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FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING

FINAL YEAR PROJECT REPORT

DESIGN AND DEVELOPMENT OF AN INFORMATION MANAGEMENT SYSTEM FOR ELECTRICITY PAYMENT IN UMEME YAKA METERS

BY

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A final year Project report submitted to the Department of Electrical Engineering in Partial fulfillment of the Requirement for the award of a Bachelor of Science degree in Electrical Engineering of Busitema University.

JUNE, 2024

DECLARATION

I hereby declare that, to the best of my knowledge and belief, this report represents my original work and has not been submitted to any other educational institution. It is a genuine and authentic account of our research and findings. Where references or secondary data have been utilized, appropriate acknowledgments have been duly made.

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APPROVAL

The project report was reviewed and approved by:

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Thank you all for your unwavering support and contributions, which have made this achievement possible.

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DEDICATION

I dedicate this report to my beloved parents, siblings, and friends and all those who have contributed to it in one way or another, I may not mention names but know this, I appreciate you all entirely.

ABSTRACT

This project report addresses the inefficiencies in manual electricity unit loading in UMEME's Yaka metering system by developing an advanced information management system aligned with Uganda's development goals. The existing method requires users to manually input a 20-digit token into the Customer Interface Unit (CIU), which is prone to errors and inconvenience, especially during periods of unit shortage. To resolve these issues, we proposed a GSM-based system for automatic and remote activation of electricity units, thereby eliminating the need for physical interaction with the CIU. This solution utilizes an 8-bit RISC Atmel ATMEGA328P-PU microcontroller interfaced with a SIM800L quad-band GSM modem. The system employs current and voltage sensors to continuously monitor energy usage and automatically updates the meter balance based on cellular messages received upon payment. Research methods including observation, interviews, and literature review were employed to gather relevant insights and inform the design of the technological solution. A functional prototype was developed and tested, demonstrating the capability to automatically load tokens and meet the project's objectives. This innovative approach supports Uganda's strategic goals of technological advancement, economic growth, and sustainable development. By modernizing the electricity metering infrastructure, this project significantly contributes to the enhancement of operational efficiency and the facilitation of socio-economic progress in Uganda.

LIST OF ACRONYMS

ASK: Amplitude Shift Keying

BER: Bit Error Rate

CPCA: Carrier Present, Carrier Absent

CPU: Central Processing Unit

DFD: Data flow diagrams

DRAM: Dynamic Random Access Memory

EEPROM: Electrically-erasable programmable Read Only Memory

FCC: Federal Communications Commission

GPS: Global Positioning System

GSM: Global System for Mobile communication.

I2C: Inter Integrated Communication

LNA: Low Noise Amplifier

OOK: On Off Keying

PCB: Printed Circuit Board

RAM: Random Access Memory

RISC: Reduced instruction Set Computer

RF: Radio Frequency

ROM: Read Only Memory

SPI: Serial Peripheral Interface

SRAM: Static Random Access Memory

TWI: Two Wire Interface

UART: Universal Asynchronous Receiver Transmitter

UEDCL: Uganda Electricity Distribution Company Limited

UETCL: Uganda Electricity Transmission Company Limited

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1 CHAPTER ONE

1.1 Introduction

This chapter focuses on the background to the study, statement of the problem, general objectives of the study, research questions, and scope of the study, significance of the study and conceptual framework.

This project report therefore discusses the design and physical modeling of a GSM-based Electricity Recharge System for prepaid Metering systems in Uganda, commonly known as YAKA. The 20-digit token number provided upon any form of payment must be entered at most three times and beyond which the meter will be locked. When a meter is locked, the customer is required to through the same procedures they took when acquiring the electricity account. With this said, the chances of inputting a correct token wrongly are very high as the token number is so long, making it harder to get all token numbers right in order. Also, the process of entering a 20-digit token number is a challenge to users as it requires their physical presence to enter the 20-digits. Currently, a situation where one can remotely enter the token to activate the units purchased is currently impossible.

The aim of the project is to minimize the error by introducing a new mechanism of loading the 20-digits token number provided without requiring physical pressing of the buttons on the customer interface unit provided. This will enable the user to recharge his/her electricity account from anywhere without physically being at the customer interface unit.

1.2 Background

Smart meters are integral to modern utility infrastructure globally, redefining energy consumption monitoring, management, and billing. These devices, initially deployed in regions like the United States, United Kingdom, Canada, and Europe, replace traditional analog meters with advanced technology, including digital displays and two-way communication capabilities. Analog meters posed several challenges, including limited accuracy, manual reading requirements, and inability to detect energy theft or tampering. In contrast, smart meters offer numerous benefits, such as remote monitoring, outage detection, and improved energy efficiency, empowering consumers to make informed decisions about energy usage. As global adoption continues to surge, smart meters play a pivotal role in promoting sustainability and efficiency in the energy sector through ongoing technological innovation and integration with renewable energy sources.

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