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Smart Control for Power Grid Operations

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ABSTRACT

Electricity, being a very necessary part of life, is found being distributed over almost every part of our country. This distribution of electricity take place over a 'grid' known as the power grid, which maps each and every power line, and distribution unit, right from the generating station to each and every electric pole. This grid therefore is nothing but a mesh reflecting the distribution of power over every area. To control such a grid is a tedious job.

So we planned to develop a solution for these processes by placing all control at centralized server. Here we can control an entire power grid, i.e. the entire power system of a city by one central computer server. We can switch the power supply to any area of the city ON or OFF with the click of a button. Also, we can divert power to any area from another source. Such a system resembles power control systems where the entire power system is computer controlled. If implemented, functions like fault detection, performing load-shedding of any area, data logging and retrieval, power diversion during major faults can be performed from one central server only.

1. INTRODUCTION

In the 21st century the power and energy industry is going through an evolutionary period. New developing technologies are changing the way we generate, transmit and deliver electric power.

The electric power industry has many new power grid applications in the forefront. The concept referred to as Smart grid control system, combines and makes use of state of the art technologies from the areas of network communications, power electronics and control systems [1].

For the distribution grid, the most important problem is how to deliver power to serve the end users better. However, as many distributed generators will be integrated into the smart distributed grid, this, on one hand, will increase the system flexibility for power generation, and on the other hand, also makes the power flow control much more complicated, in turn, necessitating the investigation of smarter power distribution and delivery mechanisms. A smart grid (SG), also called smart electrical/power grid, intelligent grid, intelligent grid, future grid, integrid, intragrid an enhancement of the 20th century power grid. The traditional power grids are generally used to carry power from a few central generators to a large number of users or customers. In contrast, the SG uses two-way flows of electricity and information to create an automated and distributed advanced energy delivery network.

Smart grid is the primary driver in providing more reliable and cost-efficient electrical power while conserving energy resources in today's digital world. The Smart Grid is a way to address an aging energy infrastructure that needs to be upgraded or replaced. The concept of Smart Grid is based on the integration of the electric grid, communication network and data acquisition technologies to monitor and control the generation, distribution, storage and consumption of electrical power. Computerized wireless power grid control system deals with the control of an entire power grid, i.e. the entire power system of a city for e.g., by one central computer server. Controlling here would mean the switching, distribution, diversion of electricity over the power lines. Switching is the process of turning supply of power to part of the grid (say an area) ON or OFF. This is often required during maintenance work as well as while repairing faults. All such activity viz. switching, diversion require mechanical switching of these lines and switches, i.e. a person would have to manually switch power on or off using huge mechanical switches. Moreover, diverting power would require a lot of switching over various two-way switches, and this is certainly not a feasible method to undertake every time such a need occurs.

We can switch the power supply to any area of the city ON or OFF with the click of a button. Also, we can divert power to any area from another source. Here the server communicates with all node stations wirelessly. It uses Intel 8051 microcontroller and also there is software that runs on pc which is written in 'Visual basic 6.0'.

Here we are using 8051 microcontroller. The Intel 8051 is an 8-bit microcontroller which means that most available operations are limited to 8 bits. There are 3 basic "sizes" of the 8051: Short, Standard, and Extended. The Short and Standard chips are often available in DIP (dual in-line package) form, but the Extended 8051 models often have a different form factor, and are not "drop-in compatible". All these things are called 8051 because they can all be programmed using 8051 assembly language, and they all share certain features. A relay is an electrically operated switch. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC

mains circuit. There is no electrical connection inside the relay between the two circuits, the link is magnetic and mechanical.

2. EXISTING SYSTEM

Power travels from the power plant to your house through an amazing system called the *power distribution grid*. The grid is quite public -- if you live in a suburban or rural area, chances are it is right out in the open for all to see. It is so public, in fact, that you probably don't even notice it anymore.

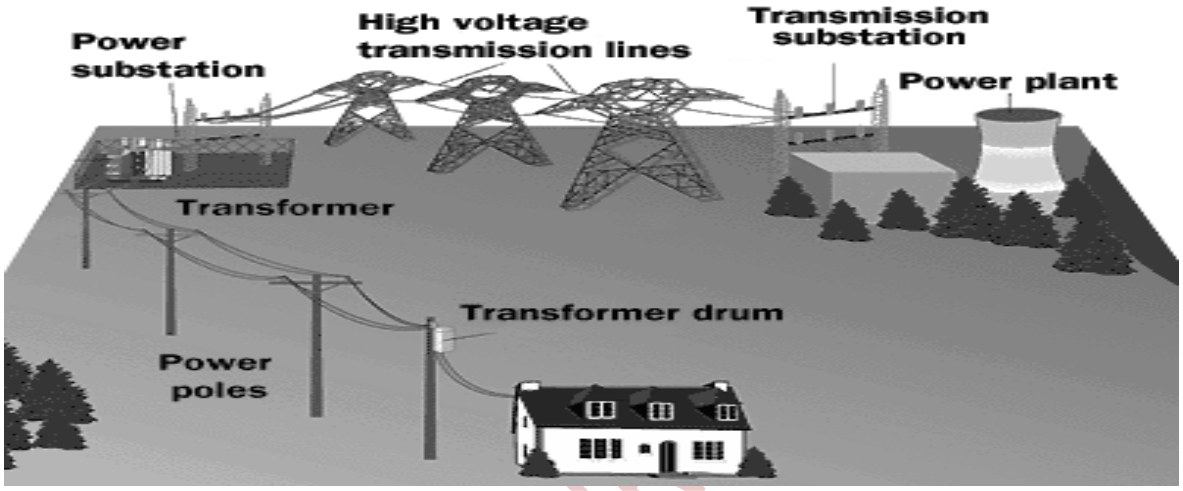

Fig 1: Existing Power Grid System

Your brain likely ignores all of the power lines because it has seen them so often. The three-phase power leaves the generator and enters a transmission substation at the power plant. This substation uses large transformers to convert the generator's voltage (which is at the thousands of volts level) up to extremely high voltages for long-distance transmission on the transmission grid. There are three-wire towers leaving the substation. Typical voltages for long distance transmission are in the range of 155,000 to 765,000 volts in order to reduce line losses. A typical maximum transmission distance is microcontroller about 300 miles (483 km). High-voltage transmission lines are quite obvious when you see them. All power towers like this have three wires for the three phases. Many towers have extra wires running along the tops of the towers. These are ground wires and are there primarily in an attempt to attract lightning.

3. PROBLEM STATEMENT

All activity viz. switching/diversion etc. require mechanical switching of the click these lines and switches, i.e. a person would have to manually switch power on or off using huge mechanical switches. Moreover, diverting power would require a lot of switching over various two-way switches, and this is certainly not a feasible method to undertake every time such a need occurs [2].

In the existing system, every task is performed manually. There are more chances of system failure since manual errors can easily happen. If the whole system is managed by one central computer, the complications will be reduced to a big extent.

Moreover, if the fault happened in any of the area, the existing system is not that much capable to overcome it immediately. Thus, the power grid helps to remove such problem & further it help to locate the specific area where fault takes place [4].

In this project, it is planned to develop a solution to automate these processes. Here one can control an entire power grid, i.e. the entire power system of a city for e.g., by one central computer server. The switch can be automated to supply power to any area of the city ON or OFF with of a button. Also, power can be diverted to any area from another source.

4. PROPOSED SYSTEM

We have seen that the existing system comes with the package of many complications and hence we have proposed a system which consists of centralized control server. Since developing a real life control system would be very expensive and unwise right now, we will be developing a prototype that demonstrates:

- Distribution
- Diversion
- Switching

Here we can control an entire power grid, i.e. the entire power system of a city for e.g., by one central computer server. We can switch the power supply to any area of the city. This can be done with the help of a button ON or OFF by clicking it. Also, we can divert power to any area from another source.The centralized server system that we plan to develop is a console based system. Node stations refer to the various stations that resemble sub stations, feeders, distribution units, transformers, etc in the power grid. Also, we are going to develop and demonstrate capabilities like fault detection, which would enable

us to view the location of any faults in the power lines, through feedback systems that communicate with our server. Also data logging, i.e. logging and communication of various parameters, like energy meter readings, and various voltage and current parameters will be performed by our device. This information will be communicated through cable to our server, and a permanent log will be generated here too for future reference.

We will be developing a Console Based Control Software for the computer in 'Embedded C'. Also, a mini GUI for most frequent functions will be provided. The microcontroller programming (the hardware programming) will be done in embedded 'C' for microcontrollers, using the standard 8051uC function Library.

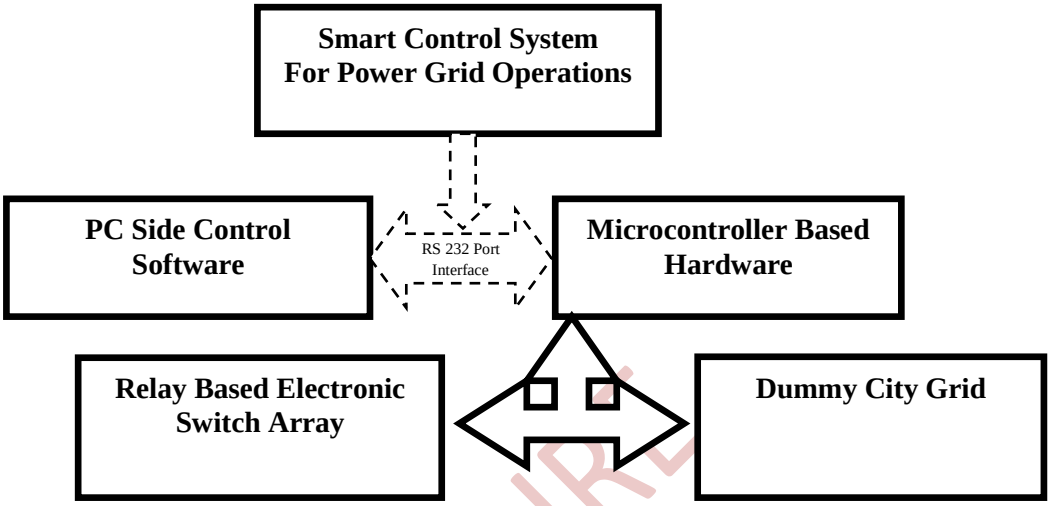

Fig 2: Control Flow of Proposed Project

Smart Grid also enables real time monitoring and control of power system as well as helps in reduction of AT&C losses, demand response and demand side management, power quality management, outage management, smart home energy system etc. Smart Grid will act as a backbone infrastructure to enable new business models like smart city, electric vehicles, smart communities apart from more resilient and efficient energy system and tariff structures[6].

Anticipated benefits and requirements of SG are the following:

i. Improving power reliability and quality.
ii. Optimizing facility utilization and averting construction of back-up (peak load) power plants.
iii. Enhancing capacity and efficiency of existing electric power networks.
iv. Improving resilience to disruption.
v. Enabling predictive maintenance and self-healing responses to system disturbances.
vi. Facilitating expanded deployment of renewable energy sources.
vii. Accommodating distributed power sources.
viii. Automating maintenance and operation.
ix. Reducing greenhouse gas emissions by enabling electric vehicles and new power sources.
x. Reducing oil consumption by reducing the need for inefficient generation during peak usage periods.
xi. Presenting opportunities to improve grid security.
xii. Enabling transition to plug-in electric vehicles and new energy storage options.
xiii. Increasing consumer choice.
xiv. Enabling new products, services, and markets.

5. CONCLUSION

We can control an entire power grid, i.e. the entire power system of a city for e.g., by one central computer server. We can switch the power supply to any area of the city ON or OFF with the click of a button.
We can divert power to any area from another source. We are implementing functions like fault detection, performing load-shedding of any area, data logging and retrieval, power diversion during major faults, etc performed from one central server only [5].
There is no need of manual switching of power lines. Logging of various parameters related to power transmission can be performed.
There is centralized control of entire power grid. No need of Internet or any other such network for the purpose of communication. It is an easy to use Interface.

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