BUSITEMA UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

A BATTERY MONITORING SYSTEM FOR A POWER DISTRIBUTION SUBSTATION

BY

AINOMUGISHA IMMACULATE

REGNO: BU/UG/2013/1569

immacimmix2@gmail.com

Tel no: 0705633503/0784612686

SUPERVISOR: MR. OCEN GILBERT

A project report submitted to the Department of Computer Engineering in

Partial fulfillment of the requirements for the award of a Bachelor's degree in

Computer Engineering at Busitema University

MAY 2017

DECLARATION

I, Ainomugisha Immaculate BU/UG/2013/1569, do hereby declare that this Project report is original and has not been submitted for any other degree award to any other University before.

Signature ……………………….......   Date………………….........................

Ainomugisha Immaculate

Bachelor of Computer Engineering

Department of Computer Engineering

Busitema University

APPROVAL

This dissertation report has been submitted with the approval of the following supervisor.

Signature……………………………….   Date ………………………………..

Mr. OCEN GILBERT

Department of computer Engineering

Faculty of engineering

Busitema University.

DEDICATION

I dedicate this project report to my beloved parents Mr. Byakatonda Josephat and Mrs Turyomunsi Veneranda for the love and support they have provided to me throughout this project period, my relatives, my classmates and all my friends for the advice and financial support they rendered to me during the research period.

I also dedicate it to my project supervisor Mr. Ocen Gilbert for his tremendous effort and guidance in relation to my project report he offered to me during my research period may the Almighty God bless him.

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to all those who have made this project a success.

Firstly, I wish to thank my supervisor Mr. Ocen Gilbert who has assisted, directed and guided me throughout my project work.

Special thanks also go to the entire Department of Computer Engineering, Busitema University, for their great assistance and technical input during the course of the study.

My sincere thanks to all my class mates for their supportive criticisms and comments on the project at various stages, without their support this achievement would have been impossible.

Special thanks to my family, relatives and friends for their never ending financial and advisory support.

Above all, I acknowledge the Almighty God for the gift of life, wisdom and guidance for without Him, I would not have been able to accomplish this project report.

LIST OF ACRONYMS

BES	Bulk Electric System
BMS	Battery Monitoring System.
DC	Direct Current.
GSM	Global System for Mobile Communication.
IEE	Institution of Electrical Engineers
LCD	Liquid Crystal Display
MTU	Master Computer Unit
RTU	Remote Terminal Units
SCADA	Supervisory Control And Data Acquisition
SOC	State of Charge
SOH	State of Health
SMS	Short Message Service
UPS	Uninterrupted Power Supply.
VRLA	Valve-Regulated Lead-Acid

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Batteries provide power to the protection and control equipment including relays, circuit breakers and other auxiliary devices. If the battery fails then the substation is left unprotected thus battery maintenance is one of the most critical aspects to ensuring power to consumers when there is an outage or a system failure. Currently, battery maintenance programs consist of the Supervisory Control and Data Acquisition systems (SCADA) in addition to the monthly, quarterly, and annual manual measurements of cell and overall battery voltages, specific gravity, fluid level, connection resistance, and visual observations which are prone to human error. These methods also require the technical personnel to always be physically present at the substation if he or she wants to know about the status of the battery which makes it hard for him or her to know in case there are any abnormal conditions in the state of the batteries. This system utilizes the use of the temperature sensor, electrolyte level sensor, voltage sensor and a GSM modem which helps to notify the technical personnel about the status of the battery as regards the temperature, the electrolyte level and the voltage of the battery by sending an SMS. This system therefore helps the technical personnel to monitor the performance of the batteries remotely without him being physically present at the substation.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1Background

A distribution system is a part of electric power system that routes electric power to consumer loads with inductive, capacitive and resistive characteristics. It consists of network components such as distribution substation, primary and secondary distribution lines, distribution transformers, voltage regulators, shunt compensators and consumer loads and batteries [1].

Batteries provide power to the protection and control equipment including relays, circuit breakers and other auxiliary devices. If the battery fails then the substation is left unprotected. Today, it has become obvious to users that battery performance cannot be taken for granted. The cost of failures makes the cost of monitoring seem insignificant, especially in large data center applications where even a momentary power glitch to the computers can equate to many millions of dollars in losses [2].

Substation backup battery maintenance is one of the most critical aspects to ensuring power to consumers when there is an outage or a system failure. Without a proper battery testing solution and preventative maintenance, the Bulk Electric System (BES) is compromised causing significant revenue loss and safety hazards [3].

As more and more emphasis is placed on availability and reliability of critical power systems, organizations need to understand that without properly operating batteries, no emergency power system can do its job. Batteries are the heartbeat of this system, and when well-managed, they protect critical operations and help facility managers avoid the high cost and detrimental impact of unplanned downtime [4].

The US Department of Energy reported electric emergency incidents and disturbances are on the rise with approximately 23 percent more events reported last year as compared to 2013. These outages or disturbances can cost facilities thousands or even millions of dollars if their emergency power systems do not immediately switch on and provide back-up power. Ensuring that emergency power systems will provide reliable back-up power begins with battery management. Batteries are considered the most critical, yet vulnerable component of emergency power systems. Battery failure is one of the leading causes of back-up power system failure and the resulting outages and losses [5].

Monitoring DC battery system at power distribution substation and ensuring that it is sufficiently healthy to carry the intended load is a remedy to total power outages.

Currently, battery maintenance programs consist of the Supervisory Control and Data Acquisition systems (SCADA) in addition to the monthly, quarterly, and annual manual measurements of cell and overall battery voltages, specific gravity, fluid level, connection resistance, and visual observations which are prone to human error. Most of these substations are found to be located in remote areas and that their maintenances are costly, time-consuming, and labour-intensive [6].

This therefore calls for a system that can remotely monitor parameters that affect battery performance like temperature, voltage, current and the electrolyte level of the batteries and send a Short Message Service (SMS) to the technical personnel via a GSM modem technology regarding the status of the battery.

1.2 Problem Statement

Currently, battery performance is being monitored by the Supervisory Control and Data Acquisition systems in addition to the manual checks by the technical personnel, in an infrastructure emergency which requires immediate attention such as the cascading failure of a power grid , SCADA operators are often off site and need to gain immediate remote access to the command facilities of the network which becomes very difficult for them since they have no way to access the information unless they are physically present at the substation. Thus the need to monitor the performance of the batteries remotely based on the GSM technology which is more cost effective.

1.3 Project objectives

The objectives of this study are divided into two parts that is general/main objective and specific objectives.

1.3.1 Main objective

To design and implement a battery monitoring system for a power distribution substation based on the GSM technology.

1.3.2 Specific objectives

1. To study and assess the current battery performance monitoring systems at power distribution substations.
2. To design and construct a battery monitoring system using the study requirements.

3. To program the microcontroller to suit the system.
4. To test and validate system.

1.4 Justification

Battery performance is currently being regularly monitored by the Supervisory Control and Data Acquisition systems in addition to carrying out visits to substations, which is costly and prone to human errors.

However, this system helps the maintenance personnel monitoring the substation to query the system and get a response on the battery status in addition to system automatic alerts sent to him. This is deemed a cost effective strategy as any sudden negative change in battery behavior can be communicated to technical personnel in real time without him or her being physically present at the substation.

1.5 Scope

The project involved designing and constructing a real time power distribution substation battery voltage, electrolyte level and temperature monitoring device based on GSM technology. The project utilized Atmel's 8-bit RISC AVR chip;-the ATMEGA328P-PU microcontroller. A custom voltage sensing circuit was designed for voltage sensing and monitoring. KL09 and TMP36 sensors were utilized to monitor the electrolyte level and temperature of the battery respectively. All the readings of temperature, acid levels and voltage are alphanumerically displayed in real time on a 16x2 character LCD. The device was interfaced with a SIM900 GSM modem to provide remote access of the device readings using SMS technology.

REFERENCES

[1] P. Amaize, A. Alayande, and A. Airoboman, "American Journal of Electrical Power and Energy Systems Influence of Power Quality Problem on the Performance of an Induction Motor," *American Journal of Electrical Power and Energy Systems,* vol. 4, no. 4, pp. 39-44, 2015.

[2] D. Chhajer and R. Foster, "Battery Discharge Testing: Implementing NERC Standards and Field Experiences."

[3] W. Wangdee and R. Billinton, "Bulk electric system well-being analysis using sequential Monte Carlo simulation," *IEEE Transactions on Power Systems,* vol. 21, no. 1, pp. 188-193, 2006.

[4] L. Hewitson, M. Brown, and R. Balakrishnan, *Practical power system protection*. Elsevier, 2004.

[5] R. E. Brown, *Electric power distribution reliability*. CRC press, 2008.

[6] Y. Liang, "Studies of Monitoring and Diagnosis Systems for Substation Apparatus," Virginia Polytechnic Institute and State University, 2005.

[7] J. L. Hieb, P. A. Ralston, and J. H. Graham, "Intelligent Systems Research Laboratory Technical Report TR-ISRL-07-01 Dept. of Computer Engineering and Computer Science University of Louisville Louisville KY 40292," 2007.

[8] R. Carlson, "Sandia SCADA program high-security SCADA LDRD final report," *SANDIA Report SAND,* vol. 729, p. 2002, 2002.

[9] V. Gurevich, "Systems for supervision of substation batteries."

[10] H. P. da Silva, J. Guerreiro, A. Lourenço, A. L. Fred, and R. Martins, "BITalino: A Novel Hardware Framework for Physiological Computing," in *PhyCS,* 2014, pp. 246-253: Citeseer.

[11] L. V. T. S. TMP35, "TMP36/TMP37 Datasheet,© 1996–2010 Analog Devices," *Inc. All rights reserved*.

[12] M. R. Zielinski and M. J. Taylor, "Proximity sensor for level sensing," ed: Google Patents, 2006.

[13] M. Mouly, M.-B. Pautet, and T. Foreword By-Haug, *The GSM system for mobile communications*. Telecom publishing, 1992.

[14] M. Margolis, *Arduino cookbook*. " O'Reilly Media, Inc.", 2011.

[15] E. A. Brewer, C. N. Dellarocas, A. Colbrook, and W. E. Weihl, "Proteus: A high-performance parallel-architecture simulator," 1991.