PLANAR B-SPLINE CURVE INTERPOLATION WITH VARIOUS PARAMETERISATIONS

By

NG ZHI SIANG
I12002035

FINAL PROJECT REPORT

Submitted to
the Faculty of Science, Technology, Engineering & Mathematics
in Partial Fulfillment of the Requirements
for the Degree of

BACHELOR OF ENGINEERING (HONS)
in
MECHANICAL ENGINEERING

At

INTI INTERNATIONAL UNIVERSITY
Persiaran Perdana BBN, Putra Nilai, 71800 Nilai
Negeri Sembilan, Malaysia

JANUARY 2015

DECLARATION

I, the undersigned, hereby declare that this report is my own independent work except as specified in the references and acknowledgements. I have not committed plagiarism in the accomplishment of this work, nor have I falsified and/or invented the data in my work. I am aware of the University regulations on Plagiarism. I accept the academic penalties that may be imposed for any violation.

Signature .....

Name ..... Ng Zhi Siang .....

Matrix No. ..... I12002035 .....

Date ..... 25-5-2015 .....

ABSTRACT

In previous days of shape modelling, the shape of engineering product are represented by points. It is will make life easier if could provide mathematical equations that able define the shape of an engineering product. The aim of the project is to interpolate the set of data points with B-Spline polynomial with different parameterization method such as chord length, centripetal and equal spaced parameterization. It is found that same set of data points, it may not be able to generate same shape of curve. The objective of this project investigate how the parameterization affect the shape of curve. In this paper, mathematical formula of different parameterization will be presented. The mathematical formula of different parameterization are then be convert into Excel Macro VBA to help generate results in a more efficiency way. Several set of data points which representing different characteristic of curve such as convex shape, inflected shape and Z shape are created to test how different parameterization on curve behave on it and the characteristic and properties of different parameterization are recorded. It was found that chord length parameterization curve are normally having bulges on longer chords, Centripetal parameterization curve following longer chords closer while for equal space easily to produce sharp points or loops with higher degree of curve. Furthermore, the impact of degree on different parameterization will also be discussed in this paper.

ACKNOWLEDGEMENTS

First of all, I would like to express my deepest gratitude to INTI International University for giving us an opportunity to do this subject. I am happy and excited to have this chance to try such a project and earn good experience for my future. Here is the chance to apply the knowledge I have learned in diploma and degree in mechanical engineer. I would like to take this opportunity to express my gratitude to the people who have been helpful throughout the successful completion of this project.

I would like to show my greatest appreciation to supervisor Engr.Dr.Chong Perk Lin for his tremendous support and help. I feel motivated and encouraged every time I attend his meeting. He is very kind and patient enough to guide me especially in the way he explain our project. My supervisor being able to see things from a different perspective was a big help and those ideas that my supervisor shared were very useful. I am very grateful for all the insight and input I gained. I would definitely can't complete my project successfully without him. And without his encouragement and guidance this project would not have materialized.

And I would like to express my special gratitude and thanks to one of my friend, Kang Chuang You for giving me such attention and time, offered his helps, opinions and suggestion when I met problems especially in doing coding of macro vba in excel. Meantime, I would like to thank an honorable mention goes to my parents, to morale and financial supports in completing this project.

Finally I am grateful for effort of involved examiners to evaluate my final presentation.

DEDICATION

Dedicated to my beloved father, mother and brothers

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

VBA	Visual Basic for Applications
CNC	Computer numerical control
CAGD	Computer Aided Geometric Design
2D	2 Dimension
3D	3 Dimension

NOMENCLATURE

Symbol	*Definition*
n	Degree of curve
k	order
C	Curve
$N_{i,p}$	Basis function
P	Control Point
u	Knot vector
p	Degree
Q_k	Points
u_k	Parameter value
U	Knot vector

CHAPTER 1

INTRODUCTION

1.1. Background

1.1.1. History

The numerical geometry was origin during the Second World War. A new design method are developed due to production pressure. The new design process are mainly graphical based on analytical curves and able to avoid tons of manual drafting work and required less time than formerly. After that, with grow of electronic computer, more technic are developed base on the traditional graphical methods. Previously, a process called lofting are used to define the cross-sections of a longitudinal curves. Lot of the new method dividing the surface and assembly to form a patches and those patches may be represented by mathematical formula (ID Faux, MJ Pratt,1979).

In 1963, Furguson develop 1 of the earliest patch system which using parametric rather than coordinates to define curve and surface. This patch system which able to twisted in three dimension has become the standard of usage then. Then the system were being invented to graphical display units, CNC machine tool and automatic drafting machines. When surface defining symtem became operation, number of important mathematical d developments occurred. First more properties of spline have been explored then a very basic theories of surface patches was evolved by Coons in year 1964. By now the system method is far removed from the origins and raised problems of how to decide freedom offered by modern methods of path. Then a new system call surface fitting which only required set of points of surface to define the curve are developed (ID Faux, MJ Pratt,1979).

1.1.2. **Parameterization Methods**

The parameterization of 2D or 3D data points is one of the fundamental steps in Computer Aided Geometric Design (CAGD) applications example: car design, aircraft design, texture mapping, remeshing, typography, and curve and surface fitting

The parameter value reflects the distribution of the given data points. A lot of research works have been done on parameterization method starting from the easiest method such as uniform, intermediate method, for instance, exponential, universal, and hybrid, until complex calculation such as rational chord length parameterization. The most common method used in solving the parameterization problems was centripetal method (H.Haron,2012). The most well-known parameterization methods nowadays are chord length, centripetal and equal spaced parameterization. These parameterizations is having its own advantage and disadvantage due to their properties.