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Project III: Simulation of Contouring Performance in Coordinated Two Axis Motion

Prelab

Part A – Trajectory Generation

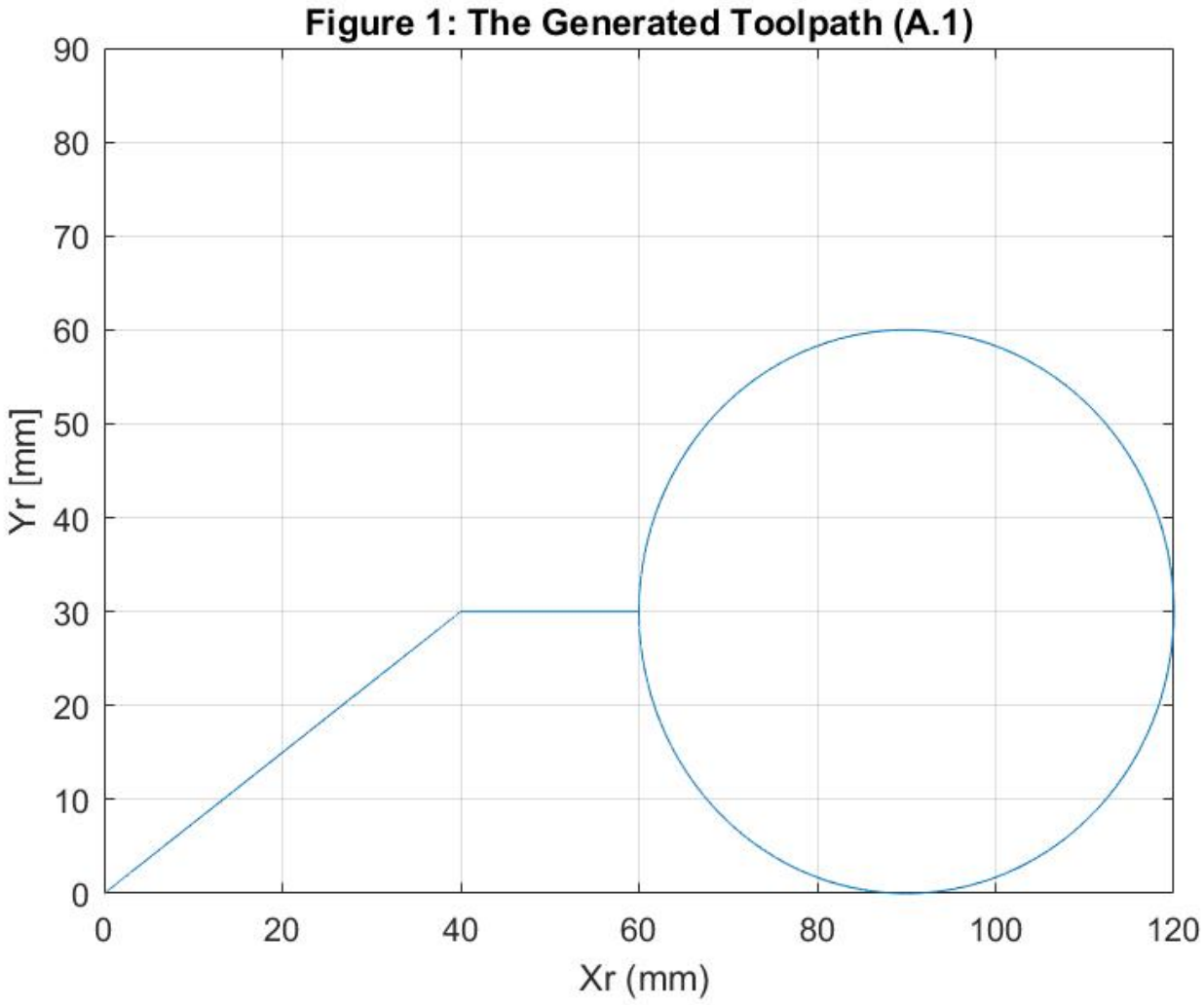


Figure 2: The Displacement, Feedrate, and Tangential Acceleration Profiles as Functions of Time (A.2)

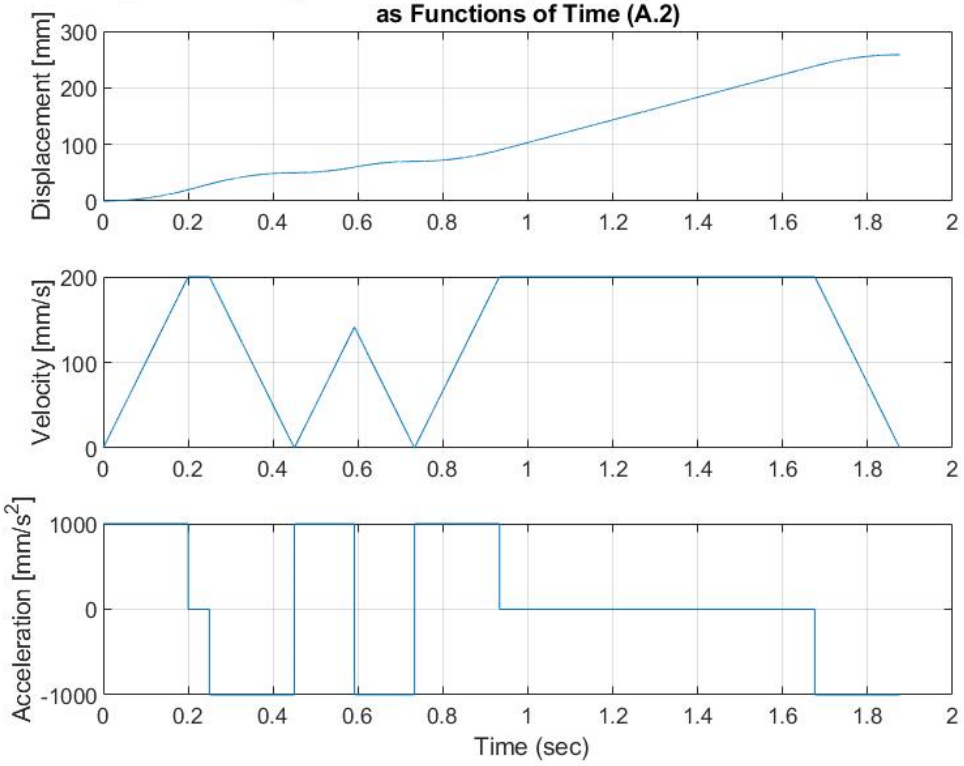
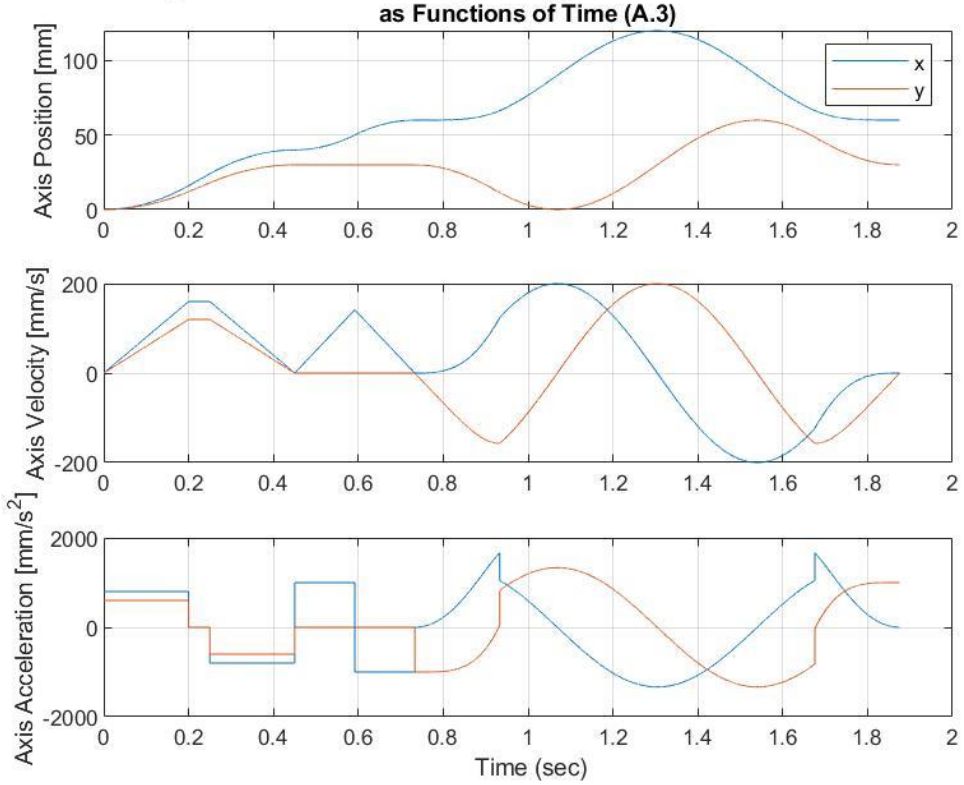


Figure 3: The Axis Position, Velocity, and Acceleration Commands as Functions of Time (A.3)



Part B – Two-Axis Controller Design

Table 1: Lead-Lag-Integrator Controllers (Low Bandwidth and High Bandwidth) for each Axis (B.1)

	Low BW	High BW
X Axis	$\frac{24.46z^2 - 48.78z + 24.32}{z^2 - 1.966z + 0.9658}$	$\frac{109.1z^2 - 217z + 107.9}{z^2 - 1.923z + 0.9231}$
Y Axis	$\frac{17.06z^2 - 34.02z + 16.96}{z^2 - 1.966z + 0.9658}$	$\frac{75.33z^2 - 149.9z + 74.55}{z^2 - 1.923z + 0.9231}$

Figure 4: Open Loop Continuous System of X axis with the LBW and HBW Controllers (B.2)

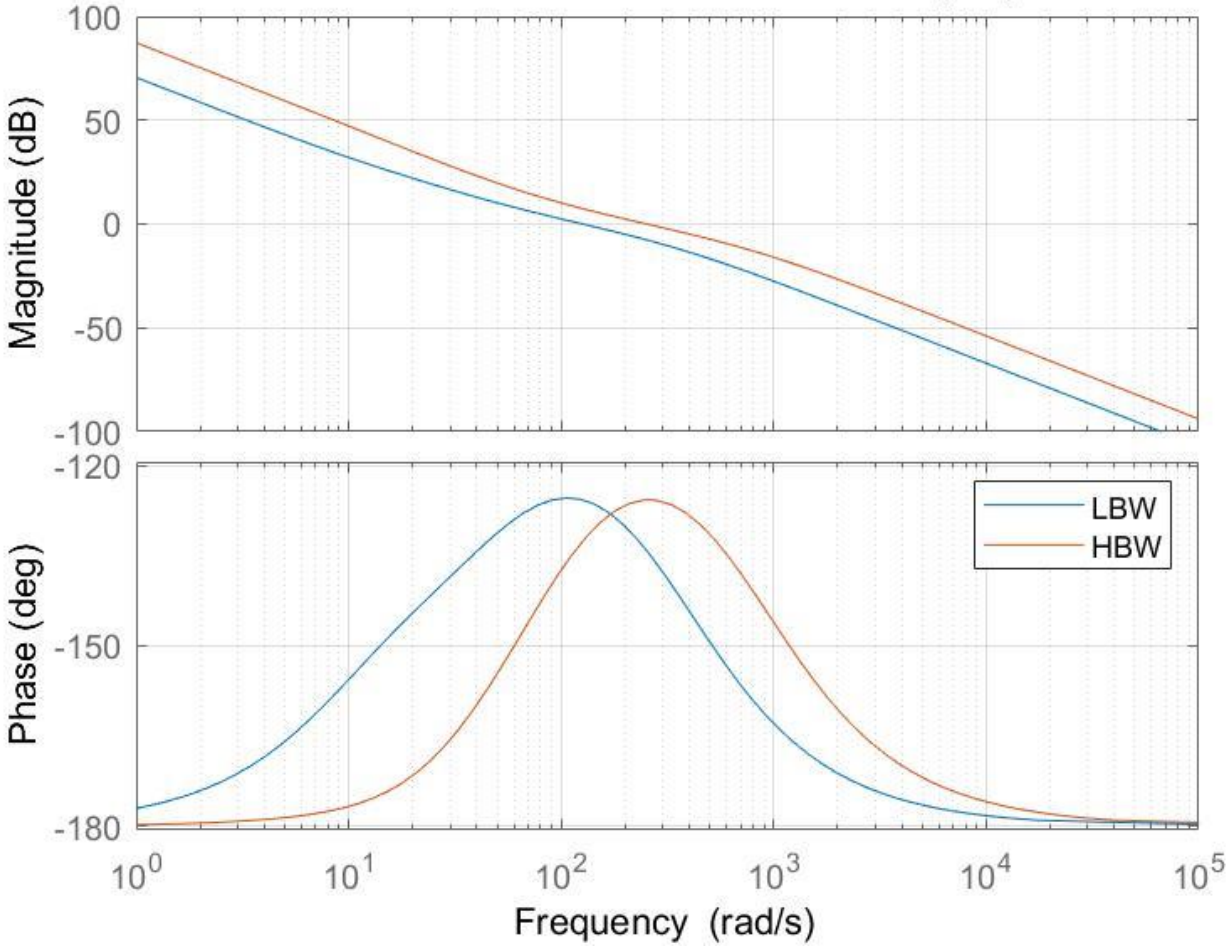


Figure 5: Closed Loop Continuous System of X axis with the LBW and HBW Controllers (B.2)

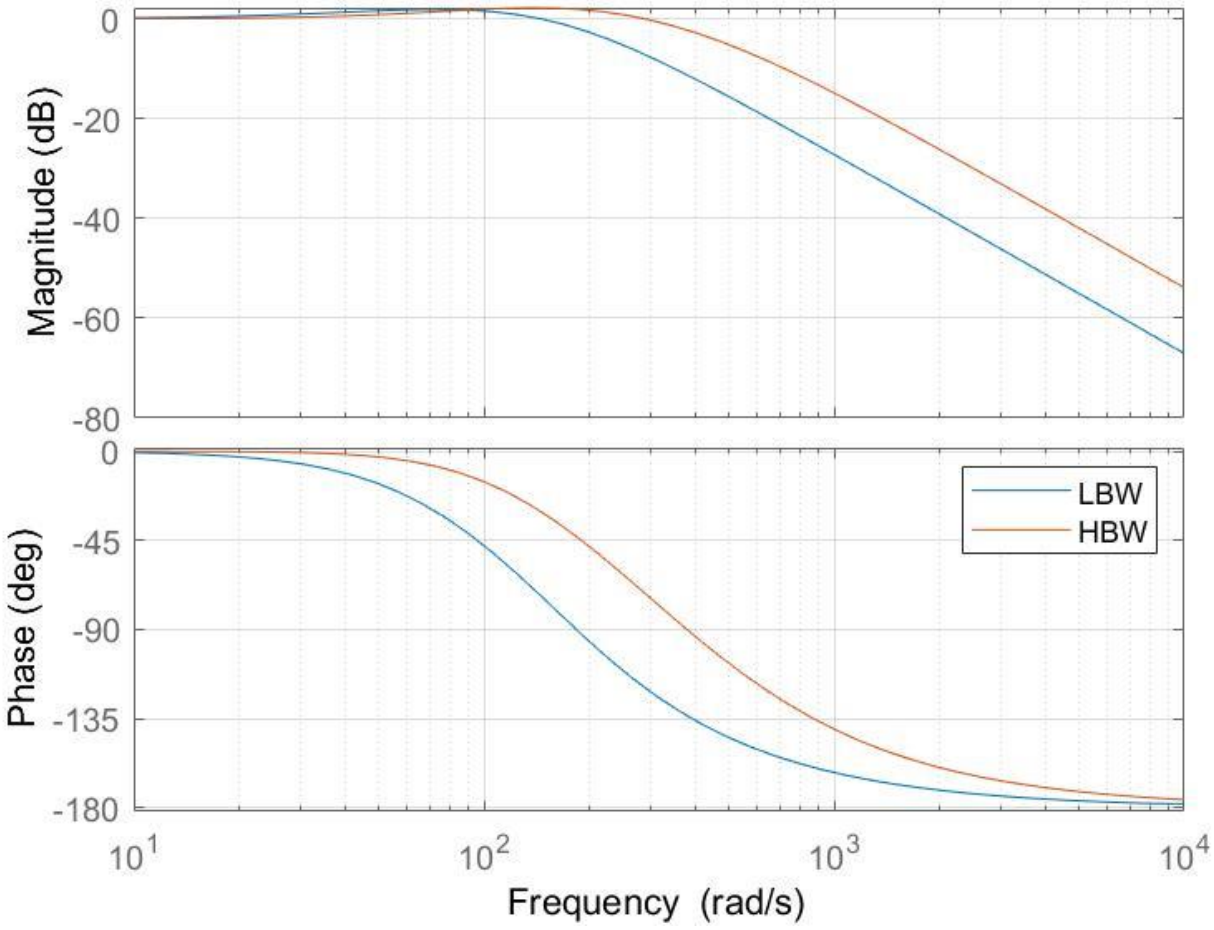


Table 2: Poles, Zeros, Bandwidth, Overshoot, and Rise Time of the Closed Loop Systems (Both Continuous (s) and Discrete (z) Domains) for LBW and HBW Controllers. (B.3)

Axes	Controllers	Poles	Zeros	BW [rad/s]	P.O. [%]	Rise Time [s]
Continuous (s) Domain						
X Axis	**LBW**	-140.65 + 79.53i -140.65 - 79.53i -75.12 -12.90	-45.4093 -12.5664	206.1182	22.1096	0.0091

	HBW	-395.29 -200.38 + 19.74i -200.38 - 19.74i -24.98	-79.0094 -25.1327	411.3056	24.1297	0.0045
Y Axis	**LBW**	-152.64 + 95.82i -152.64 - 95.82i -59.55 -13.26	-45.4093 -12.5664	202.5180	17.2006	0.0095
	HBW	-332.27 + 53.57i -332.27 - 53.57i -139.91 -25.36	-79.0094 -25.1327	406.8798	21.3804	0.0046
Discrete (z) Domain						
X Axis	**LBW**	0.9987 0.9926 0.9861 + 0.0081i 0.9861 - 0.0081i	-0.9993 0.9987 0.9955	207.3230	22.3750	0.0090
	HBW	0.9975 0.9822 0.9751 0.9652	-0.9993 0.9975 0.9921	416.4292	24.6148	0.0044
Y Axis	**LBW**	0.9987 0.9941 0.9849 + 0.0096i 0.9849 - 0.0096i	-0.9990 0.9987 0.9955	203.8057	17.4198	0.0095
	HBW	0.9863 0.9975 0.9677 + 0.0082i 0.9677 - 0.0082i	-0.9990 0.9975 0.9921	412.1331	21.8197	0.0045

Part C – Contouring Performance Simulation

Figure 6: Simulated Toolpath (C.1)

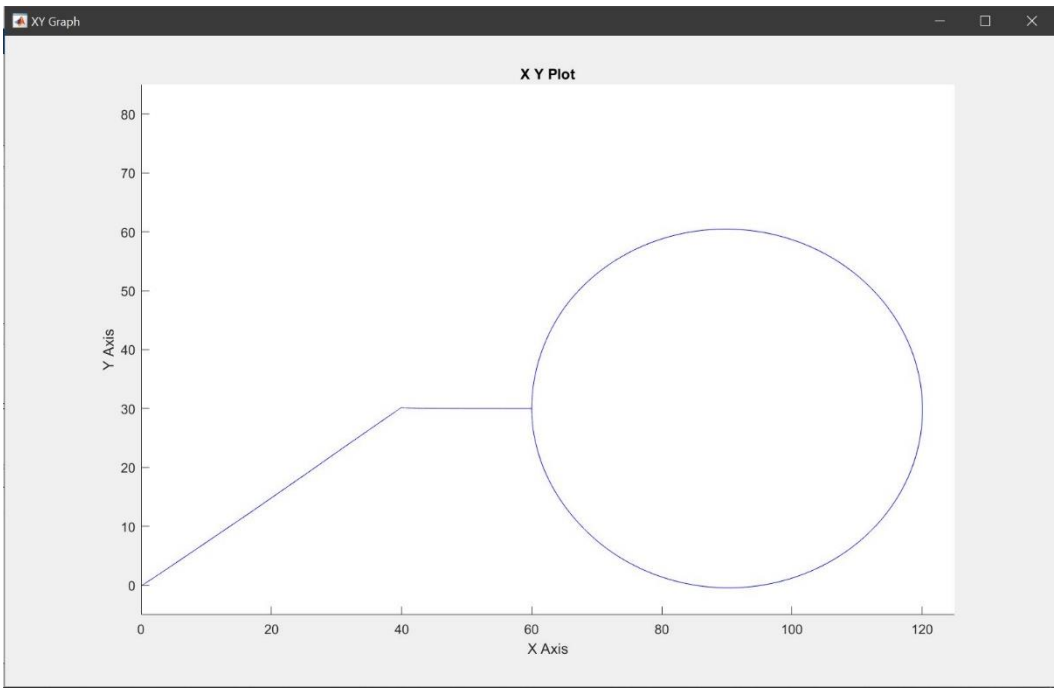
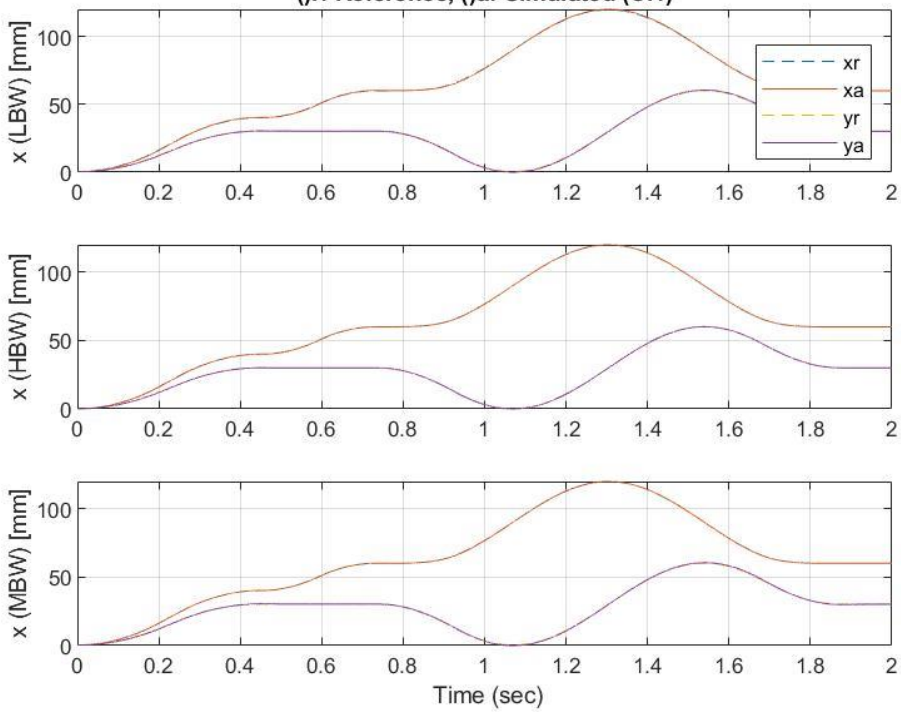


Figure 7: Reference Trajectory vs Simulated Trajectory
()r: Reference, ()a: Simulated (C.1)



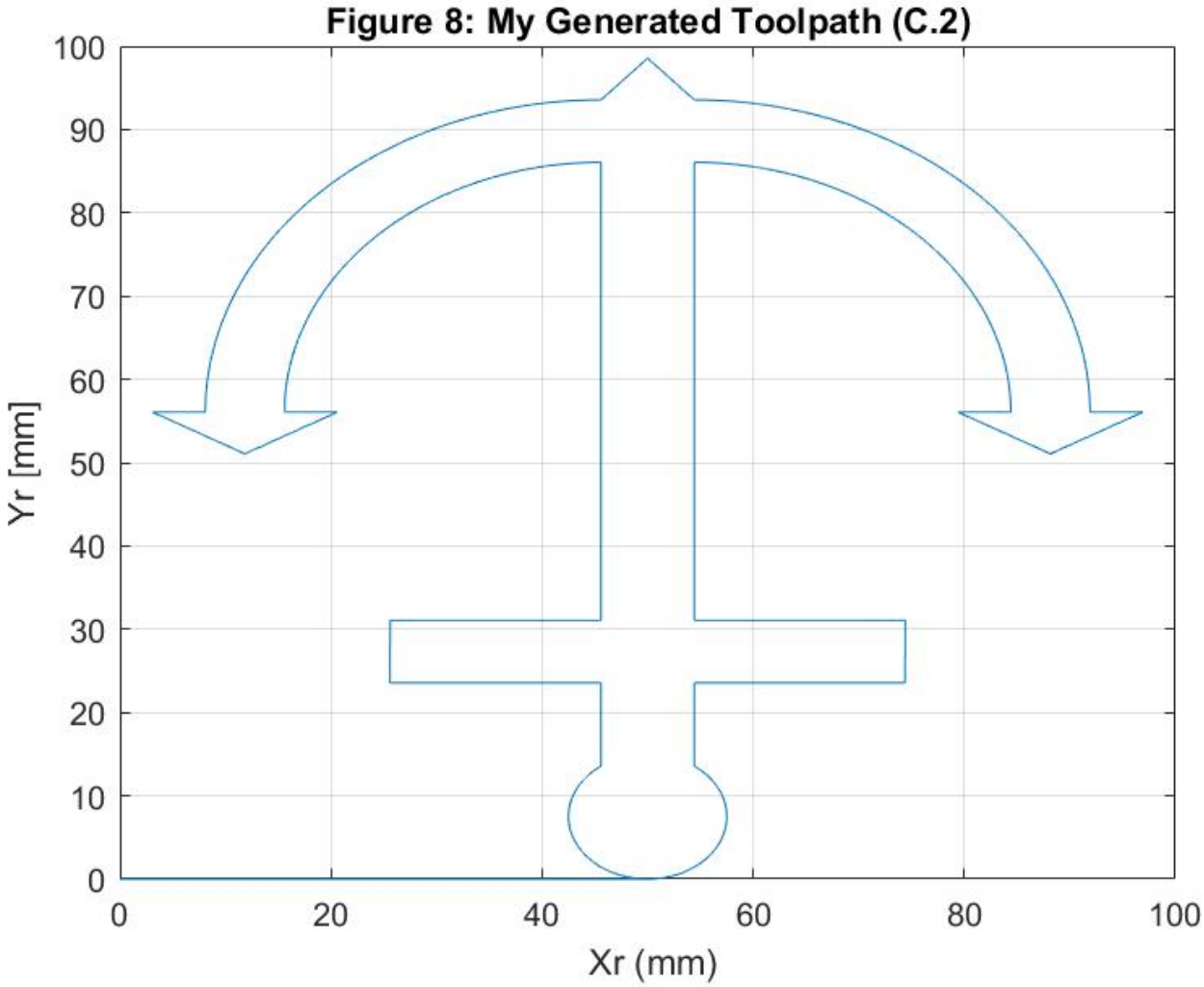


Figure 8: My Generated Toolpath (C.2)
Yr [mm]
Xr (mm)
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100