CHAPTER 3

REAL-TIME SMART CONTROL GRID SYSTEM

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3.1 INTRODUCTION

The "smart grid" has come to describe a next-generation electrical power system that is typified by the increased use of Communications and Information Technology in the generation, delivery, and consumption of electrical energy according to the IEEE definition (Shahbanzadeh & Moghaddam, 2013). Additionally, the smart grid is capable of integrating the actions of all users connected to it - generators, consumers, and those that do both - in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. It enables two-way communication between the utility and the consumer and is able to automatically adjust to changes in demand and supply. Smart grids also incorporate renewable energy sources, such as solar and wind power, and use advanced metering infrastructure to provide real-time data on energy usage. The goal of a smart grid is to improve the efficiency, reliability, and sustainability of the electric power system.

A programmable logic controller (PLC) is a digital electronic system designed for use in industrial settings (Angayarkanni et al., 2018). It utilizes programmable memory to store user-specified instructions for executing complex operations such as logic, sequencing, timing, counting, and arithmetic. These instructions are used to control various machines or processes through digital or analogue inputs and outputs. PLCs are designed to be user-friendly and easily integrated into industrial control systems. Some of the key features that set it apart from other control systems include its ease of programming and maintenance, as well as its high level of reliability in industrial environments. Human-machine interface (HMI) enables simple and effective interaction between humans and the PLC, it aims to optimize the system performance and enable human operators to make operational decisions, including the ability to manually override the automatic control operation in emergency situations. Supervisory control and data acquisition (SCADA) systems are critical for industrial organizations as they facilitate efficiency and process data for better decision-making, reducing downtime. They consist of programmable logic controllers (PLCs) or remote terminal units (RTUs) that communicate with various objects such as machines, HMIs, sensors, and end devices, and then transmit this information to computers running SCADA software. The software processes distribute, and display the data, allowing operators to analyse it and make informed decisions. SCADA is always implemented in smart grids (Regula et al., 2016), which uses the technology to improve the efficiency, reliability, and sustainability of the electric power system Figure 3.1 demonstrates the typical system architecture that utilizes this technology (Kezunovic, 2006).

The project aims to identify and address the shortcomings of the Smart Grid by implementing a remote monitoring system that utilizes PLC and SCADA technology with the Modus TCP communication protocol. A prototype for a smart grid has been developed in this paper to demonstrate the capability of the system in managing electrical distribution, detecting faults, and energy management. The system is designed to provide remote monitoring of these three operations in a secure environment. Overall, the project and the prototype described in the paper appear to be well thought out and well-structured.

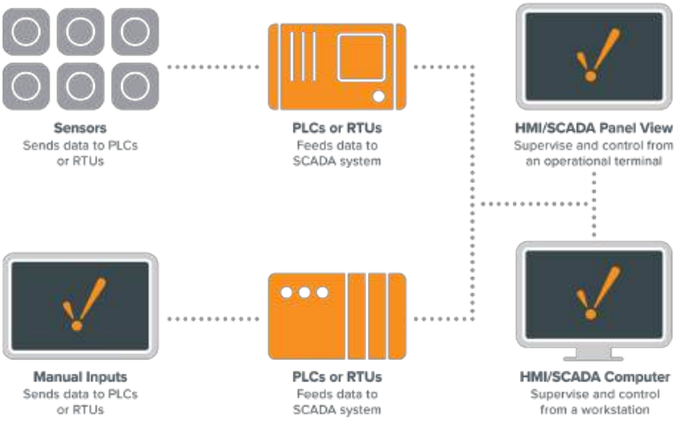

Figure 3.1 SCADA system architecture

3.2 SMART GRID REVIEW WORKS

This section of the research paper presents a review of the literature pertaining to the project's scope. The information abstracted from the reviewed literature is utilized to inform the planning and execution of the project. Additionally, the methods and objectives identified in each paper are highlighted to provide a comprehensive understanding of the challenges currently being faced in the industry.

One of the proposed solutions for the drawbacks of the Smart Grid is the implementation of a new circuit breaker monitor (CBM) (Kezunovic, 2006). The CBM can continuously record and store detailed information about each CB's operation in real-time. The relevant control circuit signals of the CBs are also captured and transmitted wirelessly to a central computer, known as the concentrator PC, which performs the analysis automatically. This approach allows precise monitoring of power system topology and overviews some important findings like the significance of state estimation, the method of fault clearing, and the enhancement of field measurements.

The work Kulkarni et al. (2019) creates a hardware panel that allows remote, authenticated cloud users to access, monitor, and control electrical grid data from any location at any time by providing an interface between the cloud users and the power grid systems. Thus,