SEEDLING DIAMETER MEASUREMENT WITH APPLICATION OF INFRARED

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PROJEK SARJANA MUDA II

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Date	: **28 APRIL 2009**

Dedicated to my beloved mother, Khalijah Bt Awang,

supportive father, Ahmad B. Hamid

and

friend, Mohd Khalis Sulaiman.

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ABSTRACT

This project eventually developed a device in measurement of seedling. The project's aims are to develop an alternative device to measuring the seedling with more accurate and practical. Traditionally, measurement of seedling still in convention way which manually using a slide micrometer and recorded on paper. Here the diameter was obtained using the timing information generated by the shadow of an object passing a pair of receivers. The optical measurement circuit consists of sensor, signal conditioning and data acquisition system. Sensor fixture is designed based on an optical time-of-flight principle. Signal is transmitted from transmitter to the receiver and analog signal generated by sensor circuit will be converted to digital by using PIC Microcontroller. Serial communication is used to interface the digital signal to computer. The sensor detects the attenuation of light for the optical system. Diameter, D of seedling can be expressed in terms of the corresponding interruption times. Prototype circuit been implemented for optical measurement system. Visual Basic is sued as interface to measure the diameter. The data is collected using data acquisition system and it was offline process. This device can reduced damaged since it will not practically touch the seed itself. On practically, devices were tested using cylindrical objects with known diameters.

ABSTRAK

Projek ini adalah mengenai pembangunan alat yang digunakan untuk mengukur diameter anak pokok. Matlamat utama projek ini adalah membangunkan alat pengukuran sebagai alternatif untuk mengukur diameter anak pokok dengan lebih tepat dan praktikal. Sebelum ini dan sehingga sekarang masih lagi mengunakan cara manual untuk mengukur diameter anak pokok iaitu dengan mengunakan *slide micrometer* dan mencatatkan bacaan di atas kertas. Kini, alat ini akan mengantikan teknik lama yang digunakan. Bacaan diameter anak pokok diperolehi dari selang masa yang dijanakan oleh bayang-bayang objek semasa dan selepas melintasi sepasang penerima. Litar pengukuran optik mengandungi pengesan, *signal conditioning* dan sistem perolehan data. Kombinasi pengesan direka berdasarkan prinsip *time-of-flight.* Isyarat akan dipindahkan melalui penghantar ke penerima dan jenis isyarat yang dihasilkan dalam bentuk analog. Isyarat analog ini akan ditukarkan ke dalam bentuk digital oleh *PIC Microcontroller*. Komunikasi dalam laluan siri digunakan untuk menghubungkan antara isyarat digital dengan komputer. Pengesan akan mengesan cahaya yang dikecilkan dalam sistem optikal. Konsep perbezaan masa selepas melepasi pengesan digunakan untuk mengukur diameter anak pokok. Litar model percubaan dibina untuk diaplikasikan dalam sistem optikal. Perisian seperti Visual Basic digunakan sebagai mukaantara untuk mengira diameter anak pokok. Sistem perolehan data dilakukan secara *offline*. Alat ini boleh mengurang kerosakan pada anak pokok kerana ia tidak menyentuh sama sekali batang anak pokok. Pada peringkat ujikaji, objek berbentuk silinder yang ketahui diameter digunakan sebagai bahan ujikaji.

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D	-	Diameter
Δtf	-	Flank Separation Signal
Δtp	-	Pulse Width of a Single Receiver
R	-	Resistance
C	-	Capacitance
Vout	-	Voltage Out
μ m	-	Meter in micro
T	-	Temperature in Kelvin
λm	-	Wavelength in micro
kHz	-	Frequency in Kilo Hertz

LIST OF ABBREVIATIONS

TOF	-	Time of Flight
RISDA	-	Rubber Industries Smallholder Development Agency
DAS	-	Data acquisition system
VB	-	Visual Basic 6
*S*1	-	Sensor 1
*S*2	-	Sensor 2
IR_LED	-	Infra-Red Light Emitting Diode
DC	-	Direct Current
AC	-	Alternating Current
PIC	-	Peripheral Interface Controller
GUI	-	Graphical User Interface
MSSP	-	Serial Communication
I/O	-	Input/ Output
IDE	-	Integrated Development Environment
RAD	-	Rapid Application Development
DAO	-	Data Access Objects
RDO	-	Remote Data Objects
ADO	-	ActiveX Data Objects
MB	-	Mega Bit
USART	-	Universal Synchronous Asynchronous Receiver Transmitter

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CHAPTER 1

INTRODUCTION

1.1 Overview of the Time of Flight Process

The measurement of diameter provides an important inspection method in research and development especially in agriculture field. Various methods have been employed for measuring the diameter. It has been interest in many research to describe the characteristic diameter using method that are low cost and suitable for optically opaque system. Thus, infrared technique applying time of flight process holds good potential for matching the requirement.

The time of flight (TOF) describes the method used to measure the time that it takes for a particle, object or stream to reach a detector while traveling over a known distance. Here time-of-flight measurement principle relies on the shadow casting effect of an object on a pair of receivers. (Computers and Electronics in Agriculture. 2006; 52: 60–70)

Optical time-of-flight sensors consist of two light beams projected into the object whose detection is either interrupted or instigated by the shadow casting effect of an object on a pair of receivers. The diameter of the object is calculated by knowing the time differences between the two beams. Four distinct events in time can be distinguished when the object passes the light beams using 2 sensors.

1.2 Objectives of the Project

The aims of this project are to develop an alternative device in measuring the seedling which more accurate and practical. Also design the low-cost measurement device using optical sensors. Specifically the objectives of this project are:

- To investigate simple measurement of diameter using optical sensors.
- To design and develop electronic measurement system which consist application of electronic components and application of microcontroller.
- To implement output of the project into related field.

1.3 Scope of the Project

Basically, this project covers on the agriculture fields. This device will be use widely for researcher of Rubber Industries Smallholder Development Agency (RISDA) in measuring the growth of seed. This project is divided into two stages, which are:

1.3.1 Stage 1: Hardware Development

Firstly literature review on the concept of diameter measurement technique using optical sensors been revised. In this technique there were four methods can be use as approach to measure the diameter. Since each of this method has advantages and disadvantages, so combination of these methods been apply in order to achieve the project's objectives. Second, the selection of sensors and design sensors' fixture are made. Than the signal conditioning circuit are designed and tested. Finally, the diameter of seedling in term of time been measured.

1.3.2 Stage 2: Software development

At this stage, the designing of graphical user interface will be made by using Visual Basic 6. Value of time differences been calculated and display. Then, the results are analyzed and finally completed the project.

1.4 Project Planning

This project is implemented base on the project planning schedule. The project starts from July 2008 to April 2009. The project planning schedule is presented in Appendix A.

1.5 Project Outline

Chapter 1 presents an overview to time of flight process, the objectives of the project, project planning and project outline.

Chapter 2 covers the literature review on the time of flight process for optical sensors and the optical principle.

Chapter 3 elaborates in details the optical system methodology, the hardware and software development and the techniques used to display the diameter profiles.

Chapter 4 discusses the result obtained from testing and problem occur during the whole project been done.

Chapter 5 presents the overall conclusion and suggestion for future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The main objectives of this chapter are to review the literature regarding the optical and its basic theories.

2.2 Time of Flight Process

The photo-interrupter based time-of-flight measurement principle relies on the shadow casting effect of an object on a pair of receivers. [1] Figure 2.1 shows four distinct events in time can be distinguished when the object passes the light beams. At time $t1$ the object reaches the upper light beam and blocks receiver $S1$ and at $t2$, the object reaches the lower light beam and blocks receiver $S2$. Similarly, at time $t3$ the object unblocks receiver $S1$ and at time $t4$ the object unblocks receiver $S2$. The receivers $S1$ and $S2$ are binary optical switches.

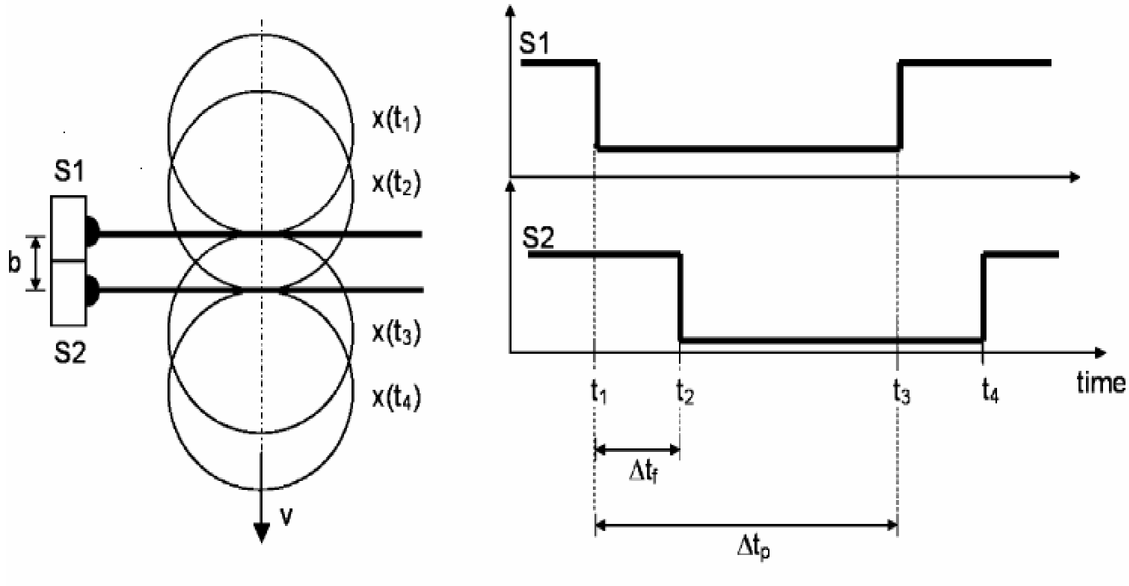

Figure 2.1: Relationship between the motion $x(t)$ of an object passing through a dual light beam sensed by a photo-receiver pair $S1$ and $S2$ (left) and their signal output timing.

$$b = x(t2) - x(t1) \quad (2.1)$$

and

$$D = x(t3) - x(t1) \quad (2.2)$$

For convenience, the timing differences were defined as follows:

$$\Delta t\mathrm{f} = t2 - t1 \quad (2.3)$$

$$\Delta t\mathrm{p} = t3 - t1 \quad (2.4)$$

2.3 Sensor System

Strictly speaking, a sensor is a device that receives a signal or stimulus and responds with an electrical signal, while a transducer is a converter of one type of energy into another. In practice, however, the terms are often used interchangeably. Sensors and their associated circuits are used to measure various physical properties such as temperature, force, pressure, flow, position, light intensity, etc. These properties act as the stimulus to the sensor, and the sensor output is conditioned and processed to provide the corresponding measurement of the physical property especially sensors which involved with process control and data acquisition. Sensors do not operate by themselves. Generally part of a larger system consist signal conditioners and various analog or digital signal processing circuits. The system would be a measurement system and data acquisition system.

Sensors may be classified in a number of ways. From a signal conditioning viewpoint it is useful to classify sensors as either active or passive. On the other hand, passive (or self-generating) sensors generate their own electrical output signal without requiring external voltages or currents. Examples of passive sensors are thermocouples and photodiodes which generate thermoelectric voltages and photocurrents, respectively, which are independent of external circuits. It should be noted that these definitions (active vs. passive) refer to the need (or lack thereof) of external active circuitry to produce the electrical output signal from the sensor. It would seem equally logical to consider a thermocouple to be active in the sense that it produces an output voltage with no external circuitry.

However, the convention in the industry is to classify the sensor with respect to the external circuit requirement as defined above. The full-scale outputs of most sensors (passive or active) are relatively small voltages, currents, or resistance changes, and therefore their outputs must be properly conditioned before further analog or digital processing can occur. Because of this, entire classes of circuits have evolved, generally referred to as signal conditioning circuits. Amplification, level translation, galvanic isolation, impedance transformation, linearization, and filtering are fundamental signal conditioning functions that may be required. Whatever forms the conditioning takes, however, the circuitry and performance will be governed by the electrical character of the sensor and its output. Accurate characterization of the sensor in terms of parameters appropriate to the application, e.g., sensitivity, voltage and current levels, linearity, impedances, gain, offset, drift, time constants, maximum electrical ratings, and stray impedances and other important considerations can spell the difference between substandard and successful application of the device, especially in cases where high resolution and precision, or low-level measurements are involved. [2]

2.4 Optical sensor system

Optical sensor system consists of photodiodes. Photodiodes may be biased and operated in two basic modes: photovoltaic and photoconductive. In the photovoltaic mode, the diode is attached to a virtual ground preamplifier and the arrival of photons causes the generation of a voltage which is amplified by the op-amp. The primary feature of this approach is that there is no dc-bias across the diode, and so there is no basic leakage current across the diode aside from thermally generated currents. Figure 2.2 shows configuration does suffer from slower response because the charge generated must charge the capacitance of the diode, causing an R-C delay.

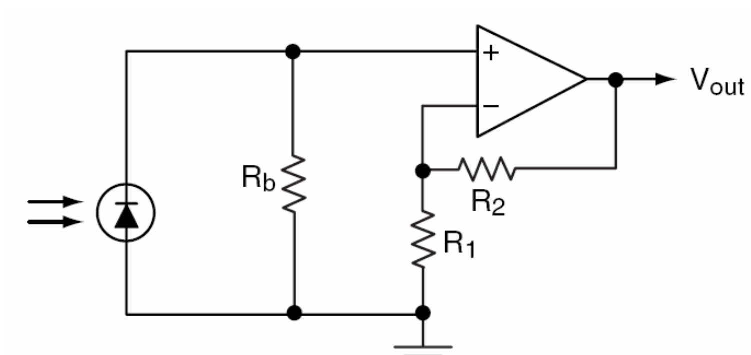

Figure 2.2: Connection of a photodiode in a photovoltaic mode.