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Design and Implementation of a Remote-Controlled Reliability Analysis and Energy Management System

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Abstract: The electricity distributed to any house, school, or industries comes from either Ceylon Electricity Board or Lanka Electricity Company (Pvt.) Ltd. Electricity is bought from LECO or CEB by its consumers under various criteria decided and defined by the Public Utilities Commission of Sri Lanka. These tariffs shall determine the cost to be paid for electricity by each consumer. Usually, due to faults within the consumer's electrical system within his or her property, the cost they have to pay is not actually the number of units that they consumed. This could be due to a faulty meter or even losses within the factory due to its machines. Power quality decreases due to many faults like this and also due to inductance. Therefore, they will have to pay for more than the units they actually have consumed. To overcome this, we could constantly monitor the system and bring about necessary solutions to fix it as soon as possible. However, doing this manually is tiring and requires the workers to constantly keep measuring the necessary parameters like current, voltage, power, frequency, and power factor. In almost all factories some machines will still be running idle when they actually not used. This project aims to develop an online energy monitoring system that can read data from the supply to factories and also machines and then display them on online application. This will also have the ability to notify on a phone or another app to remind someone to switch off or on any machine. Also, the project aims on carrying out a case study to have a thorough understanding of the factory Randhi International (Pvt.) Ltd., to help in deciding on what solution should be put forth to decrease power loss in any factory the user considers. These guidelines are presented as a case study and will be made into a generalized guide.

Keywords: Energy Management, Energy Monitoring, Loss Calculation

Introduction

In the modern world, demand for power systems has increased rapidly. Sri lanka is a developing country, where its demand for energy has increased at a fast pace over the past decades. Because of the cost of peak generation, electricity charge for the consumers will increase. Management of an energy system is very important in reducing the cost of electricity especially in commercial and industrial fields. In Sri Lanka energy conservation in commercial and industrial fields are poor. Managing energy systems require a very good knowledge in electrical, electronic and information technological fields. Due to its complexity and lack of knowledge of people on this field, they do not tend to initialize major steps in conserving energy. But with such system, production factories with high power consumption machinery would benefit.

In order to overcome this problem, we have come up with a system for companies which has the need to save power and reduce the electricity cost. This system is capable of controlling and analyzing the machinery and the power system of a company online, Specialty of this system is that the system can be controlled remotely

and its data would be saved for reliability analysis and further adjustments and developments. Information on the factory will be sent periodically (as it is required) to the operational person or anyone who is in charge. And the status of the factory will be sent to their mobile phones or computers and it will indicate the current consumptions, faulty machinery, idling machinery and many more. So as per their requirements they would be able to remotely access the system and control it. As mentioned, our main aim is to be able to make energy management simple and easy through this design by monitoring energy systems online. Future generation of Sri Lanka would benefit from the energy that was conserved and would tend to develop more advanced designs to economically develop our country.

These systems may have their own drawbacks. Due to the use of high technological devices, initial cost of these systems can be expensive. But after the implementation of the system it would save energy and also reduce the monthly electricity bill.

Background of the Study

This project is industrial, as it involves the monitoring, analyzing, and managing the energy system of commonly factories that have large machines working for a long time. In factories like these, that is with large machines, the consumption is very high and also the loss can be very high. Energy is poorly managed in places like these. Therefore, a lot of money is wasted on energy.

In order to work on, apply and implement this project we have selected two factories. They are Matara Freelan (Pvt.) Ltd. and Randhi International (Pvt.) Ltd. These two factories consist of large machines and have poor energy management. Therefore, the project team shall focus on doing a case study to bring about a good solution for energy management, develop an app to monitor the energy system and also to analyze the reliability of the system.

A. Problem Statement

Many factories, almost all, use many machines that are vulnerable to power line disturbances. Many power electronic devices inject disturbances to the power line, such as harmonics and noise. These reason increases the loss of power and thus poor utilization of power. Therefore, the cost to be paid for electricity is very high.

B. Purpose of the study

To develop a system that can monitor the energy system of the factory. And conduct a case study for energy management. To develop an online desktop application to display information of the system and which can notify the electricians or workers through SMS or calls, enabling them to remotely control machines. And automatically analyze the reliability and make energy saving and monitoring easy.

C. Research Hypothesis

Availability of a controlling the power system in a software from can reduce the power usage of the factory. And automatically analyze the reliability and make energy saving and monitoring easy.

D. Significance of the study

This research project is important to reduce the cost of the power consumption of the industrial field. The outcome of this research project is the remote controlling software app and the case study. For the industrial field this will help them to reduce power usage and case study will help them to identify the fault.

III. METHODOLOGY

This explains the methodological framework used in achieving the objectives

of the study by focusing on the topics of designing, planning and implementation of the research. It covers all the approaches taken to achieve the implementation of remote-controlled reliability analysis and energy management system.

A. Research Philosophy

To address the problem of energy loss in industries and also for monitoring their usage remotely, we have proposed a solution. This includes a scheme that could monitor the energy online and also an energy management system. This system can feed into an online energy monitoring application, either a phone or a computer. The parameters that could be monitored are current, voltage, power, power factor and frequency. The system that we develop also can automatically carry out a reliability analysis for the factory and also detect faults.

B. Research Approach

The proposed model will consist of a power analyzer, with an in-built processor that can read data from the machines or the supply and give an output. This data that has now been processed will be sent to a Printed Circuit Board, designed by us will then transfer the data to a central computer or even a mobile phone. The energy monitoring is basically done via the PCB that enables us to make a connection between the analyzer and the application built by us.

In the application that we have built, the several parameters shall be displayed. Furthermore, it shall detect faults in the system and will notify the users through a text message.

We will also carry out a case study that will help us to decide on what steps should be taken to improve power quality in the factory that we consider. Later these data shall be used to make a generalized set of guidelines for any user to implement, if he/she needs to improve their power quality. This is mostly applicable for industries. For this to be done, the power loss will be calculated. Furthermore, the necessary calculations to achieve the desired power factor will also be done.

The project we are developing has three main parts:

i. Online Energy Monitoring
ii. Energy Management
iii. Reliability Analysis

C. Research Design

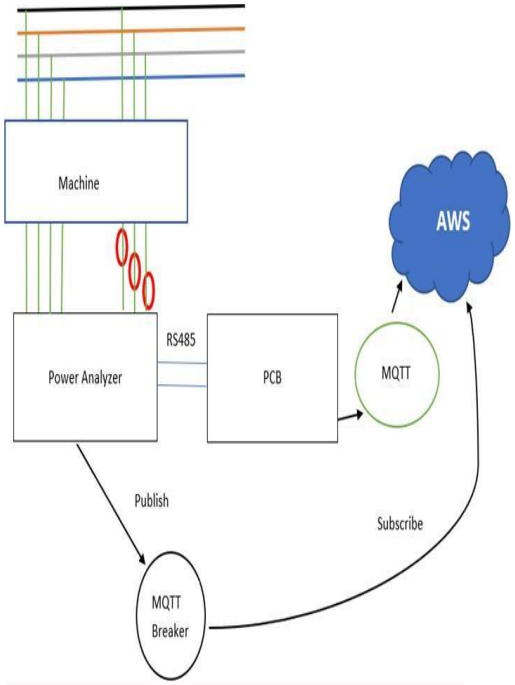

Figure 1: A figure showing the Research Design

Results and Discussion

Power quality is critical for the efficient operation of equipment. The power factor is a measure of the consumption of power by a particular company. Thus, by improving the power factor we can improve the quality of power to a great extent. The most common method of improving the power factor is to implement capacitor banks for power factor correction. The three main ways to implement capacitor banks in any organization are Global Compensation,

Individual Compensation and Group Compensation. Group and Individual compensation types are mostly followed. In factories they can follow individual compensation, fully group compensation or they can either follow a combination of both. This generalized solution was obtained from our case study. The results obtained in each of the areas are as follows:

A. Energy monitoring

In our application, the energy monitoring part is carried out by the installation of a power analyzer which is connected near the main supply and the test machine.

The voltages, currents, active powers, apparent powers and reactive powers, frequencies and power factors of the supply and machine are monitored in real time using this device. Through a custom-made PCB, information from the power analyzer is processed and sent to our mobile application wirelessly. This wireless network is made with a Wi-Fi module fixed in the PCB, which then communicates with the devices we have the mobile application installed.

Figure 2: The mobile application

B. Energy management

Energy management can be broadly defined as the proactive, organized, and systematic management of energy use in a building or organization to satisfy both environmental and economic requirements. Basically, it is the process of monitoring, controlling and conserving energy in an organization. Below diagram show the rescheduling loads for reduce the power usage.

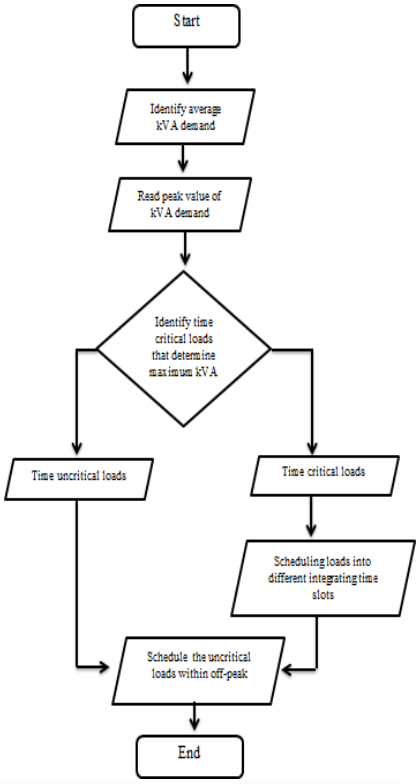

Figure 3: Energy Management flow chart

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