Application of said-ball curve with continuity in Jawi design

By

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LIST OF ABBREVIATIONS

BAC	British Aircraft Corporation
CAD	Computer Aided Design
NTP	Normalized Totally Positive
NURBS	Non-Uniform B-Spline Curve
CAM	Computer Aided Manufacturing
MRI	Magnetic Resonance Imaging
DE	Differential evolution
SSE	Sum Square Error
WSGB	Generalized Ball basis of Wang-Said Type
PSB	Partial Said-Ball Curve
RPS	Right-deflection Partial Said-Ball Curve
LPS	Left-deflection Partial Said-Ball Curve

LIST OF SYMBOLS

m	Constant
i	Initial value of m
n	Degree
t	Time
$S_i^n(t)$	Said-Ball basis function
P_i	Control point
S_n	Said-Ball Curve of degree n
C^0	Continuity degree of 0
C^1	Continuity degree of 1
C^2	Continuity degree of 2
G^1	Geometric degree of 1
GC^2	Geometric Continuity degree of 2

Applikasi Lengkungan Said-Ball dengan Kesambungan dalam Mereka Bentuk Tulisan Jawi

ABSTRAK

Fungsi Ball diperkenalkan dengan polinomial kubik oleh Ball, kemudian diteritlak dengan kuasa yang ganjil yang lebih tinggi oleh Said. Penyesuaian lengkung adalah salah satu masalah bagi kejuruteraan berbalik. Huruf Arab sukar disesuaikan kerana sifatnya yang berlengkung, mempunyai pelbagai bentuk lengkung dan lengkung yang tajam. Dalam disertasi ini, jenis lengkung yang jarang digunakan iaitu Lengkung Said-Ball berkuasa ganjil telah digunakan untuk mereka bentuk huruf-huruf Arab. Proses-proses yang dijalankan adalah seperti berikut: Pilih gambar huruf yang berkaitan, cetak gambar tersebut, kenal pastikan sempadan, titik pusingan dan segmentasi, mengaplikasikan kesambungan mengikut kesesuaian dan penyesuaian segmen lengkungan. Sebagai kaedah kejuruteraan berbalik, huruf Jawi dihasilkan dengan penyesuaian segmen lengkung berdasarkan poligon kawalan daripada huruf tersebut. Pembahagian segmen melibatkan penaikan dan penurunan bilangan titik kawalan akan memberi kesan kepada kuasa Lengkung Said-Ball yang perlu digunakan setiap segmen. Poligon kawalan and pembahagian segmen diubah supaya lengkung yang dijana kelihatan seperti imej huruf yang sebenar untuk memastikan Lengkung Said-Ball berkuasa ganjil mampu mereka bentuk Jawi berdasarkan perbandingan visual. Pencarian dalam disertasi ini adalah penyesuaian lengkungan kepada huruf Jawi menggunakan Lengkung Said-Ball berkuasa ganjil bersama-sama kesambungannya. Teknik ini boleh diperluaskan untuk menghasilkan gambaran yang lain sekiranya reka bentuk diperlukan untuk aplikasi yang seumpamanya.

Kata kunci: Penyesuaian lengkung, fungsi Ball, Lengkung Said-Ball, kesambungan, kejuruteraan berbalik, reka bentuk Jawi.

Application of Said-Ball Curve with Continuity in Jawi Design

ABSTRACT

Ball basis was introduced for cubic polynomials by Ball, then the generalized for polynomials of higher odd degree by Said. Curve fitting is one of the main problems in reverse engineering. An Arabic font is difficult to fit as it is cursive in character, having varying curves and cusps. In this dissertation, a rarely used type of curve called odd degree Said-Ball Curve has been designed to capture Arabic fonts. The process to design those characters includes the following steps: Choose image of character, print the image of a character, detections of boundary, corner points and segmentation, apply suitable continuity and then fitting the optimal curve segment. As a method of reverse engineering, the Arabic character is created by fitting the curve segments to the control polygon of the character's image. Segmentation process involves the degree elevation and reduction for Said-Ball Curve based on the number of control points selected for every segment. The control polygon and the segment are adjusted to get the curve look like the image to ensure that odd degree Said-Ball Curve is reliable in designing Jawi based on visual comparison. The finding of this dissertation is curve fitting of Jawi character by odd degree Said-Ball Curve. This technique can be extended to visualizing any other image as long as the design process is needed in various other applications.

Keyword: Curve fitting, Ball basis, Said-Ball Curve, continuity, reverse engineering, Jawi design.

CHAPTER 1

INTRODUCTION

1.1 Overview

Jawi is an adapted Arabic alphabet for writing the Malay language which is existed around 1300 CE (Asmah; Cooper, 1982). It is written from right to left and some letters are never joined and some are joined obligatorily. Jawi was the standard script for writing the Malay Language but has been replaced by a Roman script called Rumi. Nowadays, it is slightly forgotten and only being used for religious and cultural purposes. Various efforts have been done to revive the Jawi writing due to its important role in the Malay heritage. The energy of Jawi should be reviving, so that this writing is widely exposed to the younger generation. Besides, Jawi have a high value of artistic because it can be written in different styles, known as calligraphy. It is curvier compared to other script. It is important to create awareness so that Jawi is better appreciated, preserved and hence relevant to nowadays society.

Next, Ball curve was first proposed by Alan Ball who was hired for British Aircraft Corporation (BAC) and it was used for BAC's in-house Computer Aided Design (CAD) system (Ball, 1974; 1975; 1977). Then, Said developed the cubic basis introduced by Ball into arbitrary odd degree basis to achieve a type of generalized Ball curves called Said-Ball Curve (Said, 1989). In addition, Goodman and Said (1991a) proved that the generalized Ball basis is Normalized Totally Positive (NTP) and hence it occupies the same kind of shape preserving properties as the Bernstein

basis (Goodman & Said, 1991b). Also its representation for a polynomial curve is much better than the Bezier representation for the idea of increasing and decreasing the degree.

1.2 Problem Statement

Generally, all of the things that we use in daily life are all need to be creatively designed before it completely produced. And for design, curves are needed. Every single curve that used has its own Mathematics behind it. In Jawi design, since the curve is complicated, particular equation is needed to overcome the complexities in designing Jawi characters such as Said-Ball curve as long as the shape of those characters are preserved. So, utilization of the properties of curve to design Jawi is the most important to ensure the design of each character in Jawi is succeed. In this case, Said-Ball curve and its basis function is reliable to preserve the shape of each character. In Jawi design, sometimes the continuity is needed to make sure between to segments are continuous smoothly. So, the use of Continuity of Degree 1, C^1 for Said-Ball Curve is effective to generate the desirable curve so that the result in design is more preferable.

1.3 Objectives

The objectives of this study involved three main stages:

1. To detect corner points.
2. To determine control points.
3. To fit Said-Ball Curve that satisfies Continuity of Degree 1 in designing Jawi.

1.4 Scope of Study

This study considers the odd degree of Said-Ball curves. The lowest degree for Said-Ball curve is cubic Said-Ball as well as the basis function too. The highest degree that obtained in this study is ninth degree Said-Ball curve. Different odd degree of Said-Ball curves is chosen according to the suitability of the curves itself. Surely, to connect each of the Said-Ball Curve, Continuity of Degree 0, C^0 is used. For better design, C^1 continuity of Said Ball Curve also will be considered based on visual comparison.

CHAPTER 2

METHODOLOGY

2.1 Introduction

This chapter will discuss in detail about the methodology and steps used to achieve the results. For better understanding, at the end of this chapter, a flow chart for the steps used is drawn.

2.2 Methodology

The methodology of this dissertation is based on the following steps:

1. First, choose the respective image of a character. Let choose character Alif. Print the character on a graph paper as shown as the figure below.

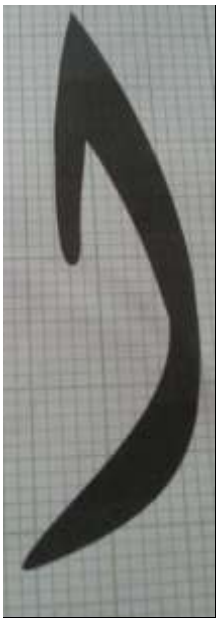

Figure 2.1 Alif is printed on a graph paper.

2. Determine the boundary, corner point and segment. For Alif, there is only a boundary, 4 corner points and 4 segments. After that, choose the suitable control points so that a control polygon can be obtained based on those points.

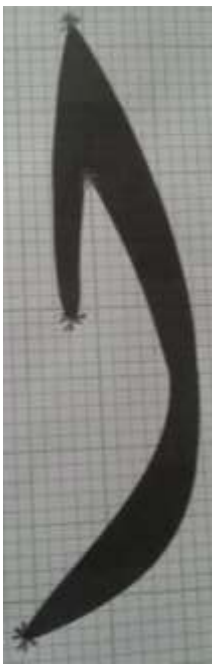

Figure 2.2 Detection of the boundary, corner point and segment.

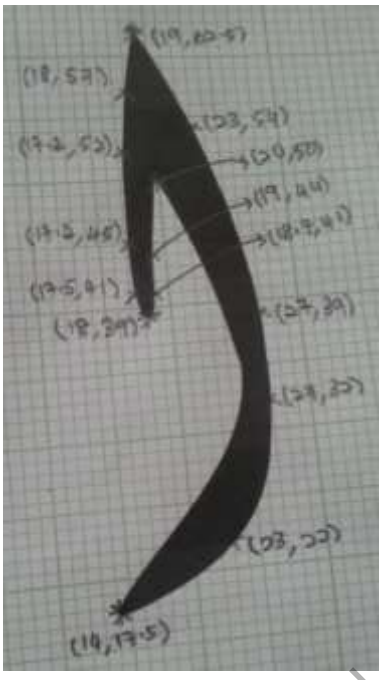

Figure 2.3 Choose the suitable control points based on boundary points.

3. Generate the control polygon. The selected control points are used as the control polygon of the character and will be used in the odd degree Said-Ball Curve equations. The generated control polygon is shown on the figure below.

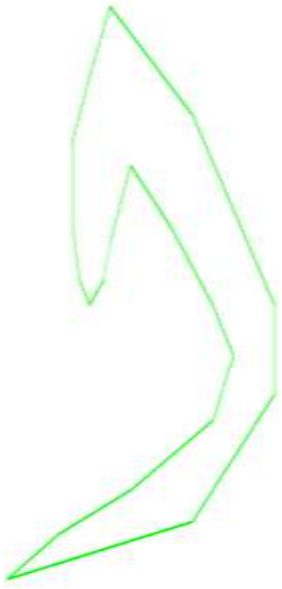

Figure 2.4 The control polygon for Alif.

5. After get the control polygon, use the points to generate the Said-Ball Curve based on the control polygon itself. The generated curves are analysed whether it is look-alike to the image of character or not based on visual comparison.

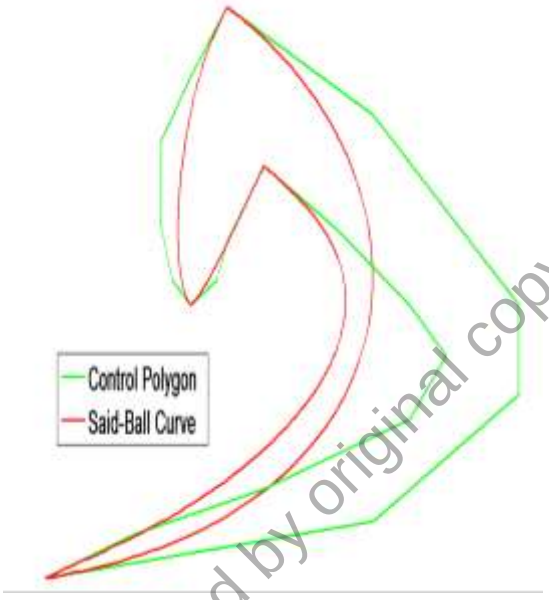

Figure 2.5 Said-Ball Curve with the control polygon of Alif.

Based on the Figure 2.5, the generated Said-Ball Curves are not satisfying the image of character Alif. So, to have a better design that look-alike to the real image, the control polygon needs to be altered by choosing another control points. In this case, the number of control point remains unchanged so the degree of Said-Ball Curve also remains unchanged. After the coordinate points are changed, the new generated curves with better visualization of the character Alif are produced.

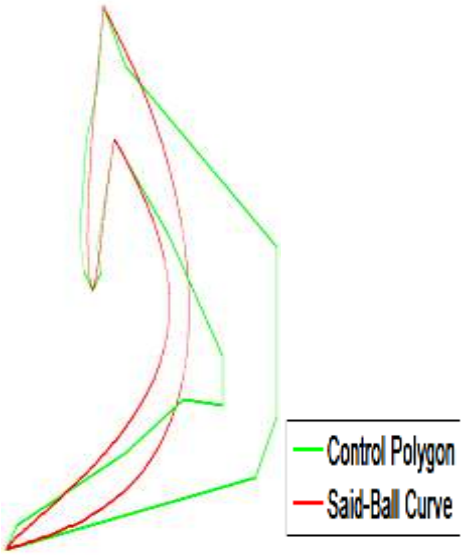

Figure 2.6 The new Said-Ball Curve with control polygon of Alif.

Figure above shows that the visualization of character Alif after the alteration of the coordinates and control polygon is much better than before. The generated Said-Ball Curves mimics the real image of character Alif. These steps are repeated to character Ba but in the middle of process to generate Said-Ball Curves to design character Ba, the number of segments need to be increased so that the result look-alike the real image. After alter the coordinates and its control polygon, the generated curves are still not satisfying the real image. Since character Ba consists of large segments, let divide the segments into 3 parts.

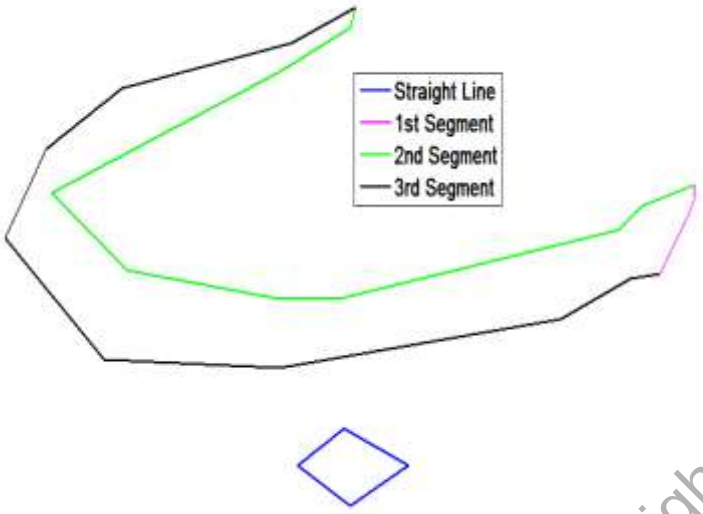

Figure 2.7 Initial control polygon of Ba.

Each line in Figure 2.7 indicates the segment needed to design character Ba. The green and black lines consist of ten control points and to be expected to apply ninth degree of Said-Ball Curve.

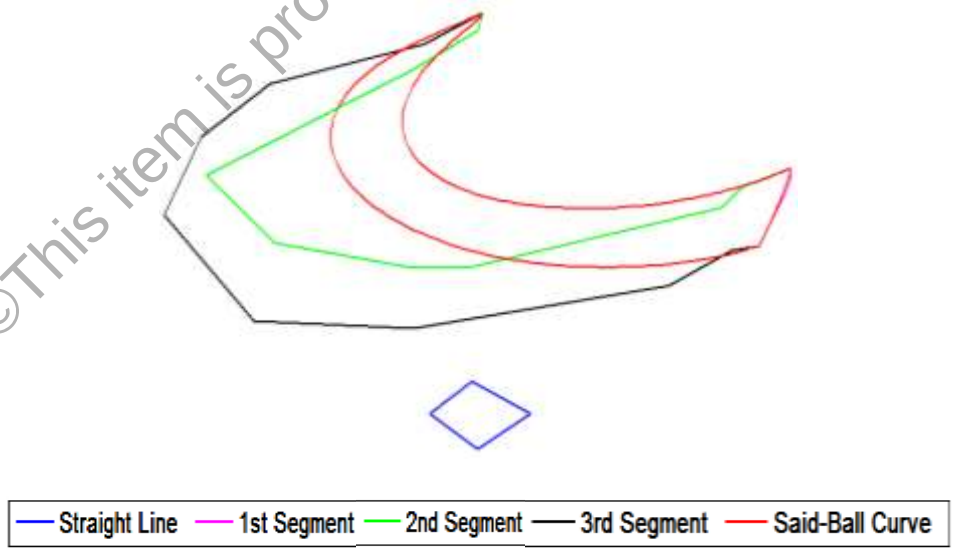

Figure 2.8 Character Ba is designed by Said-Ball Curve for the first try.

Refer to the Figure 2.8, the red curves are the generated Said-Ball Curve. The curves are obviously not satisfying the real image based on visual comparison. The best way to solve this problem is increase the segments. Initially, there are only 3 segments.

6. Increase the number of segment. Refer to Figure 2.8, the 1st segment is altered, the 2nd segment is altered and divided into 2 segments. The 3rd segment is altered and divided into 3 segments. Now, the total number of segment is 6. For some case, increase the number of control points is needed to fulfill the odd degree Said-Ball Curve. Hence, the more preferable Said-Ball Curves can be generated to design character Ba.

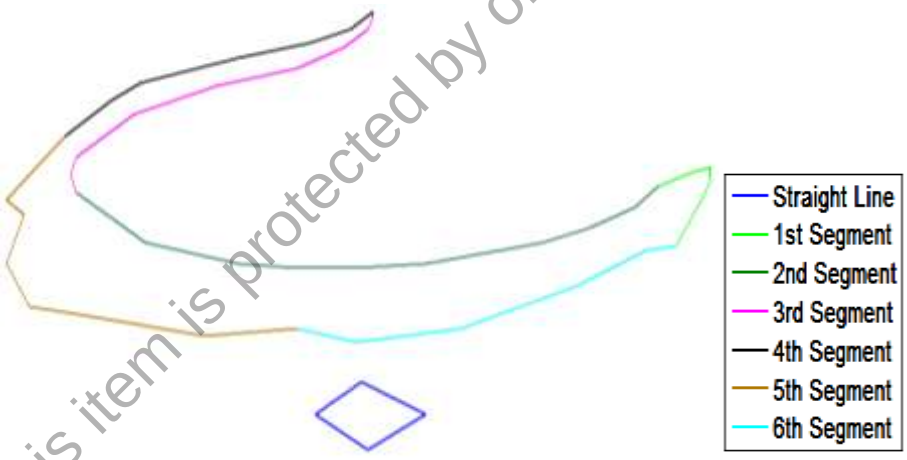

Figure 2.9 The 6 new segments of character Ba as the new control polygon.

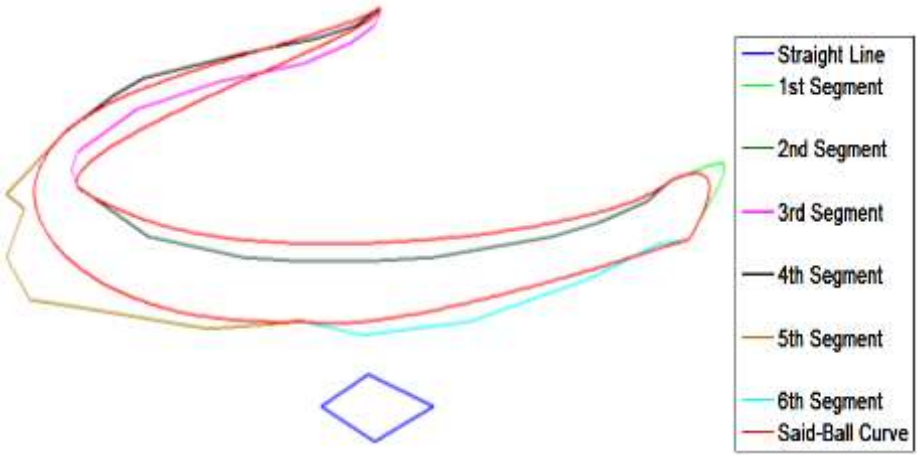

Figure 2.10 The Said-Ball Curves are produced after increase the number of segments to design Ba.

7. Based on Figure 2.10, the segments are joined not really smooth, so let use C^1 Continuity since the segments are not in the sharp end.

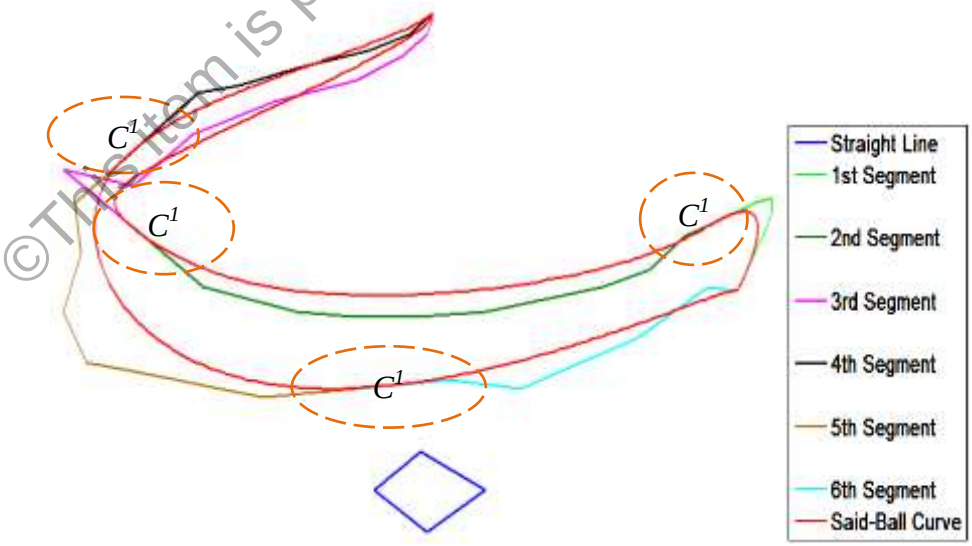

Figure 2.11 Character Ba by Said-Ball Curve and its control polygon with C^1 Continuity.