Feasibility Study of Remotely Monitored and Controlled Soil Moisture Based Irrigation System

Submitted in accordance with the requirement of the University Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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I hereby, declared this report entitled “Feasibility Study of Remotely Monitored and Controlled Soil Moisture Based Irrigation System” is the result of my own research except as cited in references.

Signature	: ……………………………………
Author’s Name	: HO SU JEN
Date	: 1 June 2019

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

……………………................................

(Dr. Silah Hayati Binti Kamsani)

ABSTRAK

Tujuan kajian ini adalah untuk mengkaji kebolehlaksanaan sistem pengairan berasaskan tahap kelembapan tanah dari segi pemantauan dan pengawalan jarak jauh. Daripada kajian ini, sebuah sistem pengairan automatik telah dihasilkan dan dibina pada akhir projek ini berdasarkan maklumat, pengetahuan, teknik, dan kaedah yang diperolehi daripada pembandingan antara sistem-sistem pengairan yang sedia ada. Sistem pengairan automatik yang dihasilkan dalam kajian ini dapat mengatasi masalah pembaziran air, menjimatkan penggunaan air dan memudahkan kehidupan manusia dalam aktiviti agronomi. Beberapa kaedah yang terdapat di pasaran menggunakan pelbagai jenis komponen dan aplikasi yang berbeza. Sistem pengairan dengan sambungan secara tidak langsung antara pengguna dengan sistem pengairan adalah sistem yang paling sesuai bagi pengguna untuk memantau dan mengawal sistem pengairan dari jarak jauh. Berdasarkan sistem pengairan tanpa wayar automatik ini, pelbagai komponen yang digunakan dapat meningkatkan fungsi dan keupayaan sistem pengairan ini. Berdasarkan kajian ini, sistem pengairan automatik ini dapat menjimatkan 24% penggunaan air berbanding dengan sistem pengairan pemasa. Selain daripada penjimatan air, sistem ini juga mencapai penggunaan kuasa yang rendah kerana sistem ini dibina oleh komponen-komponen yang memerlukan input kuasa yang rendah. Prestasi dan keputusan system dikumpulkan dalam bentuk data tabulasi untuk dibandingkan dengan sistem pengairan yang sedia ada. Dari pembandingan tersebut, sistem automatik ini dapat mencapai penggunaan kuasa yang rendah, menjimat penggunaan air dan mudah diguna oleh pengguna serta terima di pasaran.

ABSTRACT

The aim of this study was evaluated the feasibility of a remotely monitored and controlled soil moisture-based irrigation system. From this study, an automated irrigation system was generated and constructed at the end of this project based on the information, knowledge, techniques, and methods by compared with the existing irrigation systems. This automated irrigation system able to overcome the problems of water wastages and to ease human life. Several methods available in the market using different kinds of components and serving different applications. This irrigation system with wireless connection between user and the irrigation system was on of the most suitable system for user to monitor and controlled the irrigation system from a distance. Based on this wireless automated irrigation system, various components were selected to enhance the functions and capabilities of this irrigation system. The performances of automated irrigation system provided accurate reading of soil conditions, surrounding temperature and humidity. This system also provided approximately 24% of water saving resulted compare to timer-irrigation system. Besides of water saving, this system also targeted to operate under low power consumption due to the system constructed by all the components that required low power input. The performances of this system were collected in a tabulate data to compare with existing irrigation system in order to prove the achievements low power consumptions, water saving and user-friendly system.

DEDICATION

Only

My father, Ho Tee Yong

My mother, Cheng Koon Kheng

My sister and brother,

Ho Hui Jean

Ho Hui Swen

Ho Su Yang

My supportive friends and classmates,

For giving me support, knowledge, encouragement, teamwork, responsible and love.

Thank you so much, Appreciated and Love.

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LIST OF ABBREVIATIONS

PCB	- Printed Circuit Board
TDR	- Time-Domain Reflectometry
FDR	- Frequency-Domain Reflectometry
VMC	- Volume Moisture Content
IoT	- Internet of Things
USB	- Universal Serial Bus
AC	- Alternative Current
DC	- Direct Current
IDE	- Integrated Development Environment
UARTs	- Universal Asynchronous Receiver-Transmitter
ICSP	- In Circuit Serial Programming
PLC	- Programmable Logic Control
CPU	- Central Processing Unit
PC	- Personal Computer
I/O	- Input/Output
PVC	- Polymerizing Vinyl Chloride
BOM	- Bill of Material
LED	- Light-Emitting Diode
kWh	- Kilowatt Hour
BOM	- Bill of Material
Ah	- Amp Hour
TNB	- Tenaga Nasional Berhad
SAMB	- Syarikat Air Melaka Berhad
Wi-Fi	- Wireless Fidelity
ICSP	- In-circuit Serial Programming
PWM	- Pulse width modulation

LIST OF SYMBOLS

ε_a	- Apparent Dielectric Permittivity
dS/m	- Conductivity Unit
m^3	- Cubic metre
cm	- Centimetre
v	- Volume
mV	- Millivolt
°*C*	- Degree Celsius
mA	- Milliamps
%	- Percent
mm	- Millimetre
VSW	- Volumetric Soil Water Contents
V	- Volt
D	- Diameter
MHz	- Megahertz
A	- Area
K	- kilo
m	- Metre
ml	- Millilitre
W	- Watt
A	- Ampere
RM	- Ringgit Malaysia
L	- Litre
μF	- Microfarad
Q	- Flow rate
g	- Gram
L m^{-2}	- Litre per metre square
kB	- Kilobyte

CHAPTER 1

INTRODUCTION

In the age of advanced electronics and technology, the life of human being should be simpler and more convenient. Thus, there is a need for automated systems that are capable for replacing or reducing human effort in their daily activities and jobs. There are several activities that required human's huge efforts. One of the activities that close to human daily life is agriculture activities, especially backyard planting, farming and harvesting.

1.1 Project Background

Plants are very beneficial to all human beings in many aspects. Plants helps in keeping the environment healthy by cleaning air naturally and producing oxygen. According to Tasneem (2018), due to civilization and insufficiency of place many people used to grow plants in a mould or dirt, pot, and placed on the windowsill. This plant depends on conventional breeding by watering and provided the right amount of sun to sustain life and growth. In busy schedule of day to day life, many time people forget to water their plants and due to this, plants suffer many disorders and ultimately died.

From the research of Cosgrove and Loucks (2015), in recent decades the percentage increase in water use on a global scale has exceeded twice that of population growth. This has led to more, and larger, regions in the world being subject to water stress where the current restricted rates of water use and consumption, let alone the desired rates, are unsustainable. World's biggest problem in modern society is the shortage of water resources, where agriculture activities consume large amounts of water. Thus, an eco-friendly system is required, to handle this task automatically so that water resources can be utilised in a proper way. According to the research from Đuzić (2017), automated plant watering system is an eco-friendly system that estimate and measure the existing plant and then supplies desired amount of water needed by that plant. It is minimising the excess water used as well as keeping plants healthy.

Automated Plant Watering System is a model of controlling watering facilities to help millions of people. However, according to Joaquin (2013), these automated plant watering systems have been shown to use 47% more water on average than sprinkler systems that are not automated for example hose and sprinkler, which can be attributed largely to the tendency to set irrigation controllers and not readjust for varying weather conditions. Irrigation control technology that improves water application efficiency is now available. In this context, soil moisture sensors can reduce the number of unnecessary irrigation events. Ragheid (2011) proposed a smart irrigation system for wheat in Saudi Arabia using wireless sensors network technology. The system consists of real-time sensor data acquisition, a decision module for calculating the optimal quantity and spread pattern for a fertilizer and an output module to regulate the fertilizer application rate. The system was proven to be cheap, reliable and simple to use. In 2014, Joaquin (2014) suggested an automated irrigation system to optimize water use for agricultural crops. The system has a distributed wireless network of soil moisture and temperature sensors placed in the root zone of the plants. It is also a gateway unit that handles sensor information, triggers actuators, and transmits data to a web application. The system was tested in a sage crop field for 136 days and the water savings is up to 90% compared with traditional irrigation systems.

All this model uses sensor technology with microcontroller or controller to make a smart switching device. The model shows the basic switching mechanism of water motor using sensors from any part of field by sensing the moisture present in the soil by soil moisture sensor. Besides, LCD used as the function to display the soil moisture level. Thus, the automated watering system will be connected to smart gadgets that allows user controls the system from distance.

Thus, replacing the conventional plants watering system by changing it into an eco-friendly automated irrigation system could ease human being’s life and makes agriculture activities easier compare to past. This improvements and innovations move planting activities a big step towards future and build up a good green environment that brings more benefits to the next generation.

1.2 Problem Statement

According to the concept of "Green Building Constructions" progressed well around the world, Malaysia as a growing country in construction sector also focused on building 'Green Building' across the nation. Most of the buildings are residential building that eco-friendly and aim for reducing dependence on non-renewable resources. Therefore, people are moving into this type of residential area for better living environment.

Go-green concept building aim to encourage human to take part in planting activities and build a healthy living environment. But due to human's busy schedules and bad weather conditions (hot weather), plants are not receiving regular watering system. Therefore, an automated plant watering system is suggested to counter this watering problem. However, conventional watering system example, hose and sprinkler lack of efficiency and causes unnecessary irrigation events. To ensure the automated plant watering system comes with efficient irrigation system, several types of irrigation system are compared to each other and the most effective irrigation system will be chosen and apply along with this automated watering system.

Besides, there's a significant phenomenon shows the young generation are leaving agriculture activities due to conventional planting system and this activity exposed to hot weather. Therefore, the aim of the ideal of connecting the automated plant watering system to smart gadgets is to attract the young generation by replacing conventional planting system with smart controller that able to control the watering system from distance and ease the planting activities without exposed to hot weather.

1.3 Objective

The objectives of the project are important to ensure the research will fulfil the solution of the problem research. All the objectives are shown as below:

i. To develop an automatic plant watering system controlled by digital controller
ii. To minimize the water wastages on plant watering system and make an eco-friendly product that kind to environment.
iii. To implement the automatic irrigation system by connecting it with smart gadgets to ease human's daily life activities.

1.4 Scope of the Project

The scope of this project will be fixed according to the requirements from the objectives. By referring to the first objective, this project focused on the development of an automated irrigation system that controlled by digital controller which used in human's daily life planting activities, such as backyard gardening. Besides that, the automated irrigation system also connected to smart gadgets that close to human daily's life, such as smartphone, tablet, laptop or other electronic devices for controlling the system from distance. Furthermore, this project focussed on the choice of irrigation system and sensor methods to control the usages of water source and electrical consumption to achieve the standard of eco-friendly product. Hence, this product tested at backyard open air gardening area that exposed to the natural soil and weather conditions for 30 days to record the performances of the system.