DEVELOPMENT OF OPTICAL SENSOR IN MEASUREMENT OF APPLE QUALITY

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Dedicated to …..
My beloved father and mother, Ahmad Bukri and Salmah Ishak
Who has so much faith in me
Love you always…..

Also to my beloved sisters and brother, Nurhidayah, Nur'Atiqah and Muhammad Athari
I could have never done it without you…..

To all my friends, who have stood by me through thin and tick
I treasure you all…..

Thanks for showering me with love, support and encouragement
Life has been wonderfully colored by you…..

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ABSTRACT

A non-contact Near Infrared Spectroscopy (NIRS) techonology is used for measurement of apple quality by employing a diffuse reflection of fiber optic probe, whereby this technology has been widely used as an analysis method of agriculture, food etc due to low cost, minimal sample size and faster. The spectrum of NIR from apples samples will be scanned at hundred wavelengths in diffuse reflectance mode by a cooled InGaAs array spectrometer. In lieu of NIR's reflection, the spectrum will be analyzed as of to determine soluble sugars of apple which will be reflected accordingly based on the composition of soluble sugar that available in apples. Those spectrums were sensitive to groups of O-H, C-H which located in Near-IR region (1100-2500nm). This non-invasive NIR spectroscopy with a fiber optic reflection probe has an advantage for non destructive fruits (apples) when determining their quality. The calibration of the devices is very important for each time setup as of to exclude background noise be it dark or bright light from surrounding. The low cost spectrometer had shows a serious simplification with a good approach of optical knowledge been leveraged throughout the entire projects

ABSTRAK

Pendekatan terbaru melalui teknologi NIRS (Near Infrared Spectroscopy) secara tidak bersentuhan telah mengalami perkembangan sains yang aggresif terutamanya di dalam bidang pertanian di mana ianya digunakan secara terkawal utk memantau kualiti buah-buahan import melalu penggunaan fiber optik. Penggunaan fiber optic dipertingkatkan kajian dan penggunaan menggunakan teknik pantulan cahaya kerana disebabkan kos rendah, saiz sampel yang rendah dan cepat. Contohnya dalam industri epal, NIR spektrum di pantulkan ke spektrometer setelah cahaya NIR di serap oleh ikatan molekul mengikut frekuensi ikatan kimia buah-buahan. Pantulan ini di prosess oleh pengumpul cahaya yang diperbuat daripada InGaAs detector yang kemudiannya di analisis mengikut peratusan pantulan komponen buah-buahan. Perkara penting yang perlu di ambil kira sepanjang pengkajian ini adalah dari segi konsistensi jarak semasa proses pemasangan dan juga memastikan faktor-faktor luaran dikenalpasti di peringkat awal dan tidak diambil kira semasa analisis. Spektrometer berkos rendah ini adalah pendekatan baru yang berjaya mengetengahkan konsep-konsep yang mudah dan secara tidak langsung telah mengurangkan kos-kos yang tidak diperlukan dalam industri pertanian

LISTS OF APPENDICES

CHAPTER 1

INTRODUCTION

1.0 Introduction

Fruits are a dessert in which people are looking into a fresh and good quality of it and by having said so, fruits industry are really looking into some system in which able to measure fruits quality non destructively. They are rich in organic glucose, fructose, and sucrose and so on. The organic acids are important internal quality parameters of fruit. Nowadays, food safety and quality detection contracted more and more attention for both consumers and industries in the producing process or the source of raw materials.

Acetic acid is one of the most important organic acids in fruit and in some countries, the quality evaluation of fruits had been implemented by chemical analysis or sensory analysis, such as pyrolysis-mass spectrometry, ion-selective electrodes, gas chromatography , electronic nose, atomic absorption spectrum , high resolution H NMR spectroscopy and so on. However, these methods were time consuming, laborious and costly and not convenient enough for quality evaluation of fruit such as apples. Therefore, it was very necessary to develop a new and fast detection method for fruits sugar content.[4]

Above all the techniques, NIR spectroscopy technique is very close to practical use. It has been contributed to development and wide use of sorting and grading technology during the last 10 years.

1.1 Principle of NIR Spectroscopy

The electromagnetic spectrums cover large range of photon energies which include optical properties (400-2500nm) as shown in Figure 1.1.

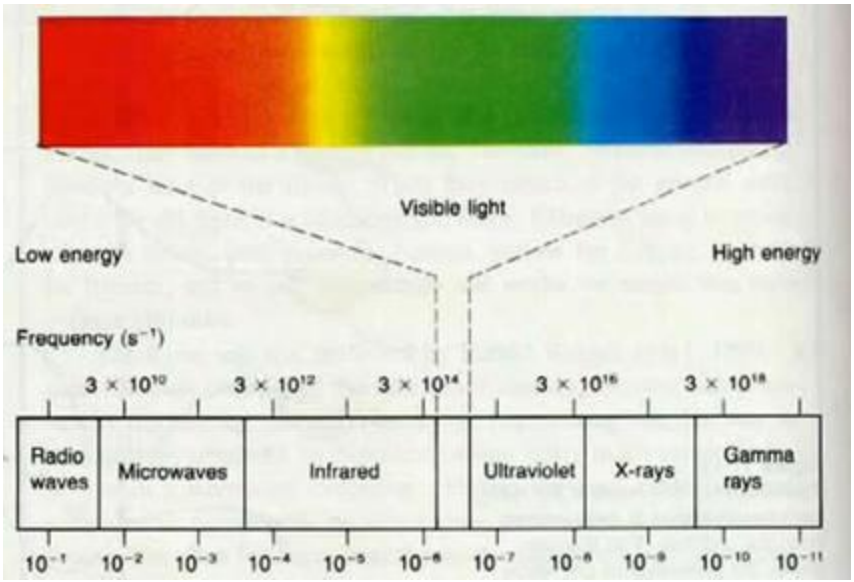

Figure 1.1 : Electromagnetic spectrums

These optical properties are based on reflectance, transmittance, absorbance, or scatter of light as shown in Figure 1.2. When a light beam falls on apples, part of the incident beam is reflected by apples surface. Some remaining radiation is transmitted through the surface into the cellular structure where it is scattered by small interference within the tissue or absorbed by tissue. The absorbed portion of radiation can be transformed to other forms of energy such as heat. Thus, part of the transmitted energy is absorbed, some parts is reflected back to the surface and remaining parts is transmitted through the object.[2]

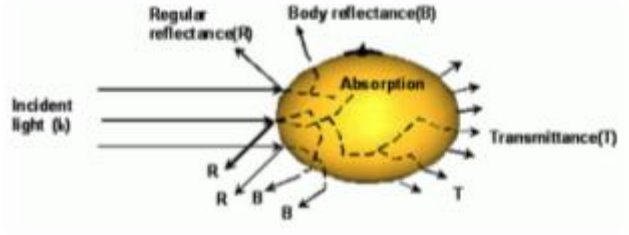

Figure 1.2: Reflectance, absorption and transmittance method

Near Infrared (NIR) spectroscopy deals with irradiating the apples with NIR light and with collecting and analyzing the absorbance spectrum. There's few advantages of NIR such as this radiation is highly penetrative and thus can be applied to the sample without any preparation, the spectra are not very discriminitive but it can give quantitative information on apples components. This NIR spectrometer consists of light source, wavelength selector and detector. Those are classified to reflectance measuring method. For this case, reflectance measuring method will be used such as the detector is located in the same direction with light source. When apples are illuminated by light source, the scattered reflected radiation is measured by detector as illustrated in Figure 1.3. Diode array sensor used to measure the intensity of the radiation at each wavelength. While, the concentrations of the components are calculated from the radiation intensity by using previously developed calibration analysis. This reflectance method can be used for apples since it have a thin peel as the limitation of this reflectance method is to the body of reflectance which means it is not very accurate for any thick peel fruits.[4]

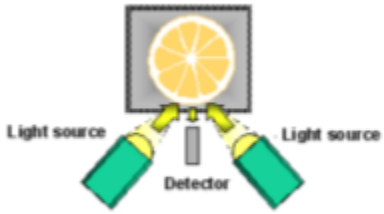

Figure 1.3: Illustration of light source, detector and sample

1.2 Problem Statement

Apples are one of the most important fruits in which they are the sources of energy and nutrients, thus it is highly important for the food industries to monitor the quality itself. This can be monitored using either manual or automated inspection, whereby the quality of inspection is very important procedure on grading the fruits. Manual, or traditional visual inspection apply-by-apple is very highly labor intensive in which might lead of having probability of human errors and variability.

Hence, a machine vision system is needed for automatic online defects as of to speed up the inspection procedure. And what available in markets nowadays is very expensive vision system which is based on their special architectures, processor boards and hardware configuration. This expensive vision system is highly unaffordable for small factory as its benchmark a traditional concept of spectroscopy, which using few mirrors, detectors, offline measurement and destructively. Thus, there is a need to design a low cost and efficient automatic system which can sort out the apple's quality using a non-destructive technique.

1.3 Objective

There are three main objectives of this research, as stated below:

1. To develop fiber optic sensor in measuring apples quality without destructing the fruits
2. To distinguish good and bad apples in agriculture industry
3. To develop low cost, cheaper, reliable and throughput devices

1.4 Scope and Project Background

A non-contact Near Infrared Spectroscopy (NIRS) technology is used for measurement of apple quality by employing a diffuse reflection of fiber optic probe, whereby this technology has been widely used as an analysis method of agriculture, food etc due to low cost, minimal sample size and faster. The spectrum of NIR from apples samples will be scanned at hundred wavelengths in diffuse reflectance mode by a cooled InGaAs array spectrometer. In lieu of NIR's reflection, the spectrum will be analyzed as of to determine soluble sugars of apple which will be reflected accordingly based on the composition of soluble sugar that available in apples. Those spectrums were sensitive to groups of O-H, C-H which located in Near-IR region (1100-2500nm). This non-invasive NIR spectroscopy with a fiber optic reflection probe has an advantage for non destructive fruits (apples) when determining their quality. The calibration of the devices is very important for each time setup as of to exclude background noise be it dark or bright light from surrounding.

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