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Application Of Phasor Measurement Units And Internet Of Things For Real Time Monitoring Of Smart Grid Using 3d Imagery

Rizwan[1], Sona Subair, J Sanjeev, Durga M.S
[1](*Electrical and Electronics Engineering,TKM College of Engineering ,India)*

Abstract: *Smart grid is the future of power grids which reinvents the system of transmission of electrical power, incorporating optimal management of the distribution of electricity and data on the electricity grid . In this form of power grid, two way passing of information and power is made possible, enabling transmission of decentralized renewable energies produced and communicating equipments like a proposed smart meter through the application of Internet Of Things (IOT). These will lead to sustainable consumption of energy and it can be monitored by the users who can limit wastage of energy and the utility to better understand the energy consumption of users. Using Wireless Sensor Networks (WSN) integrated with phasor measurement units (PMUs) can also enable better data and information exchange through the grid. This paper also discusses the possibility of simulation software using 3D imagery which can be used to create a system which can draw quick comparison between damaged and normal lines, which can be used to recognize problems and failures on the power grid and the utility can quickly determine the problem and take necessary rectification actions efficiently and quickly, reducing delays.*
Keywords: *About five key words in alphabetical order, separated by comma*

I. Introduction

In recent times, electricity consumption has increased alarmingly. The electricity production modes have also changed for the good by the development of non conventional and renewable sources of energies. But the complete utilization of this energy resources and optimal consumption of energy requires the electrical system to evolve towards greater efficiency and flexibility and achieve the balance between consumption and production in a changing energy scenario.The smart grid is the solution to this in order to guarantee a sustainable and reliable supply of electricity. The topology of power grid system can be changed to a more decentralized one, where renewable sources of energy produced at certain areas can be accommodated to transmission lines to supply energy elsewhere. The application of the Internet of Things to the power grid system makes the system smart by providing information related to energy consumption to consumers and power utility providers. This has brought the possibility of implementing a smart meter which could send the consumer energy usage data every day to both the consumer and the utility provider to light. This will enable the users to limit their energy consumption and check the cost of energy consumed real time with respect to units of power used and ensure low expense for power use. The utility end receiving the data and information can implement power saving methods such as load shedding with efficiency . PMUs integrated with WSN can enable us to get detailed data information from the grid which can be sent to a cloud server. The data being sent real time into the cloud enables real time monitoring of the grid which will help us to further study the grid, predict faults and defects, correct the necessary faults and more in real time .Furthermore, need of load energy for futuristic needs like charging of electric cars can be accommodated in a smart grid as renewable sources of energy are also integrated into the power transmission system. The smart grid can be made further reliable if the response time of utilities in rectifying failures and problems in the grid without delay and more efficiently. The physical destruction of lines and the system of the grid by falling of trees or such accidents takes a lot of work to be rectified and this can be solved by implementing a 3D model simulation software of the smart grid which interacts with the data from the cloud server which receives real time information from PMUs and sensors applied to junctions of the grid . This enables real-time comparison of the smart grid and detect exact reasons for failures and results in accurate decision making on rectification processes and diminishes the chances of delays.

II. IOT and Smart Grid

It is well known that the residential sector accounts for a big amount of of India's energy use and produces almost quarter of our energy related CO2 emissions. Realisation of smart grids and application of IOT will provide smart ways for us to heat and light our homes and use appliances, that could cost us less personally and help us all play our part in meeting our climate change obligations. The long term target has to be zeroenergy homes and in this study we suggest a few applications of IOT for the same. A simple way of converting existing power meters at houses could be adopted to create a smart meter that can efficiently give data consumption related information to both utility and the consumer which can provide huge leaps in energy saving and cost efficiency of power consumption.Usage of various sensors that connect things to cloud for data sharing and use is the sole heart of the application of IOT to any system and we suggest the use and application of Wireless Sensor Network to the grid which will enable real time data monitoring for the grid and automation techniques are discussed in this study that can be followed for smart efficiency of energy.

III. Real Time Data Monitoring

a. Smart meter using Arduino microcontroller

An existing electricity meter can be easily converted to a smart meter by using an arduino microcontroller. data can be sent to a cloud for data storage using a wifi module.The meter is interfaced with microcontroller through the pulse that is always blinked on the meter. Further that pulse is calculated as per its blinking period.This is the principle that is used and number of pulses for a unit can be calculated and later the cost of units can be calculated by multiplying the total units consumed. The equation used is mentioned as equation 1. Using such a smart meter will help both the utility and the consumer and and information regarding electricity units consumed and cost of consumption is viewed easily by both ends by using a simple web app to the data send to the cloud server by the wifi module connected to the microcontroller. Block diagram in figure 1 was used to obtain energy data from the meter and was sent to the cloud server.

b. Application of PMUs integrated to WSN system

A potential game changing smart grid concept is the notion that the distinction between electrical transmission and distribution will blurby the use of non conventional sources of energy production and feeder systems integrated to the grid which is more flexible and controllable, and as power is fed back into the grid from distributed generation and storage assets, making distribution systems two-way. A problem to tackle is, as the amount of electricity from renewable energy sources from decentralised generators grow over the years, the network operators will face significant challenges because the power being fed in is not continuously supplied. External conditions become critical factors for network utilisation and the low-voltage level is not designed for these kinds of massive fluctuations, which can cause voltage range violations and overloads. The proposed system can serve to provide the right solution for these problems.WSN applied into the grid can be customized to control the process of information exchange between the Distribution Operations Center (DOCs) and the grid. Devices can be integrated with power grid protection and measurement devices such as the suggested smart meter allowing the reliable exchange of field information in real time.Adapting transformer stations and lines to the new load situation is not advisable as the peaks in the energy network occur briefly. Smart grid control is preferred for this reason. It relies on continuous monitoring of the low-voltage level using data from the WSN. The data thus obtained can be analysed to prevents overload situations and enable the integration of future network components. A WSN can generally be described as a network of nodes that connect end to ends, enabling interaction between a applied system and the environment. In fact, the activity of sensing, processing, and communication with a limited amount of energy, ignites a cross-layer design approach typically requiring the joint consideration of distributed signal/data processing.

Integrating PMUs to this WSN system can be the real fix to transform the existing grid system into the futuristic smart grid. A phasor measurement unit measures the electrical waves on an electricity grid using a common time source for synchronization. Time synchronization allows synchronized real-time measurements. Monitoring and control scheme thus obtained can achieve the ability detect local problems before these spread through the whole system and take necessary precautions and actions. Measurements of PMUs can provide information for power system operators and regional reliability coordinators. Using PMUs we can gain the ability of the system to maintain voltage magnitudes within operating limits Voltage instability is lack of reactive power support to a load pocket with a high reactive demand. Using this method and PMU measurements, a wide-area voltage stability monitoring system which continuously monitors real-time voltage stability margin can be adopted. Following are the other significant outcomes of the use of PMUs -

1.Islanding Detection- Islanding refers to powering of a location by a distributed generator even though electrical power from utility is absent. Voltage is measured and time stamped before being sent to receiver and thus can be checked for faults and losses.

2.Line Thermal Monitoring-Temperature is monitored for power flow control as change in temperature can be directly linked to losses. Voltage and current phasors measured at both ends of a line are collected using PMUs with relation to temperatures.

All the data thus obtained through the smart energy meter using application of IOT and the data from the PMU integrated into the WSN are sent to a common cloud server which have real time data information of all regions and junctions of the entire smart grid. The block diagram in figure 2 is the proposed integration of PMUs to WSN for sending real time grid information data to the cloud server.

IV. Indentations and Equations

Equation 1 : Pulse= (Pulse rate of Meter* watt * 60) / (1000 * 3600)

V. Figures

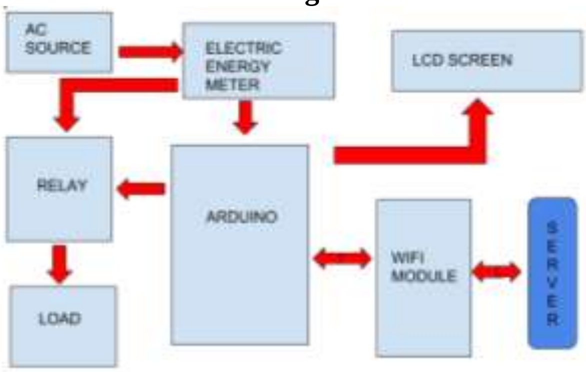

Fig.1 - Operational Block Diagram Of Smart Meter

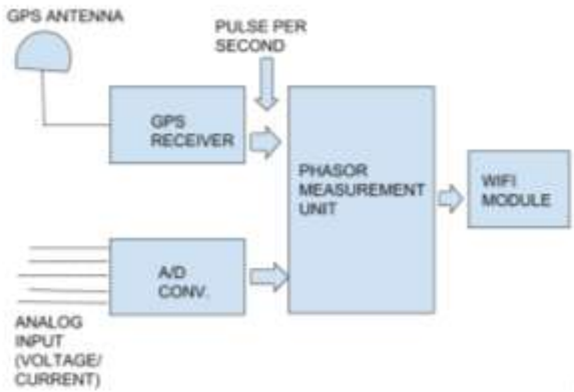

Fig.2 - Operational block diagram of PMU with wifi module to connect to WSN

VI. Conclusion

The innovation we wish to bring out through this study is the application of 3D imagery to build a simulation software that communicate with the actual smart grid in real time through the suggested cloud data obtained through the application of WSN in the grid. The appearance of powerful tools for interactive visualization of smart grids in computer vision was one of the driving forces motivating the effort for 3D imagery. Since one of the most important applications of virtual smart grid models is the generation of realistic visualizations, a proper representation of geometry and texture has to be provided. If aerial images are used for geometric data capture, the texture for each surface is already available as a by-product. In each case, the exterior orientation of the imagery is either already available or can be determined easily by standard software. One of the most promising applications of 3D models is their integration for real time data analysis. Context dependent information is fitted to the real objects being viewed and presented to the user. In addition to the further improvement and automation of algorithms for the capture smart grid models, the development and promotion of new applications becomes of growing importance. Thus the development of appropriate tools will be one of our research goals in the near future. The model thus built will enable to provide the utility real time data as it is interconnected to the data from the cloud server the WSN data is sent to. The data from the system can be compared to the 3D imagery of the grid and can be used to find the exact location and type of power failures and faults in the system, making rectification processes from utility quick and efficient. In the current system , power failures due to physical destruction of power lines caused by reasons like weather conditions and falling of trees take long time delay in identification of the spot of fault and the rectification process to be started as the utility have to send a team of man force to the site of fault to locate and identify the fault and then decide the rectification process needed and implement them . The proposed model will help in identification of the location and type of float from the comparison drawn with the 3D model and the data from the sensors of the smart grid and thus enable quick and efficient rectification of the faults and failures.

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