load

When considering the total load scenario, in fact we can explain it as a combined outcome of both Low Priority as well as High Priority circuits. The simulation signal depicted below shows it all explaining both peaks handled by the smart meter for LP and HP cases.

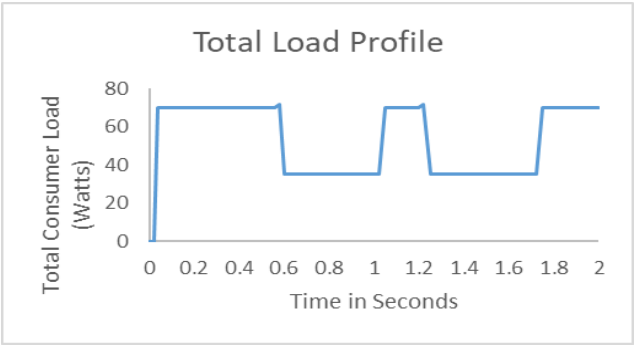

Figure 7: Total Consumer Load

Here it is shown that there are peaks at 0.5 seconds and 1.2 seconds following which a delay of 0.5 seconds have been implemented by Smart Meter with the help from circuit breakers and timers; after those delays normal load scenario can be viewed from the result [10].

4. Results

The upshots of the simulation research express that the executed prioritizing scheme was capable of enumerating the prominence of every distinct load or end-user, and arrangements' steadfastness was upgraded; M. AlOwaifeer and M. AlMuhaini as well have worked in a similar scenario for achieving outcomes at DS level. The seen load prioritization route contemplates the loads according to their priority crucially, the aggregate of energy disbursed, the integer of allied clienteles, and the repetition of demand lateral prioritization. This took numerous hands-on dynamics that sort the progression of load prioritization a byzantine and perplexing situation into ample consideration. Thus the overall work has taken out the results of a dynamic load prioritization archetypal for service reinstatement in distribution agencies and the end-users as well. The way executed here ranked loads using separate ranking of priority from distribution level as well as final consumption points later to consign a deliberate figure for separate loads in the entire connections ready to get served [4].

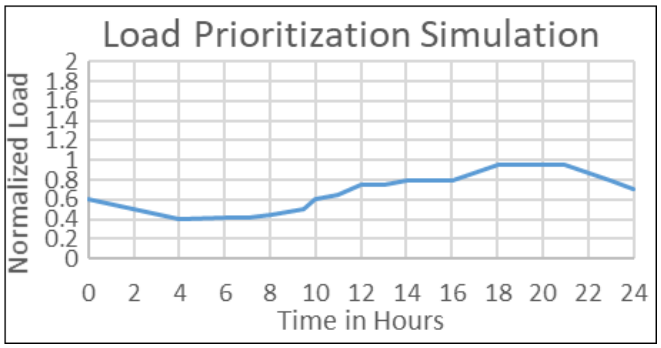

Figure 8: Simulation Results

Thus individual loads which are consumers and the appliances/rooms connected to each load has been considered to achieve a better control and priority based energy distribution and usage.

5. Conclusion

Augmenting the dependability of distribution systems or agencies has got converted to as an obligation because of the reliance of civilization on electric energy and the extraordinary expenses in association with service interludes. One strategic modus operandi for enlightening system steadfastness is to smear competent power reinstatement policies, which necessarily embrace a well-organized load prioritization elucidation that takes into consideration distinct real-world dynamics that styles the progression of load prioritization a convoluted and thought-provoking issue. A active load prioritization approach for agencies offering distribution of electric energy as well as the final users of those services has been realized under a confined environment. This scheme was able to give priority based ranks with respect to their demands from user end along with different situations like infant-care, patient-care, working-at-home and other basic requirements; thus every user gets their own normalized rank at DS level and also each appliance/room connected has been marked its priority. Circuit breakers can take care of the switching on/off while of course all of the final weightages will have influence of time, temperature and luminance of natural light serving as inputs to load prioritization.

6. Future Scope

A more attractive explanation would be possible if temperature sensors, dark-light sensors, motion sensors and live time updates could be integrated to the smart meters at both ends.

7. Acknowledgement

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Author Profile

Ahla A (DOB – 23/11/1990) received the **BTech** in **Electrical & Electronics Engineering** from **SNGCET, Korom** under **Kannur University**. Worked as **Embedded Programmer** for 5 years. Currently, doing **MTech** in **Electrical & Electronics Engineering** from **Al-Ameen Engineering College, Kulappully** under **KTU**. Being a final semester scholar of MTech, completed the paper on **“Load Prioritization with Suspicion Assessment Based Inspection [SAI] Algorithm”**. Hope to enter teaching sector after the successful completion of PG, as it was always a passion to teach and learn.