ENHANCEMENT OF VISION INSPECTION METHOD FOR MULTIPLE GAP PRODUCTS

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A master project report submitted
As a partial fulfilment of the requirements for the degree of Master of Manufacturing System Engineering

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: ENHANCEMENT OF VISION INSPECTION METHOD FOR MULTIPLE GAP PRODUCT.

SESI PENGAJIAN: **2014 Semester 1**

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DECLARATION

I hereby, declared this master project report entitled "Enhancement of Vision System Method, for Multiple Gap Product" is the result of my own research as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Author's Name : TAYALAN A/L PATMANATHAN

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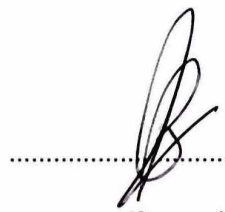
APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Master in Manufacturing System Engineering. The member of the supervisory committee is as follow:



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(Supervisor)

ABSTRACT

Digital vision system and mechanical design are areas that affect productivity. Good combination of digital vision system and mechanical design is required to obtain better vision image and accuracy. The better of the two combinations also helps operator to perform their job easier and faster and thus, increasing the productivity of the finish product. This research is to decide the most important combination of digital vision system and mechanical design in the setup of product gap inspection in a production line. The first step of the study was to determine the factors that influence the accuracy; in this case they were the accuracy of product gap measurement. The second step was to determine the level of each gap factor and then design for fractional factorial experiments. There are two factors being evaluated which have influence on the accuracy that is the digital vision camera resolution and increasing number of gaps of the product. There are forty six combinations of experimental runs to obtain the process capability index and the tolerance of the product. Minitab was used to identify the problem location. The result shows that the higher process capability index and lower tolerance of the product can be achieved by using the combination of servo motor system with digital camera system

ABSTRAK

Rekabentuk penunjuk sistem kamera digital dan ruang makanikal adalah aspek-aspek yang mempengaruhi ketepatan sistem data pemeriksaan visual. Kombinasi rekabentuk sistem kamera digital dan ruang makanikal yang baik diperlukan untuk mencapai kitaran data yang optima. Kombinasi yang terbaik juga membantu operator menjalankan kerja dengan mudah dan pantas dan seterusnya, meningkatkan produktiviti untuk hasilan product. Penyelidikan ini memperkenalkan starategi rekabentuk pemeriksaan visual kamera digital dan ruang makanikal yang paling sesuai di dalam pemasangan di kawasan pembuatan. Kaedah pertama ialah mengenal pasti faktor-faktor yang mempengaruhi ketepatan data sistem visual, di dalam penyelikan ini merupakan jarak jauh antara dua size perantara. Kaedah kedua ialah mengenalpasti tahap untuk setiap faktor accurasi bahagian perantara dan kemudian mencipta eksperimen factorial pecahan. Terdapat dua faktor yang dikenal pasti yang dapat mempengaruhi ketepatan data sistem visual. Faktor-faktor yang nyata adalah jenis resolusi kamera, dan penigkatan nombor bahagian saiz perantara produck. Terdapat empat puluh enam kombinasi dalam eksperimen ini dan setiap kombinasi data untuk mendapat data toleransi. Minitab telah digunakan mengenal pasti keupayaan system ini. Jawapan menunjukan keupayaan proses indeks yang tinggi dan toleransi produk yang rendah mengunakan sistem servo dan kamera digital visual.

DEDICATION

For my beloved wife and daughter.

ACKNOWLEDGEMENT

This project was performed under the supervision of Professor Doctor. Bashir Mohammad, to whom I would like to grateful for the freedom granted in carrying out this project. I also would like to express my deep appreciation to him for understanding the difficulties I had during the project. Furthermore, I would like to thank my mother, for her patience and support. Last but not least, thank you to all my friends and those who had contributed to my master project, directly and indirectly.

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LIST OF ABREVIATIONS

ANOVA	-	Analysis of Variance
CPK	-	Process Capability Index
DOE	-	Design of Experiments
DOF	-	Degree of Freedom
FOV	-	Field of View
LED	-	Light Emitted Diode
MSE	-	Mean Square Error
PCB	-	Printed Circuit Board

CHAPTER 1

INTRODUCTION

A classical vision system is used to check and control measurements' computability. Due to the simple and common means, however, there are some disadvantages such as inconsistent data, long cycle time data between each operator (absence of reproducibility), besides operator fatigue and error (non-repeatability). The tests that need to be resolved in the classical vision system are increasing production requests regarding better quality and lower rejects of product. The fully automated digital vision inspection system can be carefully used to satisfy such production demand. The digital vision inspection systems have established sizable production consideration in the latest years as cited by Hassan and Diab (2010). In the production process, they can be easily used in the production process to carry out online inspection to differentiate good and defective parts.

1.1 Background

Disk drive assembly requires that a ramp to be installed to the disk drive process for the purpose of head stack head landing on to the ramp (work piece 1), when the drive is power of condition. Basically the centring of the ramp (work piece 1) relative to the media (work piece 2) is very important in the assembly of disk drive. Improper centring of work piece 1 will cause possible impairment on to the head stack during the head parking. The digital vision system inspection tool is a very significant function in confirming the measurement of the product, and the measurement of the process.

However due complexity of the disk drive product in recent time, the number of media (work piece 2) have been increasing (higher capacity hard disk, up to 2 TB). This has caused the number of product gap (work piece 1) to be increase in proportion with the number of media (work piece 2). Because of the fact that all measurement product contains error, and in keeping with the basis mathematical expression: Vision value = Real Value + Measurement Error, is an important task for process improvement by Montgomery (2005). Assuming that the product form factor remains the same, and the number of product gap to be measured increases, will see increasing error on data for multiple ramp gap measurement based. This can be viewed by the pixel to mm ratio of Figure 1.1 which shows better accuracy versus Figure 1.2 which shows much a accuracy of lower value which is not viable using Cognex digital camera 5100 series. However this error can be reduced by increasing the resolution of the camera using Cognex digital camera 5403s series as shown on Figure 1.3. Hence, however the resolution of this Cognex digital camera 5403s series still has a certain amount of error which we plan to improve further due to continuous increasing number of gaps. The current system uses a single image for multiple gap product.

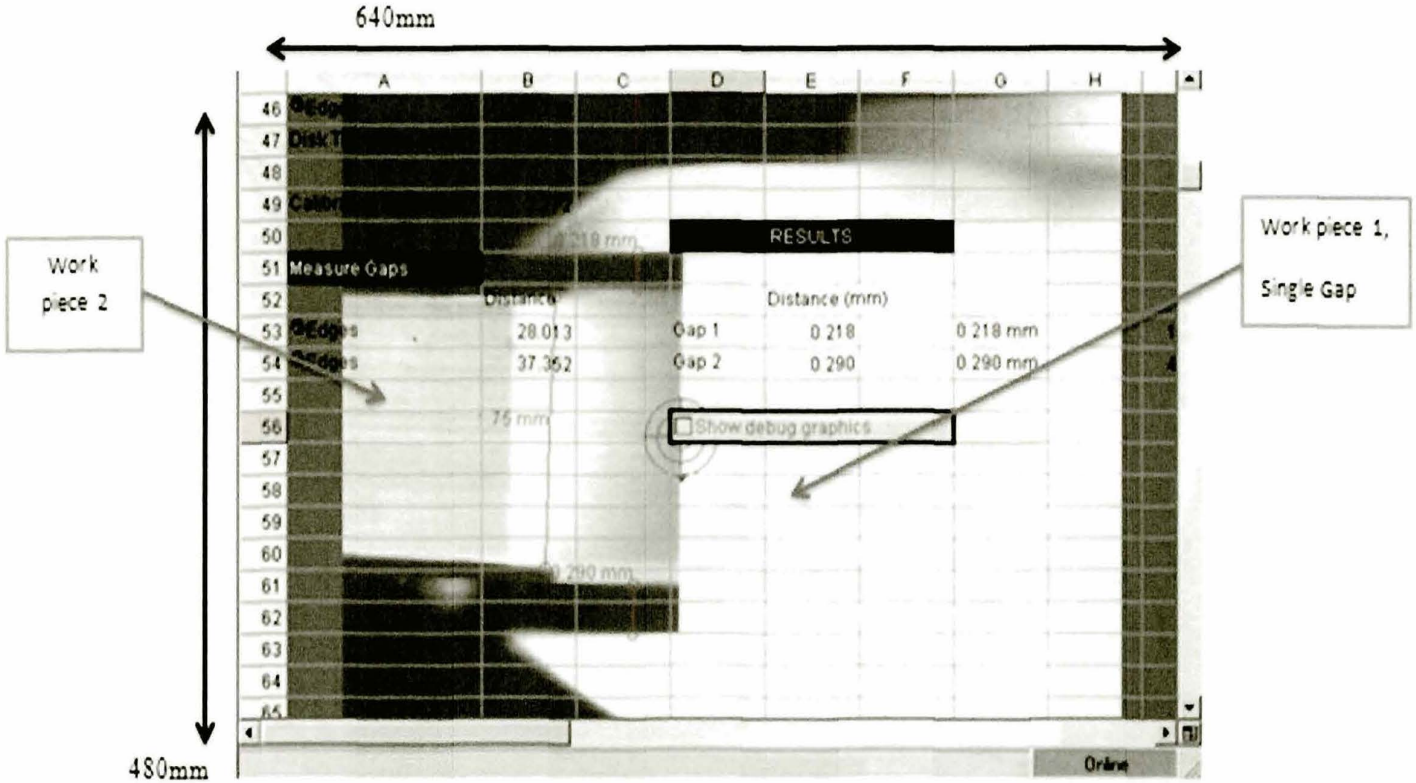

Figure 1.1 Single Gap Product Accuracy

Accuracy for Single Gap Product Inspection = disk thickness / total disk pixels

= 1.75mm / 225pixel

= 7.77 μ m/ pixel (Higher Accuracy)

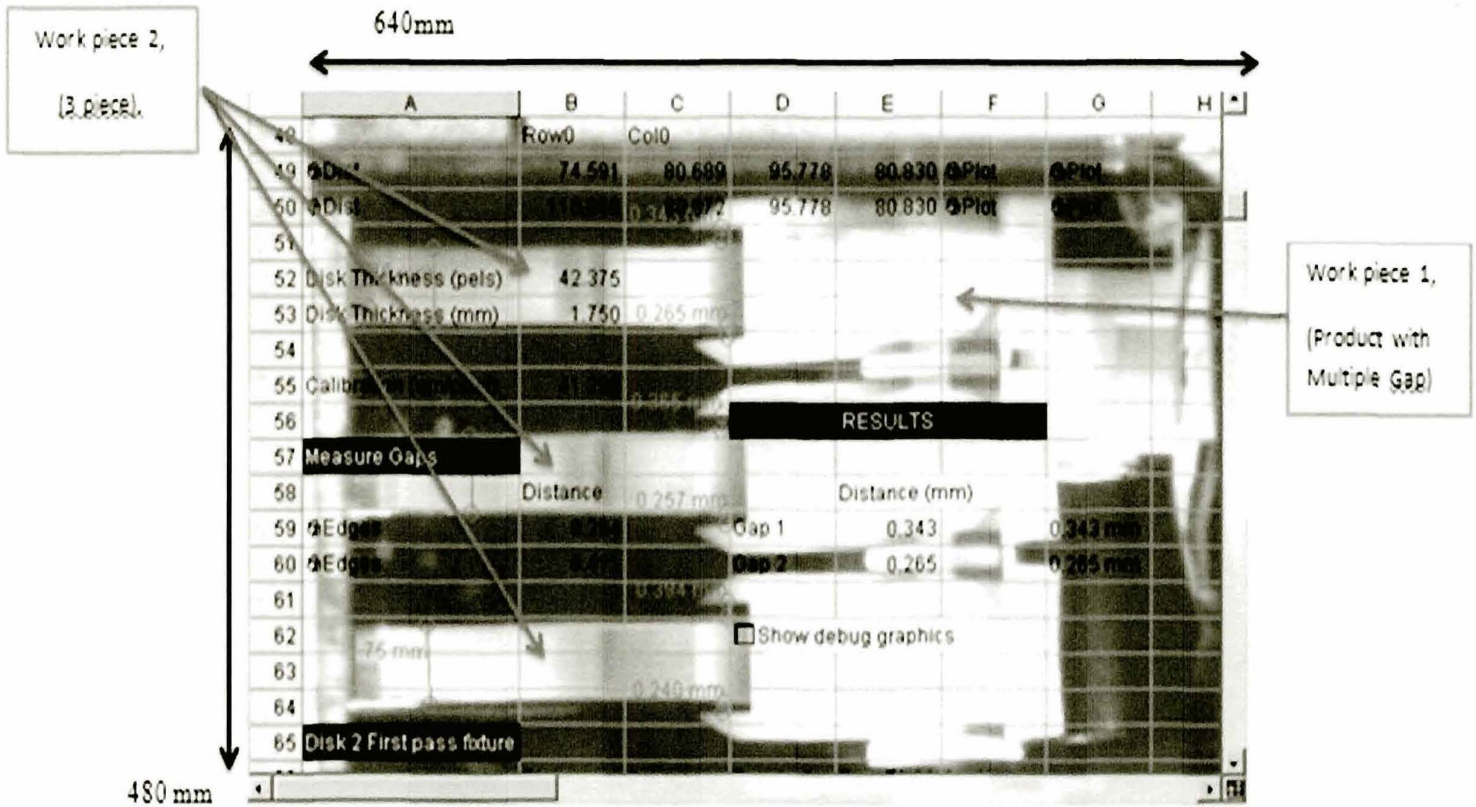

Figure 1.2 Multiple Gap Product Accuracy

Accuracy for Multiple Gap Product Inspection = disk thickness/ total disk pixels

= 1.75mm/ 42.375 pixels

= 41 μ m/ pixel (Lower Accuracy)

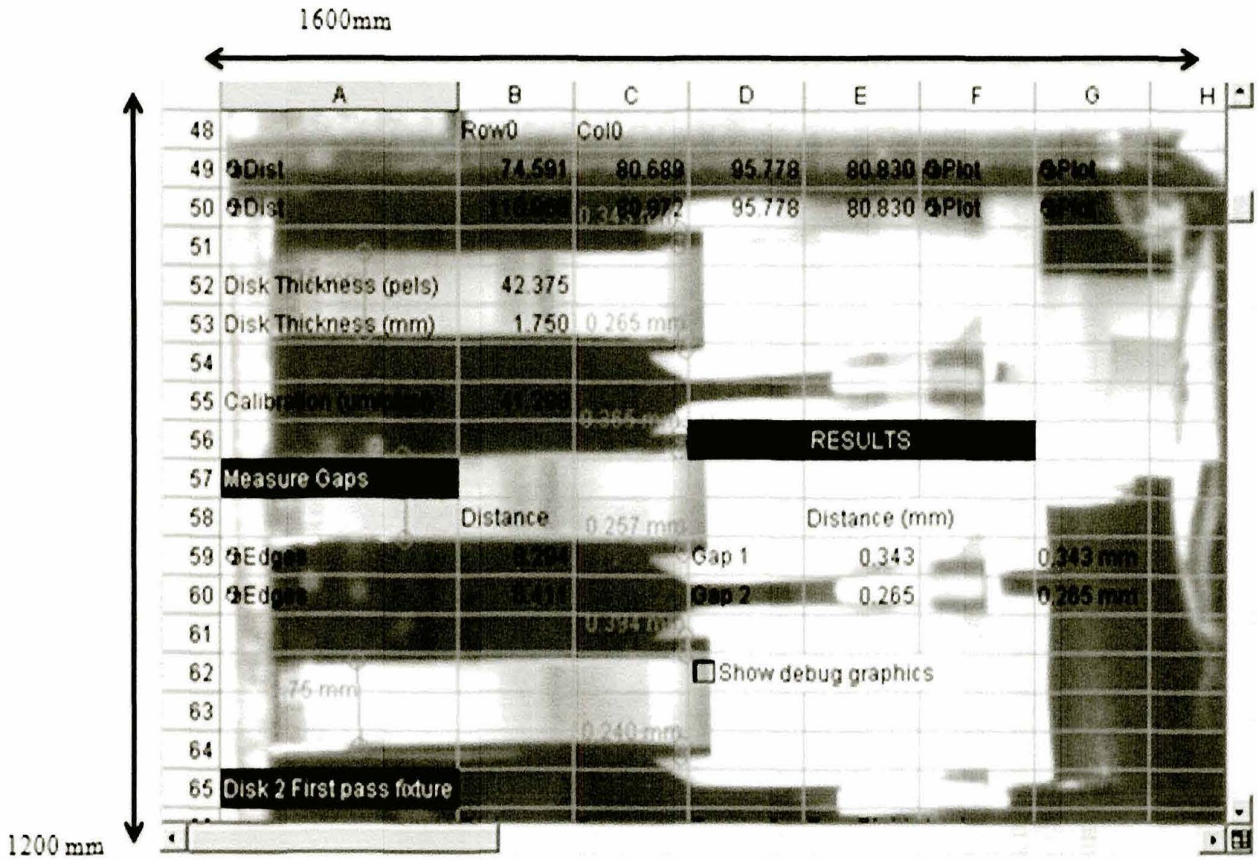

Figure 1.3 Multiple Gap Product Accuracy with High Resolution Camera

Based on the derivation of measurement for the pixel to mm ratio, from Figure 1.3, the illustration is shown below:

Reason to change the camera to a higher resolution camera for multiple gap product is of the better accuracy.

Current model: 5100 series (680mm by 480 mm)

New model : 5403 series (1600mm by 1200mm) High Resolution camera.

Hence, approximate new accuracy for Multiple Gap Product Inspection = disk thickness/ total disk pixels

= 1.75mm/ 110 pixels

= 16μm/ pixel (Improved Accuracy)

1.2 Problem Statement

Figure 1.4 shows the product gap process capability index (CPK) comparison between a multiple gap products (nine gaps) measurements for the whole month of April 2013. Line chart for the figure, shows the current vision system for product with nine gaps process capability index that is also showing an index below one and inconsistent reading.

It also shows that the data for all gaps between zero to nine are inconsistent from day to day. This could be due to the probability of the increasing number of gaps caused by the error in measurement. Due to the current system multiple gaps is only verified for five gaps, hence the error for nine gaps will increase in proportion due to the gap increase.

The reason is because the current setting of the digital camera is not capable to produce the same capability reading as compared with the lower number of gaps. Hence, it has been suggested by the supplier to use a higher resolution camera. However in this highly competitive industry, where the capacity and number of platter keeps on increasing it is not viable to keep on changing the resolution of the camera and because of this, it had resulted in a request by the maintenance team for a system which will be able to adopt with the increasing number of platter without affecting the system in term of setup and conversion time.

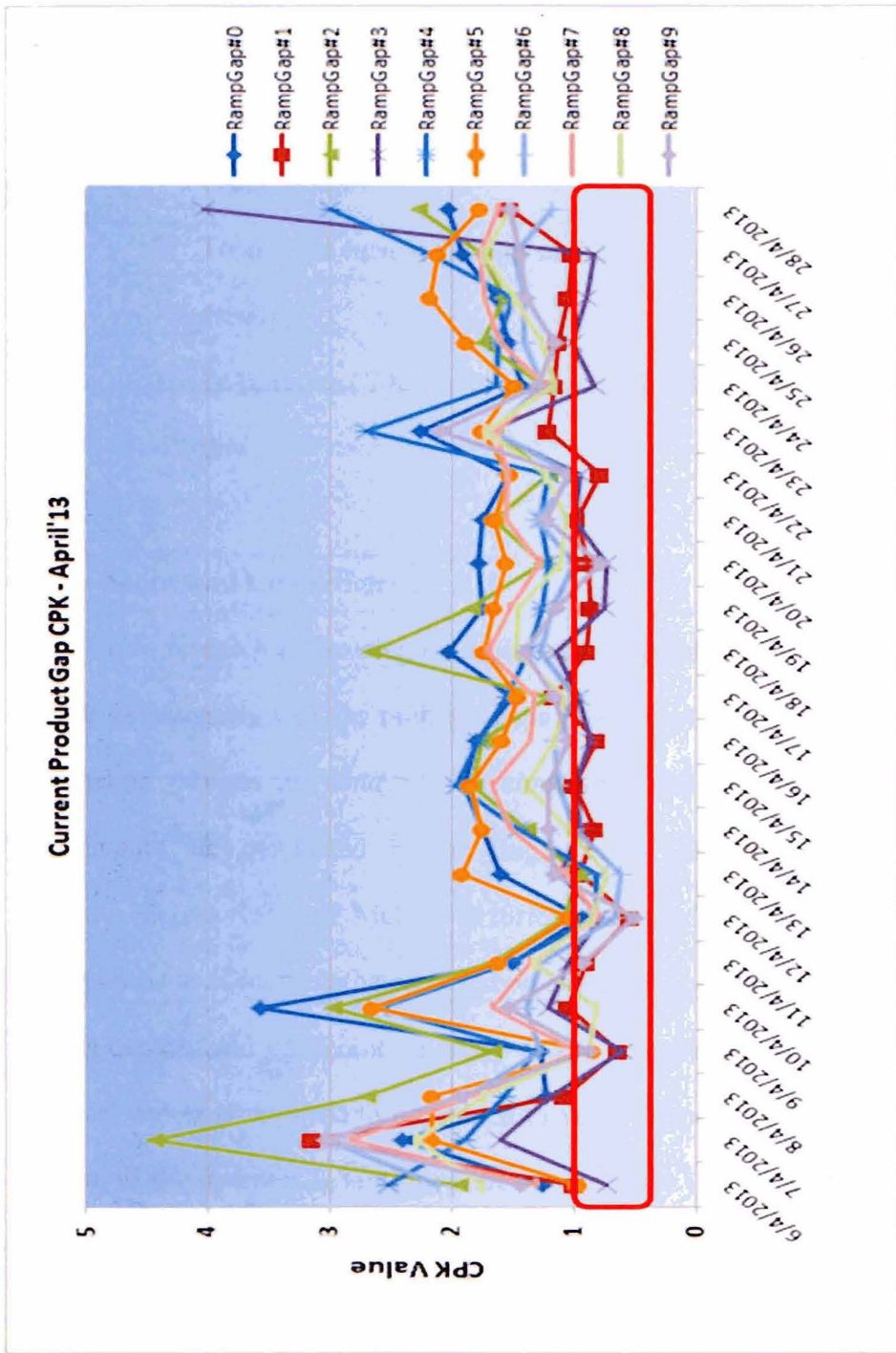

Figure 1.4 Product Gap CPK for Current Vision System (Workbench, accessed May 2013)