LED CIRCUIT DESIGN WITH IOT SYSTEM FOR AN OPTICAL SENSOR IN PRODUCT QUALITY MONITORING

MUHAMAD HAZIQ SYAHIR BIN SUFFIAN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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

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DR. HAZLI RAFIS BIN ABDUL RAHIM
Senior Lecturer
Faculty of Electronics and Computer Engineering
Universiti Teknikal Malaysia Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

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DEDICATION

This thesis is dedicated to my beloved parents, family members and supervisor for their endless support and encouragement

ABSTRACT

The optical sensing market is expected to witness market growth at a rate of 15.39% in the forecast period of 2021 to 2028. However, with the rapidly evolving optical sensing technology, most equipment has more sophisticated functions thus making every price of equipment in the system used become more expensive and difficult to operate. It is due to the equipment used in this field which are laser, fiber optic, modulator and lock-in amplifier which lead to higher investment in the system's application. The idea for this project was based on existing systems used in the industry sector by applying the same application but have few additional functions in terms of system, different electronic equipment used and price cost. The main objective is to design an LED circuit with an IoT system for an optical sensor in product quality monitoring. RGB LEDs are expected to be the light source in this application. It will be directed directly to the photodetector and will display the data received from the readings of each different light color source. Different color and thickness of transparent PVC sheet will be used as a product. Finally, all the collected data will be sent to the user's email using the IoT technology then doing research and analysis of each performance reading of all different types of transparent sheet with RGB light will be analyzed in terms of sensitivity, linearity and resolution.

ABSTRAK

Pasaran penderiaan optic dijangka akan menyaksikan pertumbuhan pasaran pada kadar 15.39% dalam tempoh ramalan 2021 higgan 2028. Namun dengan teknologi penderiaan optik yang berkembang pesat, kebanyakan peralatan mempunyai fungsi yang lebih canggih sekali gus menjadikan setiap harga peralatan dalam sistem yang digunakan menjadi lebih mahal dan sukar untuk dikendalikan. Ini kerana peralatan yang digunakan dalam bidang ini iaitu laser, gentian optic dan modulator yang membawa kepada pelaburan yang lebih tinggi dalam aplikasi ini. Idea bagi projek ini adalah berdasarkan sistem sedia ada yang digunakan dalam sektor industri dengan mengekalkan aplikasi yang sama tetapi mempunyai beberapa fungsi lain dari segi sistem, peralatan dan kos. Objektif utama adalah untuk mereka bentuk litar LED dengan sistem IoT untuk sensor optik dalam pemantauan kualiti produk. LED RGB sebagai sumber cahaya akan diarahkan terus ke pengesan foto dan akan memaparkan data yang diterima daripada bacaan setiap sumber warna cahaya yang berbeza. Warna dan ketebalan lembaran PVC lutsinar yang berbeza akan digunakan sebagai produk. Akhir sekali, semua data yang dikumpul kemudianya penyelidikan dan analisis setiap bacaan prestasi semua jenis helaian lutsinar yang berbeza dengan cahaya RGB akan dianalisis dari segi sensitiviti, leneariti dan pengesanan.

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LIST OF SYMBOLS AND ABBREVIATIONS

For examples:

RGB	:	Red Green Blue
LED	:	Light Emitting Diode
LCD	:	Liquid Crystal Display
IoT	:	Internet of Things
PCB	:	Printed Circuit Board
PVC	:	Polyvinyl Chloride
FODS	:	Fiber Optic Displacement Sensor
POFDS	:	Plastic Optical Fiber Displacement Sensor
IDE	:	Integrated Development Environment
UV	:	Ultraviolet

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CHAPTER 1

INTRODUCTION

In a variety of production processes and industrial sectors, color provides an important information that may be used to measure the product's color consistency or any other applicable measurement. There are several applications for color sensor including monitoring plant growth, detecting and identifying objects for robots, monitoring soil changes, grading fruit ripeness and etc. Moreover, in the realm of color sensing, one of the most common and straight forward functions of color sensors is to identify the color of an object for sorting purposes. In general, a color sensor is used to recognize unknown colors and classify them into the appropriate color groups. The fundamental operating principle of a color sensor is based on the concept of light reflection, such that when incident light is shone onto the surface of a material. A portion of the light will be reflected with a given intensity proportional to the surface color's brightness. The sensor will then sense the reflected light to measure the output intensity. The sensor then will detect the surface color on the RGB scale which the interaction outcome from the light source, an object and receiver.

1.1 Problem Statement

Over the past few years, measurement of thickness and color technology has become important in some areas of industries. Hence, the technology in this field needs to be in line with the passage of time so that optoelectronic field can be given more attention as one of the important technologies in today's industrial system. So the main idea for this project is to fix some of the problems in the existing system of this optical sensor technology. Among the problems that arise in the field of optical sensors are as follows :-

- The optical equipment used these two applications such as laser, modulator, lock-in amplifier and etc contribute to high cost optical sensor.
- The detection and measurement used are complicated and not suitable to be used at home or small industries.
- There is no IoT integration applied for these two optical sensors.

Most of the technologies are designed using laser technology as the light source in their systems. This causes the prices for both applications to be expensive and higher power to generate the light source. Other than that, there is no IoT integration applied for these two optical sensor technique. Thus, in this project RGB LED will be used as the light source where it can simultaneously reduce the overall cost of the optical sensor system. In addition, with the addition of the IoT system user can monitor the data and specifications of the tested sample.

1.2 Objective

The main objective of this research study is to analyze the possibility of the use of a simple and inexpensive optical device based in product quality monitoring. The following sub objectives have to be met :

- To design LED light source and photodetector circuits for an optical sensor for measuring thickness and color of the transparent flat surface.
- To integrate the designed optical sensor with the IoT platform.
- To experimentally analyze the optical sensor with IoT platform for measuring thickness and color of the transparent surface.

1.3 Scope of Project

The process of accomplishing the objectives has been subdivided into several steps. The first step is this project requires colored transparent PVC sheet, which come with variety of color and thickness. Next, prepare for the light source, RGB LED will be used. Three main colors will be used as the light source for this project which are red, green and blue. The light beams from the LED will be transmitted directly onto the transparent sheet and then received by the photodetector before it sends the information to the NodeMCU to produce an output in term of voltage value that later will be shown on the display and in the email platform as this project includes the IOT. There are also four other parameters that will be analyze which are sensitivity, standard deviation, linearity and resolution in order to determine the sensing performances.

1.4 Hypothesis

There are three major hypothesis that can be listed out for this research study which are :

- By using different color of LEDs as a light source (RGB) are expected to demonstrate different reading on PVC transparent sheets.
- In sensing different type of thickness and color of PVC transparent sheets is expected to produce different sensing performances by the optical sensor.
- The optical sensor system is expected to store and send the information into the cloud (email).

1.5 Report Structure

This thesis is organized and arranged into 5 major chapters. Initially, chapter 1 provides an overview of this work, outlining the project's aims and scope of the research study, as well as the problem statement, project's objectives and hyphothesis. Chapter 2 presents a theoretical assessment of related research, including an in-depth examination of optical sensor technology, the idea and also applications. This article reviewed a study on the use of LEDs as light sources in an optical sensor idea. The final section of this chapter discusses on the existence of IoT with optical and electrical sensors.

Chapter 3 details the methods used to accomplish the objectives of this project, which is separated into three sections. The first is to create LED light sources and photodetectors for the optical sensors. Secondly, integrate the designed optical sensor concept with the IOT platform which in this case e-mail will be used as the medium. The final methodology is to conduct an experimental analysis of an optical sensor paired to an IOT platform for the purpose of detecting the thickness and color of colored transparent sheets.

Chapter 4 examines and analyses the sensing data for various thickness and colour for PVC transparent sheet by a RGB LED. Graphs and tables illustrate the findings. Chapter 5 concludes with a conclusion and suggests additional research to improve the proposed technique.

CHAPTER 2

BACKGROUND STUDY

2.1 Optical Sensor

Optical sensors have become a major sensor technology in industrial use involving sensors due to their wide application due to the advantages available to them. Many outside applications have used optical sensor technology as an example of monitoring system in product quality, structural health monitoring and essential solution for monitoring harsh environments. Since their first development over this thirty years ago, they also found that security applications used this type of technology.