三維曲面之加工路徑預補償
The Path Precompensation Method for Tracking Complex surface

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一、 中文摘要（關鍵字：交叉耦合預補償法、切紋高度、）

本研究將新型交叉耦合預補償法應用於三維曲面之加工路徑，除對刀具路徑以交叉耦合控制外，在切紋峰至刀心之預補償方向，施以預補償控制，以控制切紋高度，其結果較傳統交叉耦合控制或傳統交叉耦合預補償法對切紋高度有更好的控制效果。

Abstract

This project provides a new type “Cross-coupled Precompensation Method” for Tracking Complex surface. The method combine the “Cross-coupled Precompensation Method ”,Scallop height and Adjacent tool path error, direct control the scallop height of the manufactured part. that is ,this method gives the part programmer direct control over the accuracy of the manufactured surface.

二、緣由與目的

含有 3D 曲面之零件被廣泛應用於航太、汽車、模具等工業，這些零件之生產常以 NC 控制銑切加工完成。此類零件經由設計者設計完成之表面稱為設計表面(design surface)；生產時藉由銑切加工完成之表面則被稱為完工表面(manufactured surface)。由於刀具之幾何形狀，加工時之切痕間距(step over)，會使相鄰切痕間產生切痕高度(scallop height)，此使得完工表面無法與設計表面相合。有關切削路徑生成法之相關研究，基本上著眼於加工時刀具與設計表面接觸，若在相同最大切痕高度條件下，其不同點在於路徑產生之難易、切痕間距均勻性、切痕高度均勻性、曲率分布、切削路徑數量、切削路徑總長以及對路徑誤差的敏感性等。這些因素對後加工(研磨)、加工時間、完工時之精度將有重要的影響。

交叉耦合預補償法可以有效的減少直線軌跡及圓軌跡的輪廓誤差。Chin 和 Liu[18]將交叉耦合預補償系統應用在高階曲線的尋軌，發現交叉耦合預補償法可有效減少高階曲線的輪廓誤差。因此，在控制器的設計上交叉耦合預補償法實為極佳的選擇，但在 3D 曲面加工時，必須再加上機器真實軌跡誤差對切紋高度之影響並加以補償，以降低完工曲面誤差。

本計劃之目的在改善一般刀具路徑生成法未能考慮機器真實誤差對切紋高度之影響，提出基於切紋高度，結合路徑生成與路徑追蹤法則，以相鄰切痕路徑誤差為基礎的切紋高度函數，對機器真實軌跡誤差作補償，再藉由本計劃主持人發展之交叉耦合預補償

法對刀具軌跡追蹤點作交叉耦合路徑追蹤，在影響切紋高度最大方向施以預補償法，將其結果在表面特性及精度上與現有方法比較分析。

三、結果與討論

(1)以相鄰實際路徑與次一加工路徑追蹤點形成之切紋峰至刀心方向為影響切紋高最大方向。
(2)對前述方向實施預補償可對切紋高度得到較大控制。

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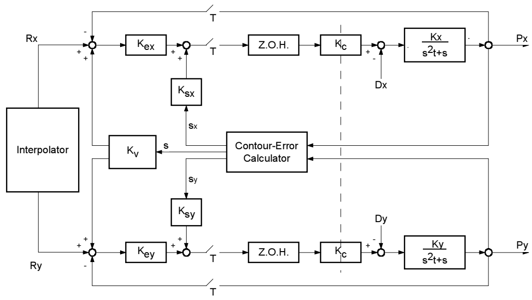

Fig.1 block diagram of CCPM

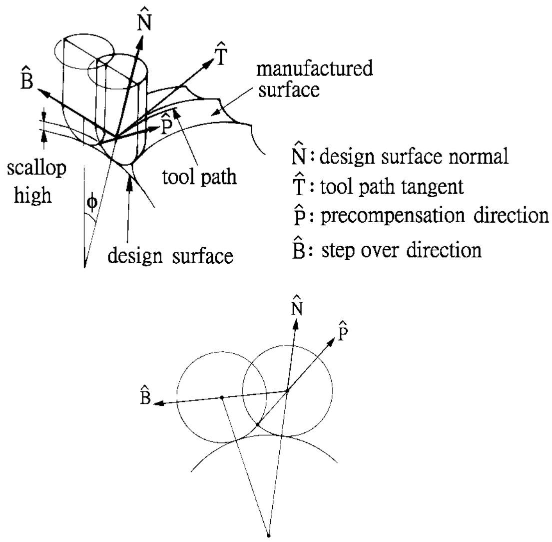

Fig .2 precompensation direction

	θ_x	θ_y	θ_z	Feedrate (mm/sec)	Scallop height $h = 0.5mm$	
	25°	15°	35°	20	$h_{\max}(mm)$	$h_{\min}(mm)$
1	CCS				0.591	0.419
2	CCPM				0.550	0.478
3	NCCPM				0.545	0.464

Table 1 Experimental scallop height for incline plane($r_t = 5mm$)

	θ_x	θ_y	θ_z	Feedrate (mm/sec)	Scallop height $h = 0.5mm$	
	10°	0°	45°	20	$h_{\max}(mm)$	$h_{\min}(mm)$
1	CCS				0.612	0.420
2	CCPM				0.555	0.470
3	NCCPM				0.551	0.475

Table 2 Experimental scallop height for part of sphere ($r_t = 5mm$)