PhD Proposal Writeup

A realtime and parallel look-ahead control and feedrate compensation strategy for CNC reference-pulse interpolation.

Faculty of Mechanical Engineering,
Universiti Malaysia Pahang (UMP),
26600 Pekan, Pahang Darul Makmur,
Malaysia.

PhD Program Registration Details		
1	Name of Student	**Wan Ruslan bin W Yusoff**
2	Student ID	**PFD18001**
3	National Reg. ID	**560911-03-5067**
4	Faculty	**Faculty of Mechanical Engineering**
5	Program	**Doctor of Philosophy (PhD)**
6	Field of Research	**Mechatronics and System Design**
7	Type of Study	**Research**
8	Mode of Study	**Full Time**
9	Registration Date	**Tue, 03 April 2018**
10	Supervisor	**Dr. Fadhlur Rahman bin Mohd Romlay**
12	External Advisor	**Prof. Yashwant Prasad Singh**
13	Document Date	**June 15, 2023**
14	Research Title	**A realtime and parallel look-ahead control and feedrate compensation strategy for CNC reference-pulse interpolation**
15	Contact EMail	**wruslandr@gmail.com**
16	Contact Mobile	**6012-3218120**

Reference: **Draft-44-Report-Latex-PhD-Proposal-WRY.tex**
Date: **June 15, 2023**
Version: **Draft-44**

Contents

List of Figures

List of Tables

Listings

1 Simulation Results

1.1 The Parametric Equations

The images of the UMP 3-axis CNC research machine for our previous work are provided in next three figures. It is an experimental CNC router-type, that instead of a tool cutter, uses a pen to create drawings on paper in the X-Y plane. The Z-axis motion is used to raise and lower the pen. As a consequence, circular arc (G02, G03 G-Code) moves are applicable to the X and Y axes only, while linear (G01 G-Code) moves are applicable to all three X, Y and Z axes.

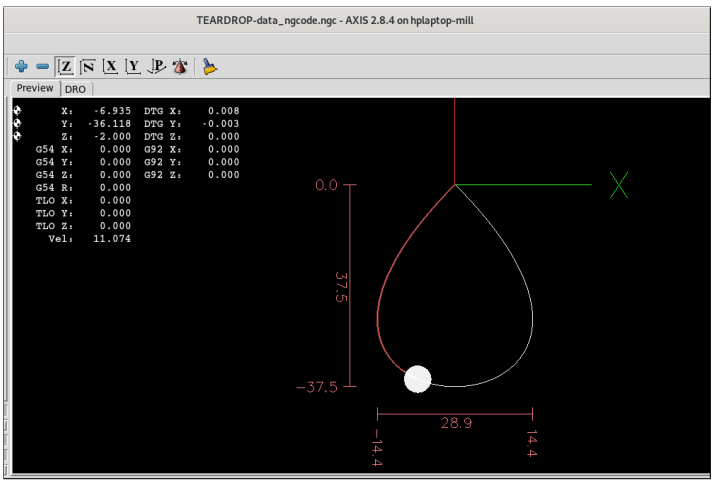
Electrical signal pulses sent to the servo-driver provide information like rotate clockwise (CW), rotate counter-clockwise(CCW), travel distance to rotate, speed to rotate, and so on. The actuation using electrical pulses makes the physical CNC machine instantaneously active.

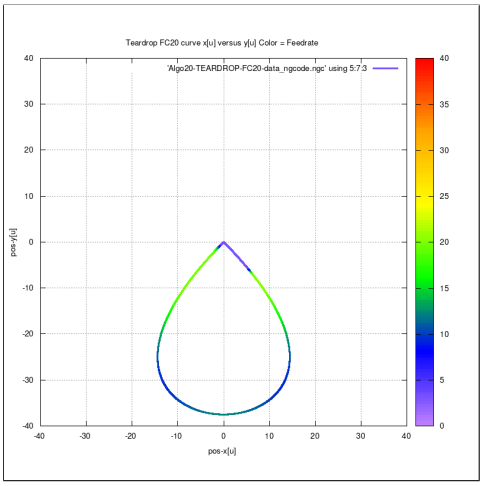
Part 1/5 Teardrop and Butterfly parametric curves

Teardrop parametric curve

$$\begin{aligned} x(u) &= -150u + 450u^2 - 300u^3 \\ y(u) &= -150u + 150u^2 \\ u &\in [0.0, 1.0] \end{aligned}$$

Closed loop
Overall Single loop
Reflection x-axis: non-symmetrical
Reflection y-axis: symmetrical

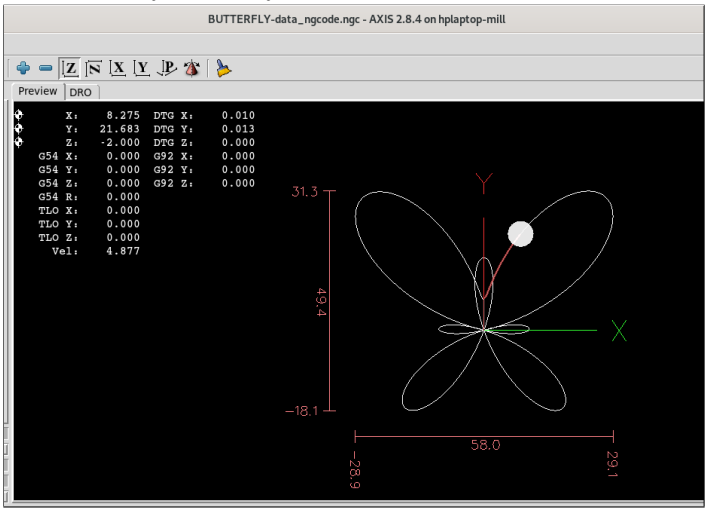


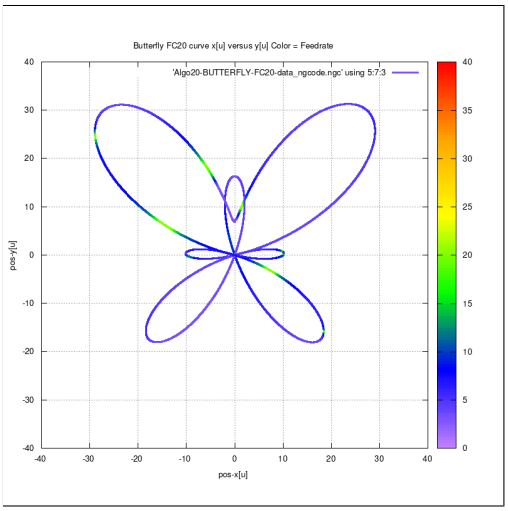


Butterfly parametric curve

$$\begin{aligned} x(u) &= \sin(2\pi u)\left[e^{\cos(2\pi u)} - 2\cos(8\pi u) - (\sin(2\pi u/12))^5\right] \\ y(u) &= \cos(2\pi u)\left[e^{\cos(2\pi u)} - 2\cos(8\pi u) - (\sin(2\pi u/12))^5\right] \\ u &\in [0.0, 1.0] \end{aligned}$$

Closed loop
Overall Multiple loops
Reflection x-axis: non-symmetrical
Reflection y-axis: symmetrical



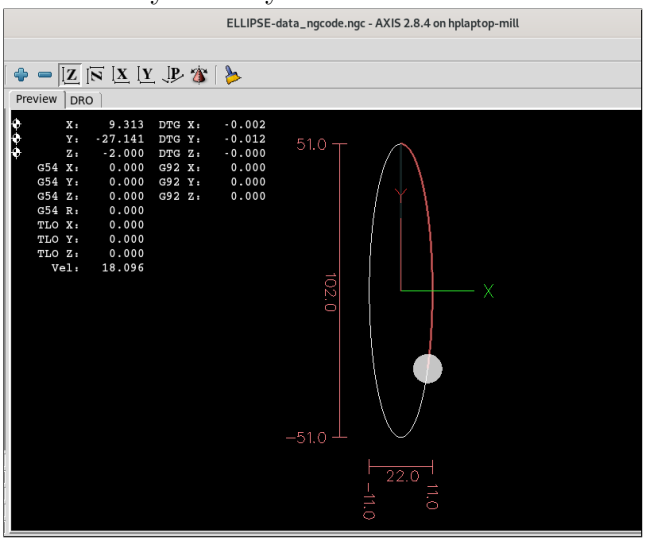


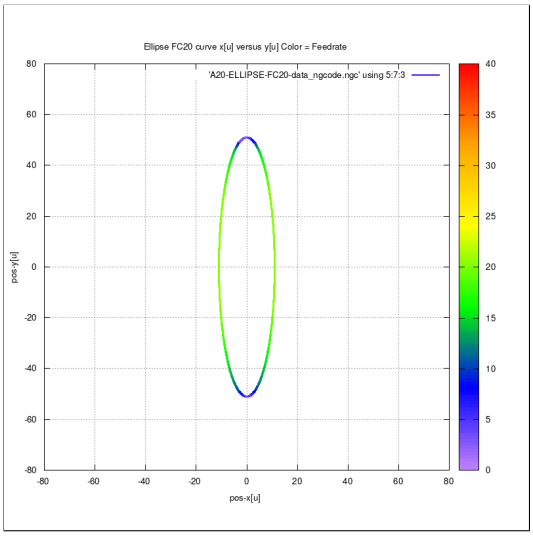
Part 2/5 Ellipse and Skewed-Astroid parametric curves

Ellipse parametric curve

$$\begin{aligned} x(u) &= 11\sin(2\pi u) \\ y(u) &= 51\cos(2\pi u) \\ u &\in [0.0, 1.0] \end{aligned}$$

Closed loop
Overall Single loop, smooth convex curves
Reflection x-axis: symmetrical
Reflection y-axis: symmetrical

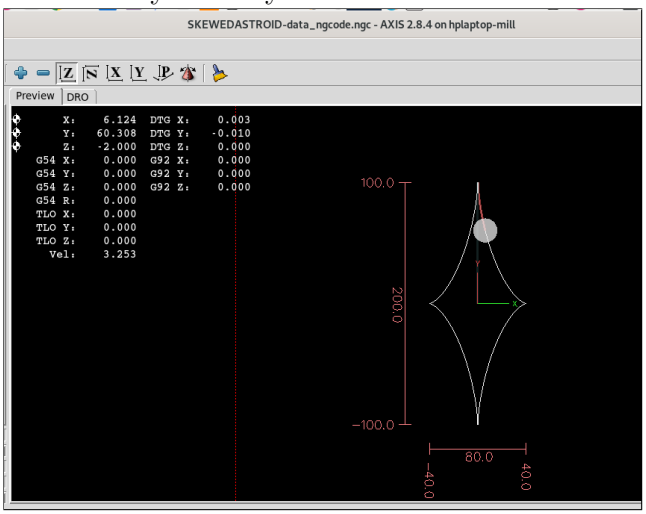


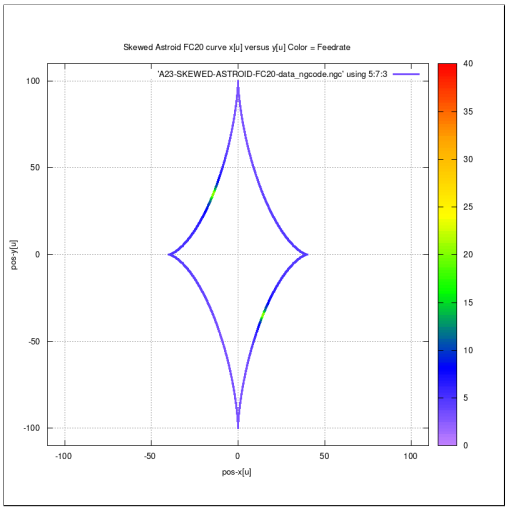


Skewed-Astroid parametric curve

$$\begin{aligned} x(u) &= 40[\sin(2\pi u)]^3 \\ y(u) &= 100[\cos(2\pi u)]^3 \\ u &\in [0.0, 1.0] \end{aligned}$$

Closed loop
Overall Single loop, 4 cusps and 4 concave curves
Reflection x-axis: symmetrical
Reflection y-axis: symmetrical



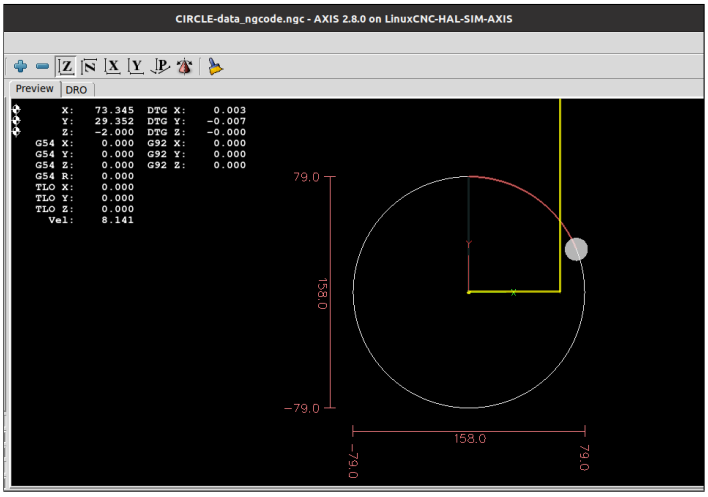


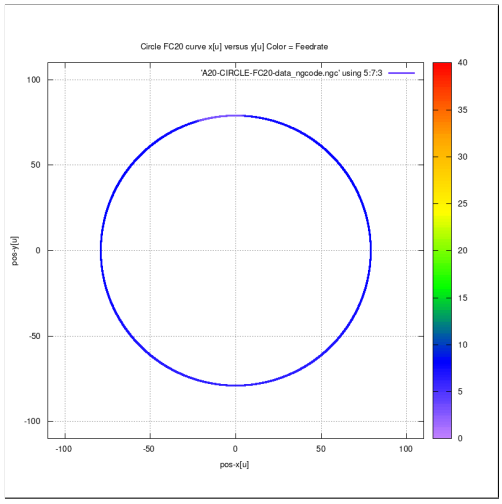
Part 3/5 Circle and AstEpi parametric curves

Circle parametric curve

$$\begin{aligned} x(u) &= 79\sin(2\pi u) \\ y(u) &= 79\cos(2\pi u) \\ u &\in [0.0, 1.0] \end{aligned}$$

Closed loop
Overall Single loop, smooth convex curves
Reflection x-axis: symmetrical
Reflection y-axis: symmetrical





AstEpi = Sum of (Astroid + Epicycloid) parametric curves

$$\begin{aligned} tiny &= 1.0\times10^{-10} \\ x(u) &= 40[\sin(2\pi u)]^3 + 50\cos(2\pi u + tiny) - 10\cos(10\pi u - tiny) \\ y(u) &= 40[\cos(2\pi u)]^3 + 50\sin(2\pi u + tiny) - 10\sin(10\pi u - tiny) \\ u &\in [0.0, 1.0] \end{aligned}$$

Closed loop
Overall Three loops, all convex curves
Reflection x-axis: non-symmetrical
Reflection y-axis: non-symmetrical