DEVELOPMENT OF VIRTUAL COMPONENT TECHNOLOGY-BASED STEP COMPLIANT SYSTEM

KRISNAN A/L KANDHIAN
B091810005

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

2022

Faculty of Mechanical and Manufacturing Engineering Technology

DEVELOPMENT OF VIRTUAL COMPONENT TECHNOLOGY-BASED STEP COMPLIANT SYSTEM

Krisnan A/L Kandhian

Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

2022

DEVELOPMENT OF VIRTUAL COMPONENT TECHNOLOGY-BASED STEP COMPLIANT SYSTEM

KRISNAN A/L KANDHIAN

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: **DEVELOPMENT OF VIRTUAL COMPONENT TECHNOLOGY-BASED STEP COMPLIANT SYSTEM**

SESI PENGAJIAN: **2021/22 Semester 1**

Saya **KRISNAN A/L KANDHIAN** mengaku membenarkan tesis ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	TIDAK TERHAD	

Disahkan oleh:

KRISNAN A/L KANDHIAN

TS DR KAMRAN LATIF

Alamat Tetap:

No: 52, Jalan 4,
Taman Sri Layang,
28400, Mentakab, Pahang.

Cop Rasmi:

DR. KAMRAN LATIF
Pensyarah Kanan
Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan
Universiti Teknikal Malaysia Melaka

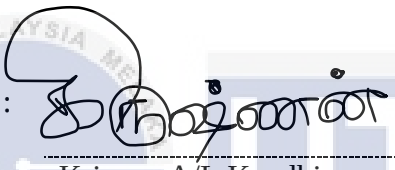
Tarikh: 18/01/2022

Tarikh: 25-01-2021

** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this report entitled Development of Virtual Component Technology-Based STEP Compliant System" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : Krisnan A/L Kandhian

Date : 18-01-2021

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature : 

Supervisor Name : TS DR Kamran Latif

Date : 25-01-2021

DEDICATION

God

Thank you God for given me your blessing and guidance in completing this project.

Dear Beloved Family

Thank you because always supporting me in every part such giving me motivation ideas and accompany me while I am doing this project.

Dear Supervisor and Lecturer

Thank you, all your guidance, patience, encouragement, and supervision, to enable me to finish this project.

Dear Friends

Thank you for all the knowledge, support and encouragement and share all the know ledges together.

ABSTRACT

After the Industrial Revolusion 4.0 (IR 4.0) occures, the world of engineering and technology has been evolving to another level of growth, where the everyday lifestyle is completly in the comfort zone. Along with the revolution, the Numerical Control (NC) system is one of the fastest-growing technologies towards development, and this method is even harder to follow. The NC system was later upgraded to Computer Numerical Control (CNC), and then it was innovated to different types of CNC such as lathe CNC, laser CNC, drilling CNC, and etc. In addition, the innovation was continued to produce the CNC machine in various sizes even mini CNC are exist in the global market. The opration of the CNC machine executed with ISO 6983 standard or G and M data interface model. Besides, limitations on the CNC system operation was found by using ISO 6983 standard. The purpose of my project is to overcome the exixting limitations by using different standard known as ISO 14649 or STEP-NC data interface modul with the integration of software and hardware. In the report, the test run of hardware after the installation and the operation of software development will be shown. The hardware testing performed after installation, as well as operation of software development will be displayed in the report. Finally, system validation of software and hardware integration and results from the system will be featured in this report.

ABSTRAK

Setelah Revolusi Industri 4.0 (IR 4.0) berlaku, dunia kejuruteraan dan teknologi telah berkembang ke tahap pertumbuhan yang lain, di mana gaya hidup seharian sepenuhnya berada di zon selesa. Seiring dengan revolusi, "Numerical Control (NC)" sistem adalah salah satu teknologi yang paling cepat berkembang ke arah pembangunan, dan kaedah ini bahkan lebih sukar untuk diikuti. Sistem NC kemudiannya dinaik taraf menjadi Computer Numerical Control (CNC), dan ia diinovasikan kepada pelbagai jenis CNC seperti pelarik CNC, laser CNC, penggerudian CNC, dan lain-lain. Selain itu, inovasi ini diteruskan untuk menghasilkan mesin CNC dalam pelbagai ukuran malah mini CNC ada di pasaran global. Pengoperasian mesin CNC dijalankan dengan standard ISO 6983 atau G dan M model antara muka data. Selain itu, terdapat had pada operasi sistem CNC dengan menggunakan standard ISO 6983. Tujuan projek saya adalah untuk mengatasi had yang sedia ada dengan menggunakan standard yang berbeza yang dikenali sebagai ISO 14649 atau STEP-NC modul antara muka data dengan integrasi perisian dan perkakasan. Ujian perkakasan dilakukan selepas pemasangan, serta pengendalian pembangunan perisian, akan dipaparkan di dalam laporan tersebut. Selain itu, pengesahan sistem integrasi perisian dan perkakasan dan hasil sistem akan dipaparkan dalam laporan ini.

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. Firstly, I would like to thank God for giving me a lot of ideas and knowledge alongside with a good health that helped me to finish this project.

I would like to thank to my beloved supervisor TS Dr Kamran Latif his guidance, constant patience, excellent support, motivation, and continuous understanding throughout this semester of my Final Year Project in Universiti Teknikal Malaysia Melaka (UTeM). His guidance played an important part helping me in finishing my project.

I would also like to dedicate my appreciation to my entire family that always support and guide me with their love. They also gave me a lot of motivation that helped me to finish this project.

Lastly, I am thankful to all friends for their understanding, suggestions, and comments throughout this project, which made my final year memorable.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

NC	-	Numerical Control
CNC	-	Conputer Numerical Control
ISO	-	International Standard Organization
CAM	-	Computer-Aided Manufacturing
CAD	-	Computer-Aided Design
STEP	-	Standard for The Exchange of Product Data
STEP-NC	-	Standard for The Exchange of Product Data-Numerical Control
CAx	-	Computer-Aided system
CAPP	-	Computer-Aided Process Planning
MCU	-	Machine Control Unit
DNC	-	Direct Numerical Control
DC	-	Direct Current
AC	-	Alternative Current
PLC	-	Programmable Logic Control
APT	-	Automatically Programming Tools
GPU	-	Grapic Processing Unit
RAM	-	Random Access Memory
USB	-	Universal Serial Bus
PC	-	Personal Computer
SC	-	Subcommittees
TC	-	Technical Committee

XML	-	Extensible Markup Language
OAC	-	Open Architecture Control
LabVIEW	-	Laboratory Virtual Instrument Engineering Workbench
GUIs	-	Graphical User Interfaces

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

The manufacturing world can be traced back to Industrial Revolution during the 1950s, where raw materials were converted into finished product. High accuracy finished product in large quantities, high degree of complexity technological equipment and machinery have been developed. Production of these components known for Numerical Control (NC) machine tool which can be set up rapidly without much attention. NC is stands for to control the different abilities of machine operations, that transfer the information in numerical sequence by an electronic controller. The NC machines often employed in the manufacturing world have been developed over the years (Yusri Yusof & Kamran Latif, 2015).

In 1970's a huge development happened in the automation of machine tool, which the CNC machines or Computer Numerical Control were introduced. The phase CNC machine refers to a control system that works in tandem with a computer. With new innovation at that time, the computer substitutes most of the electrical gears and punch card of the NC machine. The kinematic arrangement, quantity of spindles, quantity of axes, machining method, and spindle configuration are all characteristics that used to describe the new CNC machine development. Furthermore, there are multiple functions and different controller applications of CNC method generally used in drilling, turning, milling tube welding, packaging, electronic component insertion, and robotic cutting (Yusri Yusof & Kamran Latif, 2014).

The controller is the important component of the CNC machine, and it is divided of two parts which were software and hardware. The controller's software is known as an interpreter, and it is responsible for transforming the ISO (International Standard Organization) data interface model instructions controller's hardware. As of today, ISO 6983 data interface model is the 50-years-old level language known as M & G programming which is proved low-level language is used to operating commercial CNC systems, and these CNC systems are proven to be restricted in nature owing to reliance on the client's description. This low-level language of the data interface is mainly focused and specifying to the feed rate and positional of the cutting movement. M & G coding language is interpreted by the numeric codes such as M, G, S, T, F so on representing the machine motion and axis controllers (ISO 6983-1, 1982). Computer-Aided Manufacturing (CAM) systems employ Computer-Aided Design (CAD) data to produce CNC machining programming (Kamran Latif & Yusri Yusof, 2016).

Nevertheless, since the manufacturing sector has grown over time, numerous problems have arisen in the ISO 6983 data interface, such as sending restricted information to CNC machines. Despite these flaws, G-code instructions are nevertheless very useful in industrial production systems because they rely on both overt microprocessor strategy and several years of operator experience. As a result, the framework now includes a G-code data interpretation capability (Primoz Krzic, Antun Storic & Janez Kopac, 2009). To overcome the occurred, a new ISO called STEP (Standard for The Exchange of Product Data), or ISO 10303 was created. The STEP proposes to serve a framework for representing commodity data during its life cycle that is not based on a specific computer system. ISO 10303 greatly increased CAD system interoperability, necessitating the creation of a comparable standard for knowledge sharing among CAM systems and CNC machines (Kamran Latif & Yusri Yusof, 2016). As the result in the early 2000s, an international initiative was launched to

new define is STEP-NC (Numerical Control), known as ISO 14649, as a new benchmark to add the advantages of from STEP through CAM and CNC. STEP-based Computer-Aided system (CAx) and CNC connection are supported by ISO 14649 standard, which is a development of ISO 10303. The EXPRESS language used to create the data model for ISO 14649 and ISO 10303 standards. The EXPRESS language is a standard for describing entity attribute data models (Yusri Yusof & Kamran Latif, 2015).

Moreover, based on study, developing the software and hardware of NC based on GT400-SV movement Controller using Windows as the software platform and the computer as the hardware interface (XU, 2012). Other than this, the motion control system on CNC implemented by servo motor drives to regulate both velocity and position of the machine directions, with each direction being controlled independently by following Numerical Control command signals. This servo drive can be activated by the control which is consist open-loop system and a closed-loop system (Zhang, 2010).

Therefore, the CNC machining systems are dominating manufacturing in the world extremely well for the past 50 years. However, a high accuracy finished product in large quantities and a high degree of complexity technological designs have been produced with help of ISO 6983 by G & M codes which made CNC dominate the manufacturing world. Moreover, the CNC system still in development to integrate with the ISO 14649 for the STEP-NC data model.

1.2 Problem Statement

CNC machining and techniques have been dominated the manufacturing world by providing high accuracy finished product in large quantities and a high degree of complexity design finishing. Apart from that, CNC machining and techniques still in development and growth for the future. As the current stage, the CNC machining process is conducted by integrating software known as ISO 6893 with hardware.