

第五章 實驗結果

以下分別對影像相關色溫估計、影像光源置換及等色溫影像合成的實驗結果進行說明。

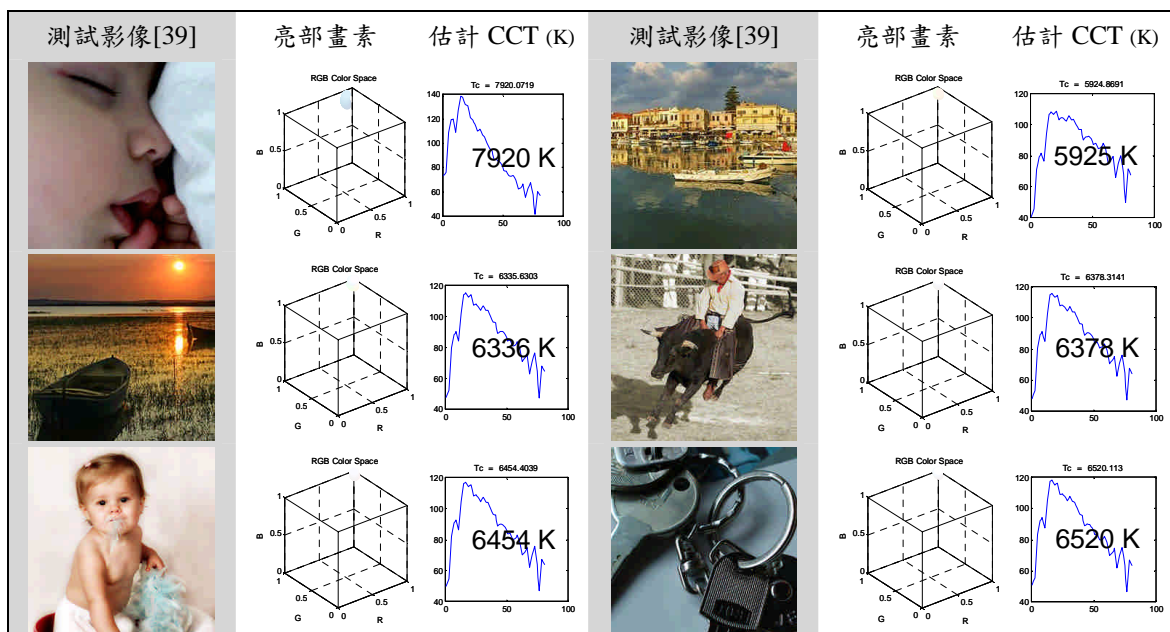
第一節 影像相關色溫估計實驗結果

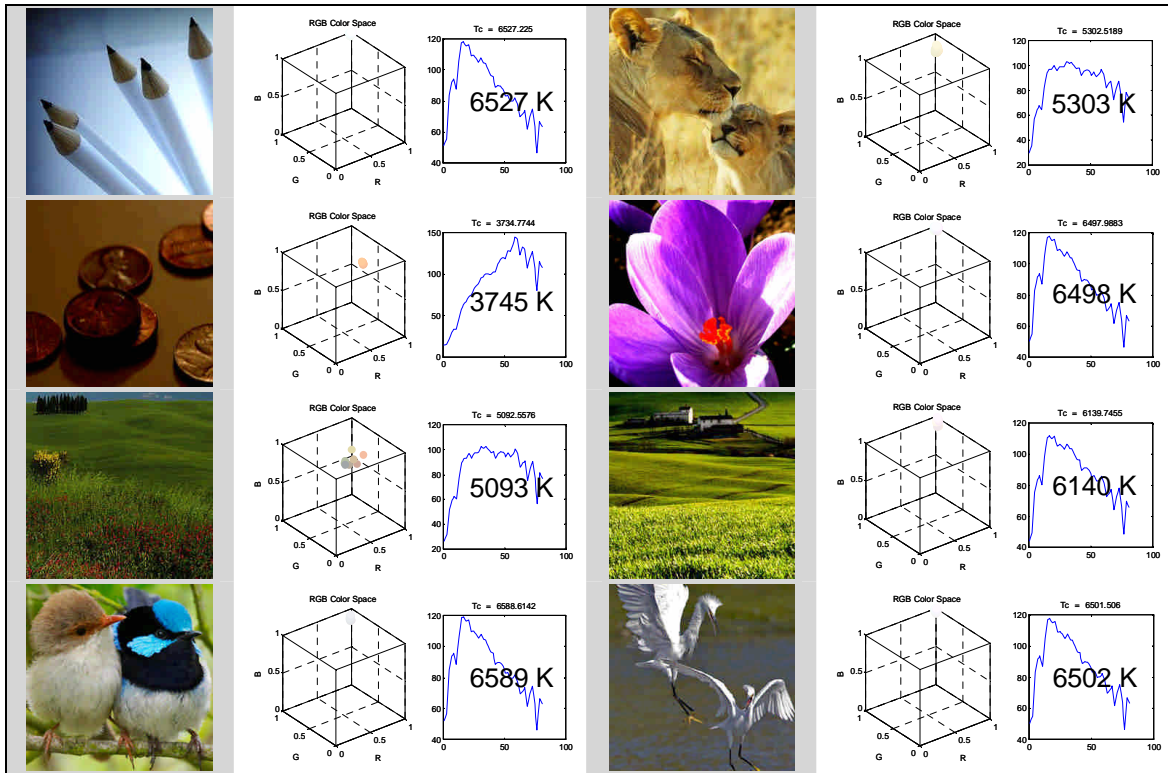
影像相關色溫估計包含四組實驗，分別為影像亮部光源偵測方法、色域重疊度光源偵測方法、色相分割多色色溫移動軌跡光源偵測方法及無色相分割多色色溫移動軌跡光源偵測方法，本節針對此四種光源色溫估計的結果詳細說明。

一、影像亮部光源偵測方法實驗結果

表 5-1 為網路擷取影像[39]採影像亮部光源偵測方法的實驗結果，當影像中具有亮部畫素時，光源色溫偵測的結果多能符合人眼知覺，但是一旦影像中出現反光的亮點或是影像中沒有亮部畫素時，光源色溫偵測就會產生不合理的結果。

表 5-1 影像亮部光源偵測結果




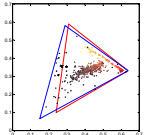

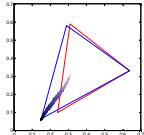

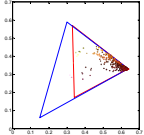
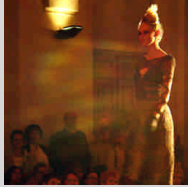
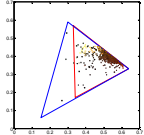

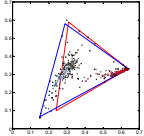

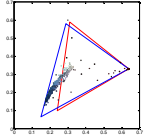

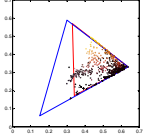

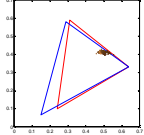

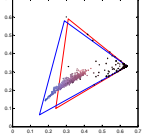

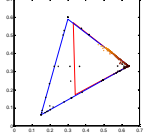
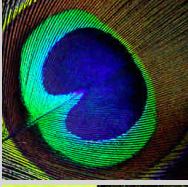
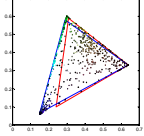
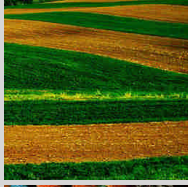
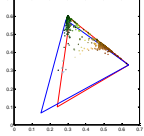
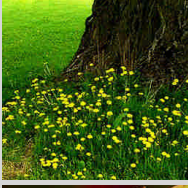
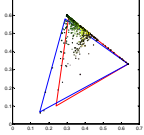
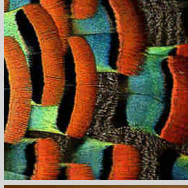
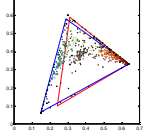
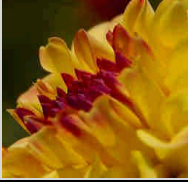
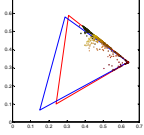
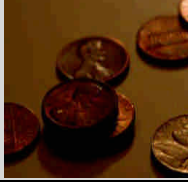
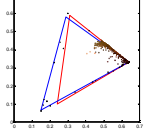


二、色域重疊度光源偵測方法實驗結果

為了偵測具有反光或無亮部之影像其光源色溫，利用影像色域及光源色域的重疊度進行光源色溫偵測，表 5-2 為網路擷取影像[39]色域重疊度光源偵測的結果，雖然估計出的影像光源色溫多能符合人眼知覺，但是由於該影像所呈現之色彩很有可能同時存在於相異的兩種光源下，因此估計出的色溫可信度並不高。

表 5-2 色域重疊度光源偵測結果

測試影像[39]	色域重疊度	估計 CCT (K) 可信度	測試影像[39]	色域重疊度	估計 CCT (K) 可信度
		4222 K 6 %			4000 K 0 %
		4644 K 14 %			4037 K 20 %


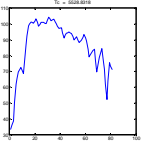

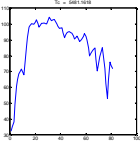

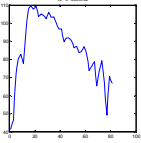
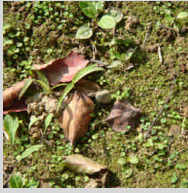
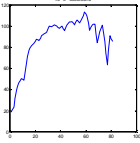

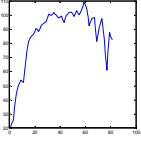

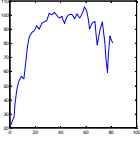

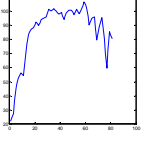

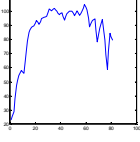

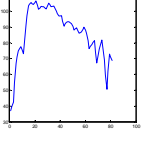
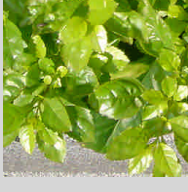
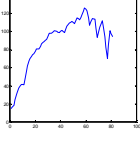

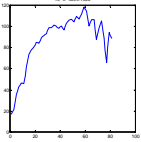

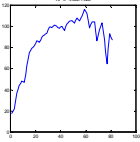
		4185 K 4 %			7743 K 75 %
		2862 K 0.3 %			2867 K 0.4 %
		4362 K 8 %			7166 K 63 %
		2891 K 2 %			4000 K 0 %
		4377 K 11 %			5103 K 57 %
		6345 K 52 %			5457 K 51 %
		4577 K 64 %			4851 K 22 %
		4000 K 42 %			4340 K 7 %

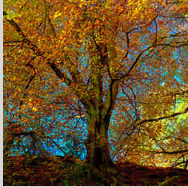
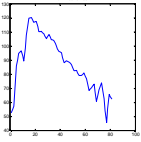

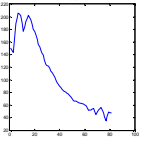

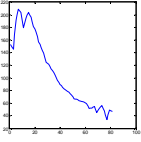
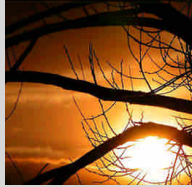
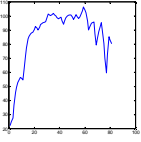

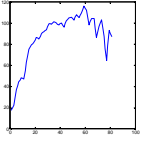
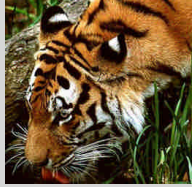
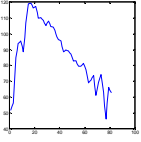

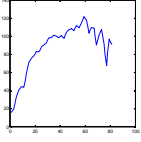
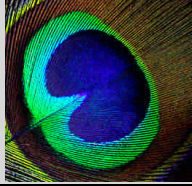
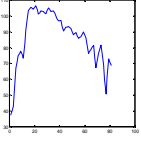
三、色相分割多色色溫移動軌跡光源偵測方法實驗結果

為了偵測具有反光或無亮部之影像其光源色溫，且提高偵測結果的可信度，採取多個參考色點的色溫移動軌跡作為評估色溫的依據，同時為了避免影像色彩

多分佈於某一色相範圍，造成該色相範圍以外的色溫移動軌跡不適用，本研究採取對色相做分割再進行光源色溫估測，表 5-3 為色相相關多色色溫移動軌跡光源偵測的部份結果，測試影像總數 110 張，依據人眼視覺判斷影像色偏程度決定色溫估計合理與否，色溫估計合理之影像約達 50%。

表 5-3 色相相關多色色溫移動軌跡光源偵測結果


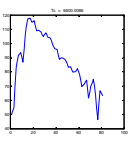

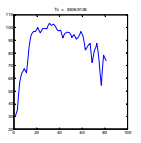
測試影像 (本研究實際拍攝)	估計 CCT (K)	測試影像 (本研究實際拍攝)	估計 CCT (K)
	 5529		 5481
	 5993		 4558
	 4715		 4839
	 4821		 4894
	 5758		 4161
測試影像[39]	估計 CCT (K)	測試影像[39]	估計 CCT (K)
	 4394		 4462


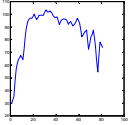

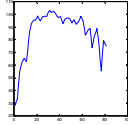

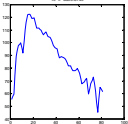

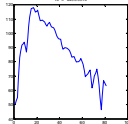

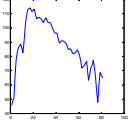

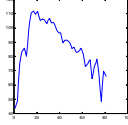

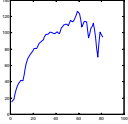

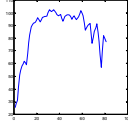

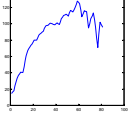

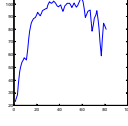

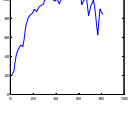

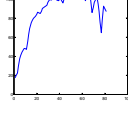
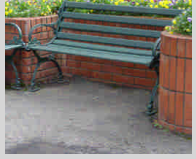
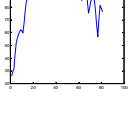

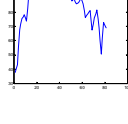

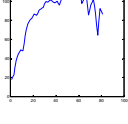

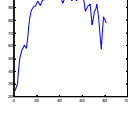

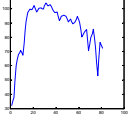

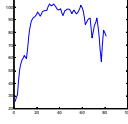
		6648			16296
		16782			4833
		4464			6596
		4293			5763


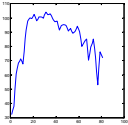
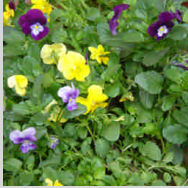
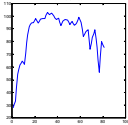

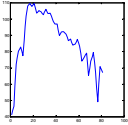

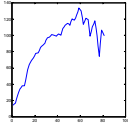

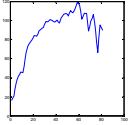

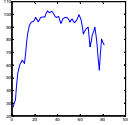
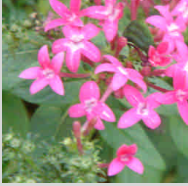
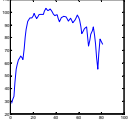

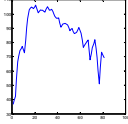
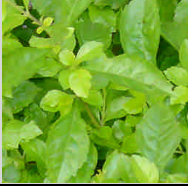
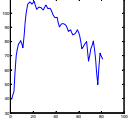

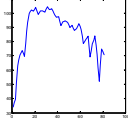
四、無色相分割多色色溫移動軌跡光源偵測方法實驗結果

為了改善色相分割多色色溫移動軌跡光源偵測方法的缺點，本研究進一步採用 CIELAB 色彩空間做為基礎，以距離權重方式取代色相分割，以下為影像光源估測的結果，表 5-4 為已知拍攝時光源色溫的影像（標準影像[40]）及本研究實際拍攝影像（拍攝時也量測當時環境光源色溫）之光源偵測結果（誤差值為實際色溫與估計色溫的差值與實際色溫之百分比），表 5-5 為網路擷取影像[39]之光源偵測結果。

表 5-4 標準影像及實際拍攝影像

測試影像	估計 CCT (K)	誤差 (%)	測試影像	估計 CCT (K)	誤差 (%)
		6500 0			5307 6.1

		5307	6.1			5215	-19.8
		6801	4.6			6500	0
		6250	-3.8			6120	22.4
		4163	1.5			5053	3.4
		4116	-6.8			4874	4.1
		4626	-1.2			4470	-4.5
		5084	-3.5			5778	13.5
		4494	-7.9			4992	-0.5
		5451	4.6			5057	-3.3

		5470	4.4			5187	-1
		5981	9.9			3988	-17.1
		4353	-25.1			5150	-12.6
		5234	-7.4			5731	-4.1
		5890	-1.4			5575	-6.7

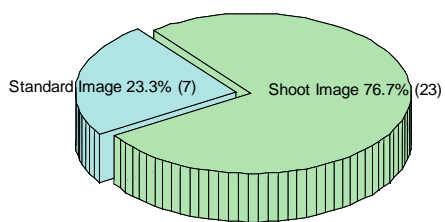


圖 5-1 影像來源比例圖

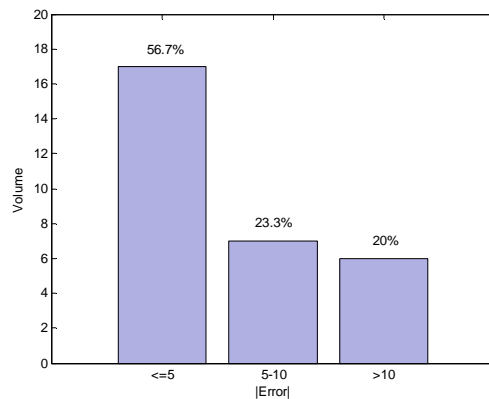

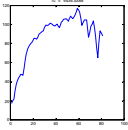

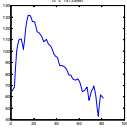

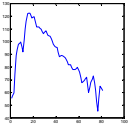
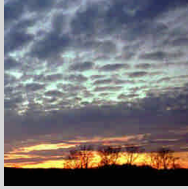
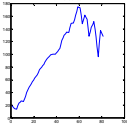
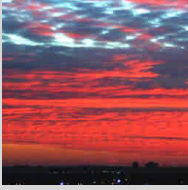
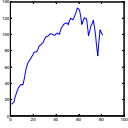

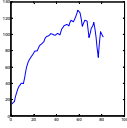
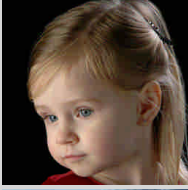
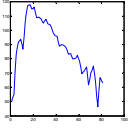

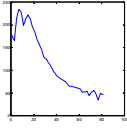

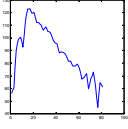
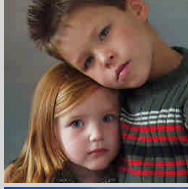
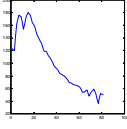

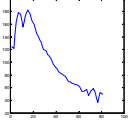

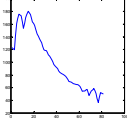

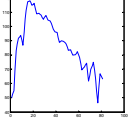
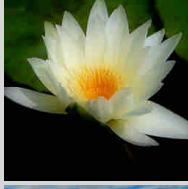
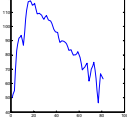
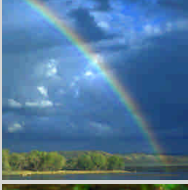
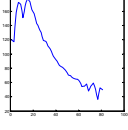

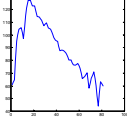

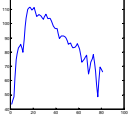

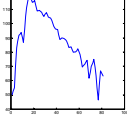

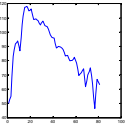

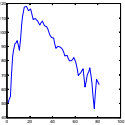

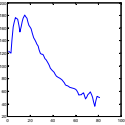

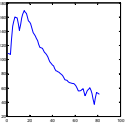
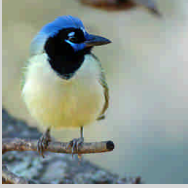
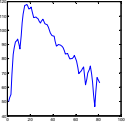

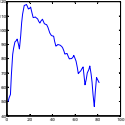

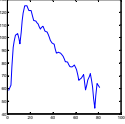
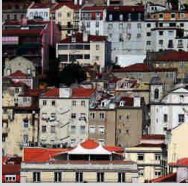
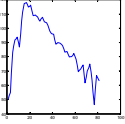

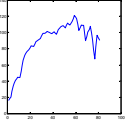

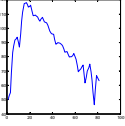

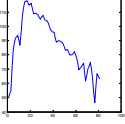

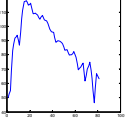

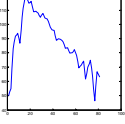
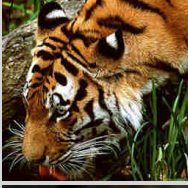
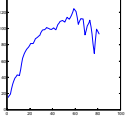
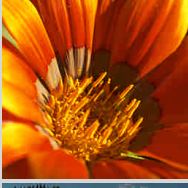
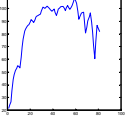
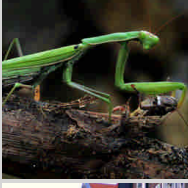
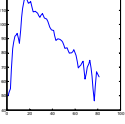

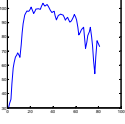

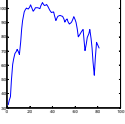


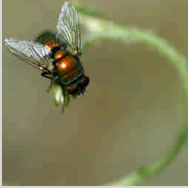
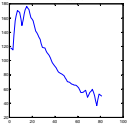

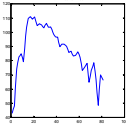

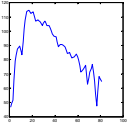
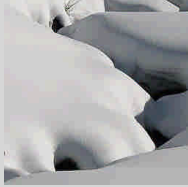
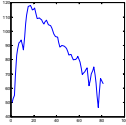

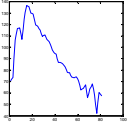

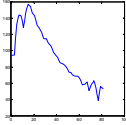

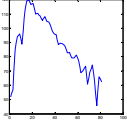

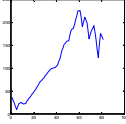

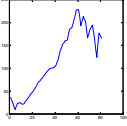

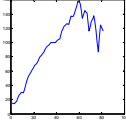
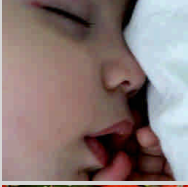
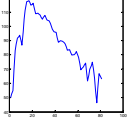

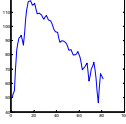

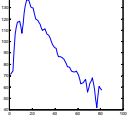

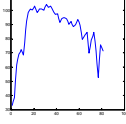

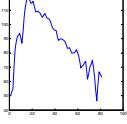
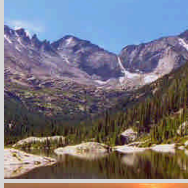
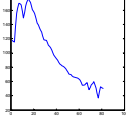

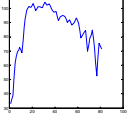
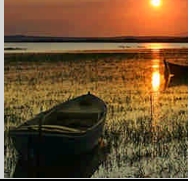
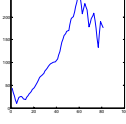
圖 5-2 標準影像與實際拍攝影像光源估測

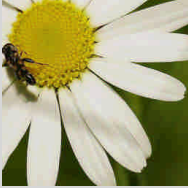
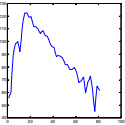

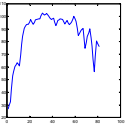
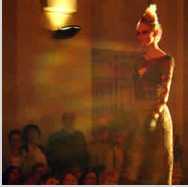
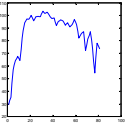

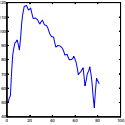

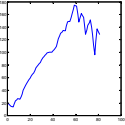

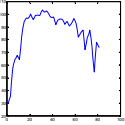

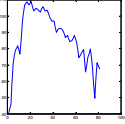
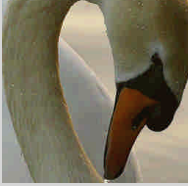
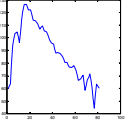

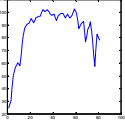

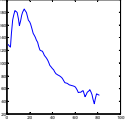

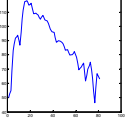

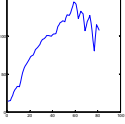

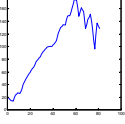

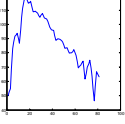

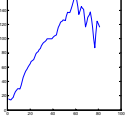

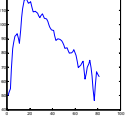

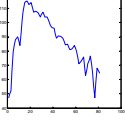
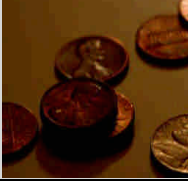
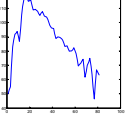
圖 5-1 為影像來源比例圖，其中標準影像共 7 張，本研究實際拍攝影像共 23 張，表 5-1 光源偵測結果彙整為圖 5-2，標準影像與實際拍攝影像之光源估測結果誤差小於 5% 者佔所有影像的 56.7%，誤差小於 10% 者佔所有影像的 80%。

表 5-5 網路影像

測試影像 [39]	估計 CCT (K)	測試影像 [39]	估計 CCT (K)
	 4437		 7414
	 6797		 3250
	 4003		 4082
	 6500		 23070
	 6844		 12212
	 12479		 12207
	 6500		 6500
	 11855		 7144
	 6108		 6500

		6500			6508
		12268			10724
		6500			6500
		7009			6501
		4318			6500
		6500			6500
		6500			4212
		4762			6500
		5362			5472

		11636			6079
		6303			6500
		7757			9433
		6615			2638
		2608			3507
		6500			6500
		7796			5510
		6500			11611
		5524			2214

		6810			5131
		5313			6500
		3250			5311
		5934			7077
		4992			13000
		6500			3744
		3250			6500
		3504			6500
		6327			6500

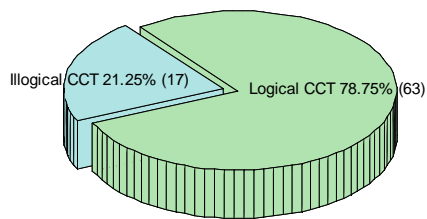
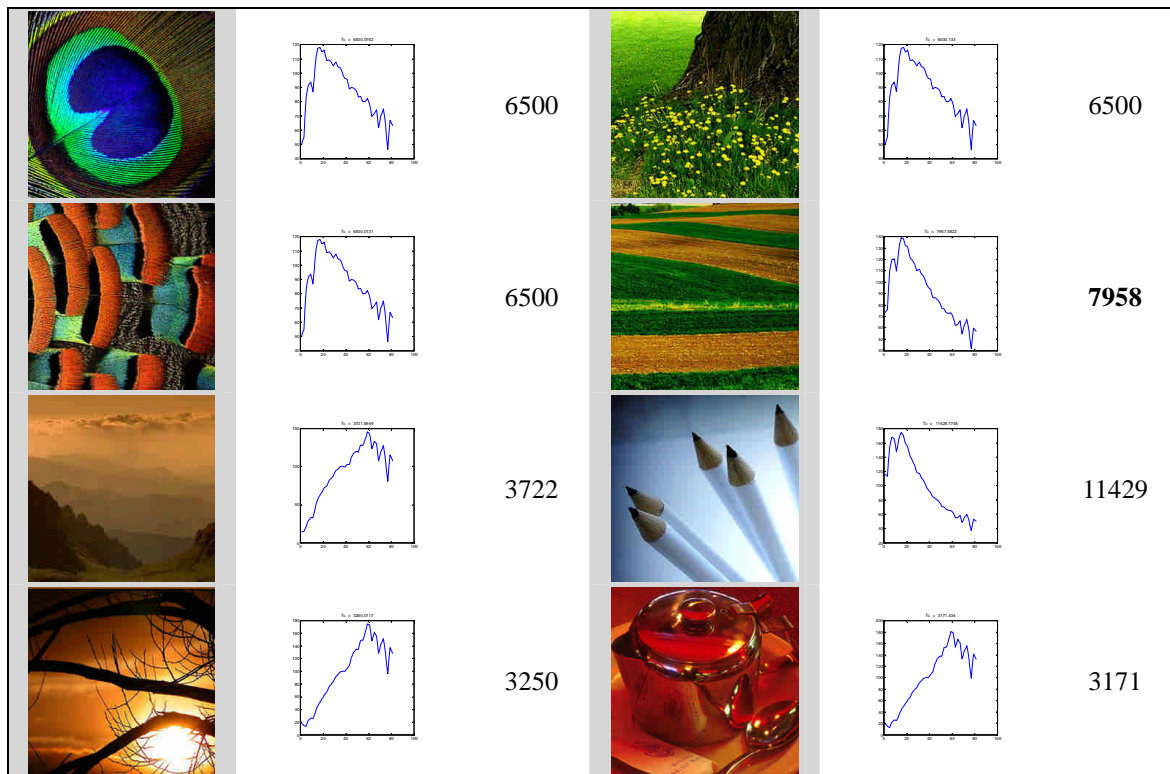


圖 5-3 網路擷取影像色溫估計比例圖

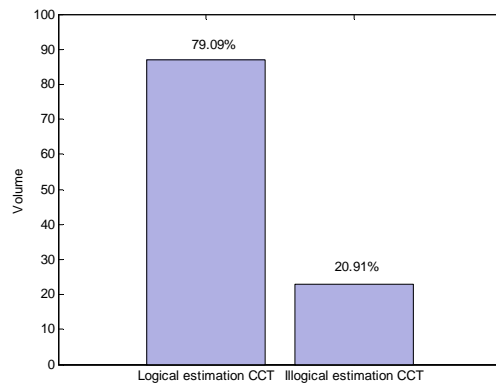













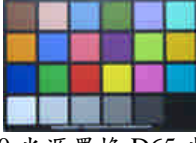
圖 5-4 光源估測結果

圖 5-3 為網路擷取影像色溫估計合理與否比例圖，其中依據人眼視覺判斷影像色偏程度決定色溫估計合理與否，色溫估計合理之影像共 63 張，色溫估計不合理之影像共 17 張，表 5-4 及表 5-5 光源偵測結果彙整為圖 5-4，標準影像、實際拍攝影像及網路擷取影像之光源估測結果於合理範圍者佔所有影像的 79.09%。

第二節 影像光源置換實驗結果

表 5-6 為實際拍攝的已知光源色溫影像置換光源後的結果，由於市售相機多半都已被設定過，因此無法取得影像原始拍攝資料，其次，色溫光箱中燈管位置不同也會造成取像的差異，因此本研究進行置換光源後的影像與原始拍攝之影像有部分差異，但仍在可接受的範圍之內，表 5-7 為置換影像光源的結果（可作為影像色彩平衡或白平衡的方法），其中，左邊第一欄為色偏之影像[39]，第二、三欄為本研究光源偵測之結果，第四欄為透過本研究光源偵測後進行光源置換為 D65 的結果，第五欄為 Gray World 白平衡的結果，可以發現 Gray World 方法對紅綠藍色刺激分佈不均的影像無法產生作用，相較之下本研究影像光源置換的方法效果較優。

表 5-6 影像置換光源結果

SONY T1 相機拍攝	置換光源	MSE / PSNR	Avg. PSNR
 A 光源	 D50 光源置換 A 光源	R 79.82 / 29.11 G 49.19 / 31.21 B 48.75 / 31.25	30.52
 A 光源	 D65 光源置換 A 光源	R 93.74 / 28.41 G 31.94 / 33.09 B 62.60 / 30.16	
 D50 光源	 A 光源置換 D50 光源	R 37.66 / 32.37 G 24.04 / 34.32 B 76.54 / 29.29	
 D50 光源	 D65 光源置換 D50 光源	R 44.52 / 31.65 G 21.64 / 34.78 B 37.76 / 32.36	
 D65 光源	 A 光源置換 D65 光源	R 45.83 / 31.52 G 0.6 / 50.36 B 61.16 / 30.27	37.38
 D65 光源	 D50 光源置換 D65 光源	R 46.88 / 31.42 G 22.91 / 34.53 B 42.81 / 31.82	

		R	189 / 25.36	
A 光源	D50 光源置換 A 光源	G	128 / 27.07	27.19
		B	80 / 29.13	
A 光源	D65 光源置換 A 光源	R	202 / 25.08	
		G	168 / 25.88	26.38
D50 光源	A 光源置換 D50 光源	B	116 / 27.47	
		R	225 / 24.61	
D65 光源	D50 光源置換 D65 光源	G	128 / 27.06	26.31
		B	122 / 27.26	
D50 光源	A 光源置換 D50 光源	R	230 / 24.51	
		G	160 / 26.1	25.86
D65 光源	D65 光源置換 D50 光源	B	131 / 26.96	
		R	170 / 25.84	
D65 光源	A 光源置換 D65 光源	G	173 / 25.74	25.68
		B	185 / 25.47	
D65 光源	D50 光源置換 D65 光源	R	134 / 26.87	
		G	82 / 29	27.88
D65 光源	D65 光源置換 D65 光源	B	109 / 27.77	
		R	304 / 23.3	
A 光源	D50 光源置換 A 光源	G	215 / 24.8	24.71
		B	162 / 26.03	
A 光源	D65 光源置換 A 光源	R	227 / 24.58	
		G	125 / 27.16	26.94
D50 光源	A 光源置換 D50 光源	B	80 / 29.08	
		R	254 / 24.08	
D50 光源	D50 光源置換 D50 光源	G	234 / 24.44	24
		B	293 / 23.45	
D50 光源	D65 光源置換 D50 光源	R	109 / 27.76	
		G	101 / 28.07	27.42
D50 光源	D65 光源置換 D50 光源	B	148 / 26.42	





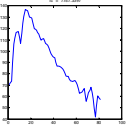



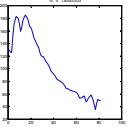



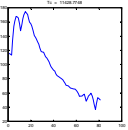



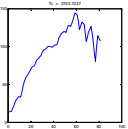



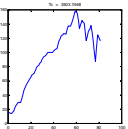



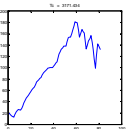


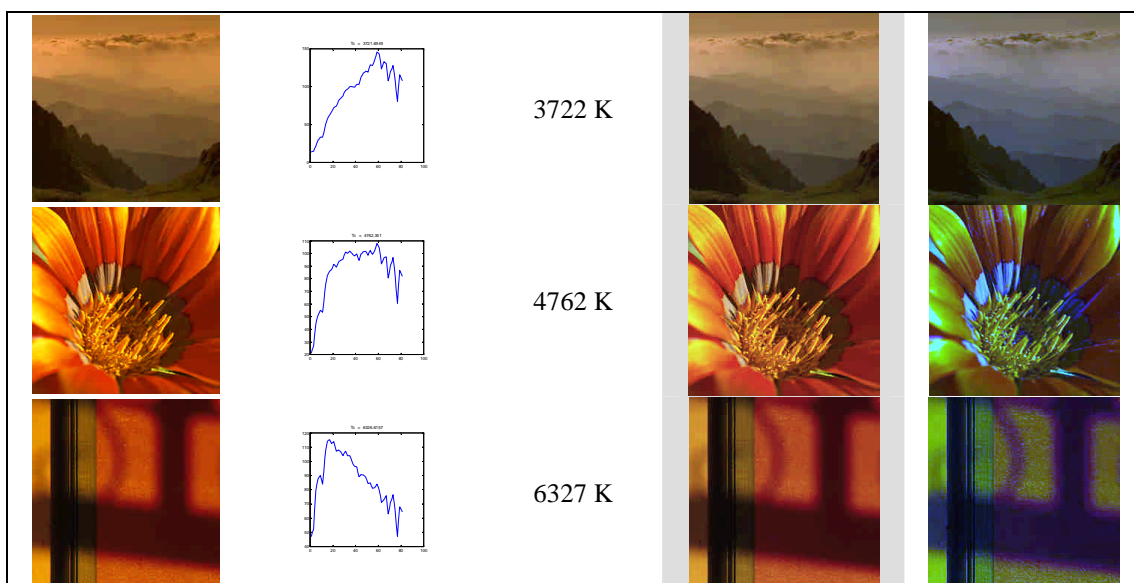
		R	151 / 26.34	
D65 光源	A 光源置換 D65 光源	G	140 / 26.68	26.31
		B	166 / 25.92	
		R	96 / 28.31	
D65 光源	D50 光源置換 D65 光源	G	105 / 27.92	27.16
		B	195 / 25.24	

表 5-7 影像置換為 D65 光源

	Color cast		Color balance	Gray World
		7757 K		
		13000 K		
		11429 K		
		3744 K		
		3504 K		
		3171 K		



從影像光源類型的估測成果來看，多數影像色溫的推測合理，本研究設計出的影像色溫調整技術能排除龐雜的光源及物體反射率量測問題，直接從影像本身著手使影像光影處理快速且便利。

第三節 影像合成實驗結果

在影像合成的部分，本研究採取等色溫的影像合成方式，利用影像色溫調整技術提高合成品質與創造自然的畫面（見圖 5-5~圖 5-23），套用本研究發展的影像合成技術，創造虛擬攝影棚的效果，使受眾感覺畫面中人或物真實置於各式場景中，進而數位內容更加活潑而引人入勝，為數位內容做更多元且完美呈現。

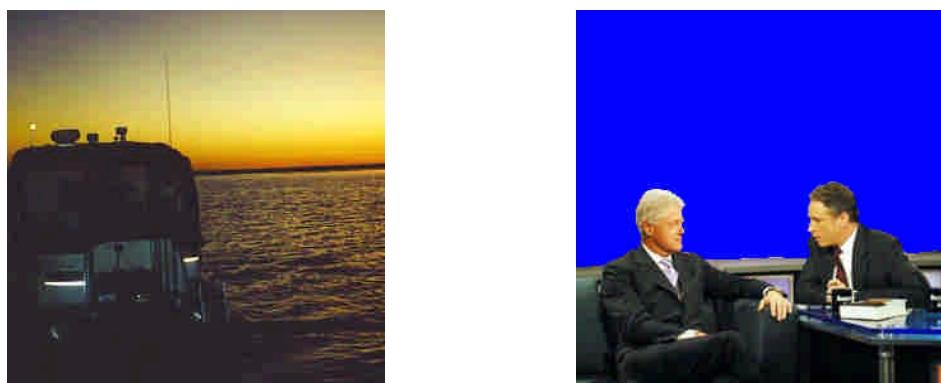


圖 5-5 合成前之原始影像



圖 5-6 無色溫分析之合成影像



圖 5-7 經色溫分析後之合成影像



圖 5-8 無色溫分析之合成影像



圖 5-9 經色溫分析後之合成影像



圖 5-10 無色溫分析之合成影像

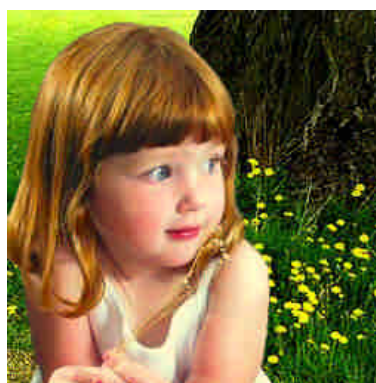


圖 5-11 經色溫分析後之合成影像



圖 5-12 無色溫分析之合成影像



圖 5-13 經色溫分析後之合成影像



圖 5-14 無色溫分析之合成影像



圖 5-15 經色溫分析後之合成影像



圖 5-16 無色溫分析之合成影像



圖 5-17 經色溫分析後之合成影像



圖 5-18 無色溫分析之合成影像

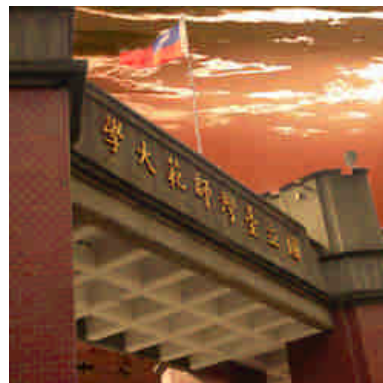


圖 5-19 經色溫分析後之合成影像



圖 5-20 無色溫分析之合成影像



圖 5-21 經色溫分析後之合成影像



圖 5-22 無色溫分析之合成影像

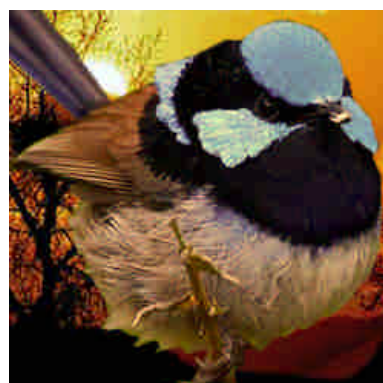


圖 5-23 經色溫分析後之合成影像