APPLICATION OF SIMULTANEOUS THERMOELECTRIC COOLING AND HEATING TO IMPROVE THE PERFORMANCE OF A SOLAR STILL

SAID AL FARHAN BIN SA'ID AL-JIFRI

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SAID AL FARHAN BIN SA'ID AL-JIFRI

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

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Application of Simultaneous Thermoelectric Cooling and Heating to Improve The Performance of A Solar Still

Sesi Pengajian : 2021/2022

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Dr. Azdiana Binti Md Yusop
Pensyarah Kanan
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

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DEDICATION

A special dedication and gratitude to Allah, the Almighty God, for my success in completing this project in time and for giving me the strength to overcome any trouble during this project. Also, to my parents, Mr Sa'id Al-Jifri bin Ismawi and Nur Azlina Binti Baharudin, for supporting me in terms of moral and physical to finish the project. Then, to my supervisor, Dr Azdiana Binti Md Yusop, for always guiding and sharing opinions to make this project successful.

ABSTRACT

Solar still is a process of getting clean water from dirty by using the power of sunlight. There are various method to do solar still and one can be done using thermoelectric effect which able to directly converts different temperatures to electric voltage or vice versa via a thermoelectric module. Conventional solar still faces some problems as there are too many designs of solar still, depend on heat from the sunlight and surrounding humidity to collect clean water, and most do not have any monitoring system. This project attempts to increase the efficiency of the solar still by integrating the thermoelectric system into it, analysing water temperature and the level of clean water and developing a real-time monitoring system. The objective can be achieved using galvanised sheet metal and plexiglass to build solar still, WeMos D1 R2 as the main microcontroller, DS18B20 temperature sensor and Water Level sensor Arduino and Peltier thermoelectric TEC1-12706 as the main thermoelectric module. The results showed that the solar still had an increase in water temperature efficiency of 18.44 % compared to without the use of thermoelectric system.

ABSTRAK

Solar still adalah proses mendapatkan air bersih dari kekotoran dengan menggunakan kuasa cahaya matahari. Terdapat beberapa kaedah untuk melakukan penyulingan matahari ini dan salah satunya adalah menggunakan kesan termoelektrik yang mana ia mampu menukar nilai perbezaan suhu berbeza voltan elektrik atau sebaliknya melalui modul termoelektrik. Solar still konvensional masih menghadapi beberapa masalah kerana terdapat terlalu banyak reka bentuk, kebergantungan kepada haba daripada cahaya matahari dan kelembapan di sekeliling untuk mengumpul air bersih, dan kebanyakannya tidak mempunyai sistem pemantauan secara langsung. Projek ini bertujuan untuk meningkatkan kecekapan penyuling matahari dengan menyepadukan sistem termoelektrik ke dalamnya, menganalisis suhu air dan tahap air bersih dan membangunkan sistem pemantauan masa nyata untuk projek itu. Objektif boleh dicapai menggunakan kepingan logam tergalvani dan kaca plexiglass untuk membina penyuling matahari, WeMos D1 R2 sebagai sebagai mikropengawal utama, peranti suhu DS18B20 dan peranti aras air Arduino, termoelektrik Peltier TEC1-12706 sebagai modul termoelektrik utama. Hasil kajian menunjukkan bahawa penyuling matahari mempunyai peningkatan kecekapan suhu air sebanyak 18.44 % berbanding tanpa penggunaan sistem termoelektrik.

ACKNOWLEDGEMENTS

Praise be to Almighty God, Allah, for His reward and prayers, His messenger, Muhammad S.A.W, the descendant and family, and his noble companion.

Firstly, I want to thank my family for always supporting me in everything I have done. Even if they don't understand how engineering works, they always are there to give me the encouragement that I need. Never forget the love of my life, Nuraishah Binti Kamaruzzaman, for always supporting me in finishing the project, always understanding how my situation was finishing the project and providing some materials I couldn't get by myself. To my friend, Afiq, Ariff, Ammar, Shahmir, Amirul Hafiz, Firzan and Haziq, thank you for pushing me to the limit to finish the project on time. Without them, I will have a problem finishing the project. Next, I would like to thank my supervisor, Dr Azdiana Binti Md Yusop, who was eager to help and guide me through the project's two semesters and welcomed me as a student. Dr Azdiana was a pleasure to deal with. Her desire to help me meant I learned from and remedied my mistake during the assignment. Furthermore, the project will never be completed until all essential equipment and components are loaned.

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CHAPTER 1

INTRODUCTION

This chapter anticipates all aspects of the project, beginning with the problem to be solved and the end objective to be achieved. The problem statement will explain how the project tackles the issue for the main aim of the project. The main goal is what is needed to accomplish for the project to be done. The scope of work will show how the project is to be completed and the expected outcome as mentioned in the objective. The project methodology will show how the process flows for the project work and briefly explain the method used to complete the project.

1.1 Project Overview

Sunlight or solar energy is significant energy that has been used since the early civilisation of humans from farming, fishing, livestock, and map direction moving toward the present to be used in science and technology like nowadays, sunlight been used to power up house and industry by using the solar panel, making solar vehicles such as aircraft, cars, and ship. Solar energy has also been used in reducing carbon print technology such as solar still to purify dirty water to clean water, powering up water turbines at the dam to change into electricity and lighting up the street at night using a solar panel that has been charged up in the day.

Simultaneous application of thermoelectric cooling and heating to improve the performance of solar still is a system and device that want to enhance the already existing solar still nowadays.

1.2 Objectives

The goal of this project is to complete the objective, explore the gap, and present prototypes to achieve the following parameters:

a) To increase the efficiency of solar still by integrating the thermoelectric system into solar still.
b) To analyse the heat temperature for water evaporation and the level of the water collected
c) To develop real-time monitoring of the solar still

1.3 Problem Statement

Conventional solar still had the same problem throughout history since its making where its dependency on the heat from the Sun and the surrounding rate of humidity to collect water vapour trapped inside the solar still. Next is the design of the solar still, where there is much design when it's come solar still. Due to that, it has become a hassle for people who need to research how to make a solar still from scratch. As conventional solar still does not have any technology attached to it, no real-time monitoring happens when the collection water process is ongoing, so people can't know the exact amount of water collected after a total of time.

1.4 Scope of Work

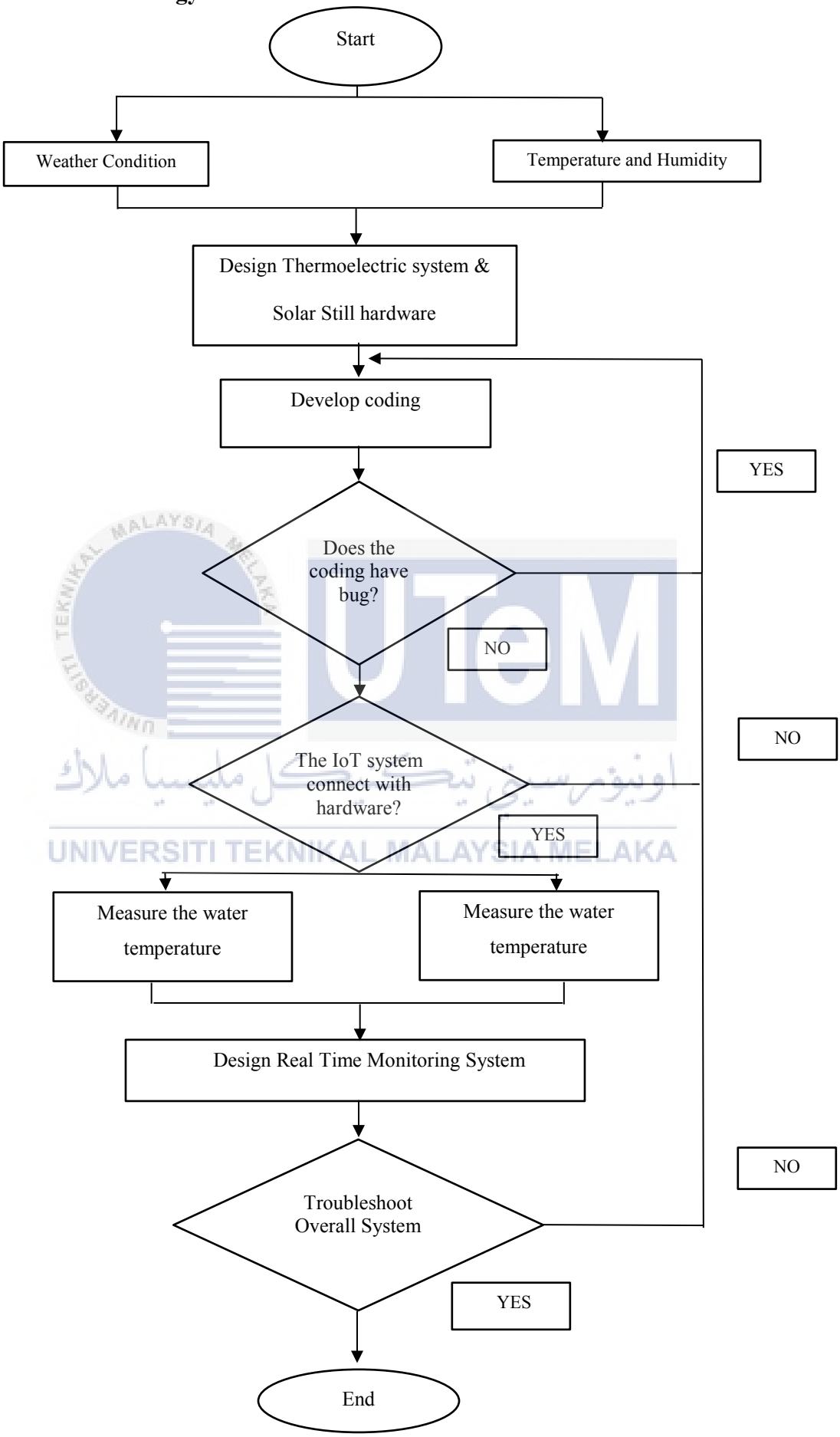
The project consists of 6 scopes of work that need to be completed. The first one is selecting the material to construct the solar still. Next is choosing the type of thermoelectric module or Peltier for the thermoelectric system to integrate into the solar still. After that, determine what kind of microcontroller to act as the central brain for the project Iot monitoring system and determine what IoT platform for the monitoring system. Then putting, the limit for the project, such as how many hours the project should run and how much water can be collected by that timeframe, has been limited according to the limit of the project.

1.5 Methodology Synopsis

This project consists of two compartments: the solar still with a thermoelectric module and a real-time monitoring system. The thermoelectric act as a water heater to heat water to rapid up the rate of evaporation of water to gas, and the gas that has been trapped in the solar still will go through the process of condensation to change into the water to be collected in a different container than the water that heats up by thermoelectric. To determine the efficiency of the thermoelectric cooling and heating, all data that have been monitored will be analysed and compared to the conventional solar still.

The project will utilise the power of sunlight while the heat from the thermoelectric to heat the water to increase the rate of evaporation of water per day. There will be a 12V dc power battery to power up the thermoelectric Peltier, an Arduino Wemos D1 R2 Uno ESP8266 IoT to control the temperature sensor and water level sensor, and the data obtained from the sensor will be sent through the IoT platform

1.5.1 Methodology Flow Chart



1.5.2 Methodology Synopsis

The development of this project consists of the solar tracking system and real-time data monitoring to finalize this prototype. The solar tracking system consists of an input of sensor that is used to detect the sun light and move the solar panels vertical and horizontal to the sun position directly. The light intensity is detected using LDR sensors on the top solar panel as the sensor input. There are four LDR sensors used to control two servo motor that move in vertical and horizontal position. The surrounding of solar tracker will collect the temperature using the temperature and humidity sensor so that the analysis of the solar energy efficiency can be done. The main component is programmable, which is a program-loaded Arduino microcontroller to make the servo motor obtain the input according to the reading from the LDR sensors to drive the solar panel.

The real time data monitoring is the system consists of the IoT platform to exposure the parameters collected from the solar energy absorbed by the solar tracker. The programmable component used is Arduino Wemos D1 R2 to link the interface for data monitoring from solar using the Thing Speak platform. In the Thing Speak platform, the voltage, current, and power that the dual axis solar tracker absorbs from the sun will be measured. The temperature and humidity sensor will be monitored using the Liquid Crystal Display LCD that also programmable in Arduino Wemos. This overall method is close to the complexity of the modular programme used because it ensures a simple understanding and easy approach, which is both reliable and logical. It also allows for errors which are considered and corrected separately.

1.5.3 Detail Description of The Methodology

I. Weather Condition, and Temperature and Humidity

Weather plays the central role in the project as the project depends on the Sun, sunlight, and heat to work. This is due to the rate of water collection happening to be high during sunny day and when it is cloudy or raining on that day, the water collection will drop down compared to the sunny day.

II. Thermoelectric System and Solar Still

The Thermoelectric System will consist of three thermoelectric Peltier powered by a 12V battery, where the three thermoelectric Peltier are for the heating side water container to heat the water to turn in into water vapour. The solar still will be trapping all the water vapour at the upper surface using glass, and when the water vapour goes through condensation, the water will go through the drainage to be collected into the cold side container.

III. IoT Real-Time Monitoring System

The monitoring system will be using WeMos D1 R2 Wi-Fi UNO Shield Based on ESP8266 to act as the main microcontroller. Then the system will connect to Thingspeak software as the central IoT Analytic platform that can analyse the data get from the sensor to know the current condition of the process.