Integrating Local Environmental Conditions In An Engineering Program Towards Globalization

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Abstract

Technological advancements in the present age have assumed such proportions that all activities are being driven by technology in one form or another. Such is the case in this information age where it can be considered that effective dissemination of information can accelerate the learning process and therefore the choice of technology for the dissemination has some importance.

On a national scale, the target group may be in urban or rural areas, or in both urban and rural areas. At the present, the choice of technology for this purpose is the Internet. This is because it combines the speed of transmitting information and the multi-tasking functionality of computers hence different sources of information can be accessed quickly. Computers also provide access to a vast resource of educational materials. The added advantage of having global connectivity will enable the user in a developing nation to access developmental information from other nations. To people in developing countries like Ghana, the process will improve the knowledge base of Ghanaians, and hence the country's developmental progress.

Dissemination of information may be a problem even in urban areas in a third world country such as Ghana. It is therefore needful to find a means of communication that is effective as well as relatively inexpensive that can reach people in both urban and rural areas. The technology of choice for this purpose is Broadband Powerline Communication (BPL). The BPL technology combines transmission of power and data along the power line and that makes the line behave as a traveling wave antenna. The engineers and technicians who will work on the system will need to be updated in topics that relate to the system. These are power transmission, data transmission, antenna theory, and electromagnetic radiation through the radio space. This paper discusses the cooperative effort between Penn State Wilkes-Barre and Kwame Nkrumah University of Science and Technology (KNUST) in Ghana in incorporating local environmental conditions in a telecommunications program at the baccalaureate level through a student project.

Introduction

The fact that the Internet is a ubiquitous technology makes it readily available for connectivity between any two users without regard to distance. Two areas that must be achieved to employ the Internet are skills in information communication technology (IT or ICT) and closing of the digital divide wherever it exists. These two are essential for obvious reasons. ICT is a world-wide phenomenon that provides connectivity to all parts

of the world, and hence provides access to knowledge in all areas of endeavor as for example, in the academic field or in different professions. The importance attached to ICT applications can be demonstrated by the interest that bodies such as the Federal Communications Commission, FCC[1], have shown in its use. In considering the use of computers being extended to all sectors of the population in support of closing the digital gap, Ghana intends to introduce computer studies and ICT in basic and secondary schools[2] to complement the efforts in tertiary institutions. For a third world country, the problem of digital divide cannot be overstated. While the use of computers is common in some places such as tertiary institutions and hospitals, computer applications have not assumed the proportions that render the computer as a tool as is the case in Western societies. It must be noted that the digital divide is experienced even in advanced Western nations such as the US[3,4]. A timely and appropriate action in third world countries will therefore alleviate this problem early in their development[5].

The government of Ghana has put in place, a development plan for the people of Ghana. A necessary requirement in achieving the objectives of the plan is information dissemination as stated above. The development plan is intended to be comprehensive in order to initiate solutions that are broad in scope to resolve issues that may be linked in some fashion. And it is helpful in reducing the cost of implementation in cases where the required components for implementing the ideas can have multiple applications. This was the view taken in selecting the delivery system for the information, and the system that has been decided on is the Broadband Powerline Communication (BPL). This specific application is new to Ghana hence it is necessary to consider capacity building. The cooperation between Penn State Wilkes-Barre and KNUST is to assist in this endeavor among others.

Selection of Information Delivery System

Various factors must be considered in selecting the delivery system. In many cases where the initial cost for a project is high and there is no return on investment, the project is not viewed favorably. For the BPL, data transmission is overlaid on power transmission along the power line[6]. In Ghana, a power grid is already in operation provided by Volta River Authority (VRA) and it covers both urban and rural areas. To achieve the same coverage with cable, DSL or wireless will be extremely expensive financially, and to use satellite will be equally expensive. These other applications are all in their infancy in Ghana hence the infrastructure to support any of them is not as advanced as is the national grid. Even though electrification is well established in Ghana, it is still being further improved[7].

Compared to other technologies Broadband Power Line Communication is relatively new but it is ideal for a developing country in which the national grid is uniform and is controlled by one authority. Also an existing power line infrastructure is already familiar to all the people and hence a development based on that will only be an extension of a system that the people are already used to, and they will therefore have to adapt only to the addition. This therefore eliminates the initial capital outlay for providing the supporting infrastructure for the BPL system. The initial outlay of capital for the

additional application will therefore be for the additions necessary to access the system, which will be a small percentage of what will be needed to create a new infrastructure.

Achieving the BPL Technology

Three major technologies, electrical power transmission, travelling-wave antenna, and data transmission combine to provide the selected application. The primary function of the grid is to supply power to various destinations, and this is done mostly using Medium Voltage (MV) overhead power lines in Ghana. This subject has been studied and reported on in the literature[8], so has the related area in Low Voltage (LV)[9]. Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI) are important issues[8,9] among others such as how signal is coupled to the lines and the propagation constant of the line itself.

The problem can be described as wave propagation on a transmission line[10], for which the traveling wave can be analyzed by use of the voltages and currents travelling in opposite directions on the line. Due to the finite conductivity of the line, losses will be observed in the waves that propagate along the line. The line will also radiate as well as absorb electromagnetic energy, as it behaves like an antenna. It is therefore important to evaluate the electromagnetic effects on the structure.

In transmitting data along any medium, it is essential to ensure that its integrity is not seriously impaired. All sources of electromagnetic interference can adversely impact the transmission as noise[11]. It is therefore important to assess its combined (both internal and external) effect on the transmission. As part of the external (man-made) noise, sources of electromagnetic waves such as radio and TV transmissions will be evaluated. Another form of external interference, atmospheric effects which can be significant along the equator and within the tropics, will also be evaluated. Heating effect within the system has to be considered, and in line with this, the high ambient temperature in the environment can add to the problem to be resolved.

In dealing with data, it is desirable to discuss the transmission in terms of energy waveform, and the signal as energy signal. Whereas a ratio of signal power to noise power is a useful figure of merit for analog communication, for digital communication the figure of merit is bit energy to noise power. A useful metric of performance is therefore the bit-error probability versus bit energy to noise power ratio. Trade-offs for the different parameters such as intersymbol interference (ISI) which should be zero, and the appropriate choice of pulse modulation waveform that is used for baseband transmission to yield the performance metric can be effected to achieve the desired result[11].

Local Content

The factors discussed above are not new to manufacturing or design processes. The environmental conditions and the electromagnetic radiation in the radio space can

however impact the performance of the system. These form the local content that needs to be emphasized in the curriculum as they impact the design of the BPL system.

Additive noise can be a major problem[11] in all electrical and electronic systems, and where there is a high ambient temperature as experienced in the equatorial region, particular attention must be paid to the problem of noise. Electromagnetic radiation from sources such as radio and TV transmissions in the region of the system will also contribute to the overall noise problem. Also, possible atmospheric noise may be encountered in the equatorial region and that should be evaluated. The fidelity of the received signal is a function of the type of modulation among other factors such as noise. The receiver will thus have to perform other functions such as filtering and noise suppression, and these factors can be influenced by the conditions of the equatorial region.

In addition to the analytical work that can be done, experimental work can be done in collecting data that will confirm solutions derived from analysis. One such experiment is by using an RF Analyzer to collect data on radio and TV broadcast stations in the selected area for experimentation to characterize the electromagnetic radiation presence in the radio space at the site. The magnitude of each emission will be determined and the result will be used to determine the impact of that particular source.

Another experiment is to use an earth magnetometer will also be used to determine the earth's magnetic field at the site. As stated above the intention is to determine if this will affect the transmission line in any way that will adversely affect the desired purpose of the project, this being the transmission of data on the line. While this is not anticipated, it will be useful to eliminate it as a source of problem. These will form the initial hands-on experiential component of the project. Other aspects will cover topics such as transmission rate and bit error rate.

Torrential rainfalls are prevalent in the tropics. The aspect of importance here is the level of humidity that is experienced, and what effect this will have on the equipment, and the set-up.

Sample of Student Project

The project outline presented below has been proposed and accepted to be implemented in a course in Electricity and Magnetism. It will be included in the laboratory component in the next academic year starting Fall 2008.

Measurement of the Earth's Magnetic Field Strength Around KNUST

Abstract

The effort to understand magnetism has led in part to extensive study of magnetic induction. Some of the work done in this area, which also involves electromagnetic (EM) emissions, has centered on magnetic and EM fields created through the use of technology such as in the cases of machines and antennas. The earth's magnetic field has also been studied extensively in some regions of the world. It is yet to be done to the same extent in the equatorial regions. This work is to initiate such study in Ghana.

Objective

1. Select suitable sites around UST campus.
2. Measure and record the earth's magnetic field at the selected sites.
3. Plot the magnitudes on a map.

(Note: Areas that have no or little human settlements will be chosen.)

Equipment List

Magnetometer
GPS
Surveyor's Tape
Plumb Bob
Hammer and Pegs
Rope and Paint or Marking device

Measurement Procedure

1. Search for and remove any metallic (magnetic) objects from the selected site.
2. Use the GPS to locate a point and put a peg in the ground at that point. Note the coordinates of the point.
3. Record the date, time of day and weather conditions.
4. Measure a distance of 100m from the first point and put a second peg at that point. Note the coordinate of the second point with the GPS.
5. Tie the rope to the two pegs and mark sections of 10m lengths along the rope.
6. Connect the two rods of the magnetometer together
7. Initialize the magnetometer by setting each of the three knobs to zero, and turn the Milligauss Range to the 1999.9 scale.
8. Place the white pointed end of the rod, and record the magnitude and direction.
9. Repeat steps 2 through 8 at each of the 10m marks.
10. Repeat steps 1 through 9 at each selected site, while covering as much land areas around UST as possible
11. Plot all these on a map of UST.

Presentation

Write a report on the experiment performed using the following guidelines.

Title Page: **Title of experiment, name of author and date experiment was performed.**

Introduction: **The introduction should contain a description of the technology on which the experiment is based. Also state some practical applications of it.**

Equipment: **List the components/equipment used in the experiment.**

Procedure: **Briefly describe the procedure used.**

Results: **Provide results of the experiment.**

Conclusion: **Write a conclusion for your work, discussing the results obtained. Include any observations made during the experiment.**

References: **List references used where applicable.**

The report should be written in narrative form, and in the third person.

Conclusion

The need to be involved in the global economy is driving developing nations to upgrade their technology to take advantage of the advances western nations are employing. This has led to a situation where the technicians, technologists and engineers of developing nation have to work with cutting-edge technologies. These advanced technologies were primarily developed for use in the temperate region hence their application in the equatorial region introduces the harsh environmental conditions of the equatorial region to contend with. The local conditions are therefore being highlighted in a curriculum to ensure that the engineers, technologists and technicians have adequate training to operate, service, and where possible, modify the equipment to suit local conditions.

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