

(hyperspectral and Multispectral images )

Covariance

(Thematic Mapper, TM)

Signal to noise )

.74.7217 (ratio, SNR

(Visual C# 2008)

### **Best Band Selection Based on Principle Components Analysis Applied on Remote Sensing Data**

#### **Abstract**

The best band selection from remote sensing image plays an important roles in multispectral and hyperspectral remote sensing image processing due to the intercorrelation that inherent in the multispectral images taken by remote sensing sensors.

In this paper we use principle component analysis algorithm applied on remote sensing data and find covariance matrix for bands that should be processed then find eigen vector using Jacobi methods .The algorithm was applied on multispectral images of Thematic Mapper sensor , it concluded that the six band was the best band , the value of it's eigen value was the biggest one and the value of signal to noise ratio equals to 74.7217. This algorithm is constructed using Visual C# 2008 that is characterized by efficient and high speed implementation.

hyperspectral and Multispectral )

(images

(Bands number)

(dimensionality reduction)

(Band selection)

(Feature Extraction)

[5]

[3]

-

[3]

-

[13] Xiaoling

Weight Independent Component Analysis Matrix

Weigh . matrix

Optimal [ ] Hongjun Band Index

covariance matrix

Correlation Factor

[ ] Sanaeinejad

ETM

Color

.Composite

**Principle Component Analysis**

-

(eigen)

( )

( )

. [7](Multivariate techniques)

(dimensionality reduction)

.(feature extraction)

( ) (Band)  
 (Multivariate statistics) bands  
 (Machine learning)  
 . [10][8] (ComputerVision)  
 (dimensionality reduction )  
 . [13]  
 (PCA)  
 (PCA) .[5] (Variance)  
 (Variance) PCA  
 Variance PCA  
 .(Variance) (noise)  
 . [9]  
 Variance/ Covariance )  
 (matrix)  
 . (Jacobi Methods) (Power Method)  
 (Eigen values)  
 (Principal components)  
 ( )



Semi\_definite  $C$   $j = i$   $c_{ij} = c_{ji}$

Covariance  $T$   
covariance  $D$   $D$  [2]

$$D = \begin{bmatrix} \lambda_{11} & 0 & \dots & 0 \\ 0 & \lambda_{22} & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 & \dots & \dots & \lambda_{nn} \end{bmatrix} \dots (4)$$

أن العناصر القطرية  $D$  تسمى قيمة ايكن Eigen value لمصفوفة Variance/Covariance حيث  $\lambda_{ii}$  لكل  $i = 1, 2, \dots, n$  هي التباينات لمحاور المركبات الرئيسية ان العناصر خارج القطر (Off\_diagonal) للمصفوفة  $D$  هي صفر مما يدل على أن المركبات الخارجة غير مترابطة أي أنها مستقلة [4][10].

تتم عملية تحويل الصورة باستخدام المركبات الاساسية وفقا للمعادلة التالية:

$$\bar{Y} = T\bar{X} \dots (5)$$

حيث أن

$\bar{X}$  متجهه يحوي قيم مدخلات الصور

$\bar{Y}$  متجهه يحوي قيم المركبات الرئيسية

$T$  مصفوفة تمثل الصفوف لها قيم متجهه ايكن المعياري

### Jacobi's Method

$C$

$$i, k \quad \text{Max\_element} = a_{ik}$$

$i \neq k$  Covariance

$$\theta$$

$$\theta = \frac{1}{2} \arctan(2a_{ik} / (a_{ii} - a_{kk})) \quad \text{if } a_{ii} \neq a_{kk}$$

$$\theta = \begin{cases} \pi/4 & \text{When } a_{ik} > 0 \\ -\pi/4 & \text{When } a_{ik} < 0 \end{cases} \quad \text{if } a_{ii} = a_{kk}$$

C (rotation) -

$$\begin{aligned} d_{ii} &= a_{ii} \cos^2 \theta + 2a_{ik} \sin \theta \cos \theta + a_{kk} \sin^2 \theta \\ d_{kk} &= a_{ii} \sin^2 \theta + 2a_{ik} \sin \theta \cos \theta + a_{kk} \cos^2 \theta \\ d_{ik} &= d_{ki} = -(a_{ii} - a_{kk}) \sin \theta \cos \theta + a_{ik} (\cos^2 \theta + \sin^2 \theta) \end{aligned}$$

$$d_{ii} = \frac{1}{2}(a_{ii} + a_{kk} + \sigma R)$$

$$d_{kk} = \frac{1}{2}(a_{ii} + a_{kk} - \sigma R)$$

$$d_{ik} = d_{ki} = 0$$

R

$$R = \sqrt{(a_{ii} - a_{kk})^2 + 4a_{ik}^2}$$

$\sigma$

$$\sigma = \begin{cases} 1 & \text{if } a_{ii} \geq a_{kk} \\ -1 & \text{otherwise} \end{cases}$$

:

$$d_{ir} = a_{ir} \cos \theta + a_{kr} \sin \theta$$

$$d_{kr} = -a_{ir} \sin \theta + a_{kr} \cos \theta$$

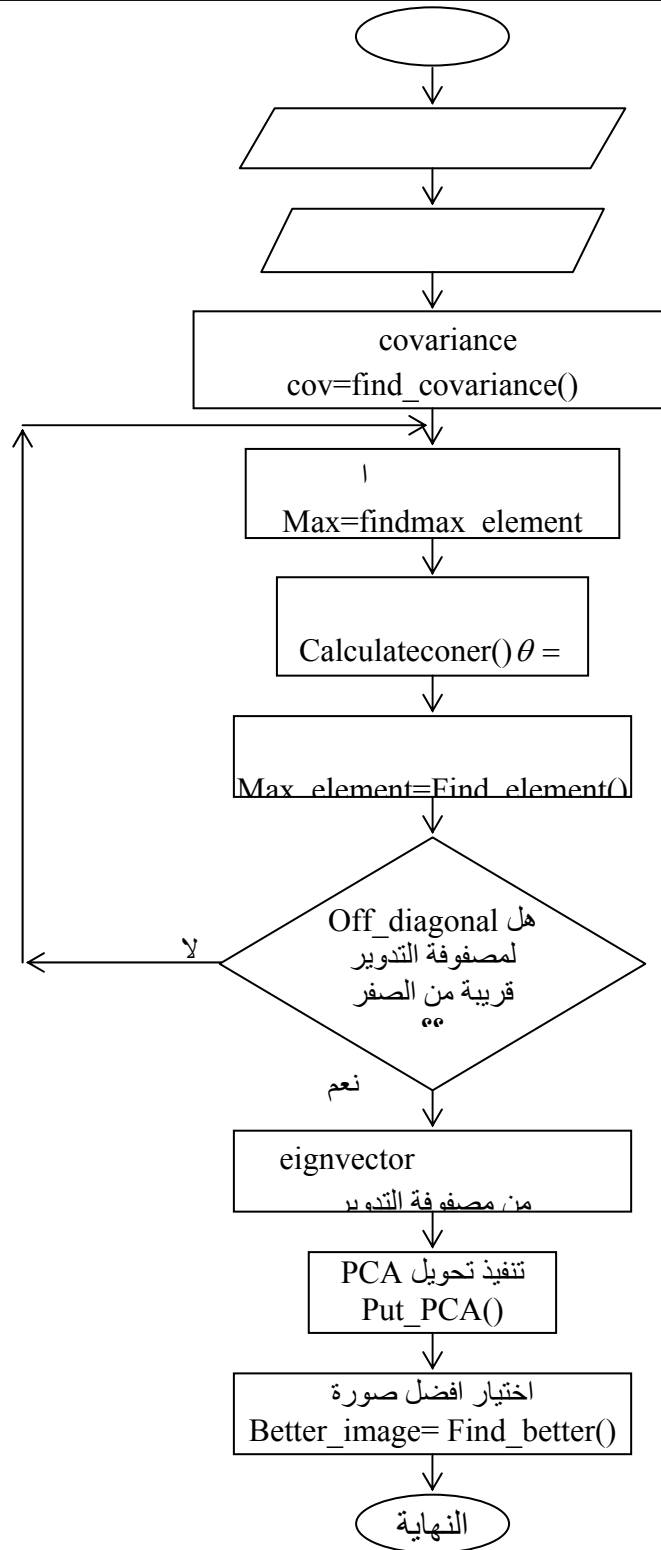
$$i, k \quad r \neq k \quad r \neq i$$

[2]

(off\_diagonal)

(PCA)

( )



PCA

( )



: Variance /Covariance ( TM)  
 Variance /Covariance Matrix of TM

2847.810	2964.085	3055.1168	2974.3864	3076.74	3180.0915
2964.085	3176.542	3301.7963	3230.6633	3399.456	3509.3644
3055.1168	3301.7963	3479.507	3397.4943	3617.41	3741.7662
2974.3864	3230.6633	3397.4943	3420.930	3583.500	3674.62
3076.74	3399.4560	3617.41	3583.500	4434.707	4514.195
3180.0915	3509.3644	3741.7662	3674.62	4514.195	4650.3946

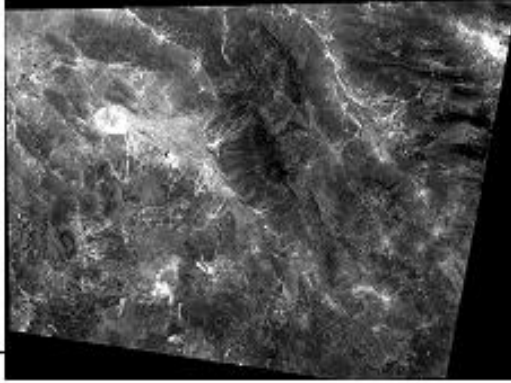
:  
 Eigen Vector Matrix of TM

20896.8049	0.0000	-0.0000	0.0000	0.0	0.0000
0.0000	908.135	-0.0000	0.0	0.0000	-0.0000
-0.0000	-0.000	127.1215	0.0000	-0.0000	0.0
0.0000	0.0	0.0000	48.0547	-0.0000	-7.5530
0.0	0.0000	-0.0000	-0.0000	19.1278	0.00000
0.0000	-0.0000	0.0	-7.5530	0.00000	10.648

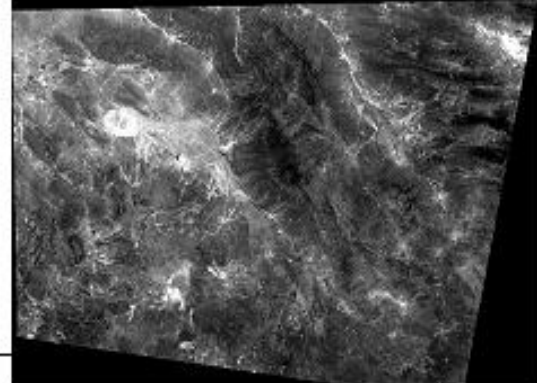
SNR Eigen value

SNR	Eigen value	Band
73.3707	127.1215	TM1
73.6854	10.6488	TM2
73.6788	908.1358	TM3
73.745	48.0547	TM4
74.714	19.1278	TM5
74.7217	20896.8049	TM6

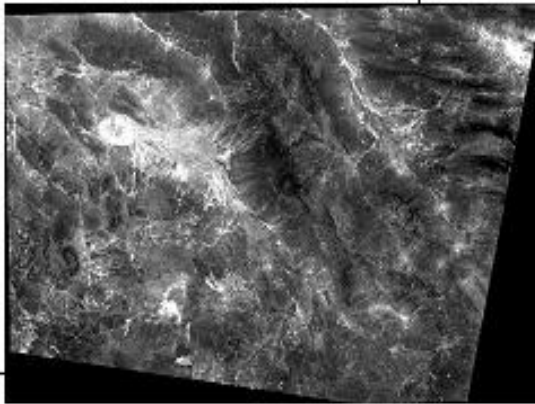
( )



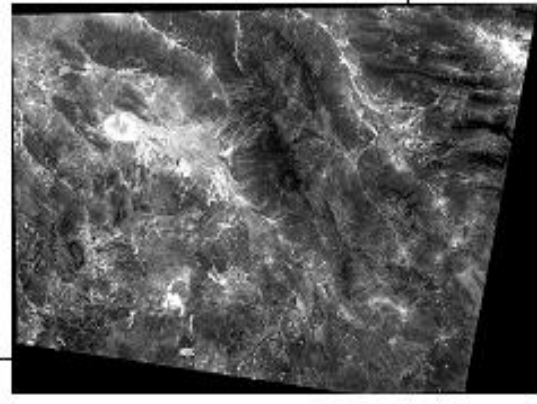
TM



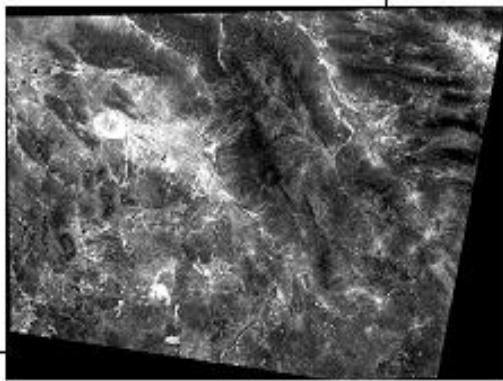
PCA1



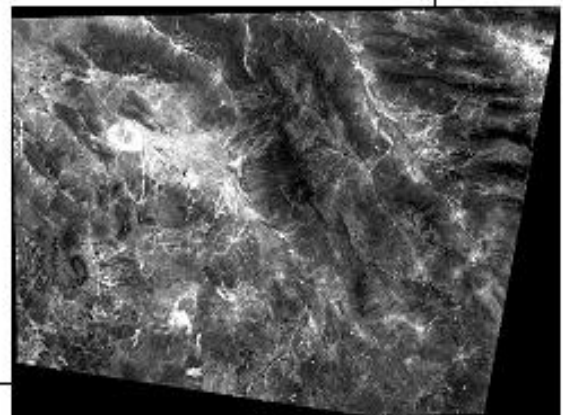
TM



PCA2



TM



PCA3

الصورة (1): صورة متعددة الاطراف لمتحسس TM، الجهة اليسرى تمثل الصورة الاصلية والجهة اليمنى تمثل الصورة بعد اجراء تحليل المركبات الاساسية عليها.

PCA Eigen vector

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