

# Smart Grid and Smart Home

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**Abstract-** The modern world aims at a clean energy production and consumption outlook. Efficiency can be treated as the foremost priority for all industries and households.<sup>[1]</sup> The ever increasing consumption of fuels has pressurized the society to undertake a paradigm shift into more efficient means of energy consumption.<sup>[2]</sup> This is further enhanced by the establishment of strict guidelines and rules enforced by the Government and International Agencies. To decrease the load that conventional fuels like petrol, diesel and other fossil fuels are facing in the modern day, renewable sources have been much emphasized upon in recent times.<sup>[3]</sup> Fluorescent lamps have been supplanted by LED lamps, Conventional fan motors have been supplanted by Brushless DC Motors, conventional refrigerants have been supplanted by better ones, all of which aim at enhancing allover efficiency.<sup>[4]</sup> A smart home is one that uses energy efficiently and conserves most of it, thus, the objective of this technology is to ensure better living standards, and cut down electricity consumption in a smart way.<sup>[5]</sup> A smart home comprises of a number of smart devices whose working can be controlled remotely and can themselves sense the presence of a resident and turn them off when not in use, thereby conserving energy.<sup>[6]</sup> Thus, it can be said that smart homes are the future of the modern scenario.

**Keywords-** Smart Home, Smart Devices, IoT, Network, Cisco Packet Tracer, MatLab Simulink, Model.

## I. INTRODUCTION

'Internet of things', also known as, internet of objects refers to a network of daily objects which most often are named smart objects. These smart objects are devices in the technology domain.<sup>[7]</sup>

With a reliable internet connection between the devices, their operation becomes very convenient.<sup>[8]</sup> A smart device is one that can be controlled wirelessly through Smartphones, Tablets or Laptops.<sup>[9]</sup>

A smart home comprises of a number of small devices. The smart devices may be smart fans, smart lights, smart televisions, smart Air Conditioners etc. These appliances can be controlled even when the user is not at home as the devices are connected to the internet.<sup>[10]</sup> As a result, this Paradigm shift has enhanced energy conservation because any appliance in the smart home can be remotely switched on and off.<sup>[11]</sup>

The main advantage of such systems is they are smart enough to sense the presence of a person in the house<sup>[12]</sup> and can even sometimes control the appliances without manual input. Such systems are totally automatic and switch themselves off when they are not needed<sup>[13]</sup> or even when the user has forgotten to turn them off.

## II. SYSTEM DESCRIPTION

Cisco Packet Tracer: A smart home with 2 rooms was designed viz. a Dining and a Living room. The Living Room has a Smart light, a Smart fan, a Smart window and a Smart AC. The Dining Room has a Smart light and a Smart AC. A Home Gateway Server was set up and connected with the smart devices in the rooms wirelessly. A Smartphone was then introduced in the system and connected to the Home Gateway Server wirelessly. Fig 1 depicts the aforesaid system in Cisco Packet Tracer. Also it is noted that no device is working now as they are all switched off by default.

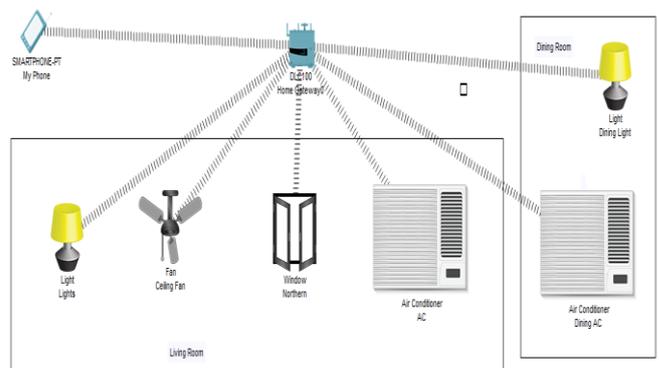


Fig 1: A smart home designed and simulated on 'Cisco Packet Tracer'

MatLab Simulink: A Smart Curtain System was designed that remains closed during the day from 10:00 am in the morning to 04:00 pm in the evening and during the rest of the day, it closes only when it detects light outside. Light has been analogized as a triangular signal where the positive half cycle represents the presence of outside light and the negative half cycle represents darkness. Fig 2 depicts the design of the smart curtain system. The System consists of 4 logic gates: 2 AND gates and one OR and NOT gate each. The triangular function generator acts as the source of light. The relay works only when it detects light. Also, a Clock is used that keeps track of the time of the day. The instantaneous time is compared with the constant times : 10 (10:00 am) and 16 (04:00 pm), the system works accordingly.

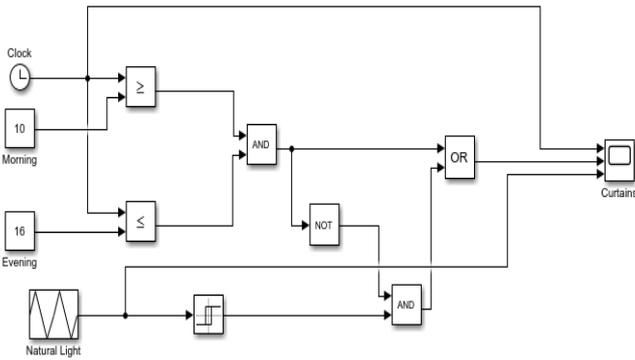


Fig 2: A smart Curtain System designed on MatLab Simulink

### III. EXISTING METHODOLOGY

Existing systems comprised of devices that consumed a lot of electrical energy and produced a lot of heat due to inefficient conversion. Such systems comprised of devices like incandescent lights (Edison’s Bulb), inefficient fans (Brushed DC Motors) (Construction of such motors is given in Fig 5), CRT Televisions.

### IV. DISADVANTAGES OF EXISTING SYSTEM

- Incandescent bulbs were extremely inefficient. They produced only 14 Lumens per Watt.
- Brushed DC Motors were also very inefficient as most of the power was lost as heat during commutation process.
- CRT televisions used high DC voltage, which was required to excite the electrodes to emit electrons.
- DC transmission was practised. This was ineffective as high  $I^2R$  losses was more as low transmission voltage resulted in high current.
- DC Transmission lines causes interference in devices that utilizes of electromagnetic waves to work, like radio waves.

### V. CURRENT METHODOLOGY

Current systems on the other hand use fairly efficient devices like Incandescent Lamps, Induction motors in fans (Construction of such motors is given in Fig 5), LCD Televisions etc. The use of such devices have reduced energy consumption a lot. Introduction to HVAC power transmission reduced  $I^2R$  power losses due as high voltages means lesser current through lines. An advantage of HVAC was that AC power levels can be very easily altered with the use of Transformers in lines. Another advantage is the presence of three phases in transmission. Phases contribute greater voltages when appliances are connected between two phases instead of one phase and neutral

### VI. DISADVANTAGES OF CURRENT METHODOLOGY

- Fluorescent lamps are fairly efficient. They produce 62 Lumens per Watt.
- Induction motors, in spite of being more efficient than Brushed DC Motors as friction losses are reduced, have their efficiency limited to 85%.
- LCD Televisions are more efficient than CRT Televisions.
- Power losses occur due to phenomena like Skin Effect and Corona. Skin Effect is the phenomena that leads to loss in conduction as current flows near the periphery or surface of the conductor, i.e., current conduction is non-uniform throughout the cross-section. Fig 3 depicts skin effect in AC conductors. Corona is the unwanted ionization of air molecules around the conductor.

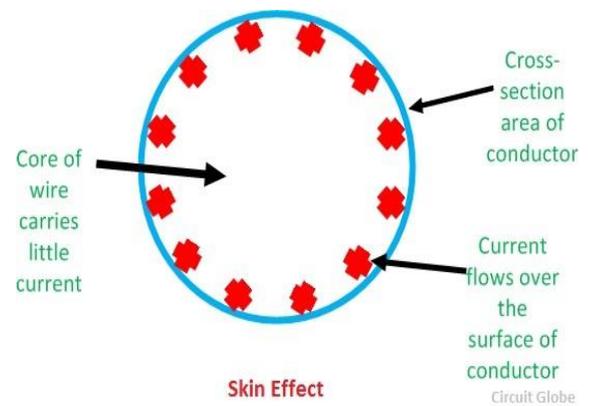


Fig 3: Skin Effect <sup>[19]</sup>

### VII. PROPOSED METHODOLOGY

The proposed system will use HVDC for transmission. It will use smart devices that will monitor the entire system. Future homes will be powered by yet more efficient technologies like LED lamps, Brushless DC Motor (BLDC) fans and LED Televisions. Conventional appliances will be replaced with smart ones. Such devices can be wirelessly controlled by the user even from outside the home. These appliances will sense the presence of a resident and will thereby automatically turn themselves on and off accordingly. This will prevent unwanted exploitation of electricity. Smart Home Security systems will be installed in such homes. These systems will be able to differentiate between residents and burglars and will act accordingly. Artificial Intelligence will collect realtime data like sleep cycle, physical activities etc. of the resident and will change the conditions of the system automatically. Machine Learning will eventually reduce the response time of such systems. Future transmission will be based on HVDC as it is the most efficient for transmission.

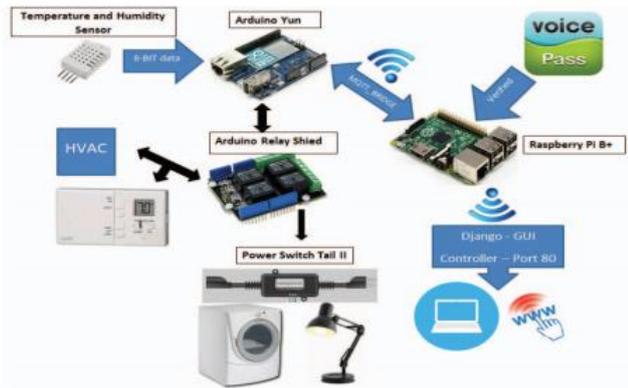


Fig 4: Block Diagram of a typical smart home with smart appliances [20]

VIII. ADVANTAGES OF PROPOSED SYSTEM

- LEDs have an average life of 25000 hours compared to 1000 hours of incandescent lamps and 10000 hours of fluorescent lamps.
- BLDC motors are more productive and efficient than Brushed DC Motors as they lack friction due to brushes, i.e, they produce more mechanical energy from electrical energy.
- LED Televisions consume less electricity than LCD as each pixel can adjust itself independently to the requirements. For example, each independent LED in such display panels can turn themselves off even when neighbouring LEDs are turned on. LED panels are less harmful for the eyes than conventional CRT displays.
- I<sup>2</sup>R losses are minimized due to high voltage levels. Also other losses like Skin Effect and Corona are absent.
- Unwanted harmonics that may occur in AC transmission is prevented, making it more desirable.
- Cost of wiring is reduced as only one line (Live) is needed. Neutral may be connected to ground.
- In DC transmission, synchronism is not a factor as there is no frequency component in transmission, for example, a grid operating at 50Hz AC can be connected with one operating at 60Hz.

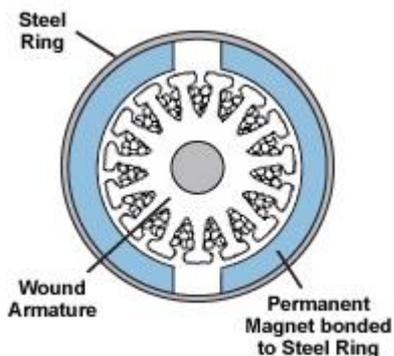


Fig 5: Construction of Brushed Motor [21]

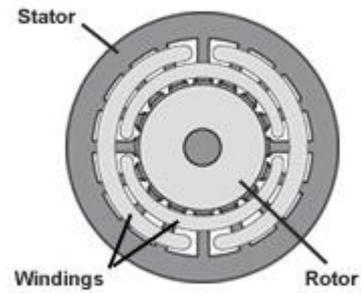


Fig 6: Construction of Induction Motor [21]

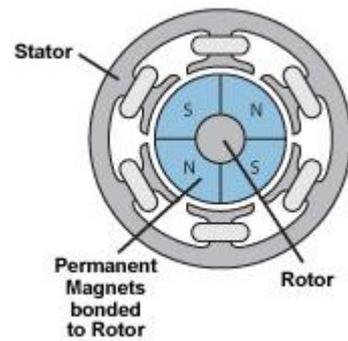


Fig 7: Construction of Brushless DC (BLDC) Motor [21]

IX. RESULT

The aforesaid smart systems were designed and simulated. The Smart Home was designed and simulated using Cisco Packet Tracer and the Smart Curtain System was designed and implemented using Matlab Simulink. The results are as follows.

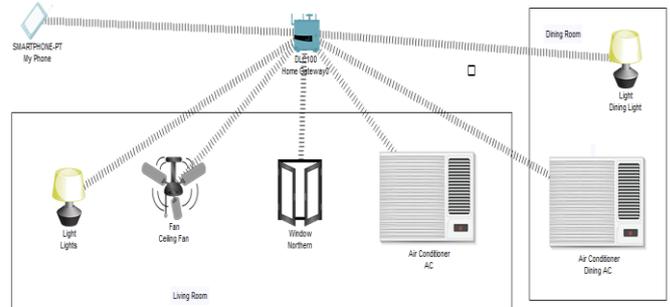


Fig 8: Result of Cisco Packet tracer

Cisco Packet Tracer: Note that all the devices are switched on using the Smartphone.

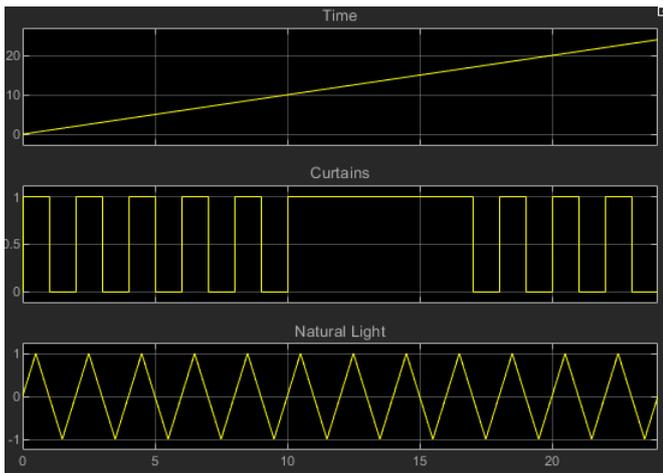


Fig 9: Result of MatLab Simulink Simulation

#### MatLab Simulink:

- The first graph denotes the passage of time.
- The second graph denotes the status of the curtains. Positive amplitude denotes that the curtains are closed and negative amplitude denotes that the curtains are open.
- The third graph denotes the natural light. Positive half denotes presence of light and negative half denotes its absence.

### X. CONCLUSION

Internet Of Things has reformed data and media transmission innovations and brought the likelihood of brilliant network and keen home advancements. We are still in the beginning periods of smart network advancement, and to date, a lot of it has been created along vertical applications. In any case, as IoT propels, the utilization cases for shrewd gadgets and applications will expand. As they do, urban areas and its natives will profit by arrangements that fill different needs of today's world. This paper addresses how IoT is being utilized in HVDC frameworks which decreases the loses in a framework and modifies itself to give a brilliant home answer for our life. At present, Indonesia is in the advancement of keen framework and Indonesian Agency for The Assessment and Application of Technology (BPPT) said that before 2025, brilliant lattice innovation could be executed in any event half to help the presence of smart cities with smart home. The use of IoT reduces energy consumption and loses, although many more challenges has to be faced before we get to a situation where only smart home techniques are used in our day to day life.

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