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Smart Grid Implementation Using Internet of Things

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Abstract— In today's world due to availability of miniaturized highly efficient embedded devices and due to improvement in data handling, processing capabilities and further due to improved data communication capabilities there is explosion of the Internet of thing applications ranging from home automation, Health care service, Public securities Industrial automation to other important domains. This paper explains the applications, challenges and scope of Internet of things technology in implementing smart grid. This paper will open issues pertaining to development, implementation and operation smart grid using Internet of Things.
Keywords— Smart Grid, Internet of things(IOT), Smart meter.

1. INTRODUCTION

In technology using Internet of Things many smart devices are interconnected using internet to communicate with each other so as to perform a real time application. Devices are smart in the sense that they are equipped with embedded technology to interface either with sensors or controllers and can communicate with each other through high speed internet without human intervention [1-2]. Central Processing Unit is considered the heart any IOT based system. It is CPU which is concerned with managing all interfaces among sensors and controllers and taking appropriate decision as per the algorithm. The most severe requirement in IOT system is identification of various devices. Every device in IOT should be uniquely identifiable so as to obtain an efficient and optimized system [3-4]. A complete IOT system is basically convergence of two technologies i.e. operational Technology and information technology. Operational technology includes various smart devices interfaced by sensors and controllers. Operational technology is used to sense the desired physical changes through sensors, convert the collected information from sensors in to form compatible for transmission and convert the received information into form recognizable by controllers using smart devices equipped with embedded technology [5]. Information technology on the other hand is concerned with handling all the process on data like storing the date, efficient transmission and reception of data, encoding and decoding the data for security purpose. Data transmission rate and energy requirements to transmit data are the two important factors which must be considered for efficient IOT system. In IOT systems convergence of two technologies i.e Operational technology and information technology is achieved in such a way to avoid human intervention. Human intervention is avoided to improve the reliability of the system so as to get rid of human errors.

Implementation of smart grid (SG) is the first requirement of fulfilling the dream of smart city. Smart grid is basically concerned with generation and distribution of electricity under controlled and monitored environment [6-8]. Smart grid is based on communication between various sensors and controllers supported by IOT technology. By using smart meters in houses which are connected through IOT consumer can view their daily energy consumption or even can limit their daily energy consumption. Demand of electricity does not remain uniform throughout the year. By using SG owner can control the generated energy as per the requirements. By using suitable analytic techniques owner can search the area of distribution losses in form of theft and can control distribution losses of energy. Smart Grid can detect any tempering with smart meter which will come into the knowledge of owner and consumer for their further action. Even by using appropriate sensors and controllers the near future requirement of electricity can be estimated and generation of electricity can be planned accordingly. Due to continuous improvement in technology of achieving smart sensors and controllers, miniaturized embedded devices, large and reliable data handling capability and due to improved communication network available smart grid implementation can be considered as the biggest application of IOT. A large number of architecture are available for implementing Smart Grid using IOT [9-11]. In this work various design issues related to implementation of smart grid using IOT is presented. First section explains the introduction to IOT and its application in achieving smart grid. Section 2 describes the proposed design for implementing smart grid. Section 3 explains the challenges and opportunities in implementing smart grid using IOT. Section 4 explains the conclusion. References are presented in section 5.

2. DESIGN OF SMART GRID

The proposed design of SG is presented in Fig(1).

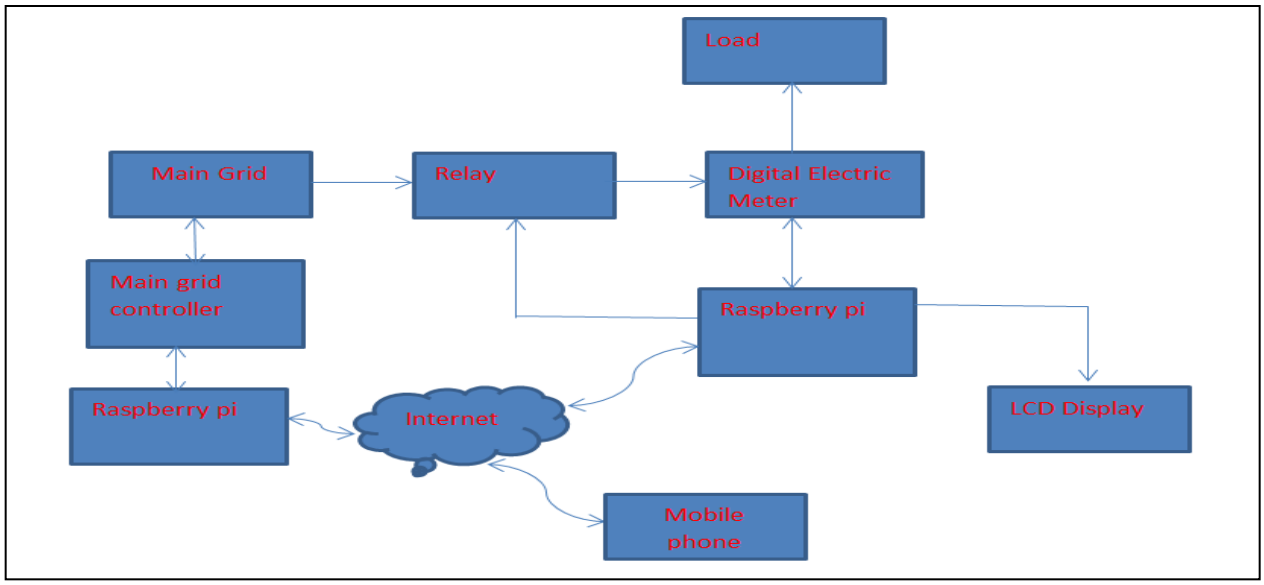

Fig (1) Smart Grid

Implementation of smart grid requires installation of smart digital electric meter in house of consumer. Meter is smart in the sense that it is interfaced with a central processing unit through sensors. Interfacing is required for exchanging of data between meter and CPU. Smart meters are fitted with LED so generally a photo detector is used for the purpose of interfacing between meter and CPU.

Device that is used as CPU is either Arduino or raspberry pi. The main difference between arduino and Raspberry pi lies in the construction and operations that can be performed by two. Arduino is just a motherboard of microcontroller. Memory, Wifi module need to be connected with Arduino for its operation. However Raspberry pi is a minicomputer with supported devices in addition to microcontroller board. It uses Linux operating system for its operation. As Raspberry pi can handle multiple tasks at a time as compared to Arduino. After exchanging the reading of meter between Raspberry pi and electric meter it is processed by Raspberry pi for further analysis as per the requirements of applications. One application can be to display the meter reading in LCD display. Other application can be send the reading of meter on mobile phone by using the WiFi module of Raspberry pi. Mobile phone can send the control signals to WiFi module of Raspberry pi for to control the working of meter through some relay. Monitoring and analysis of meter can also be also be performed by a processing unit installed on the owner side. It is achieved by installing another Raspberry pi processor which is connected to Raspberry pi processor at consumer side through internet. Control signals can be generated by either consumer or by owner to monitor and control the working of meter. Further more mini grid can be designed in houses as well for remotely controlling various household devices.

3. CHALLENGES AND OPPORTUNITIES IN IMPLEMENTING SMART GRID USING IOT

It is very common situation that whenever a new technology is implemented various sorts of problems are to be encountered by the society. It brings various challenges for its implementation . If society is able to meet the challenges technology will survive otherwise it will be obsolete.

Various challenges and opportunities to implement smart grid using IOT are as follows.

1. Technical and economical framework: Today most of the grid system implementation involves analog system. In order for the implementation of smart grid it is required to switch over to digital domain. Conversion from analog domain to digital domain requires a lot of technical framework in terms of compatibility with existing system, technical specifications of digital domain systems and procedures involved in implementing smart grid and last but not the least regarding the feasibility of the system. The challenges can be met by professionals who have proficiency in field of networking, embedded technology and power generation and distribution techniques. Economical frame work requires the estimation and arranging funds for implementation of smart grid. Economical frame work must include the cost of new equipments, expenses involved in installing smart grid and expenses involved towards professionals. So it provides an opportunity to large group of society.

2. Internet availability: Most of the devices in smart grid need to communicate with each other. In order for reliable and uninterrupted communication high speed and dedicated internet connectivity is required. Most of the remote places have not the accessibility of internet in absence of which smart grid implementation is not possible. Providing internet at remote places is another challenging and opportunistic work related with implementation of smart grid.

3. Miniaturized embedded devices: Complete smart grid operation is basically dependent on the availability of embedded devices. Functionality of smart grid is dependent on the sensors, controllers and used processing units. Bulky size of these devices defeat the purpose of installing these devices. Technology need to be enhanced to provide miniaturized embedded devices.
4. Data management: Smart grid is implanted using digital techniques which generate a lot of digital data. Big data handling is another issue for reliable and secure implementation of smart grid. Professional having proficiency in handling big data are required for this purpose.

5. Communication networking and wireless sensor networking: In IOT based system sensors and controllers are installed at various locations ranging from within house to various distant places. Theses sensors or controllers are connected either through wired network or through wireless networks. Appropriate networking scheme depending upon the power to be transmitted, processing capabilities, data transmission rate and volume of data to be transmitted is required to be adopted. Compatibility with different protocols for communication networking and wireless sensor technology is big challenge while implementing smart grid using IOT.

6. Skilled professionals: As IOT technology is in growing stage so it is very difficult to find professionals who are acquainted with complete of installing smart grid. It is an opportunity for professionals to be acquainted with networking, embedded system design, power generation and distribution technologies for implementing smart grid.

7. Hackers: In IOT many devices are interconnected using digital domain. Personnel data can be hacked by unauthorized persons which may be cause of some mishappening. For example burger can check the availability of owner in house by hacking his electricity consumption. So developing secure algorithms for IOT based system is an challenge.

8. Addressing Techniques: As millions of devices need to be connected through internet in IOT technology address of each device need to be unique for its reorganization. Managing address of millions of devices is another challenge that need to be addressed.

9. Compatibility with existing system: It is neither possible nor achievable to completely replace the existing grid with smart grid. So SG implemented using IOT should be compatible with existing system.

4. CONCLUSION

Smart grid implementation is definitely advantageous from the view point of consumer and owner. Both consumer and owner have the capability to monitor and control the utilization of energy which makes the system transparent. However various challenges in terms of internet connectivity, big data handling capacity, compatible system design, skilled professional, secure and user friendly system acceptable to society should be kept in mind while implementing smart grid.

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