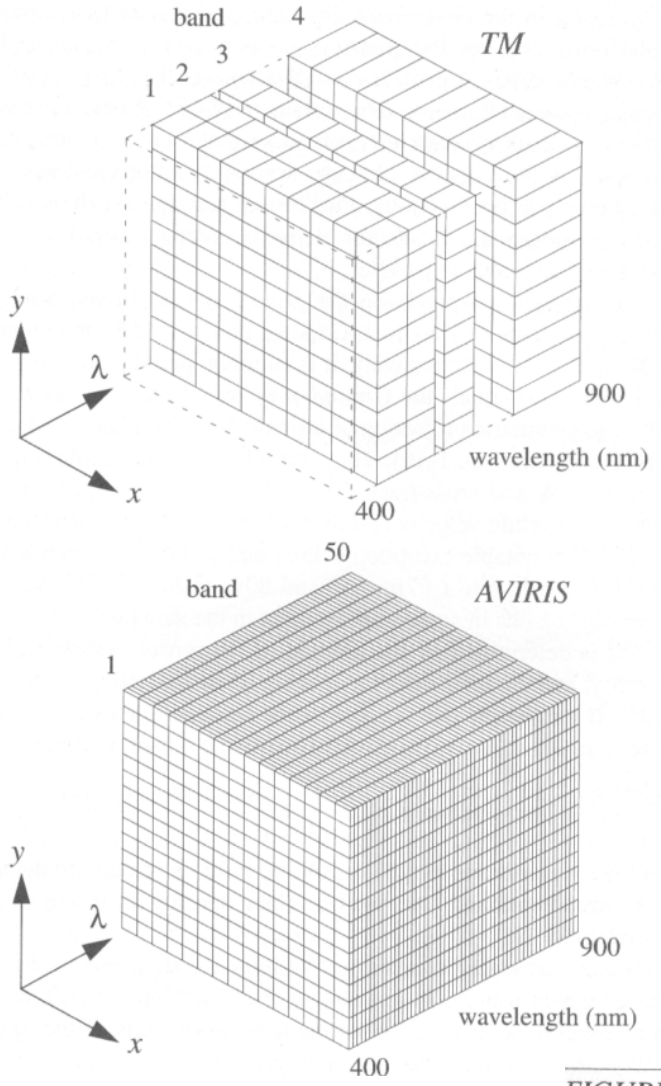


FIGURE 1-7. Visualization of the spatial and spectral resolutions of the Landsat TM and AVIRIS in the VNIR spectral range. The relative proportions between the two sensors are correct along each axis, and each small rectangular box represents one image pixel. The TM samples the spectral dimension incompletely and with relatively broad spectral bands. In comparison, AVIRIS represents almost a continuous spectral sampling. It also has a somewhat smaller GIFOV. This volume visualization is called an "image cube."

遙測影像處理演算法

植生指數

Ratio Vegetation Index (RVI)

$$RVI = \frac{NIR}{R}$$

Normalized Difference Vegetation Index (NDVI)

$$NDVI = \frac{NIR - R}{NIR + R}$$

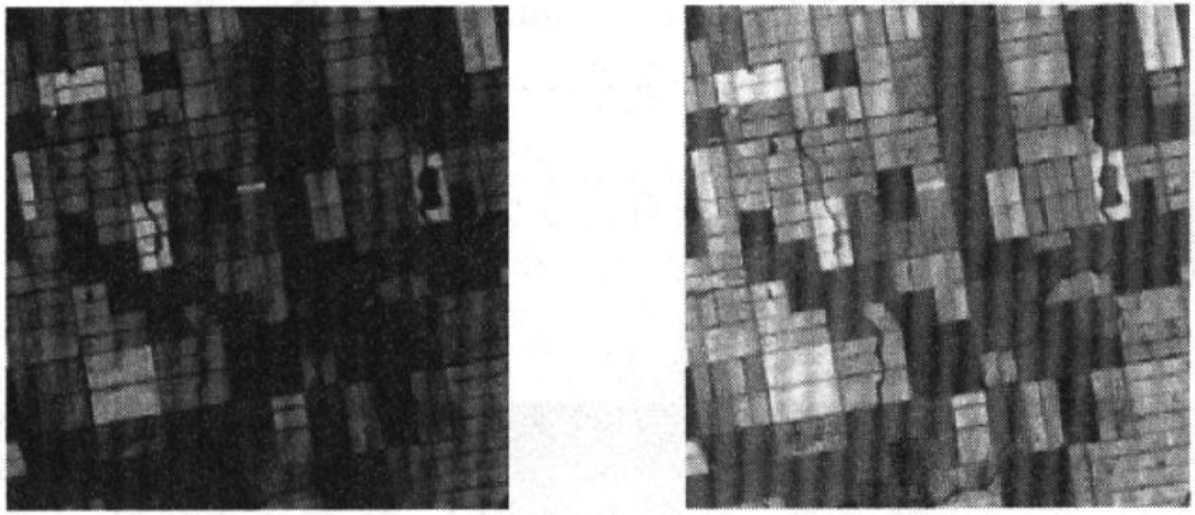


FIGURE 5-5. The RVI and NDVI index images for the TM agriculture image of Plate 5-1. Bands 4 and 3 were used and the indexes are calculated from uncalibrated DNs.

PCA

- Principal Component Analysis
- 對一組高維度空間中的資料投影到低維度空間
- 找出最佳的投影方式，使得投影後的資料點能盡量散開

假設我們的資料點是由維度爲m的向量Xi來表，其中 $i = 1,2,\ldots,n$

假設這一組資料的平均值是零：

$$\sum_{i=1}^{n} X_i = 0$$

目標是要找一個單位向量u，使得在u方向的投影平方和爲最大

用一個 $m \times n$ 矩陣A來表示此資料

$$A = \begin{bmatrix} X_1 & X_2 & X_3 & \cdots & X_n \end{bmatrix}$$

這一組資料在方向的投影可以表示爲下列向量：

$$p = \begin{bmatrix} X_1^T u \\ X_2^T u \\ \vdots \\ X_n^T u \end{bmatrix} = A^T u$$

投影平方的總和爲：

$$J(u) = \|p\|^2 = p^T p = \left(A^T u\right)^T \left(A^T u\right) = u^T A A^T u$$

欲使投影總和爲最大，並滿足 $\|u\|=1$，
我們可引進Lagrange Multiplier，並形
成新的目標函數：

$$\tilde{J}(u)=u^T AA^T u-\lambda\left(u^T u-1\right)$$

微分取極值 $\nabla_u \tilde{J}=0\Rightarrow 2AA^T u-2\lambda u=0$

$$\Rightarrow AA^T u=\lambda u$$

根據線性代數

λ爲AA^T的*eigenvalue*

u爲AA^T的*eigenvector*

AA^T eigenvalue的大小排列

$$\lambda_1 \geq \lambda_2 \geq \lambda_3 \geq \cdots \geq \lambda_m$$

對應的eigenvector則是

$$u_1, u_2, u_3 \cdots u_m$$

透過PCA，我們能找出一組單位向量 $\{ u_1, u_2, u_3 \cdots u_m \}$，使得

$$y_i = A^T u_i$$

其中，yi 稱爲第 i 組主要分量（the i-th principal component）。

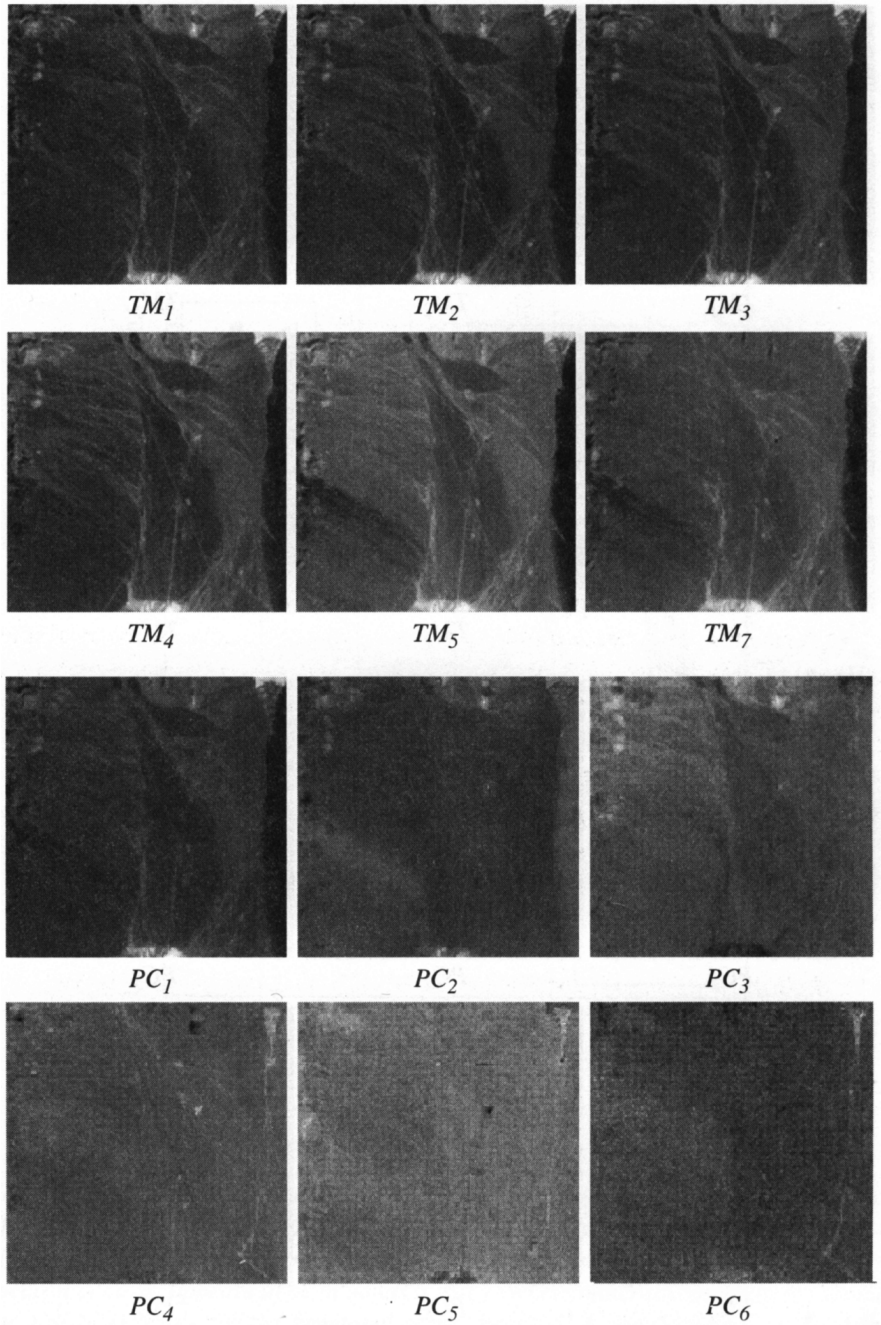
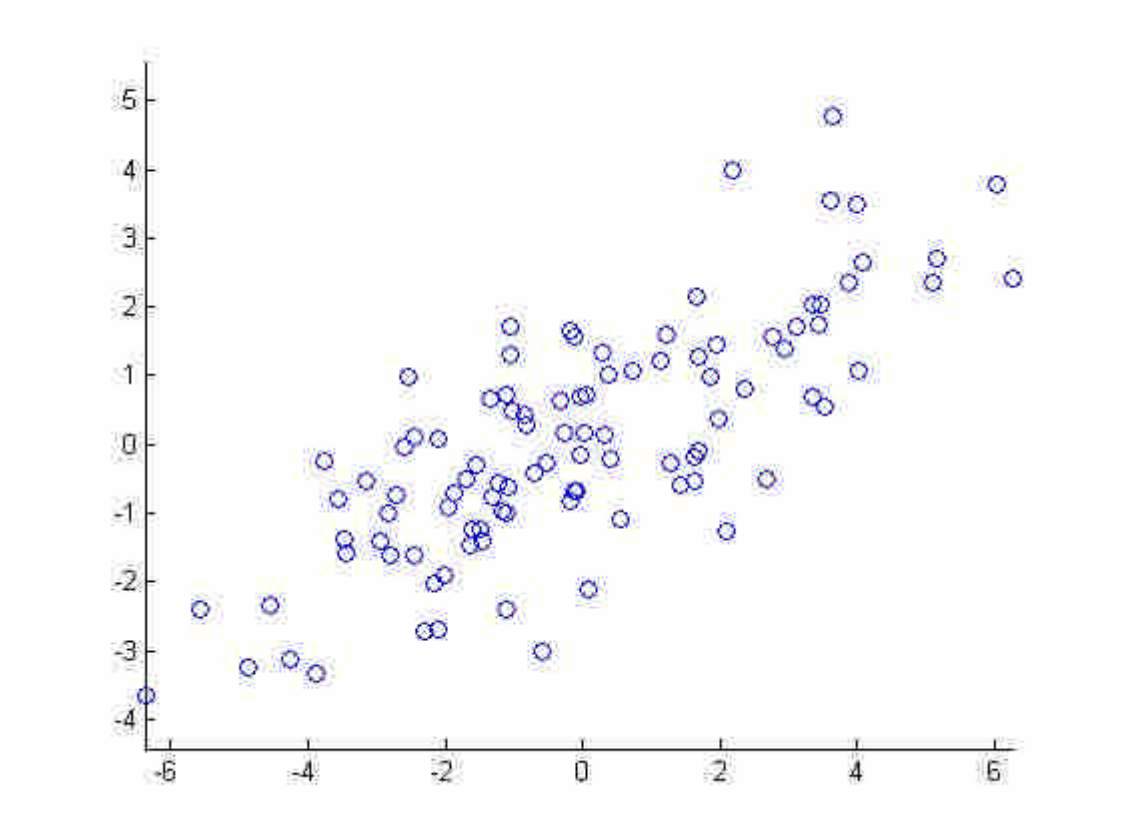


FIGURE 5-13. PC transformation of a nonvegetated TM scene.

Example



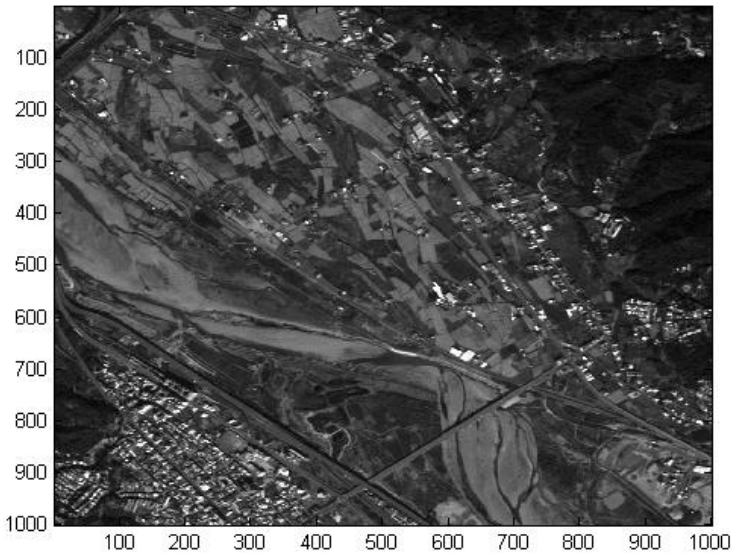
原始資料

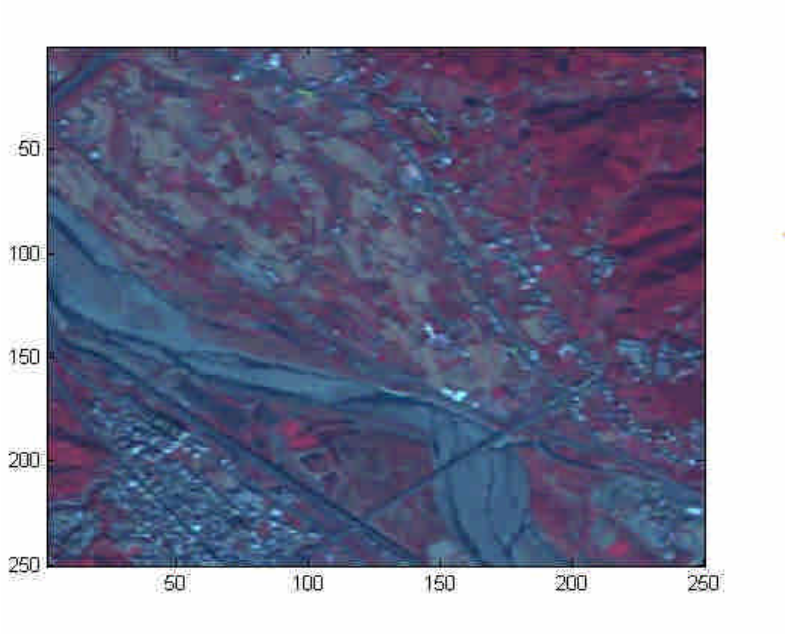
sensor	axis name	W_{TC}
	MSS band	1 2 3 4
L-1 MSS	soil brightness	+0.433 +0.632 +0.586 +0.264
	greenness	–0.290 –0.562 +0.600 +0.491
	yellow stuff	–0.829 +0.522 –0.039 +0.194
	non-such	+0.223 +0.120 –0.543 +0.810
L-2 MSS	soil brightness	+0.332 +0.603 +0.676 +0.263
	greenness	+0.283 –0.660 +0.577 +0.388
	yellow stuff	+0.900 +0.428 +0.0759 –0.041
	non-such	+0.016 +0.428 –0.452 +0.882
	TM band	1 2 3 4 5 7
L-4 TM	soil brightness	+0.3037 +0.2793 +0.4743 +0.5585 +0.5082 +0.1863
	greenness	–0.2848 –0.2435 –0.5436 +0.7243 +0.0840 –0.1800
	wetness	+0.1509 +0.1973 +0.3279 +0.3406 –0.7112 –0.4572
	haze	–0.8242 +0.0849 +0.4392 –0.0580 +0.2012 –0.2768
	TC5	–0.3280 +0.0549 +0.1075 +0.1855 –0.4357 +0.8085
	TC6	+0.1084 –0.9022 +0.4120 +0.0573 –0.0251 +0.0238
L-5 TM	soil brightness	+0.2909 +0.2493 +0.4806 +0.5568 +0.4438 +0.1706
	greenness	–0.2728 –0.2174 –0.5508 +0.7221 +0.0733 –0.1648
	wetness	+0.1446 +0.1761 +0.3322 +0.3396 –0.6210 –0.4186
	haze	+0.8461 +0.0731 +0.4640 –0.0032 –0.0492 +0.0119
	TC5	+0.0549 –0.0232 +0.0339 –0.1937 +0.4162 –0.7823
	TC6	+0.1186 –0.8069 +0.4094 +0.0571 –0.0228 +0.0220
	soil brightness	additive terms: +10.3695
	greenness	–0.7310
	wetness	–3.3828
	haze	+0.7879
	TC5	–2.4750
	TC6	–0.0336

TABLE 5-2. Tasseled-cap coefficients for Landsat-1 MSS (Kauth and Thomas, 1976), Landsat-2 MSS (Thompson and Whemanen, 1980), Landsat-4 TM (Crist and Cicone, 1984) and Landsat-5 TM (Crist et al., 1986). The MSS coefficients are for a 0-63 DN scale in band 4 and a 0-127 DN scale in the other bands, i.e. the same as data supplied to users.

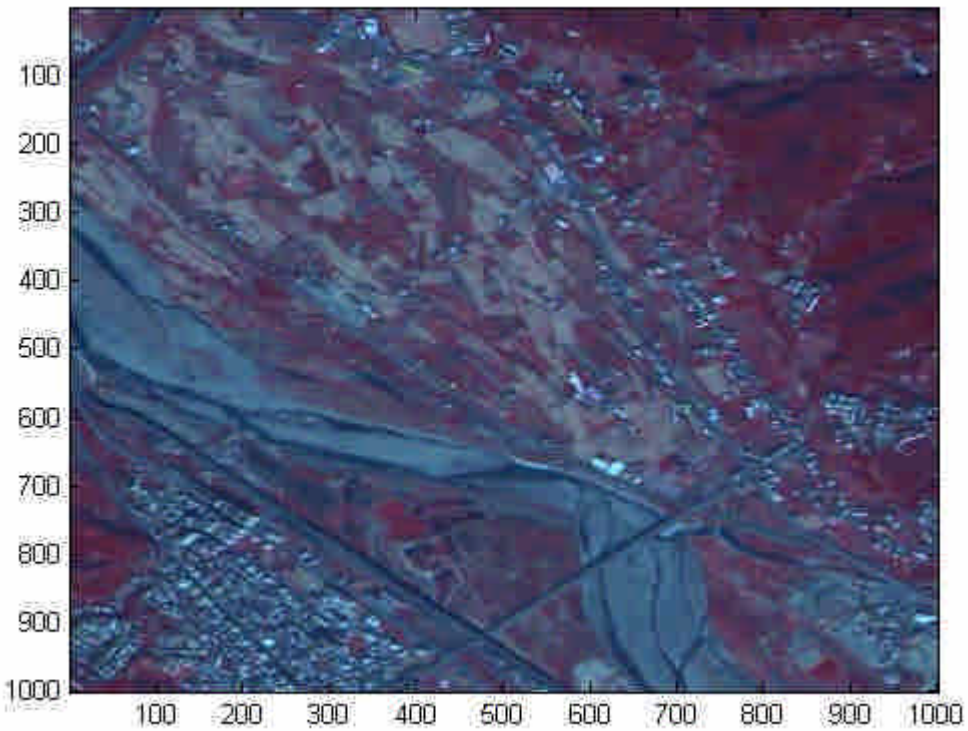
CST

```
load fusion_spot
imagesc(A)
colormap(gray)
figure
image(A1(:,:,[3 2 1]))
```





CST




```
C=rgb2hsv(B);
D=zeros(1000,1000,3);
for i=1:4,for j=1:4
    D(i:4:end,j:4:end,:)=C;
end,end
D(:,:,3)=double(A)/255;
F=hsv2rgb(D);
```

Color Space Transform

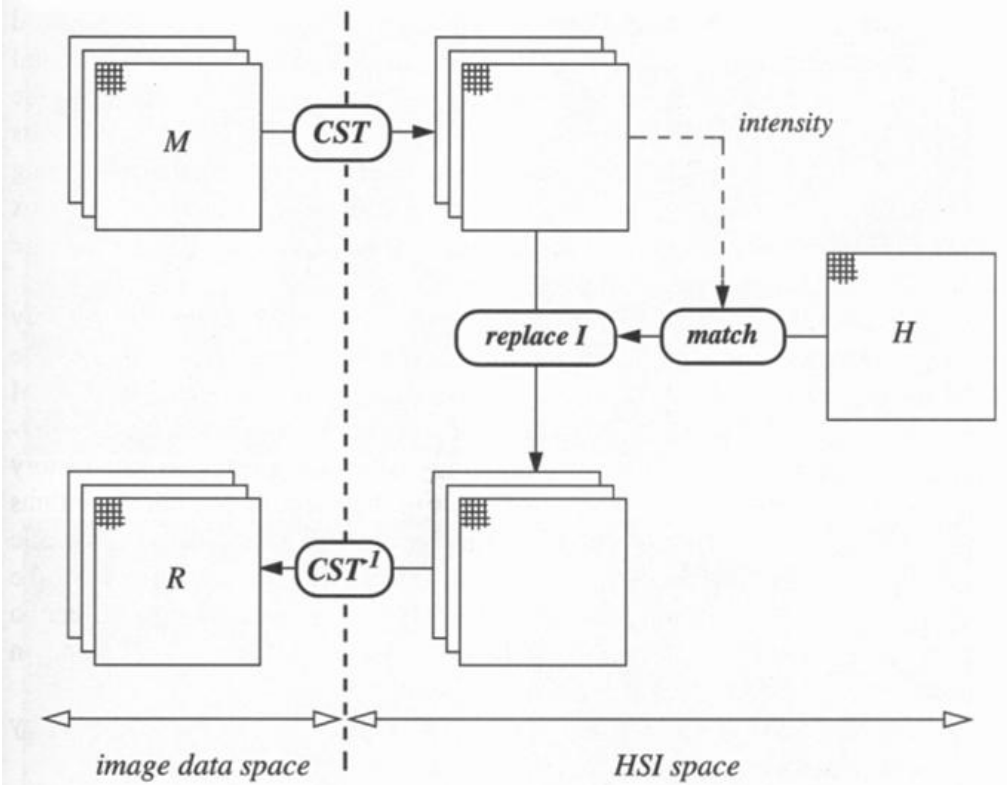


FIGURE 8-14. Image fusion using a color space transform (CST) and replacement of the intensity component. The multispectral image M has been previously registered to the high resolution image H.