UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SURFACE ROUGHNESS MEASUREMENT BY USING IMAGE PROCESSING BASED TECHNIQUES

This report submitted in accordance with requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Robotic and Automation) (Hons)

By

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics & Automation) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Penglihatan mesin adalah teknologi dan kaedah yang digunakan dalam penyediaan spesimen berdasarkan pengimejan yang digunakan untuk menganalisis imej untuk aplikasi seperti pemeriksaan automatik, kawalan proses dan bimbingan untuk robot dalam industry. Penglihatan mesin meliputi skop yang melebih luas bergantung pada kegunaan yang berbeza. Dengan menggunakan penglihatan mesin, teknik pemprosesan imej digunakan secara meluas hari ini. Dalam kajian ini, Teknik pemprosesan imej digunakan untuk meramalkan nilai kekasaran permukaan (Ra) dengan menggunakan nilai min tahap kelabuan dikira dari imej yang ditangkap menggunakan sistem penglihatan. Gambar akan diproses menggunakan perisian MATLAB untuk mencari nilai paras kelabuan min imej. GUI boleh dibangunkan dengan menggunakan perisian MATLAB untuk memudahkan pengiraan min nilai tahap kelabuan pada imej. Kekasaran permukaan spesimen diukur menggunakan profil stylus, Dengan menggunakan data kekasaran permukaan dan nilai min tahap kelabuan, satu persamaan dihasilkan iaitu persamaan garis lurus untuk mencari hubungan antara kedua-dua tersebut, dengan menggunakan persamaan garis lurus, kekasaran permukaan baru dapat dicari berdasarkan data yang ada. (Ra) baru berdasarkan garis persamaan linear akan dibandingkan dengan nilai yang diukur menggunakan profil stylus untuk mencari peratusan ralat untuk setiap data yang dikumpul. Dalam usaha untuk mengesahkan kebolehpercayaan kaedah ini, kesilapan yang dibenarkan maksimum ditetapkan untuk 10% dan lebih rendah. Kaedah ini menunjukkan bahawa dengan menggunakan nilai min tahap kelabuan, ia adalah mungkin untuk meramalkan kekasaran permukaan spesimen.

ABSTRACT

Machine vision is a technology and method used in specimen preparation based on imaging that used to analyze image for an application like automatic inspection, process control and guidance for robot in the industry. Machine vision covers a wider area which based on what application it's being used for. By using machine vision, image processing technique is widely used these days. In this work, the image processing technique is used to predict values of surface roughness (Ra) by using the mean gray level value calculated from an image captured using a vision system. The image is processed using MATLAB software as to find the mean gray level value of an image. The GUI also can be developed using the MATLAB software in order to ease the calculation of mean gray level value on an image. Surface roughness of specimen are being measured using the stylus profile. Using the surface roughness data and mean gray level value, it is possible to find the relationship between those two data and generate a regression line. By using the regression line equation, new surface roughness based on the linear equation line can be calculated. The new Ra based on the linear equation line will be compared with the value measured using stylus profile as to find the percentage of error for each data collected. In order to validate this method realibility, the maximum allowable error are set to 10% and lower. This method shows that by using the mean gray level value, it is possible to predict the surface roughness of specimen.

DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents, Wan Jusoh and Saadiah whose words of encouragement and a push for tenacity ringing in my ears. I also dedicate this dissertation to my many friends and family who have supported me throughout the process. I will always appreciate all they have done, especially supervisor En Ruziadi for helping me develop my knowledge in this project. I dedicate this work and give special thanks to my best friend Che Mohd Hamzah for helpful being there for me throughout the entire bachelor program.

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Chapter 1

Introduction

Background of Study

Surface roughness have three elements must be identified in accordance with the wavelength or frequency. For low, medium and high frequency variations of different square sizes are referred to as type, waviness and roughness separately. Any surface continues to have three of these components together and to analyze these components need one by one (Mooneghi, Saharkhiz, & Varkiani, 2014). In addition, the surface roughness should consider the determinants of work satisfaction of machined parts (Jeyapoovan & Murugan, 2013).

Surface roughness is a very important underlying downside like friction, contact deformation, warmth and current physical phenomenon, tightness of joint and point accuracy. According to (Zhang, Chen, Shi, Jia, & Dai, 2008), surface roughness is a very important factor to evaluate machining work items to its impact on friction, wear, corrosion resistance. And the variation of surface roughness of a work piece may indicate some variations of the manufacturing process or tool wear. Surface roughness, waviness, and lay are geometrical value of surface quality and they are manner as criteria for the recognition of finished, the characteristics of finished surface can determine the fit and function of the part in larger machine or assembly. Surface roughness is an important factor in determining the satisfactory functioning of the machined components (Jeyapoovan & Murugan, 2013). Workpiece surface finish quality is a key issue on the manufacturing industry and the workpiece surface roughness inspection is a very important technology. Basically, the measurement of surface roughness can be divided into two approaches,methods of direct and indirect (B. Y. Lee & Tarng, 2001). For the direct contact a traditional method to measure the surface roughness based on the stylus profiles, this method using contact nature and give defect of scratching to work pieces, this method also unfit for online application for the slow speed. For the indirect method uses optical instruments which are inherently non- contact measurements and easy to automate (B. Y. Lee & Tarng, 2001). Over the years, a number of texture feature extraction strategies are developed, each of them getting data in a way that is very different. for example, the classic strategy, such as co-occurrence matrix, Gabor filters or approach supported wavelet transform. Recently, several alternative approaches developed to inspect the relationship between pixels in a pattern texture, such an approach supports advanced network theory, the trajectory made by walkers completed, and analysis form (de Mesquita Sá Junior & Ricardo Backes, 2012).

The parameters are the most important characterise to measurement surface roughness is Average Roughness (Ra). Parameter for surface texture is Average Roughness (Ra). Ra is calculated by an algorithm that measures the average length between the peaks and valleys and the deviation from the mean line on the entire surface within the sampling length. The geometrically it can be represented as the total ruled area divided by evaluation length L.

To measurement the surface roughness in this procjet machine vision techniques applied. Machine vision-based techniques are suitable for online inspection of surfaces of machined parts and are safe on surfaces being measured and the measuring system (Jeyapoovan & Murugan, 2013). Image processed using a computer is digitized first, after which it may be represented by a rectangular matrix with elements corresponding to the brightness at appropriate image locations using machine vision approach (Jeyapoovan & Murugan, 2013).

1.1 **Problem statement**.

In today manufacturing, surface roughness is the important factor to the surface finish. Lots of method can be used to measure the roughness. Direct contact method make use of physical contact between workpiece and measuring apparatus but this method consume a lot of time. This project focus on indirect method to measure the surface roughness using vision system

1.2 Objectives of Study

I. To develop MATLAB code to calculate mean gray level value for images.
II. To predict the surface roughness of metallic surface using linear regression.

1.3 Scope of Study

This project used the image processing method to detect scratches on the metal surface.

Chapter 2

LITERATURE RIVIEW

2.1 Introduction

Chapter two discusses previous studies in the field of machinery that involve surface roughness on the work piece and the techniques have been applied to measure. The detail review of the method of measurement the surface roughness will be shown in this chapter about the information from different kind of sources such as the reference book, journal, internet, etc. will be used. The information also used to design the methodology section, in this section will focus on machine vision system use for measuring the surface roughness.

2.2 Surface roughness measurement

The procedure could be a post-process approach, applied in off-line and not amenable to automation, and therefore the activity is additionally comparatively slow. In recent years, the modeling and prediction issues of surface roughness of a work by computer vision in turning operations have received a great deal of attention. Although, surface roughness is powerfully characterised has been shown by the surface image, however the sensible surface roughness instruments supported computer vision technology area unit still troublesome (K.-C. Lee, Ho, & Ho, 2005)

2.3 Computer vision

Computer vision technology has maintained tremendous vitality during a ton of fields. New applications still be found and existing applications to expand. Many investigations are performed to examine surface roughness of a piece of work supported pc vision technology. Though it's been shown that the surface roughness of a workpiece is strongly characterised by the surface image,sensible surface roughness instruments supported computer vision technology are still tough (B. Y. Lee & Tarng, 2001).

2.4 Contact method

For these methods, to make the measurement process, the sensor comes in contact with the surface and calculate the parameters.

2.4.1 Stylus technique

As the stylus scans the surface, the pick-up converts the mechanical movement of the stylus to an electrical signal (via transducer) which is transmitted to the computer. The stylus is not mathematical point, it has finite dimension. According to ISO standards a stylus may have an included angle of 60 or 90 degrees and a tip radius of curvature of 2, 5 or 10 micrometers. The stylus tip radius is very important in measuring of surface topography. The so-called mechanical filtration is done during the stylus tip movement. The effect of tip radius is larger than the influence of flank angle. This mechanical filtration effect is similar to low-pass digital filtration.

2.5 Non-contact method

There are many techniques to measure the surface roughness in non-contact ways. There is no contact between the sensor and surface with any of these methods.

2.5.1 Light scattering

A light beam of a certain wavelength is created incident on the surface under test at a controllableangle of incidence. once the surface is ideally swish, the incident light-weight is reflected in thesecular direction, specified the angle of incidence equals the angle of reflection. once the surface is rough, a locality or all of the incident beam are scattered away from the reflective region, providing a diffuse beam (Manoj& Shivakumar, 2010). Light scattering has been used of finding the surface characterization of machined surfaces.used plane polarized light and a scatter light detector for surface characterization. Have a the two methods the angular-resolved scatter (ARS) and total integrated scatter (TIS), the two methods based on light scattering to measure surface roughness. In ARS method, the theoretical expression of ARS against surface roughness involves the state of polarization of the incident light. In TIS method, the light that scatters into a hemisphere from the surface being investigated is collected and measured using a scatter light detector for surface roughness measurement(Jeyapoovan & Murugan, 2013). When the surface is rough, a part or all of the incident beam will be scattered away from the specular region, providing a diffuse beam.

2.5.2 Laser speckle image

Laser speckle been thought-about within the study of the surface since the invention of the optical maser in 1960. once a beam of coherent light-weight (laser) emitted to a rough surface, a speckle image is obtained from disturbance with the scattered light-weight attributable to fluctuations inspatial a rough surface.

Some optical maser speckle techniques were developed to guage the surface roughness.. light-weight scattering caused by surface roughness and then forth specklepictures obtained is also accustomed live the surface roughness(Jeyapoovan & Murugan, 2013). Developed to evaluate the surface roughness.. Light scattering caused by surface roughness and so forth speckle images obtained may be used to measure the surface roughness(Jeyapoovan & Murugan, 2013).

2.5.3 Machine vision

The illumination plays a very important role within the machine vision system for capturing image. evaluated the influence of lighting supply, like grazing angle and distance between light and specimen, on optical surface end parameters extracted from image (Z. Zhang, Chen, Shi, Ma, & Jia, 2009). in several manufacturing, Machine vision has been very successfully employed to apply including to material handling, assembly and inspection (Manoj& Shivakumar, 2010). Machine vision-based techniques area unit appropriate for on-line examination of surfaces of machined components and area unit safe on surfaces being measured and therefore the measuring instrument. Used a vision system to get surface pictures and quantified the surface roughnessemploying a multivariate analysis. the common grey value (Ga) of the surface image was calculated and calibrated with the various average surface roughness (Ra) of the surface measured by the stylus. Used the Gray Level Co-occurrence Matrix (GLCM) method.This method considers the spacial relationship of pixels on the surface image. Surface roughness is extracted by exploring the relationships of average surface roughness (Ra) with the options of GLCM of the surface image (Jeyapoovan & Murugan, 2013).

2.6 Journal mapping

Based forty journals used to create the mapping. From mapping, extraction was made through the journal is divided into nine such as the years, the title, author, sources, the application follows by parameter and method, when find all items the summary have made. The journal mapping develops to guidance in this project. The table 2.1 show the list of journal has be used in this researah.

Refer appendix A table for journal summary

Table 2.1:List of journals

No	Title
1	A neural network-based machine vision method for surface roughness measurement.
2	Surface roughness prediction using hybrid neural networks.
3	A vision-based approach for surface roughness assessment at micro and nano scales.
4	Accurate estimation of surface roughness from texture features of the surface image using an adaptive neuro-fuzzy inference system.
5	An overview of optical methods for in-process and on-line measurement of surface roughness.
6	A neural network-based machine vision method for surface roughness measurement.
7	Surface roughness prediction using hybrid neural networks.
8	A vision-based approach for surface roughness assessment at micro and nano scales.
9	Accurate estimation of surface roughness from texture features of the surface image using an adaptive neuro-fuzzy inference system.
10	An overview of optical methods for in-process and on-line measurement of surface roughness.
11	A neural network-based machine vision method for surface roughness measurement.
12	Surface roughness prediction using hybrid neuralnetworks.
13	Surface roughness and cutting force prediction in mql and wet turning process of aisi 1045 using design of experiments.
14	Predicting surface roughness in machining: a review.
15	In-process roughness measurement on moving surfaces.
16	Surface roughness classification using image processing.

17	3d laserimaging for surface roughness analysis.
18	Optimization of radial basis function neural network employed for prediction of surface roughness in hard turning process using taguchi's orthogonal arrays.
19	Measurement of rollover in double-sided shearing using image processing and influence of clearance.
20	Detection of tool condition from the turned surface images using an accurate grey level co-occurrence technique.
21	Surface roughness classification using image processing.
22	Study on prediction of surface quality in machining process.
23	Machine vision based surface roughness measurement with evolvable hardware filter
24	In situ non-contact measurements of surface roughness.
25	Modeling surface roughness in the stone polishing process.
26	Evaluation of surface roughness using machine vision.
27	The influence of afm and vsi techniques on the accurate calculation of tribological surface roughness parameters a. spencer a,n, i.dobryden b, n.almqvist b, a.almqvist a, r.larsson a
28	A hybrid inspection method for surface defect classification.
29	Determination of seal coat deterioration using image processing methods.
30	Evalution of 3d surface roughness parameter of emd component using vision system
31	Surface roughness classification using image processing.
32	A simplified gravitational mode to analyze texture roughness.
33	Analysis of surface roughness parameters digital image identification
34	Improved spatial gray level dependence matrices for texture analysis.
35	Roughness measurement using optical profiler with self-reference laser and stylus instrument- a comparative study.
36	Using artificial neural networks for modeling surface roughness of wood in machining process
37	A dual domain approach for surface roughness evaluation.

38	Application of digital image magnification for surface roughness evaluation using machine vision.
39	A simplified gravitational mode to analyze texture roughness.
40	Analysis of surface roughness parameters digital image identification

2.6.1 Journal extraction

From the journal mapping, an extra one more time to make the graph based on information from mapping. The Graph has been Developed by parameters and method, to make comparison between method in past research.
Refer Appendix A:

2.7 Conclusion

This chapter discussed about the method that need to be taken for ideas. The data from past research was gathered to identify the appropriate technique to measure the surface roughness by using image processing.

Chapter 3

METHODOLOGY

3.1 Introduction

This chapter presents the methodology where it can be described as technique and procedures that will be used in the project in a detailed way. This chapter is designed according to the previous chapter that is literature review and limitation are being considered too. The fifth step has several phases where its phase introduces the various method and tools used in order to reach objectives.

3.2 Gantt chart

The Gant chart shown in appendix states all the activity for the PSM 1 and PSM 2. The total activity for every week is 15 weeks starting from week 1 until week 15 week.

3.3 Flow chart

The figure 3.1 shows the flow chart for this project. Every step explains about the flow of this project starting from title to the submission of full report.

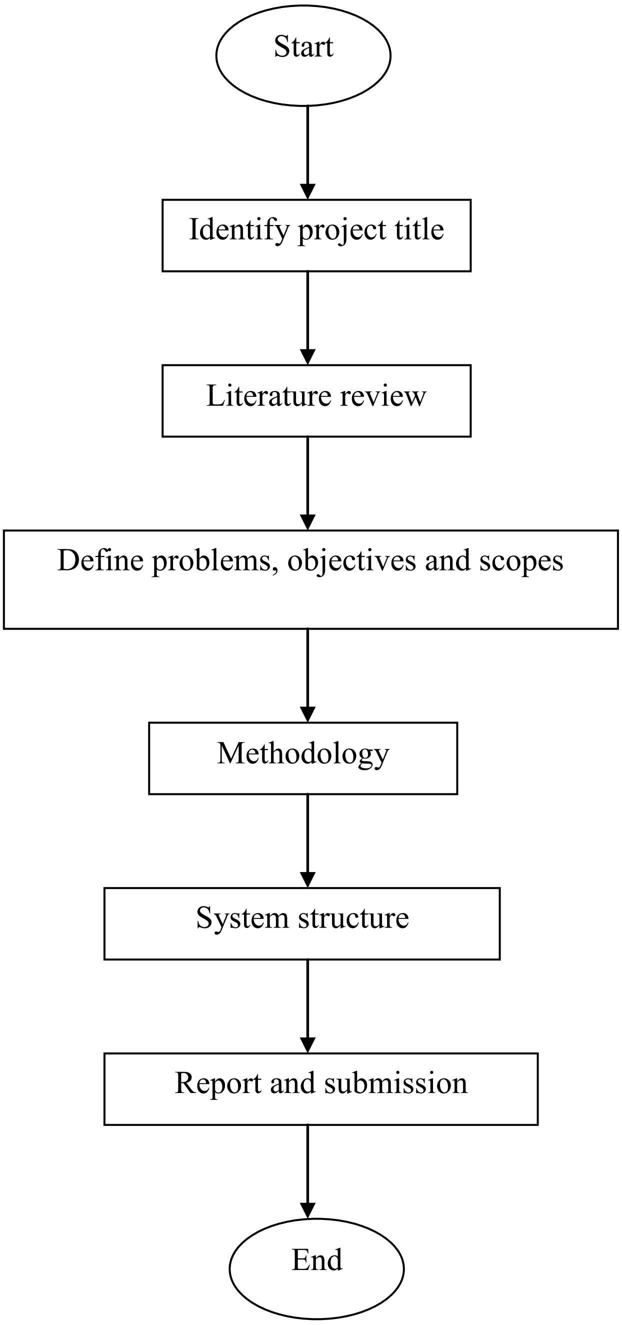

Figure 3.1: Flow chart