FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING.

PROJECT TITLE: AN INTEGRATED RESIDENTIAL SMART HOME ENERGY MANAGEMENT SYSTEM IN UGANDA

By

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(BU/UP/2020/1239)

"A final year project report submitted to the Faculty of Engineering in partial fulfillment of the requirement of the award of a Bachelor's Degree of Science in Electrical Engineering at Busitema University".

JUNE, 2024

ABSTRACT

A Home Energy Management (HEM) system plays a crucial role in realizing residential Demand Response programs in the smart grid environment. It provides a homeowner the ability to automatically perform smart load controls based on utility signals, customers preference and load priority. The HEMs communication time delay to perform load control is analyzed, along with its residual energy consumption. The main aim is to design how each load performs when being controlled by the HEM unit and measure electrical measurements for the different loads. Demand response (DR) is defined as changes in electricity use by demand-side resources from their normal consumption patterns in response to changes in the price of electricity. HEM system comprises an HEM unit that provides monitoring and control functionalities for a homeowner, and load controllers that gather electrical consumption data from selected appliances and perform local control based on command signals from the HEM system. A gateway, such as a smart meter, can be used to provide an interface between a utility and the data base for the electrical consumption is maintained and by use of an LCD screen that displays all the readings of different loads.

DECLARATION

I WADUMA JOHN DERICK (BU/UP/2020/1239) _declare that all the contents in this project report is my own work, obtained from the knowledge of class, fields of training and has never been submitted for any academic or commercial purposes.

Any work that does not belong to me has been duly referenced.

Signature: ..... Date: 11/07/2024

APPROVAL

This final year project report under the tittle (AN INTERGRATED SMART HOME ENERGY MANAGEMENT SYSTEM IN UGANDA) has been submitted to the Department of Electrical Engineering for assessment with approval of our supervisors.

Signature: .....

Date: 13/06/2024

Main Supervisor

MR. ARINAITWE JOSHUA

Department of Electrical and Computer Engineering

Signature: .....

Date: 11/07/2024

Co Supervisor

Ms. NABWIRE LUCY

Department of Electrical and Computer Engineering

DECLARATION

I, **SEBAGALA ALI (BU/UP/2020/1579)**, affirm that the entirety of this project report is original my own creation, derived from class teachings and training experiences, and has not been previously utilized for academic or business ends.

Any work that does not belong to me has been duly referenced.

Signature: ..... Date: 25th/06/2024.....

APPROVAL

This final year project report under the title (AN INTERGRATED SMART HOME ENERGY MANAGEMENT SYSTEM IN UGANDA) has been submitted to the Department of Electrical Engineering for assessment with approval of our supervisors.

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DEDICATION

I dedicate this report to my dear parents, brothers and sisters for the support rendered to me towards this project may the almighty God bless them.

ACKNOWLEDGEMENT

Am so thankful to the Almighty God for the presentation and provision throughout this project.

Am also grateful to my supervisors for the guidance and support they have rendered to me in the running of the project basing on the acquired knowledge from class by our lecturers.

I do also take this appreciation to my Lecturers who have always encouraged me to keep moving on however much challenges could come on my side.

Finally, I thank my parents for their provision, facilitation in terms of paying tuition, care and guidance offered for my well-being to ensure that my studies go on smoothly.

LIST OF ACRONYMS

AOA	Automatic of Appliances
A	Amperes
AC	Alternating Current
AHEM	Advanced Home Energy Management
AOP	Aspect Oriented Programming
CPP	Critical Peak Time
DC	Direct Current
DR	Demand Response
HAN	Home Area Network
HEM	Home Energy Management
LCD	Liquid Crystal Display
MOA	Manual of Appliances
PCTs	Programmable Communicating Thermostats
Pf[1]	Power factor
PTR	Peak Time Rebate
SH	Smart Home
TH	Temperature High
TL	Temperature Low
TOU	Time of Use
VA	Voltage Ampere
V	Voltage
W	Watt

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Chapter 1: INTRODUCTION

1.1 Background

A smart home is a designed structure with sufficient access to assets, communication, controls, data, and information technologies for enhancing the occupants' quality of life through comfort, convenience, reduced costs, and increased connectivity [2]. The idea has been widely acknowledged for decades, but few people have ever seen a smart home, and fewer still have occupied one. A commonly cited reason for this slow growth has been the exorbitant cost associated with upgrading existing building stock to include "smart" technologies such as network connected appliances [3]. A smart home functions as a switchboard for data flow among appliances and participants such as the end user, the electric utility, and a third-party aggregator. Looking outward, a smart residential building has two-way communication with the utility grid, enabled by a smart meter so that it can interact dynamically with the grid system, receiving signals from the service provider and responding with information on usage and diagnostics [3]. Looking inward, a smart home employs automated home energy management (AHEM), an elegant network that self manages end-use systems based on information flowing from the occupants and the smart meter. The value of AHEM is in reconciliation of the energy use of connected systems in a house with the occupant's objectives of comfort and cost as well as the information received from the service provider. Sensors and controls work together via a wireless home area network (HAN) to gather relevant data, process the information using effective algorithms, and implement control strategies that simultaneously co-optimize several objectives: comfort and convenience at minimal cost to the occupant, efficiency in energy consumption, and timely response to the request of the service provider and the smart meter [4].

Home energy management system is the minimal unit of smart grid, which is a new generation of information technologies such as Internet of Things, cloud computing, mobile Internet, and big data, combined with the household as a carrier to achieve a low-carbon, healthy, intelligent, comfortable, and safe family lifestyle [2]. By combining distributed power technologies such as household photovoltaic and energy storage, it flexibly controls various household appliances and realizes an intelligent mode of electricity and energy use.

HEMS is an intelligent network control system based on smart grid, smart home, and smart meters. It is also a monitoring and data collection application for energy management systems, covering power grid

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