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**Application of cubic timmer curve with countinuity
on batik design**

By

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A dissertation submitted in partial fulfillment of the requirements for the degree of
Master of Science in Engineering Mathematics

**Institute of Engineering Mathematics
UNIVERSITI MALAYSIA PERLIS**

2017

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ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful. All the praises and thanks be to Allah, the Lord of the world who has showed us the straight way, the way of those on whom He has bestowed His Grace, not (the way) of those who earned His anger, nor who went astray.

The writing of this dissertation has been one of the significant academic challenges that I have ever had to face. Without the support, patience and guidance of a few significant people in my life, this study would not have been completed successfully.

It is difficult to overstate my gratitude and appreciation to my supervisor, Dr.Zainor Ridzuan Yahya. Throughout my dissertation- writing- period- with his inspiration, patience and his great efforts in explaining things clearly and simply, his wisdom and encouragement.

Next, a special thanks to Institut Matematik Kejuruteraan, Universiti Malaysia Perlis for giving me the opportunity to do some analysis on this case. In addition, I would like to acknowledge my appreciation to my dearest family members who have been encouraging and supportive a lot while completing this dissertation. Last but not least, I also want to give a special thanks to all my friends who have been very helpful solving any problem arises. This dissertation would not be completed successfully without the help and encouragement by all the individuals.

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APLIKASI LENKUNGAN KUBIK TIMMER DENGAN KESAMBUNGAN

DALAM REKABENTUK BATIK

ABSTRAK

Dalam dunia CAGD untuk membina lengkungan, pengkaji lebih cenderung untuk menggunakan lengkungan yang selalu digunakan seperti lengkungan B-Spline dan lengkungan Bezier. Apa yang dapat dilihat sekarang, pengkaji cenderung untuk memilih lengkungan kubik kerana ia senang untuk menghasilkan dalam pengekodan yang dibina. Dalam kertas kajian ini, lengkungan kubik Timmer yang dipilih untuk membina lengkungan berdasarkan contoh yang dipilih iaitu sampel dari reka bentuk Batik disebabkan kelebihan lengkungan kubik Timmer yang cenderung untuk melalui titik tengah poligon kawalan yang memberi banyak pertolongan dalam menghasilkan lengkungan. Lengkungan kubik Timmer yang dibina haruslah mempunyai kesambungan C^0 atau kesambungan C^1 dengan menggunakan perisian Mathematica dan MATLAB. Selepas satu sampel dari reka bentuk Batik dipilih, sampel itu dimasukkan ke dalam Mathematica dan titik kawalan dipilih. Titik kawalan yang dipilih dimasukkan ke dalam pengekodan yang dibina di dalam MATLAB dan dihasilkan. Dalam kalangan lengkungan yang dihasilkan, mestilah terhasil kesambungan C^1 jika tidak ia adalah kesambungan C^0 . Jika lengkungan terhasil tidak menepati lengkungan yang diinginkan, titik kawalan perlu diubah suai untuk mendapatkan lengkungan yang diinginkan. Hasil menyerupai sampel dari reka bentuk Batik dengan baik disebabkan ciri-ciri uniknya tersendiri yang banyak membantu dalam membina lengkungan.

APPLICATION OF CUBIC TIMMER CURVE WITH CONTINUITY ON BATIK DESIGN

ABSTRACT

In the world of CAGD, to create curve the research tends to use the curve that been usually used such as B-Spline and Bezier. Apparently, the researcher tends to choose cubic curve because it is easier to generate in coding that been created. In this study, Cubic Timmer curve that been chosen to create the curve based on chosen example which is a sample of Batik Design because advantages of Cubic Timmer curve is it tend to go through the midpoint of control polygon that brings a lot of help in creating the curve. Cubic Timmer curves that been created had C^0 or C^1 continuity by using Mathematica and MATLAB software. After a sample of Batik design is chosen, the sample been inserted into Mathematica then control points are selected. The control points that been selected are insert into coding in MATLAB then been generated to have a curve. Among the curves that been generated, the control point must be adjusted to make the curve having C^1 continuity if the curves are not to be connected by C^1 continuity then it is C^0 continuity. If the curve that been generated is not fulfilled the curve that desired then the control points must be altered to have a good resemble curve as sample. The result is mimicking the sample of Batik design perfectly since of its uniqueness properties that help a lot in creating the curve.

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CHAPTER 1

INTRODUCTION

This chapter includes the introduction of the Timmer function and Batik design and the purpose of this study by stating the problem statement and the objectives. This chapter also states the limitation of the study by discussing scope of the study.

1.1 Overview

Generally, in the world of designing and modeling, curves have been an important role. For designer there a lot of function that creates the types of curves that lead to amazing design and modeling of an object. But for the mathematician, there are several functions of the curve that are usually been used that can create curves that satisfying all property of curve such as B spline and Bezier. Timmer function has satisfied all property of curve but somehow has 'extra' property that been its uniqueness that makes it rarely been used by the researcher.

Timmer cubic curve has uniqueness when it is intended to force its curve to go through the midpoint of control polygon. With this uniqueness, the curves that been created by using Timmer cubic curve will be more following the control polygon, then the curves are resembled as the example or the curves that researcher desire. When piecewise of Timmer cubic curves have been connected, the curves that been created are more following control polygons. As the curve created it tends to be resemble as the example that been chosen from Batik design.

Batik design is widely been used in Malaysia and other countries. Batik is originated from Java in Indonesia and Kelantan and Terengganu in Malaysia. Batik designs are different depends on the place it comes since its carries culture, style, and

distinct identity. Malay batik is more to flora design such '*bunga raya*' (hibiscus)() Old days Batik design just been used on '*kain batik*' which is been used by Malay women but nowadays Batik design also been used on dress and clothes. Batik design not only been used by Malay people but also by other people from other countries, they interested with Batik design.

Batik design itself has varied of the curve that can be used as the example in this study. Batik design has its own uniqueness pattern. Timmer cubic curve will help to create the curves that are likely as the pattern that been chosen from Batik design.

1.2 Problem Statement

Generally in the world of design and mathematics, when come to designing or creating the curve, the researcher are usually choosing familiar curves such as B-spline curve and Bezier curve. Timmer curve is rarely been choose by the researcher since its properties that are slightly different to the properties of Bezier curve and B-splines curve.

The basic problem is simply stated is to create or to design the curve to behave exactly as the sample or as it have to be. When it comes to more complicated curve, it will be more difficult to create the curves as desired. By using the cubic curve, the curves will satisfy the continuity properties and to make it easier to create the curves that have to be connected. As using the Timmer Cubic Curve, to create curves is easier rather than by using the different degree.

. Timmer cubic curve has properties that make it curve more mimicking the control polygon and brings the curves to behave like it has to be. The other type of curves, the curves are floating in the control polygon, thus they will not satisfy the curves that the

designer required to be. Timmer Cubic Curve will create better curves that more similar as the curves that been desired by the designer.

1.3 Objectives

The objectives of this study are:

- (i) To detect control point from a sample been chosen.
- (ii) To fit Cubic Timmer curve based on the sample.
- (iii) To adjust continuity based on the connection between curves been created.
- (iv) To compare Cubic Timmer curve with B Spline curve.

1.4 Scope of Study

This study is about Cubic Timmer Curve and its continuity. Most of the curves that created in this study have continuity whether C^0 or C^1 continuity. Cubic Timmer curves have uniqueness where its curves must go through the midpoint of control polygon. The curves generated are based on Batik design that been chosen. The software been used in this study is MATLAB 2012b.

CHAPTER 2 LITERATURE REVIEW

This chapter have discussed about previous research on Timmer curve from a few researcher. This chapter also discussed about the history behind batik such as type of batik and pattern of batik.

2.1 Background of Timmer

Timmer function is an advanced function from Bezeir function. Bezier function can be say as basis of the modern field of Computer Aided Graphics Design (CAGD) which is application in many areas. Bezier is introduced in the early 1960s by Pierre Etienne Bezier. At beginning Bezier been used in car manufacture but after a while been used mostly in surface designing. Around 1969, James Ferguson, a plane designer comes with idea about construction of surface and curves (D.Salomon, 2006). Bezier curve is a parametric curve that is a polynomials function of the parameter. The degree of the polynomials depends on the number of points used to define curve. It used control points and produce an approximately curve (K.V.Pang, 2013). The equation of Bezier curve defined as,

$$P(t) = \sum_{i=0}^n P_i B_i^n(t) \quad (2.1)$$
$$t \in [0,1]$$

In Equation (2.1), $P(t)$ is defined as Bezier curve while P_i as the control points. The n defined as the number of order of the curve. B_i^n as the Bernstein polynomials which been explain detailed in Equation (2.2).

In order to create a Bezier curve, Bezier function used Bernstein polynomial. Even to create other curve such as Timmer curve and B Spline curve also used Bernstein polynomials. Bernstein polynomials defined as,

$$B_i^n(t) = \binom{n}{i} t^i (1-t)^{n-i} \quad (2.2)$$

Harry Timmer introduced a Timmer function in early 1980s as an advanced function from Bezier function but this function does not obey convex hull property. This function is started with Timmer cubic function. Even though its disobey convex hull property but it make things easier in designing objects because curve produced is nearer to the control polygon and apparently for cubic Timmer function, its cuts the control polygon and makes easier to manipulate the curve by manipulating the control points as to demonstrate with some object design (R.Norhidayah & J.M.Ali, 2014).

Gobithasan and Ali (R.Gobithasan & J.M.Ali, 2004) had discussed about creating piecewise Timmer curve that has G^1 and G^2 continuity and surface of wine glass by using piecewise Timmer curve that have G^2 continuity. In their study, the author discussed about the connection between piecewise Timmer curves using G^1 and G^2 continuity to create a better curve. The author also used unit tangent vector and curvature in order to get a surface of wine glass. Instead, this study shows the uniqueness of Timmer Cubic Curve and confirming its existence.

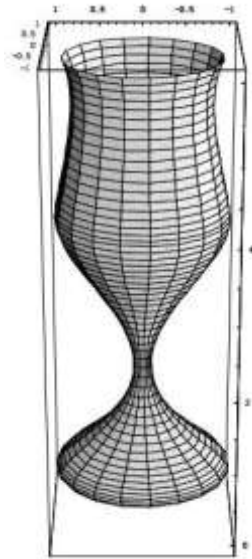


Figure 2.1: Wine glass by Gobithasan and Ali (R.Gobithasan & J.M.Ali, 2004)

Abbas and Ahmad (Abbas et al, 2014) discussed about the rational Timmer curves that effectively represent circular arc more than other curves which is range circular arc up to 2π (but not including 2π). In their study, there is a comparison between cubic Said-Ball curve, cubic Bezier curve and cubic Timmer curve. Rational cubic Timmer curve has been compared by using different weight on it where they shown that the smaller the weight the more circle likely to the curve itself. The authors also discussed about Rational Cubic Timmer curve as conic segment and the representation of circular by using Rational Cubic Timmer curve with different turning angle which came with result that the bigger the turning angle the curve became more like a perfect circle. As the finding, the authors give conclusion that to have a curve likely a perfect circle is to have the smallest weight and the big turning angle

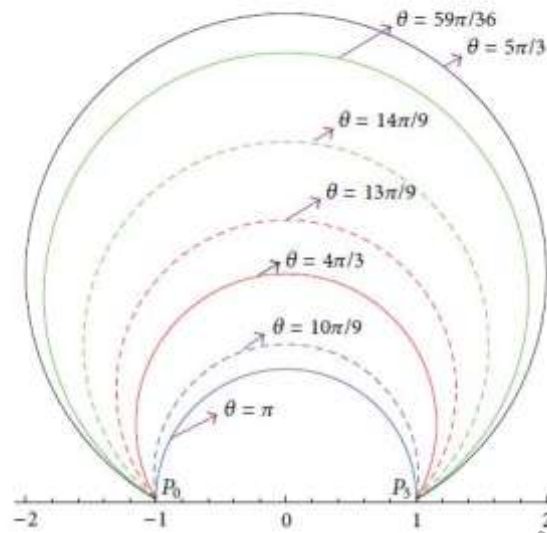


Figure 2.2: Curve with different turning angle by Abbas and Ahmad (Abbas et al, 2014)

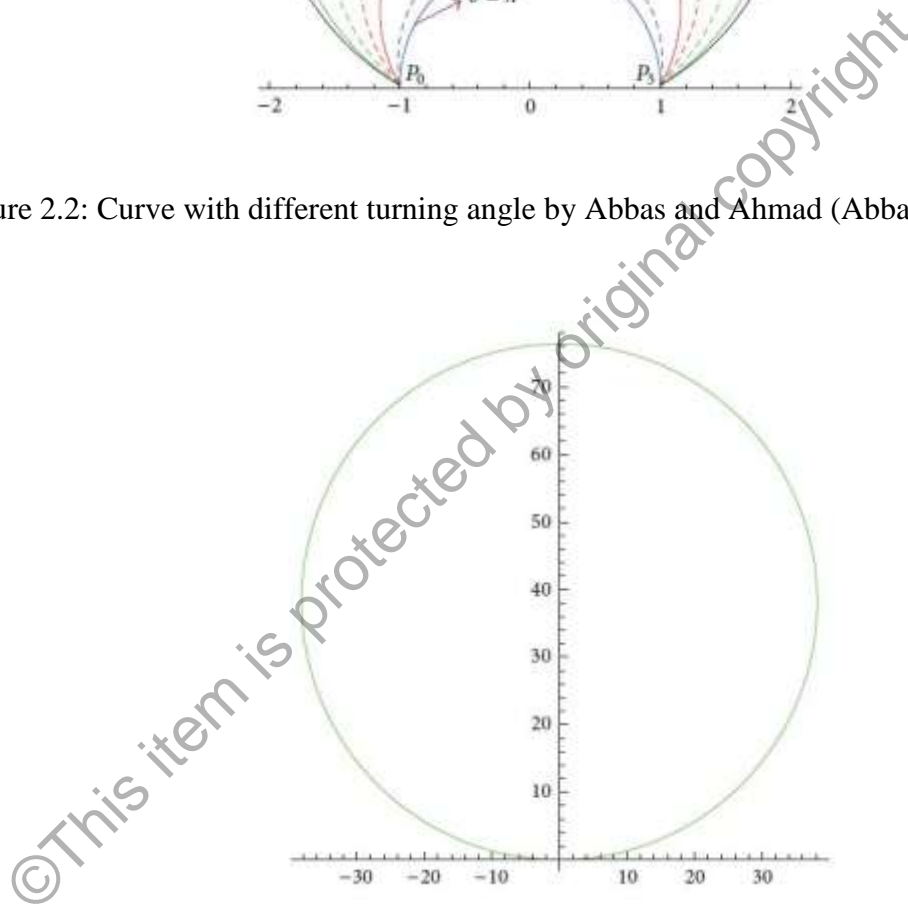


Figure 2.3: Curve with small weight and big turning angle by Abbas and Ahmad (Abbas et al, 2014)

Norhidayah and Ali (R.Norhidayah & J.M.Ali, 2014) discussed about the designing object by using blending of rational Timmer and higher degree of Timmer basis that is quantic Timmer basis that had been used to design formation of sink, glass, and

vase that also used the weight of each basis. In their study, the authors show Timmer Quartic and Timmer Quintic but for all design the authors are using Timmer quantic in order to manipulate the control points. The authors are not just using Timmer quantic but Rational Timmer quantic has weight for each basis function. By using the weight, the curve can be more controlled because curve will follow the weight. The authors created curves in order to have formation of surface of glass, vase and sink.



Figure 2.4: A wine glass by Norhidayah and Ali (R.Norhidayah & J.M.Ali, 2014)



Figure 2.5: A sink by Norhidayah and Ali (R.Norhidayah & J.M.Ali, 2014)



Figure 2.6: A vase by Norhidayah and Ali (R.Norhidayah & J.M.Ali, 2014)

2.2 Background of Batik Design

When we mention about design for Malay people old days, there are two types whether it is Batik or Songket. Both of them been known around the world, been improvise for modern people nowadays. Batik and Songket been design based on several motif, there are flora and fauna, geometrical, and else.

Songket is a beautiful piece of traditional Malay fabric woven in silk or cotton yarns, its been created by using *menyongket* technique. Historically, Songket is worn by royalty and leaders. However, nowadays, it is mostly worn as tradisional Malay ceremonials clothes during royal ceremonies and wedding. Songket also been improvised into handbags and home products. Most Songket weavers in Malaysia can be found in Terengganu, Kelantan, Pahang and Sarawak (Ngo & June, 2007). Jamil had shown that motifs of Songket can be changed or been improved such as Songket Kufik (Jamil, n.d).

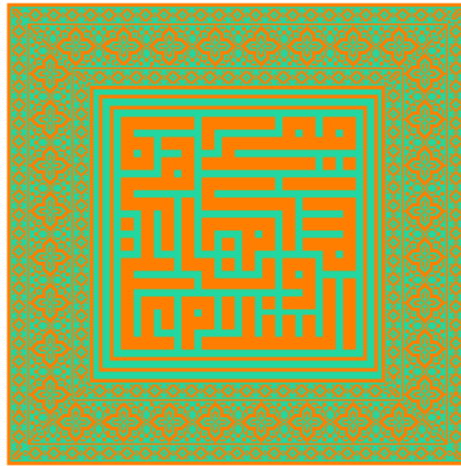


Figure 2.7: Songket Kufik (Jamil, n.d)

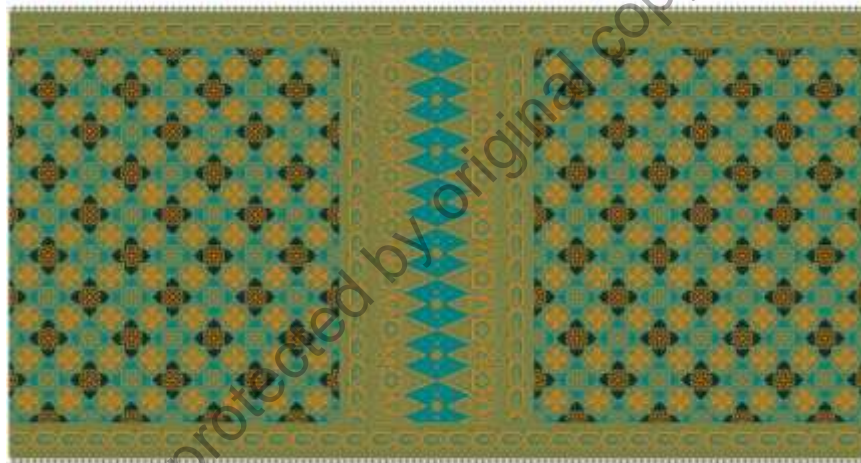


Figure 2.8: Songket Sampin (Jamil, n.d)



Figure 2.9: Songket Selendang (Jamil, n.d)

However, the sample been chosen from Batik design because Batik design have complicated and unique design than Songket where mostly of them designing geometrical. The curve that created based on Batik design. Batik design consist three main types, namely "batik tulis", "batik cap" and "batik ikat". Each of this main types has its own techniques and specialist needed, and thus its produce a different kind of design creativity.

There are some of Batik design usually been used including “pucuk rebung” (bamboo shoots), “bunga raya” (hibiscus), “daun sirih” (betelnut leaves), “sirih mas” (golden betelnut), “bunga tanjung” (cape flower), “parang rusak” (damaged blade or knife, this pattern was once only been used by Javanese royal families), and “mega mendung” (a type of cloud pattern). In traditional Malay batik, Islamic tradition do not encourage the depictions of human and fauna so that the richness Malay batik draws a lot of design from geometrical and also flora patterns (QuaChee, 2007).



Figure 2.10: Example of Batik Cap



Figure 2.11: Example of Batik Tulis



Figure 2.12: Example of Batik Ikat



Figure 2.13: Example of pattern Batik Bunga Raya



Figure 2.14: Example of pattern Batik Bunga Tanjung

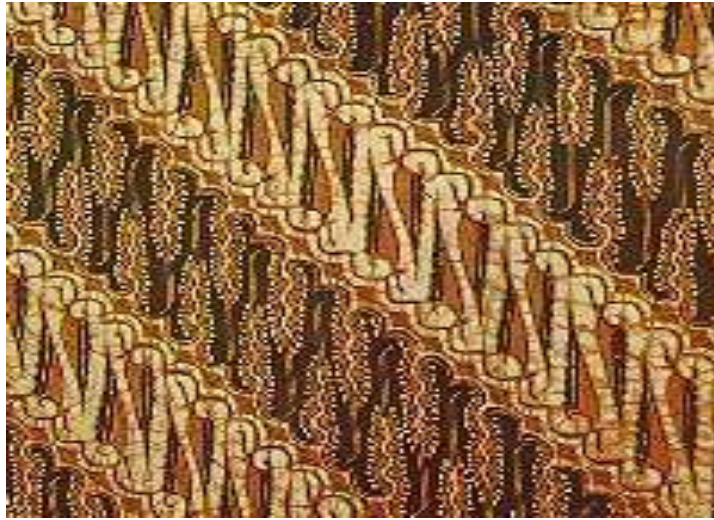


Figure 2.15: Example of pattern Batik Parang

There are some proved that Batik design widely known around the world. The legend said that when soldier came back to Africa, they brought back of fine Javanese batik. Today in Africa, many women earns from creating modern batik clothing, skirts and shirts, bags, bed linens and tablecloths by hand. The pattern of batik are a form of expression, abstract geometry, and religious belief (Globalmamas, n.d). While in American, in 1907, Batik firstly brought into America by Nieuwe Kunst batik projects. But, it became popular when an English-American chemist, Pellew taught dyeing and fabric decorating technique including Batik at Teachers College, Columbia University, in Manhattan. This can be observes in a Batik silk purse made by Mary C. Whitlock whose studying with Pellew at Teacher College as shown in Figure 2.10 (Abby, 2004).



Figure 2.16: Batik silk Purse made by Mary C. Whitlock (Abby, 2004)