UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DESIGN OF AUTOMATIC LOADING AND UNLOADING OF WORKPIECE SYSTEM FOR HAAS CNC MILLING MACHINE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) with Honours

by

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DECLARATION

I hereby, declared this report entitled "Design of Automatic Loading and Unloading of Work pieces System for HAAS CNC Milling Machine" is the result of my own project except as cited in references.

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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 committee is a follow:

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(Official Stamp of Supervisor)

ABSTRACT

This project report presents the work done on the design of automatic loading and unloading of work pieces system for HAAS VF-1 CNC Milling Machine. This CNC machine is currently being used at CNC Lab at Block B of Faculty of Manufacturing Engineering, University Technical Malaysia Malacca (UTeM). However, this machine still uses human operator to load and unload the work pieces for the machine which are considered inefficient and also dangerous. The objective of this project is to select a suitable automatic system for loading and unloading work piece for HAAS CNC Milling Machine, to design a suitable gripper or tool for handling the work pieces for loading and unloading the CNC Machine and also to develop a soft prototype of the designed gripper or tool. In order to ensure the automatic loading and unloading process to occur without any error, a proper analysis and also comparison must be done in order to determine type of system to be used, types of tool to be used, type of power system to drive the system, also type of software to simulate the process. Flow chart of the methodology used for achieving all the project objectives are presented. Furthermore, a process simulation is done to represent the real life process of the improvise system, giving it a better look on how the system will look like. Besides that, an analysis on the selected tool given be carried out in order to determine the effectiveness and also the scale of safety of the tool. In order to do so, the force exerted by the work piece should be taken into consideration and also the lifting force required by the tool itself to lift the work piece.

ABSTRAK

Laporan projek membentangkan kerja yang dilakukan pada reka bentuk automatik memuatkan dan memunggah sistem kerja keping untuk HAAS VF-1 CNC Milling Machine. Mesin CNC sedang digunakan di CNC Lab di Blok B Fakulti Kejuruteraan Pembuatan, Universiti Teknikal Malaysia Melaka (UTeM). Walau bagaimanapun, mesin ini masih menggunakan pengendali manusia untuk memuatkan dan memunggah bahan kerja untuk mesin yang dianggap tidak cekap dan juga berbahaya. Objektif projek ini adalah untuk memilih sistem automatik yang sesuai untuk memuatkan dan memunggah bahan kerja untuk HAAS CNC Milling Machine, untuk mereka bentuk penggenggam yang sesuai atau alat untuk mengendalikan bahan kerja untuk memuatkan dan memunggah mesin CNC dan juga untuk membangunkan prototaip yang lembut daripada penggenggam direka alat. Dalam usaha untuk memastikan pemunggahan proses automatik untuk berlaku tanpa apa-apa kesilapan, analisis yang betul dan juga perbandingan perlu dilakukan untuk menentukan jenis sistem yang akan digunakan, jenis-jenis alat yang digunakan, jenis sistem kuasa untuk memacu sistem, juga jenis perisian untuk mensimulasikan proses. Carta aliran metodologi akan digunakan untuk mencapai semua objektif projek yang dibentangkan. Tambahan pula, simulasi proses dilakukan untuk mewakili proses sebenar sistem yang telah ditambah baik, untuk memberikan pandangan yang lebih baik mengenai bagaimana sistem akan kelihatan dalam situasi sebenar. Selain itu, analisis ke atas alat dipilih dijalankan untuk menentukan keberkesanan dan juga skala keselamatan alat. Dalam usaha untuk berbuat demikian, daya yang dikenakan oleh bahan kerja perlu diambil kira dan juga daya angkat yang diperlukan oleh alat itu sendiri untuk mengangkat bahan kerja .

DEDICATION

To my beloved family, lecturers, and friends whose have guided and inspired me to complete this project successfully

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INTRODUCTION

1.1 Background of the Project

Automation has become an important aspect in manufacturing industry. At early stage, human was responsible for executing all the process from forging, grinding, until welding. Even though automation have been replaced the human labor, yet manufacturing still relies on the manual labor due to the complexity of the process requires the human dexterity. (Charalambons, Fletcher, and Webb. 2008)

Nowadays automation also involved together with Computer Numerical Control Machine (CNC). CNC machine is a type of operating machine, whereby a computer monitors the machine tools. CNC is actually a further innovation from NC Machine. Almost every manufacturing industry uses CNC machine in their process. CNC machine can execute same operation repeatedly for a long period of time as long the work piece is being feed into in.

Loading and also unloading task could not be performed by CNC Machine as it could only execute machining task only. Loading and unloading task can be either done by human labor or can be automated using robots. Automation by robots are proven to be

more effective and efficient compare to human labor because human could not execute any task for a long period of time as fatigue will takes toll on them. HAAS VF – 1 CNC Milling Machine are designed to perform machining process only. Hence it need the work piece to be feed into it in order for it to operates

Figure 1.1: HAAS VF-1 Milling Machine at FKP Lab

1.2 Problem Statement

The problem arises when the HAAS CNC Milling Machine in CNC Lab at Block B of Faculty of Manufacturing Engineering, UTeM uses human operator to load and unload the raw work piece or semi finish work piece into the machine. This action seems to be less productive and also might cause injuries if the operator that is loading the work piece accidentally drops it. To solve this problem, a suitable automatic system will be selected and designed to load and unload the work piece.

Figure 1.2: Manual loading of work piece into CNC Machine

1.3 Objective

i. To select a suitable automatic system for loading and unloading work pieces for HAAS CNC Milling Machine.

ii. To design a suitable gripper or tool for handling the work pieces for loading and unloading the CNC Milling Machine

iii. To develop a soft prototype of the above designed gripper or tool.

1.4 Scopes

i. Study and select a suitable automatic system such as robot or other equipment for loading and unloading work pieces for HAAS CNC Machine.

ii. To design a suitable tool or gripper for handling the work piece based on the following dimension:

Length = 150mm (max)

Width = 150mm (max)

Height = 80mm (max)

Work piece material = Steel

Density of steel = 8050 kg/m^3

Maximum weight of the work piece :

= Volume x Density

= Width x Height x Density

= 0.15m x 0.15m x 0.15m x 0.08m x 8050kg/m^3

= 14.49kg

iii. Develop a soft prototype of the designed gripper or tool using a suitable 3D CAD / CAM software.

CHAPTER 2

LITERATURE REVIEW

This chapter discusses the entire element that needed to automate the loading and unloading of the work piece into HAAS VF – 1 CNC Milling Machine. This chapter uses various resources from books, journals, and also internet to review the elements in the automated process

2.1 Introduction about HAAS VF – 1 CNC Milling Machine

HAAS Automation in a USA based company to manufacture Computer Numerical Control machine (CNC) such as vertical machining centers and horizontal machining centers, lathes/turning centers, and rotary tables and indexers. By using CNC in manufacturing industry, fewer supervisors is need as the tool and the machine itself are pre – programmed to run a certain course of operation. HAAS VF – 1 CNC Milling Machine was first introduced in 1988 and immediately achieves high industry benchmark for high quality, and high – value CNC technology.

Besides that, high performance of vector drive spindles, high – torque brushless servos, and rigid cast – iron construction are among of few features possess by the CNC Milling Machine. Configurations range from 40 – 50 taper gear – driven models for high – torque, heavy – duty cutting, to Super Speed models with the inline direct – drive spindles to handle the most demanding high – speed machining operations. (Haas Automation, 2013).

2.2 Types of system used for loading and unloading process

The process of loading and unloading the work piece falls on the Flexible Manufacturing System (FMS). Simultaneously process medium – sized volumes of a variety of part types is called FMS whereby it is an integrated, computer controlled complex of automated material handling devices and numerically controlled (NC) machine tools. In FMS, there are several methods used to execute loading and unloading task, namely hydraulic jack system, and robot operation system. These systems will be compared and analyzed with the current method of loading and unloading the work piece.

2.2.1 Man power in loading and unloading process

The currently used method which is manual loading and unloading the work piece are considered less productive, inefficient, and also dangerous. Loading and unloading manpower consume ample of time, especially when the multiple of work piece need to be placed inside the HAAS VF -1 CNC Milling Machine to undergo the same process of all

work piece. This kind of ineffective requires a human labor besides the machine all the time just to load the work piece and unload the finished product.

Figure 2.1: Process of Loading a work pieces for the HAAS VF-1 CNC Milling Machine

Furthermore, during the loading and unloading process, there are chances for any kind of incident to occur which mostly due to either human recklessness or fatigue due to working of long time of period. Studies were carried out in Holland and found out that from a data obtained from more than 9000 accidents in six years of the period, occupational risk rates per hour of exposure are quantified for 63 occupational hazards for the Dutch working population. All this accidents can be classified into three categories which are fatal injury, permanent injury, and recoverable injury requiring at least one day hospitalization. (Bellamy, 2015). Besides human recklessness and fatigue, machine failure also cooperates with the probabilities of the accident takes place. An incident such as power failure or error in the programming might cause the machine to go haywire and collide with the human labor. When an error in the programming line, the machine will read inaccurately and might cause to move unexpectedly, which might startled the user of the machine.