AUTOMATIC STREET LIGHTING CONTROL SYSTEM WITH FAULT CURRENT ANALYSIS

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Specially dedicated to my family…..

In memories, my late Father, Allahyarham Che Hassan bin Che Soh

Dearest Mother, Rafeah Yusoh,

Brother, Mohd Al Hafiz bin Che Hassan

Sister, Noor Hazwani bt Che Hassan

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ABSTRAK

Tujuan projek ini dijalankan adalah untuk mengesan kerosakan arus pada lampu jalan bersistem kawalan automatik. Projek ini akan menggunakan SCADA (Supervisory Control And Data Acquisition), dimana ianya akan menggunakan perisian Indusoft yang akan disambungkan pada Remote Terminal Unit (RTU) sebagai pengawal dengan menggunakan perisian IsaGRAF. Berdasarkan system yang akan dilaksanakan, sekiranya berlaku kerosakan arus pada lampu jalan bersistem kawalan automatic, seperti arus lebih, arus bocor ke bumi dan juga voltan kurang, system tersebut akan mengesan kerosakan dengan serta merta dan penyelenggaraan akan dilaksanakan pada masa yang sama.

ABSTRACT

This project is based on fault current to the automatic street lighting control system. The project has used SCADA (Supervisory Control And Data Acquisition), which is a software using Indusoft and also can link to Remote Terminal Unit (RTU) as a controller using IsaGRAF software. Based on this, if any faults occurs with the automatic street lighting control system such as over current, earth leakage current and also under voltage, the system will detect instantaneously and maintenance will be done.

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CHAPTER I

INTRODUCTION

1.1 Definition

- **A Street light, lamp post, street lamp, light standard or lamp standard,** is a raised source of light on the edge of a road, turned on or lit at a certain time every night.

- **Fault current**: current which results from the loss of insulation between conductors or between a conductor and ground.

- The level of current that can flow if a short circuit is applied to a voltage source

- RTU- **control system** is a device or set of devices to manage, command, direct or regulate the behavior of other devices or systems.

- There are two common classes of control systems, with many variations and combinations: logic or sequential controls, and feedback or linear controls

1.2 General Description (project overview)

This SCADA (Supervisory Control And Data Acquisition) analysis project is based on fault current to the automatic street lighting control system. The project has used SCADA (Supervisory Control And Data Acquisition), which is a software using Indusoft and also can link to a controller using IsaGRAF software. SCADA/HMI software is used because it runs on everything from mobile phones to PC workstations, handles an unlimited number of tags for large process control systems, and interfaces to high level software systems. Then, the system interfaces with the ready made hardware to run the program.

1.3 Problem statements

Every day, there is fault which occurs in to our street lighting system. When the fault occurs, TNB workers cannot detect the fault instantaneously, what type of fault and which part the fault occurs. It causes problems for the customers that they could not get the services for several hours and days. At the same time, if any fault occurs it will take a lot of time to maintain it again while the same fault occurs again and again. So, the objectives of this project are to avoid the problem which occurs during the fault and to monitor what type of fault it is. These problems that might be solved using SCADA (Supervisory Control And Data Acquisition) system.

1.4 Objectives of the project

The project is aimed to meet the following objectives:

- To study the Isagraf software and Indusoft software
- To study how to automate street lighting system
- To avoid the problem which occurs during the fault in the street lighting system
- To develop fault current analysis application

- To study and monitor what type of fault such as over current, earth leakage, or under-voltage.

1.5 Scope of the project

The project scopes for implementations are:

- Automatic Street lighting control system is proposed to the street lighting company.
- The RTU (Remote Terminal Unit) will be main the controller for the system.
- The programming or software development and implementation consists of SCADA (Supervisory Control and Data Acquisition), using IsaGRAF software and Indusoft software to interface with the hardware.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter will discuss about sources or articles that related to the project. There are many sources or researches done before and from there, details about this project are known and can understand briefly about the project.

2.2 First Review

In countries such as France, Germany, Belgium, UK and the Northern part of the US, street lamps are burning an average of 4000 hours per year. Considering that the average wattage of a lamp is around 150 watts, considering that a 100,000 inhabitant city contains about 18,000 lamps, such a city spend around 11 giga watt hours (11 billion watt hours). Considering that producing 1 kWh implies the emission of 340 grams of CO_2 (average in Europe), the streetlights of such a city are responsible for the emission of 3700 tons of CO_2 in the atmosphere per year.

Technologies and techniques now exist to:

1. save electricity without impacting the lighting level perceived by citizens
2. automatically identify 99% of lamp and ballast failures, saving on maintenance cost and increasing security

3. Leverage the same technologies and the same infrastructure to monitor other environmental data (through temperature, humidity, air pollution, air quality and noise sensors) to build a real-time environmental database and enhance control.
4. by replacing timers and photocells in cabinets with a centrally controlled unit primarily using GPRS as communication carrier and a centralized photocell, savings of 5-8% can be achieved according to experience in Scandinavia (Aalborg and Copenhagen). Furthermore, a communication unit in the cabinet can monitor all major problems with the street light (breaker and fuse errors, cable faults and broken bulbs to a certain extent). This reduces maintenance costs significantly and increases the overall light quality.

Amongst the key technologies and techniques:

1. Electronic communicating ballasts (such as SELC ballasts) dim lamps intelligently when less light is required (such as middle of the night in industrial and commercial zones). They consume 4 to 5 watts while magnetic ballasts consume up to 20 watts. In 2005 the European Union voted a directive (2000/55/EC) to incitate Cities to deploy electronic ballast that result in up to 45% electricity savings. Such electronic ballasts can usually identify failures of the lamp and the electrical network and communicate them through protocols such as EIA709 on powerline. EC directive (2000/55/EC) relates ONLY to fluorescent lighting and fluorescent ballasts. This directive has little to do with the vast majority of street lighting ballasts.
2. Power Regulator can be installed in the cabinet that supplies electricity to the street lights. Power regulators enable electricity regulation and can usually dim the lamps in the darkest time of the night. Unfortunately, power regulators are less efficient than electronic ballast for several reasons. The length of the supply links, different technologies of lamps that cannot be dimmed at the same levels. Power Regulators can provide electricity savings around 20%. There are other systems to control conventional HPS ballasts that can cut power use by 40%.

There are methods to dim existing magnetic ballasts which also identify failure conditions. There are solutions that will pay back the capital cost for adding controls in 2 and not more than 3 years where street lighting costs range from 12 to 10 euro cents per kilowatt hour and are used 11 to 12 hours a day [6].

2.3 Second Review: Street Public Lighting Control and Monitoring using PLC Communication

There may be tens of thousands of street lamps in the streets and along the highways. To inspect each lamp to check if it is working is an arduous task. Isn't it nice to have a system, which will automatically report if a lamp in a Public Lighting System has broken down? The infrastructure required of such self-reporting function must be very complicated and the cost prohibitively high. Not if you use ARCHNET power line modems.

The ARCHNET power line modem makes use of the power cable as a communication medium and data communication can take place between two points on a power line without the need of a dedicated signal wires. An ARCHNET power line modem and a sensor connected at the power source of the street lamp of a public lighting system can sense the current flow through the lamp, thus monitoring the operation of the street lamp. If the lamp breaks down, the modem will report the address code of the lamp report back to the monitoring station through the power cable. At the Public Lighting control station, a signal will flash on the screen giving the location of the street lamp. A repairman can then be sent immediately to the right location to check and replace the bulb.

Using the PLC Modem, the Public Lighting Control Center can send a command to operate the On / Off relay of a particular street lamp over the power line to turn on or off that street lamp in a public lighting system. Similarly, the Public Lighting Control

Center can broadcast an On / Off command at fixed times over the power line to operate street lamps in different zones of a Public Lighting System [7].

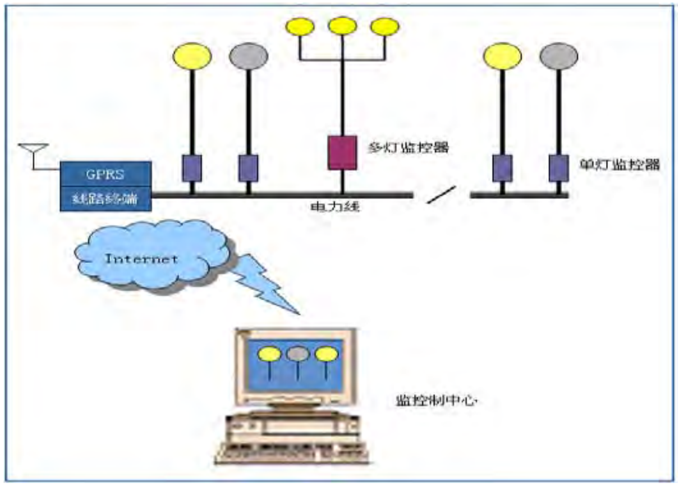

Figure 2.1: ARCHNET power line modem

2.4 Third Review: Remote Street Lighting Monitoring And Control System

Currently, street lights are controlled by photocells. These have only one function, which is switching lights on and off according to factory-fixed, light-level thresholds. Telensa's proposed system operates by replacing the traditional photocell with an 'outstation'. This performs the lamp switching and monitoring functions. It also contains a small radio, which communicates back to the base station or 'hub'. A large deployment would have a number of hubs, which themselves would be connected to a central system computer and database. Switching can be set in various ways, for example by time or by centrally measured light level [13].

2.4.1 Objectives

The objective of this project is to demonstrate a remote street lighting monitoring and control system that is not only has a wide range of energy saving features, but is also sufficiently low cost to make it the first commercially viable solution for the market.

The project aims to:

- Show that the innovative radio technology can be used to provide a real, practical and reliable solution to the needs of the street lighting industry;

- Verify the details of the functionality required, and show that the functionality does yield the claimed operational and energy saving benefits;

- Show that the product can be produced cost-effectively;

- Clear the regulatory path to enable the use of a metered supply for street lighting;

- Show accuracy and flexibility of lighting control that will enable the elimination of waste and the 'fine tuning' of burning hours, leading to energy cost savings;

- Show a range of continuously and periodically monitored electrical parameters that can be used to provide prompt lamp failure notifications and operating performance statistics;

- Show diagnosis of operating power factor and potential for power factor improvement;

- Meter energy consumption;

- Investigate the practicalities of installation, volume deployment and system set up and configuration;

• Explore, understand and prioritize product design features and system functionality for a fully commercial system;

Figure 2.2: Illustration of outstation

2.5 Conclusion

Based on the study that have been done, there are so many technologies and techniques now exist to make the street lighting system become more easier to monitor and control the fault, especially fault current. From the first review, experience in Scandinavia (Aalborg and Copenhagen), savings of 5-8% can be achieved by replacing timers and photocells in cabinets with a centrally controlled unit primarily using GPRS as communication carrier and a centralized photocell. Furthermore, a communication unit in the cabinet can monitor all major problems with the street light (breaker and fuse errors, cable faults and broken bulbs to a certain extent). This reduces maintenance costs significantly and increases the overall light quality.

For the second review, the usage of an ARCNET power line modem and a sensor which connected at the power source of the street lamp of a public lighting system can sense the current flow through the lamp, thus monitoring the operation of the street lamp. If the lamp breaks down, the modem will report the address code of the lamp report back to the monitoring station through the power cable. At the Public Lighting control station, a signal will flash on the screen giving the location of the street lamp. A repairman can then be sent immediately to the right location to check and replace the bulb.

Based on the third review, the objective of this project is to demonstrate a remote street lighting monitoring and control system that is not only has a wide range of energy saving features, but is also sufficiently low cost to make it the first commercially viable solution for the market.

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CHAPTER 3

PROJECT BACKGROUND

3.1 Project Overview

This SCADA (Supervisory Control And Data Acquisition) analysis project is based on fault current to the automatic street lighting control system. The project will use SCADA (Supervisory Control and Data Acquisition), which is a software using Indusoft and also can link to a controller using IsaGRAF software. SCADA/HMI software is used because it runs on everything from mobile phones to PC workstations, handles an unlimited number of tags for large process control systems, and interfaces to high level software systems. Based on this, if any faults occurs with the automatic street lighting control system such as over current, earth leakage current and also under voltage, the system will detect instantaneously and maintenance will be done on the spot. So, this reduces maintenance costs significantly and increases the overall street lighting quality. The system is used to control and monitor the problems to the automatic street lighting control system, which is by making it more functional to control and monitor fault analysis. Using this system, it will be easier to control and monitor any fault that could occur to the automatic street lighting system. The project will also use controller as remote terminal unit which is also using IsaGRAF software. GSM Mobile can only used with sms (short message service), that will control and monitor the fault. When the fault occurs, it will sms what type of fault it is, be it over current, earth leakage, or under voltage; and which part of the street lighting were faulted. So, at the same time, no matter how far we are, we can only use GSM

Mobile to monitor and also control the fault. Therefore, it will save our time and the work will be easier.

3.2 System Concept

We need to develop both of the software packages and the hardware at the same time because we must interface with them. For ISaGRAF software, we must link it using modbus RS232 to the controller. While for the power analyzer, we must use modbus RS485 to link with the controller as Remote Terminal unit (RTU). But, we found that there was a problem to get the actual street lighting module due to technical problem. So, in this project we are not using power analyzer but we need to use the other hardware such as controller I-7188XG, I/O Module I-7051, DB9 Serial Port 4 RS232, connector and DC Supply.

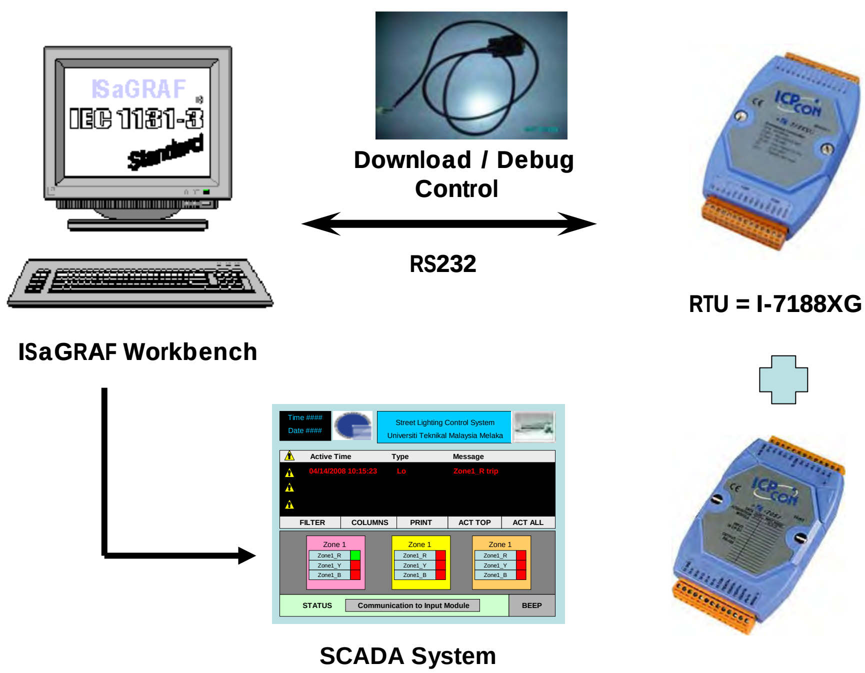

Figure 3.1: System Concept

In this project, we use I-7188XG controller which is a palm-size ISaGRAF SoftLogic μPAC, supporting popular & easy programming software: ISaGRAF Ver.3. It is default has 2 serial ports (COM1:RS232/RS485 & COM2:RS485) and supports to plug one X-borad to add more ports or I/O channels. The ISaGRAF μPAC supports: Modbus serial protocol, Modbus master protocol, Fbus: RS485, remote I/O, SMS: Short Message Service, modem link, MMICON / LCD and user defined protocol.

3.3 Software Implementation

3.3.1 Indusoft Software

InduSoft Web Studio is the most powerful collection of RACE tools offering Web and wireless integration on the market today. You can use InduSoft Web Studio to create native applications that run on all supported. Windows operating systems and Web-based HMI/SCADA applications – with no other tools required. The simple drag and drop, point and click development environment enables you to mimic the most complex behaviors of your live processes. Use InduSoft Web Studio with the most popular Web Browser to manage workstations; monitor, debug, and update software remotely; and access real-time, dynamic graphic screens, trends/alarms, reports, and recipes online.

InduSoft Web Studio is a powerful, integrated collection of automation tools that includes all the building blocks required to develop modern Human Machine Interfaces (HMI), and Supervisory Control and Data Acquisition System (SCADA) applications that run native on Windows NT, 2000, XP, CE and CE .NET or in an Internet and Intranet environment. A simple drag-and-drop, point-and-click development environment lets you mimic the most complex behavior of your live processes. InduSoft Web Studio is the ideal E-Automation solution in the industry [3].