BUSITEMA UNIVERSITY
Pursuing Excellence

P.O. Box 236, Tororo, Uganda
Gen: +256 - 45 444 8838
Fax: +256 - 45 4436517
Email: info@adm.busitema.ac.ug
www.busitema.ac.ug

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

FINAL YEAR PROJECT REPORT

By:

NAME: NKOOBE HASSAN

REG No: BU/UG/2018/2430

Email. *nkoobehassan21@gmail.com*

0777937110

TITLE: REAL-TIME MEDICAL COLD STORAGE MONITORING AND CONTROL SYSTEM

SUPERVISOR: DR. OWOMUGISHA GODLIVER

A project Report submitted to the Department of Computer Engineering in Partial Fulfillment of the Requirements for the Award of a Bachelors Degree of Science in Computer Engineering of Busitema University

January 2023

DECLARATION

I **NKOOBE HASSAN** BU/UG/2018/2430 hereby declare that this project report is my original work except where explicit citations have been made and has never been published and/or submitted for any other degree award to any other university or institution of higher learning for any academic award.

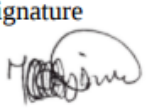
Sign .....

Date 1st/2/2023

APPROVAL

This is to certify that the project under the title "**Real-time medical cold storage monitoring and control system**" has been under my supervision and is now ready for examination.

Signature



Date ……31/01/2023……

DR. OWOMUGISHA GODLIVER

Department of computer engineering.

ACKNOWLEDGEMENT

I thank the almighty God for providing me with the life and knowledge that helped me complete this project.

Appreciation also goes to my colleagues for their support through group discussions and advice when needed, my supervisor Dr. Owomugisha Godliver, the Department of Computer Engineering for guidance and insight into concepts of research and project management as well as technical knowledge applicable in the design of the system and my parents for their financial support.

ABSTRACT

This report presents the implementation and results of Real-time medical cold storage monitoring and control system which employs a DHT11 sensor for temperature and humidity detection in pharmaceutical cold storage. This data can trigger short-term actions such as remotely controlling the freezing or heating of cold storage medications using two Peltier modules and relay switches (Relay switch 1 for Peltier module 1 and Relay switch 2 for Peltier module 2), one Peltier module is for heating and the other Peltier module is for cooling placed together. The two Peltier modules are connected to the H-Bridge motor driver. The H-Bridge changes the polarities of the Peltier modules by switching the relay switches forward and backward to maintain the temperature range of (2^0c-8^0c) such that when temperature drops below 2^oc, the H-bridge motor driver changes polarity of Peltier module to heating and when temperature is above 8^0c, the H-bridge motor driver changes the polarity of Peltier module to cooling to maintain the temperature range of (2^0c-8^0c) for the safety of cold storage medicines. The Buzzer sounds for out-of-range temperatures and humidity (above 65%).

The real-time sensor data from the medical cold storage is displayed on a mobile application on the pharmacist's mobile phone or tablet to allow the pharmacists monitor real-time temperature and humidity in the medical cold storage. The system employs an Arduino UNO board, a DHT11 sensor, and a Bluetooth module, which creates a wireless communication with the mobile phone or tablet to allow real-time monitoring of temperature and humidity.

The designed system helps medical personnel easily monitor the medical cold storage remotely without having them present at cold storage to visually take the readings of temperature and humidity of the cold storage.

I recommend it be used by medical personnel for the proper safety of cold storage medications in hospitals, pharmaceutical industries, medical laboratories, etc.

TABLE OF CONTENTS

Contents

LIST OF FIGURES

LIST OF ABBREVIATIONS

CAGR: compound annual growth Rate

DDL: Digital Data loggers

ECG: Electrocardiogram

I/O: input output

DHT: Digital Temperature and Humidity

IDE: Integrated Development Environment

CHAPTER ONE: INTRODUCTION

This chapter comprises of background, problem statement, justification, objectives and scope.

1.1 BACKGROUND

Medicines are chemicals or compounds used to cure, halt, or prevent disease; ease symptoms, or help in the diagnosis of illnesses. These days, medicines come from a variety of sources. Many were developed from substances found in nature, and even today many are extracted from plants. Some medicines are made in labs by mixing several chemicals. Others, like penicillin, are by-products of organisms such as fungus. And a few are even biologically engineered by inserting genes into bacteria that make them produce the desired substance [1].

Overall, global use of medicine has increased at a 3% compound annual growth rate (CAGR) since 2014, slowing from a 4% rate seen in 2009–2014. In 2019, patients globally received an estimated 1.8 trillion days of therapy or an average of 234 per person. The majority of medicine use is in pharmerging markets, which have large populations but have per capita rates of use still markedly lower than in higher income countries. Areas identified as global health priorities, such as diabetes and cardiovascular diseases, have seen significantly increased use of medicines [2].

Because of their importance in improving public health services, regulatory processes concerning their quality are necessary to ensure that intended treatment outcomes are met. For a medicine to qualify as safe and effective and to be of good quality, it should be properly labelled, stored, and transported. Refrigerated medicines are frequently disposed of in hospitals because of incorrect storage despite Good Distribution Practice guidelines. However, the incorrect storage and handling of refrigerated medicinal products may result in their unnecessary destruction and consequent financial loss for the hospital[3].

The typical storage conditions are separated into 4 types. First, the freezer-maintained temperature is between -25^0C to -10^0C. Second, cold conditions with the refrigerator's-maintained temperature of around 2^0C to 8^0C. Third, cool conditions with the refrigerator's-maintained temperature between 8^0C and 15^0C. Fourth, the control room kept the temperature around 20^0C-25^0C[4]. The relative humidity in the medical cold storage is required to be 65% or below independent of the temperature. Excessive humidity can lead to mold growth and label

REFERENCES

[1] "Understanding Medicines and What They Do (for Teens) - Nemours KidsHealth." https://kidshealth.org/en/teens/meds.html (accessed Jul. 16, 2022).

[2] "Global Medicine Spending and Usage Trends - IQVIA." https://www.iqvia.com/insights/the-iqvia-institute/reports/global-medicine-spending-and-usage-trends (accessed Jul. 16, 2022).

[3] L. Colberg, L. Schmidt-Petersen, M. K. Hansen, B. S. Larsen, and S. Otnes, "Incorrect storage of medicines and potential for cost savings," *Eur. J. Hosp. Pharm.* , vol. 24, no. 3, pp. 167–169, 2017, doi: 10.1136/ejhpharm-2015-000744.

[4] S. Poochaya and D. Widjaja, "Enhancing vaccine refrigerator temperature reporting system using iot technology," *Suranaree J. Sci. Technol.*, vol. 25, no. 3, pp. 225–234, 2018.

[5] "TPP Reference:," no. July, pp. 1–11, 2020.

[6] D. Marshall and A. Rees, "The Temperature Requirements for Medicines Storage," *Care Ispectorate*, no. 2, pp. 1–3, 2016.

[7] "How Should Freezer and Fridge Temperatures be Monitored for Research?" https://www.news-medical.net/whitepaper/20190329/How-Should-Freezer-and-Fridge-Temperatures-be-Monitored-for-Research.aspx (accessed Aug. 20, 2022).

[8] "Digital Data Loggers – California Vaccines for Children (VFC)." https://eziz.org/vaccine-storage/digital-data-loggers/ (accessed Jul. 28, 2022).

[9] "Fridge Temperature Log - Eupry." https://eupry.com/knowledge/fridge-temperature-log/ (accessed Jul. 28, 2022).

[10] A. I. Puy, "Bluetooth," pp. 1–20.

[11] L. Louis, "Working Principle of Arduino and Using it as a Tool for Study and Research," *Int. J. Control. Autom. Commun. Syst.*, vol. 1, no. 2, pp. 21–29, 2016, doi: 10.5121/ijcacs.2016.1203.

[12] "Temperature and Humidity Monitoring in the Pharmaceutical Industry -

SensoScientific.” https://www.sensoscientific.com/temperature-and-humidity-monitoring-in-the-pharmaceutical-industry/ (accessed Dec. 11, 2022).

[13] R. Hatchett, “The medicines refrigerator and the importance of the cold chain in the safe storage of medicines,” *Nurs. Stand.*, vol. 32, no. 6, pp. 53–63, 2017, doi: 10.7748/ns.2017.e10960.

[14] “Cold storage monitoring, walk in freezer monitoring | VackerGlobal.” https://www.vackerglobal.com/divisions/cold-chain-management/remote-temperature-monitoring/cold-room-monitoring/ (accessed Jul. 14, 2022).

[15] “How Should Freezer and Fridge Temperatures be Monitored for Research?” https://www.news-medical.net/whitepaper/20190329/How-Should-Freezer-and-Fridge-Temperatures-be-Monitored-for-Research.aspx (accessed Aug. 22, 2022).

[16] “Arduino Nano Board: Features, Pinout, Differences and Its Applications.” https://www.elprocus.com/an-overview-of-arduino-nano-board/ (accessed Jan. 02, 2023).

[17] HC-Bluetooth, “Bluetooth Module - User Instructional Manual,” *HC Ser. Bluetooth Prod.*, pp. 1–16, 2011.

[18] “DHT11 Sensor Pinout, Features, Equivalents & Datasheet.” https://components101.com/sensors/dht11-temperature-sensor (accessed Dec. 11, 2022).