IMPLEMENTATION OF IOT BASED DATA ACQUISITION SYSTEM FOR PHOTOVOLTAIC PANELS

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature : ....

Supervisor Name : Ir. Dr. Ranjit Singh Sarban Singh

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DEDICATION

Dedicated to my beloved family, father and mother Nurdin Bin Kadim & Zalila binti Mohd Yassan

ABSTRACT

Solar is one of the renewable resources that widely used in the world. To use solar as a source of energy the important thing needed is solar photovoltaic panel. Solar photovoltaic panel are known for producing electricity from the solar radiation which is available from the sun. Monitoring the performances of photovoltaic panels in a solar photovoltaic system is important for overall solar photovoltaic system efficiency. Hence, this project proposes to implement a proof of concept of IoT based data acquisition system for photovoltaic panels. The proposed system will use off-the-shelf available microcontroller developed system to develop then implement the IoT based data acquisition system. The system will record information of voltage, current and temperature at the photovoltaic panel and use this information to analyze the output energy produced by the photovoltaic panels.

ABSTRAK

Suria adalah salah satu daripada sumber yang boleh diperbaharui yang digunakan secara meluas di dunia. Untuk menggunakan suria sebagai sumber tenaga, perkara penting yang diperlukan ialah panel fotovoltaik solar. Panel fotovoltaik solar dikenali kerana menghasilkan tenaga elektrik dari sinaran suria yang boleh didapati dari matahari. Memerhati prestasi panel fotovoltaik dalam sistem fotovoltaik solar adalah penting untuk kecekapan sistem photovoltaic solar secara keseluruhan. Oleh itu, projek ini mencadangkan untuk membuktikan konsep sistem pemerolehan data berasaskan IOT untuk panel fotovoltaik. Sistem yang dicadangkan akan menggunakan sistem yang dibangunkan oleh mikrokontroler yang sedia ada untuk memhasilkan kemudian melaksanakan sistem pemerolehan data berasaskan IoT. Sistem ini akan merakam maklumat voltan, arus dan suhu di panel fotovoltaik dan menggunakan maklumat ini untuk menganalisis tenaga output yang dihasilkan oleh panel fotovoltaik.

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Praise be to Allah, his majesty for his uncountable blessings, and best prayers and peace be unto his best messenger Mohammad, his pure descendant, and his family and his noble companions.

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Finally, thanks and appreciation to my parent, friend and others for their moral support, encouragement, and constructive suggestion for the project and report completion from the beginning till the end.

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LIST OF SYMBOLS AND ABBREVIATIONS

V/I	:	INA 219 Voltage/current sensor
MAX31855	:	Thermocouple Amplifier
WSN	:	Wireless Sensor Network
IP	:	Internet Protocol
Wi - Fi	:	Wireless Fidelity
MC	:	Monitoring Center
PV	:	Photovoltaic
RF	:	Radio Frequency
PIC	:	Peripheral Interface Controller
IoT	:	Internet of Things
GSM	:	Global System for Mobile Communication
VNC	:	Virtual Network Computing

CHAPTER 1

INTRODUCTION

1.1 Project Overview

Nowadays, photovoltaic panel is used widely in the world as the secondary resources to generate electricity but then they have difficulty to monitor the performance of the solar photovoltaic panel. This project aims to implement a proof of concept of IoT based data acquisition system to monitor the output (voltage – current – temperature) of each individual solar photovoltaic panel. The project monitors the performances of every solar photovoltaic panel and recorded information or data is used to handling maintenances for problems happen during the system operational. Each solar photovoltaic panel is included with voltage-current and thermocouple sensors. The nature of wireless sensor network (WSN) offers several advantages on monitoring and controlling application over other traditional technologies. In this project, Wireless Fidelity (Wi-Fi) is technology that support low-power wireless sensor network (WSN) with the ability of process and communication is equalized to perform the monitoring tasks. Each Wi-Fi based system integrated at the individual solar photovoltaic panel is tasked to sense and measure, record and sent the information or data to a communication system. The received information is stored and send to a cloud database system.

1.2 Objective

1. To develop voltage-current-temperature data acquisition module/system for photovoltaic panel.
2. To synchronize all the voltage-current-temperature data acquisition module/system installed at individual photovoltaic panel without deteriorating the output voltage and current.
3. To create cloud-based data storage system for voltage-current-temperature of individual photovoltaic panels as cloud computing to store real-time conditions.

1.3 Problem Statement

Current installed photovoltaic panel system is perform monthly evaluation analysis. The current photovoltaic panel is connected parallel each other up to 5 or 10 pieces. The module of the photovoltaic panel is hooked up to the last photovoltaic panel. From the module the data collected from the sensor is using another communication system to send the data to cloud. In that way they may be hard to detect which photovoltaic panel are damaged or not running well. The way to detect the problem is by checking the photovoltaic panel one by one. Thus, the user do not allows to observe the performances of individual photovoltaic panels. In the other way, the user need to develop another communication system for send data to cloud. The major monitoring system is for commercial at industrial places.

1.4 Scope of Work

- Task 1: Install temperature-voltage/current sensor onto photovoltaic panel and connect to Raspberry Pi Zero Wireless.

This task involves connection testing for thermocouple sensors and voltage/current sensor. The sensors connectivity testing is important to sense and measure the temperature, voltage and current of the photovoltaic panel. This will also involve the process of initialization of the sensors before is activated for sensing and measurement.

- Task 2: Create embedded source code to read temperature-voltage/current from the sensors.

In this task, the embedded source code for read temperature-voltage/current from the sensor need to be create. The source code use to functional the sensors to capture temperature, voltage and current data. This will involve the connectivity of Raspberry Pi and sensors.

- Task 3: Create cloud-based data storage system to store photovoltaic panel temperature-voltage/current information.

In this task, the cloud-based data storage need to be create for store data collected from the sensor. The data are used to monitor the performances of photovoltaic panel in daily, weekly and monthly.

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- Task 4: Create rules to push temperature-voltage/current information from the Raspberry Pi Wireless Zero to cloud storage.

In this task, the rules to push the data collected from the Raspberry Pi Zero Wireless need to be create. This thing important to make sure the data is correctly achieve without any disruption.

1.5 Thesis Structure

The remainder of thus thesis is structured into FIVE (5) chapters as follows: Chapter 2 presents the theoretical background of system using in monitoring Photovoltaic Panel available, including IoT Technology and Microcontroller. Chapter 3 describe the research of methodology including hardware design and development, hardware sensors placement, software design and development. Chapter 4 is mainly focused on the hardware system design , software design and the cloud/database system and monitoring. Finally, Chapter 5 disscusses the conclusion from analysis.

CHAPTER 2

BACKGROUND STUDY

2.1 Theory

2.1.1 Solar Photovoltaic Panel System

The increasing political and environmental problems associated with fossil fuels are the main disadvantages of this energy exploitation. The use of solar photovoltaic systems to convert solar energy from sunlight into electricity is a way to overcome these difficulties and meet the growing worldwide demand for electricity. This clean technology has inspired the performance of various systems designed to monitor the solar photovoltaic panel and maximize low cost photovoltaic production. The photovoltaic monitoring system collects and analyzes the number of parameters measured in a photovoltaic panel to monitor its performance. Each photovoltaic panel has a small single board computer, Raspberry Pi Wireless Zero, which is integrated with the voltage current and thermocouple sensor for recording information or data and for sending data via a wireless system. Wireless Fidelity (Wi - Fi) is a technology that supports the Wireless Sensor Network (WSN) with the ability to monitor and communicate the tasked processes. The information received will be saved in the Raspberry Pi Wireless Zero and sent to the cloud.

2.2 Monitoring system from previous study

Refer to the previous explanation in the 2.1, this section will analysis some of the previous study and developed solar photovoltaic monitoring system. Refer to Figure 2.1, Monitoring Center (MC) receives real time data from the connected sensor at the photovoltaic cells and from other sources. The MC is integrated with a set of tools to monitor the production as well as to detect failures and send alerts message through different communication channels. ZigBee-based protocol which integrates wireless sensor network for collecting data and sending to MC is proposed in [1]. To establish communication between Smart Modules and Central Node, each PV panel is installed with a low- power XBee 802.15.4 module from Digi [2] and and an 8-bit PIC microcontroller from Microchip [3] but also includes an extended range module from XBee- Pro 802.15.4 to allow communication with the Monitoring Center. ZigBee can be developed in larger mesh network than it is possible with Bluetooth.

Depending on the RF setting, and the energy usage needed for a particular implementation, ZigBee compatible wireless systems are anticipated to convey 10-50 meters. This node also includes the entire circuit that detects the magnitudes of interest. The ZigBee network used in this competition consists of a couple of two nodes, one being the inner power unit assistant and the other the external terminal unit. This protocol's maintenance provides clear advantages, including the capacity to connect various nodes and generate fresh networks like stars, mesh and clusters. The ZigBee protocol can provide a mesh link which crosses the gaps between two units by replicating the signal through routers.

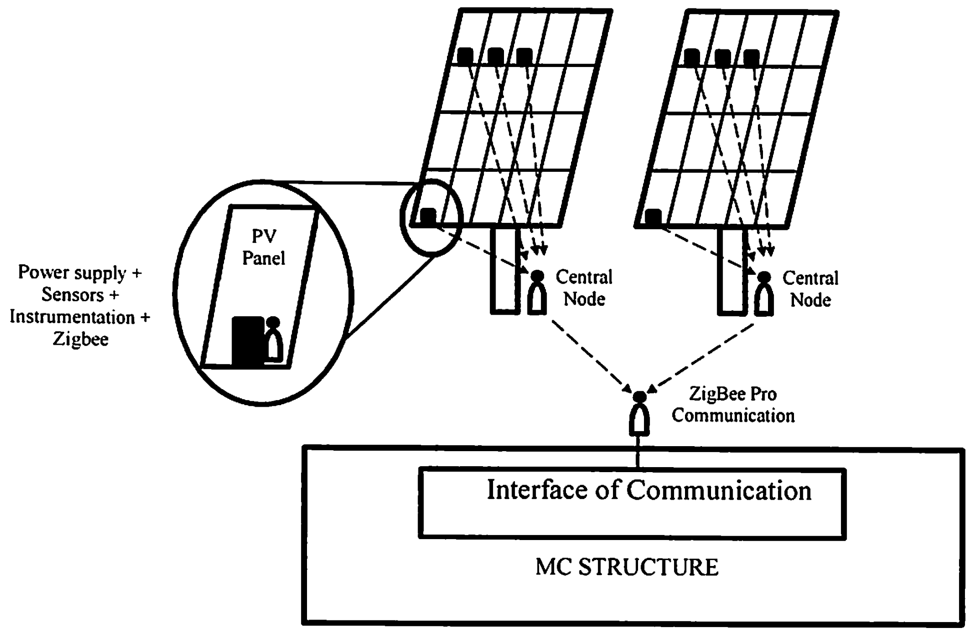

Figure 2.1: Photovoltaic panel system using Zigbee [1] [4]

Refer to Figure 2.2, the figure shows the Xbee Pro block diagram photovoltaic panel system. All sensors are installed and connected to the microcontroller to measure temperature, voltage and current. The wireless system is then developed using the Labview and Xbee module to operate the system correctly. The microcontroller then reads the respective voltages and currents through the voltage and current transducers in the PV module. In addition, two XBee Pro transceivers were used to transmit the measured data wirelessly from rooftop sensors and electronics modules to a LABVIEW-based monitoring station in Figure 2 [5]. The LabVIEW program initializes the communication protocols via the microcontroller between the XBee Pro