DEVELOPMENT OF MACHINE VISION SYSTEM BY USING TENSORFLOW FOR OBJECT DETECTION IN MANUFACTURING

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Sesi Pengajian: **2021/2022 Semester 2**

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I hereby, declared this report entitled "Development of Machine Vision System by Using TensorFlow for Object Detection in Manufacturing" is the result of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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ABSTRAK

Projek tahun akhir ini bertujuan untuk menjalankan laporan teknikal pembangunan sistem penglihatan mesin menggunakan TensorFlow untuk pengesanan objek dalam pembuatan. Dalam projek ini. Sebelum kemunculan teknologi moden, pemeriksa manusia menyebabkan konsistensi rendah dalam pemeriksaan kawalan kualiti kerana keletihan dan gangguan lain. Seterusnya, penglihatan manusia membawa kepada mengambil masa yang tidak tetap untuk mengesan kecacatan pada produk menggunakan deria manusia. Lebih-lebih lagi, sukar untuk mengenal pasti produk apabila ia keluar dengan warna yang sama dan bentuk yang hampir sama. Oleh itu, projek tahun akhir ini memberi tumpuan kepada membangunkan sistem penglihatan mesin yang lebih konsisten tinggi dengan melaksanakan TensorFlow dan Python dengan masa pengambilan yang berterusan untuk pengenalan objek. Projek ini juga bertujuan untuk menilai ketepatan dengan analisis untuk sistem penglihatan mesin dalam mengenal pasti produk dengan proses kawalan kualiti warna dan bentuk yang sama dalam pemeriksaan industri. Metodologi yang terlibat dalam kajian ini adalah pelaksanaan Phyton dan algoritma perisian TensorFlow yang digunakan dalam pembangunan sistem penglihatan mesin untuk pengecaman objek untuk pemeriksaan biskut. Seterusnya, pengumpulan dan pelabelan imej akan menjadi penanda aras untuk pengesanan objek secara nyata untuk mengenal pasti kecacatan dalam projek ini . Akhir sekali, untuk menilai keberkesanan sistem penglihatan mesin dalam mengenal pasti proses kawalan kualiti, analisis akan dilakukan dan diukur menggunakan pengumpulan data dan tafsiran data. Ia adalah untuk mengenal pasti keberkesanan menggunakan sistem penglihatan mesin. Hasil yang diharapkan dalam projek ini adalah dapat melaksanakan proses kawalan kualiti tinggi dalam pembuatan melalui pengesanan objek dalam pembuatan. Pengesyoran masa hadapan melaksanakan spesifikasi TensorFlow yang lebih tinggi dengan pengesanan yang lebih cepat mengimbangi dan ketepatan yang lebih tinggi. Untuk mengatasi masalah tersebut, analisis masa depan diperlukan untuk menilai keberkesanan pengesanan objek

ABSTRACT

This final year project aims to conduct a technical report on developing a machine vision system using TensorFlow for object detection in manufacturing. Before the advent of modern technology, human inspectors cause low consistency on quality control inspection due to fatigue and other disturbances. Next, human vision led to inconstant take up time to detect the defect on product using human sense. Moreover, it difficult to identify the product when it come out with same color and almost the same shape. Therefore, this final year project focuses on developing a high-consistent machine vision system by implementing TensorFlow and Python with constant take-up time for object identification. This project also aims to evaluate the accuracy of machine vision systems in identifying the product with the same color and similar shape quality control process in industrial inspection. The methodology involved in this study is the implementation of phyton, and the TensorFlow software algorithm is used in the development machine vision system for object identification for biscuit inspection. Next, the image collection and labelling will be the benchmark for real-time object detection to identify the defect in this project. Lastly, to evaluate the effectiveness of machine vision systems in identifying quality control processes, the analysis will be performed and measured using the data collection and data interpretation. It is to identify the effectiveness of using a machine vision system. This project's expected outcome is to perform a high-quality control process via object detection in manufacturing. The future recommendation is performing a higher specification of TensorFlow with counterbalance faster detection and higher accuracy. To overcome the problem, future analysis is needed to evaluate the effectiveness of object detection.

DEDICATION

In honour of my beloved parents, Salimi Bin Ismail and Saripah Normah Binti Syed Mahamood who have been my source of inspiration and gave me strength when I thought of giving up, who continually provide moral support, emotional and monetary support and help to us, this report is dedicated to you.

Finally, I dedicated this report to my brothers Alif Norman Bin Salimi, sister Nur Aina Zulaikha Binti Salimi and friends who gave me helps and words of wisdom as I worked on it.

ACKNOWLEDGEMENT

First and foremost, I'd like to thank God for helping me finish the report successfully. Thank you for providing me with the perseverance, determination, and faith that have seen me through these 14 weeks without faltering. I will always be thankful to God for the blessings he has given to my family and for the peace that he has provided.

This project would not have been possible without my supervisor's support, attention, dedication, and patience Dr. Shariman Bin Abdullah. Every day, I strive to be a better professional because of you. Because of your help, I was able to finish this project.

Finally, I am very grateful to my family, who provided me with an excellent education and fought tirelessly for my success to complete this stage of life. Thank you for making my dream come true. I am grateful for their love, prayers, concern, and support as I work to complete this project. Once again, I want to express my gratitude to everyone who has assisted and encouraged me throughout this process.

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CHAPTER 1
INTRODUCTION

1.1 Research Background

This project investigated the development of a machine vision system for object detection in manufacturing, which uses TensorFlow for object detection. An overview of related articles, publications, journals, websites and books, including those on machine vision systems and methods for providing imaging-based automatic detection, and other topics is presented in this literature review. Also covered the effectiveness of the capacity of humans and machine vision systems to detect product. An additional consideration is provided, which focuses on the TensorFlow competence in the area of object detection.

A machine vision system allows a computer to analyse and identify still or moving images. While identifying or inspecting the images, the machine vision system will go through image acquisition, image processing, and classification. Image classification will classify the label images and determine whether or not the labelling of the products contains flaws such as torn or missing information. The product will be rejected from the manufacturing system due to this.

This leads to a better result, which is the object detection system's ability to detect fault labelling with high detection precision and the technology on the machine vision system's ability to boost the efficiency of the production process.

1.2 Problem Statement

Companies should implement a machine vision system to reduce workforce costs and time spent tracking defective products in today's industrial environment. Automating and optimising quality processes can be made easier with the assistance of machines, which can aid with consistency and reduce the need for human intervention. However, the current method of tracking object detection faults in production is time-consuming, costly, low quality and performance because companies require manual inspection. The first issue is usually in assembly and manufacturing in product and process inspection are performed by human inspectors cause low consistency on quality control inspection due to fatigue and other disturbances. Therefore, in these cases a machine vision solution is recommended(Silva et al., 2018). For second issue is that the previous camera for detection objects is not truly distributed to quality control inspection of complex parts biscuits on conveyor. Previous cameras were big, slow, fragile, poor in quality and required special lighting to detect object precision. Computer vision systems, which first became widely available in the 90 eras, promised change but delivered little in the field of the human vision lead to inconstant take up time to detect the defect on product using human sense (Hopper, 2009). The third issue is that has been identified is that the end's product control is inadequate when going through quality inspection. As a result, workers cannot differentiate products that look comparable between poor and excellent products by eye vision because almost the product need to be inspected with same color and almost the same shape. Consequently, consumer loyalty drops because they do not get what they want (Ngadiman et al., 2017).

1.3 Objectives

a) Develop and design multipurpose with high consistency machine vision system for quality control processes in manufacturing.

b) Implement Python and TensorFlow algorithm in machine vision system with constant take up time for object identification.

c) Evaluate the accuracy with analysis of machine vision systems in identifying product with same color and almost the same shape quality control process in industrial inspection.

1.4 Scope

This project limitation is to develop machine vision systems that identify and detect ripped labels in industrial inspections using TensorFlow and Python. The intelligent software is used to train the image with specific architecture SSD MobileNet V2 FPNLite 320x320 with, speed 22 ms, average precision of object detection is 22.2 and output in boxes. The implementation of phyton version 3.7-3.10 is use as programming language. TensorFlow object detection version Tensorflow_gpu-2.8.0 combine with compiler MSVC 2019, build tools is Bazel 4.2.1, cuDNN 8.1 and CUDA 11.2. During image collecting and labelling, the product is classified into 3 category which is good biscuit, defect biscuit and double biscuit with proper number of image and training time.

1.5 Significant Of Study

The significant study are as follows:

a) Develop a new design of simple machine vision system for quality control processes in manufacturing.

b) Construct Python and TensorFlow algorithm to achieve flexible via object detection in all sectors in manufacturing.

c) Perform high quality control process in manufacturing via object detection in manufacturing.

1.6 Summary

Chapter 1 consists of 6 sub-chapters: research background, problem statement, objectives, scope, and summary. The research background explains the art in the machine vision system for inspection in manufacturing and the big picture of real-world application of this vision technology. The next sub-chapter is the problem statement: to study in depth it is important to have an accurate problem statement based on the situational problems faced in the Malaysian industry. Next, three main objectives must be achieved by the end of the study. The scope describes the priority things in developing a machine vision system by using TensorFlow for object detection in manufacturing that it should focus on this research.

CHAPTER 2
LITERATURE REVIEW

An overview of related articles, journals, websites and books, such as machine vision systems and methods for providing imaging-based automatic detection, is presented in this literature review. A comparison of human vision and machine vision systems' ability to identify fault detection is also discussed. Additionally, a study is offered that focuses on the TensorFlow capability for object detection. This results in a better result: the object detection's capacity to detect flaws in the manufacturing process with high detection precision and the technology on the machine vision system's ability to increase the manufacturing process's efficiency.

2.1 Machine Vision System

Machine vision is a term that refers to a combination of hardware and software that is used to provide operational guidance. When a part is detected, this signals the vision system to activate a camera positioned above or to the side of the inspection point, which captures an image of the part and passes it to the machine vision processor (Simpson, 2003).

Diesing (2021) said that the production process would be more efficient if Industry 4.0 detects and indicates faulty products. Operators or engineers can immediately identify and correct issues by uploading data to an external system using a vision system. Besides that, researchers may even improve deep learning models by incorporating the data

collected, a model built, and predictions made using the model's trained model. (Khan & Al-Habsi, 2020). Figure 2.1: Example deep learning frameworks for TensorFlow and other models (Pathak et al., 2018a) shows many examples of deep learning frameworks and their features for programming.

Name	Features	Interface	Deep learning model			Multi-node parallel execution	Developer	License
			CNN	RNN	DBN/ RBM			
Caffe [4]	Speed, modular structure, plaintext schema for modelling and optimization, Data storage and communication using blob	C, C++, command line interface, Python, and MATLAB	√	√		Yes	Berkeley Vision & Learning Center	BSD License
Microsoft Cognitive Toolkit CNTK [5]	Multi-dimensional dense data handling, automatic hyperparameter tuning, batch normalization	Python, C++, C#, and command line interface	√	√		Yes	Microsoft Research	MIT License
TensorFlow [6]	Math computations using data flow graph, inception, image classification, auto-differentiation, portability	C++, Python, Java, Go	√	√	√	Yes	Google Brain team	Apache 2.0

Figure 2.1: Example deep learning frameworks for TensorFlow and other models (Pathak et al., 2018a)

As shown in Figure 2.1: Example deep learning frameworks for TensorFlow and other models (Pathak et al., 2018a) above, since there are many types of deep learning model can be used for programming engineering system. Thus, everyone can choose and use it since it is a low cost software. As a non-destructive grading technology, machine vision is a cost-effective method with high precision that can be used to predict the dimensions and mass of a sample using different cameras, such as colour, multispectral and/or hyperspectral cameras. This method can also be used to detect defects on both the interior and exterior of a sample (Su et al., 2018).

Machine vision systems do not perform the first-hand examination of a scene or item. An object or setting is photographed and then evaluated using these images. Decisions and/or processes can be controlled by analysing the data from the captured image. Because of this, the quality of the collected image impacts how accurate a choice process can be. Figure 2.2: Machine Vision System (Anand & Priya, 2019) shows the components that machine vision