HUMAN MACHINE INTERFACE DEVELOPMENT
OF A DISTRIBUTION AUTOMATION SYSTEM

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Bachelor of Electrical Engineering
(Control, Instrumentation and Automation)

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“ I hereby declare that i have read through this report entitle “Human Machine Interface Development of a Distribution Automation System” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)”

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OF A DISTRIBUTION AUTOMATION SYSTEM

MUHAMMAD AZLAN ARIF BIN SA'ADON

A report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)

Faculty of Electrical Engineering

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2014

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I declare that this reports entitle “Human Machine Interface Development of a Distribution Automation System” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature:

Name :

Date :

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To my beloved mother and father

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ABSTRACT

A distribution automation system (DAS) is a monitoring and controlling power supply grid network system. The most important of this system is the operation reliability to supply the power to the customer efficiently. The outages happen because of an overload in the region supply area. It will affect the critical 24-hours none stop customer such as hospital, financial institutions and many more. The power supply restoration will take longer time while one or second of outages cannot be accepted. This research is to develop a Human Machine Interface (HMI) of a Distribution Automation System (DAS) as to increase the reliability of the system. In this research, the HMI is capable to monitor and control the system efficiently when there is fault occurring. A data logger is needed to store the information and data for further analysis.

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ABSTRACT

Sistem automasi pembahagian ialah sebuah sistem pemerhatian dan pengawalan rangkaian bekalan kuasa elektrik. Kepercayaan terhadap operasi pembekalan kuasa kepada pelanggan secara cekap ialah faktor yang terpenting dalam sistem. Gangguan bekalan elektrik terjadi disebabkan oleh sistem menangung lebihan bebanan. Kesan utama gangguan bekalan elektrik ialah pengguna kritikal yang mengunakan secara seharian seperti hospital, institusi kewangan, dan lapangan terbang. Pemulihan bekalan elektrik juga memakan masa yang lama. Kajian ini ialah untuk membangunkan Human Machine Interface (HMI) untuk sistem automasi pembahagian untuk meningkatkan lagi kebolehpercayaan terhadap sistem. Di dalam kajian ini HMI berkebolehan untuk digunakan sebagai pemerhatian dan pengawalan sistem secara efektif sekiranya berlaku sebarang gangguan sistem. Sebuah data logger diperlukan untuk menyimpan maklumat dan data untuk penggunaan di masa hadapan.

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CHAPTER 1

INTRODUCTION

1.1 Background

Electricity supply has become one of the most important utilities. However, the increasing of customer and the demand whether in domestic or commercial cause lots of challenge to the electrical supplier to deliver a better service. Distribution networks are major parts of the total electrical supply system, as it provides the final link between the customer and the bulk transmission system [1].In order to improve the reliability of the system, distribution automation is applied to the system.

Distribution Automation System (DAS) is a utility's operation of the distribution power system. A multifunction system to monitor and control the scattered feeder remote terminal unit (FRTU) is the definition of DAS [2]. DAS is based on a centralized system, where the central server receives all information from the field and has full authority of monitoring and control Remote Terminal Unit (RTU) [2].

To improve the reliability of the system, there are many ways and one of it is Supervisory Control and Data Acquisition (SCADA) by using Human Machine Interface (HMI). HMI is a computerized system that between human and machine occur. It is used for maximum supervisory on system, control and receives the feedback of the machine in order to achieve effectiveness of operation [3].

In this project, a small scale of load will be used as *emulation* of the large scale of DAS. It is because the real scale of DAS is way of scope to bachelor level. Besides that, there is a lot of aspects and protocols need to be considered before applying in real DAS. Tenaga Nasional Berhad (TNB), one of Malaysian company will not let their system to be tested or simulate to avoid and prevent the interruption to their system that give risk them cost.

The small scale of load system will be implemented by using a DC Motor as load, a current sensor, SK40C. This hardware will represent the real DAS. Five different speed

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of DC motor will be used to varying the current. The higher the speed of DC motor the higher current uses. When the current is high, it will represent the over current in real DAS that will risky the equipment to damage. When the current is low, it will represent the overload in DAS, which the system cannot afford to supply enough power to consume and will cause the outages.

The five different speeds will be framed by using a current sensor. This algorithm will be sent to computer and will be analysed by Visual Basic software in order to represent the data in a graphical way which is Human Machine Interface (HMI). Form HMI, it will monitor the current thoroughly from the system. When there are over current or overload occur, the HIMI will cut off the supply to protect the system before damaged whether in automatically or by manual.

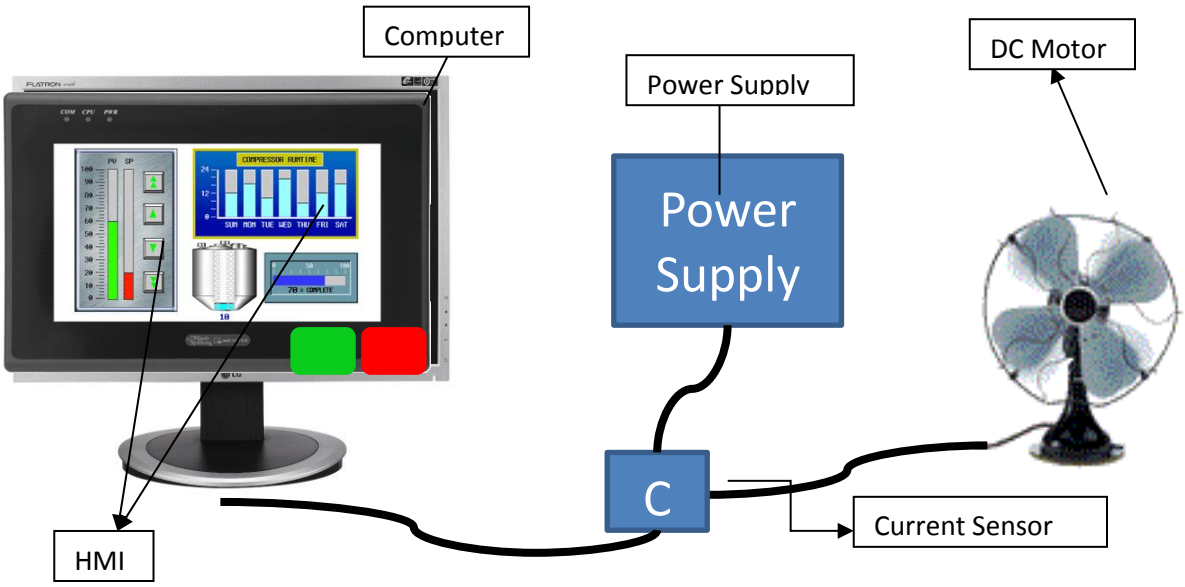

Figure 1.1 The overview of small scale of DAS

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1.2 Problem Statement

The electrical supply is affecting a lot in human daily life as to run in domestic or commercial purpose. The reliability of power supply is important for country for developing country and economic growth [2][4].

The outage of electricity would be unacceptable even for one second after fault[2].When the outage occurs it will take so much time to restore back the power supply as the engineer or technician need to troubleshoot the fault location by manually. Outages can give impact the system failures seriously especially in critical those industries that require 24 hour service such as:

- Medical informatics system
- Airlines system
- Financial institutions

To overcome these outages, Distribution Automation System (DAS) through the Human Machine Interface (HMI) is applied. Distribution Automation System the most important function is to improve the power supply reliability. The DAS will monitor and collecting the data needed for HMI application that will be developed using Visual Basic (VB) software.

1.3 Objective

The objectives of this project are:

i) To implemented load current sensor in order to get algorithm for current sensor by using microcontroller and for data logging.

ii) To develop Human Machine Interface (HMI) that can monitor and control Distribution Automation System (DAS) by using Visual Basic (VB) software

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1.4 Scope of Research

DAS is a big scale system and there are a lot of aspects and protocols need to be considered. There is no way to Tenaga Nasional Berhad (TNB), the Malaysian utility company to let their DAS to be test by some experiment. It is to avoid the interruption. This project will be implemented in a small size of scale of load system as *emulation* in order to show that my theory on DAS is capable to increase the reliability of the system.

This project will focus on development of Human Machine Interface (HMI) for Distribution Automation System (DAS) by using Visual Basic Software. The hardware uses a current sensor to collect the data. The hardware will be used a direct current Motor as a load and will be implemented in five different speed in order to vary the current. The algorithm produced from varying current will be used to set the limitation before the system is outages or over current.

1.5 Report Outlines

In chapter 1, it's an overview of the research is discussed along with objective and scope. This chapter also will go deeper into the problem statement that referring current. In chapter 2,it will be a detailed about hardware and software details and the reason of selecting that equipment. This chapter also will cover the related previous works. In chapter 3, the procedure of this research is discussed with the aids of the flow chart. The preliminary project also covered in this chapter.

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CHAPTER 2

LITERATURE REVIEW

2.1 Theory

In order to develop monitoring and controlling system, the criteria of software and hardware also play role to increase the reliability of the system. Supervisory Controlling and Data Acquisition (SCADA) is a system that monitor and control industrial process by computer controlled [5]. There are four types of SCADA which is Human Machine Interface (HMI), communication network, field device interface and field device [6].

2.2 Power Distribution Substation

Power substation is a station that received supply either from Main Intake Substation (PMU), Primary Distribution Substation (PPU) or Primary Switch Station (SSU). Distribution substation is the final station providing electricity to consumer in Power Grid System. In power substation building, it contains of three major electrical equipment which is switchgear, transformer and low voltage distribution board (LVDB). However, the use of transformers is depending on the maximum demands of that area. The larger the demands of power supply, the higher the quantities of transformer.

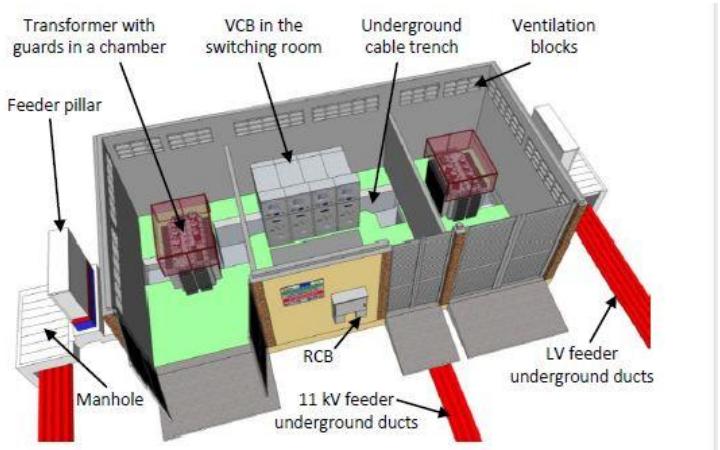

Figure 2.1 : Overview of double chamber substation

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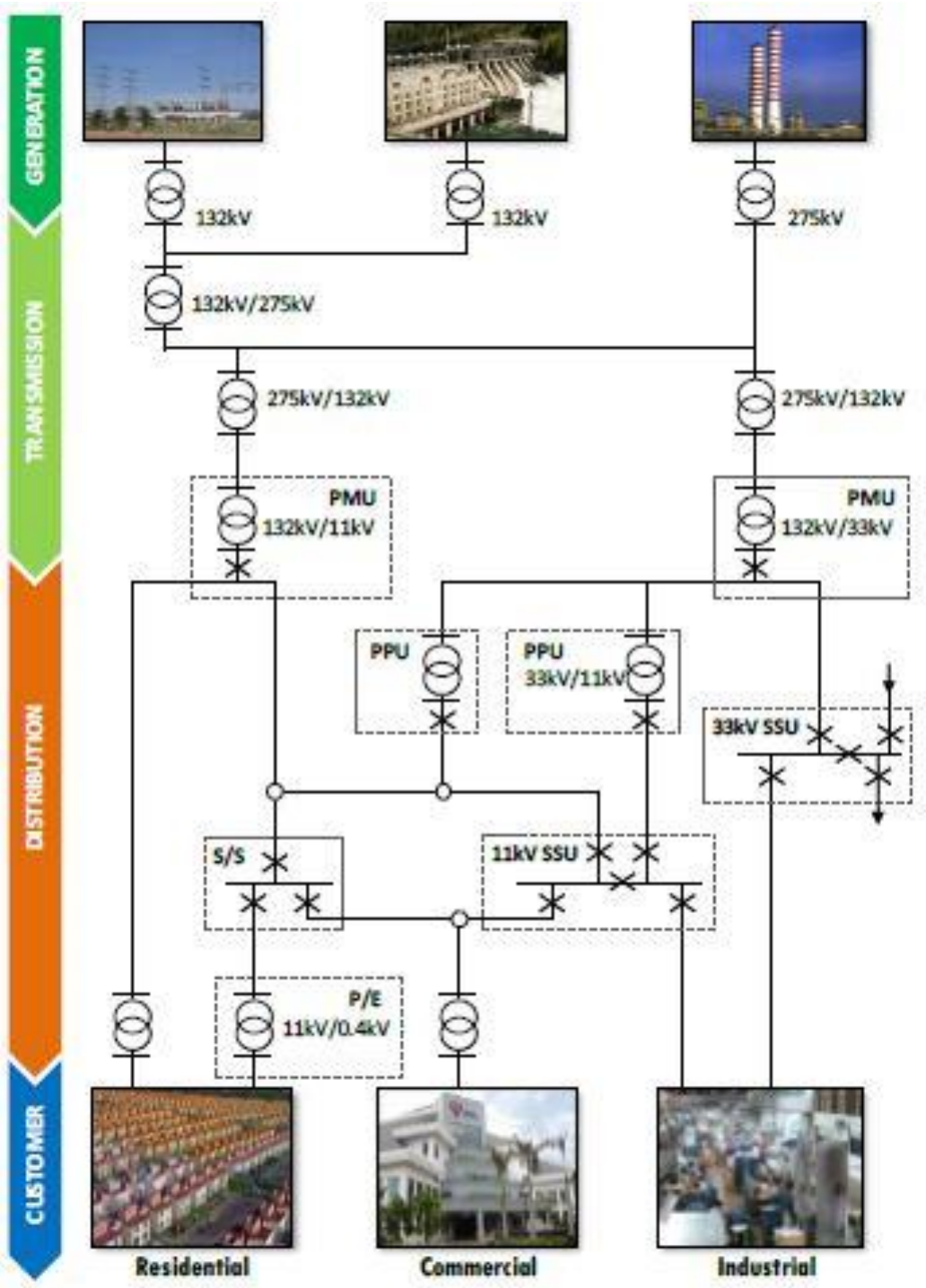

Figure 2.2: Typical flow of electricity

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2.3 Distribution Automation System (DAS)

DAS is a multi-function utility's system to monitor and control the Remote Terminal Unit (RTU). By using a computer, DAS is an automatic controller does not need human force to monitor the system. It be able to increase the efficiency in the context of automation in power supply system. This DAS are equipped with protection system so when there is fault happening, the system will trip to avoid any risks.

2.4 Fault Current

Fault current is a situation in which the flow of current that is travelling through an electrical circuit is not within a normal range. There are a lot of causes of fault current and it's divided into two which is internal and external cause. For the external cause or to be exact is transient fault, is a physical contact that interrupt to the system such as momentary tree contact, animal contact and lightning strike. For internal cause, it happens because of overload that carrying by the substation. As an example if the substations carry maximum demands is 232 kW.

$$P = IV\cos\theta$$

$$I = \frac{P}{V\ \cos\theta}$$

$$= \frac{232 \times 1000}{415\sqrt{3}\ (0.8)}$$

$$= 403.45\ Amp$$

P = Power

I = Current

V = Voltage

$\cos\theta$ = Power factor

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By using this formula, the substation needs to produce 403.45 Amp in order to supply maximum demands which is 232kW. In order to select the transformer for the substation, the transformers must work under 70 percent to 80 percent capacity. If the transformer works more than requirement it will trip the system for protection. According to the Table 2.1 transformer with power of 500 kVA is selected as it can produce 665 ampere which is more than current maximum demands which is 403.45 ampere and it makes the transformer works in the range 60 percent which is meeting the requirement of transformer selection. However, after years, the maximum demands are larger due to increasing of power supply usage. After years, new maximum demand now is 400 kW. By using the same formula, the new current maximum demand is 695 ampere which had made the transformer working over capacity with 104 percent. This situation is called overload.

Table 2.1 : Transformer rating

Transformer Power	Ampere
100 kVA	133 A
300 kVA	399 A
500 kVA	665 A
750 kVA	997.5 A
1000 kVA	1330 A

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