Creates a New GIS Tool for Classifying Lands Around selected monument

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Abstract: The proposed system of this paper creates a new GIS tool which classifies the lands around the selected monument by taking a set of sub-images . The system will extract a vector of textural features for each sub-image using second order statistics Gray Level Co-occurrence Matrix (GLCM) and calculate eight textural feature. The vector of features will be the input to Minimum distance classifier and the Euclidean distance used to measure distance between vectors of features .
The system then classifies the lands around the selected monument to find a flat area used for building a museum or a visitors rest.

Keyword:-: *sub-image Classification, Gray-Level Co-occurrence Matrix (GLCM), Texture features, Geographic Information System (GIS).*

I.   INTRODUCTION

Developing a system for classification of images to any class with the use of their textures features in different direction of GLCM matrix . This association between local trained features values and recognized class of flat area as an example led to obtain a good results using this method. Another direction is extracting the texture feature for unknown image and let the system detect the type of this image using Minimum distance classifier. Conceptually, geographic data can be broken up in two elements: observation or entity and attribute or variable. GIS have to be able to manage both elements. Spatial component, the observations have two aspects in its localization, absolute localization based in a coordinates system and topological relationship referred. A GIS is able to manage both while computer assisted cartography packages only manage the absolute one. R. Methre et al. [17] investigated the texture retrieval using combination of local features of Haralick derived from one level discrete wavelet transform coefficients and global statistical features computed from three level wavelet transformed images. Y. Zhang et al. [20] proposed a hybrid classifier for polarimetric SAR images, the feature sets consist of span image, the H/A/α decomposition algorithm, and the GLCM-based texture features. Then, a probabilistic neural network (PNN) was adopted for classification. E. S. Flores et al [3] used GIS techniques to improve the classification capabilities of a feature extraction algorithm for land use/cover change detection in a deciduous forest environment.

II.   METHODS AND MATERIALS

1. GEOGRAPHIC INFORMATION SYSTEMS (GIS)
A key characteristic of GIS is the linkage between geographic features represented on a map with attribute data that describe the geographic feature [14].

Within the GIS database a user can enter, analyze and manipulate data that is associated with some spatial element in the real world. The cartographic software of the GIS enables one to display the geographic information at any scale or projection and as a variety of layers which can be turned on or off. Each layer would show some different aspect of a place on the Earth. These layers could show things like a road network, topography, vegetation cover, streams and water bodies, and the distribution of annual precipitation received [2]

2. GLCM AND TEXTURAL FEATURES
Gray-level co-occurrence matrix (GLCM) is the statistical method of examining the textures that considers the spatial relationship of the pixels. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial
relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix [15].

The matrix element P (i, j | d, θ) contains the second order statistical probability values for changes between gray levels i and j at a particular displacement distance d and at a particular angle θ. Instead of using the frequency values in a GLCM directly, it is common practice to normalize them to the range [0, 1] to avoid scaling effects. Eight textural features are extracted in proposed system for each visible band from each land sample to be the vector of features which represented the entire land sample [6][13].
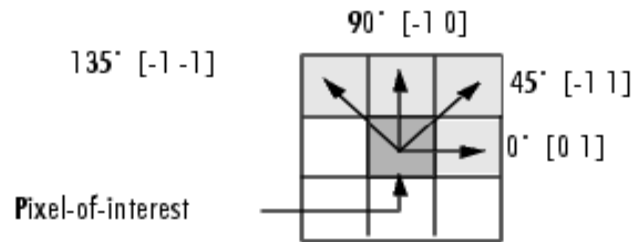
Fig.(1): Directions for generation of GLCM

Figure (2) : some examples of different texture features.

3. RECOGNITION TECHNIQUES

Recognition techniques based on matching represent each class by a prototype pattern vector. An unknown pattern is assigned to the class to which it is closest in terms of predefined metric. The simplest approach is the minimum distance classifier, which, as its name implies, computes the (Euclidean) distance between the unknown and each of prototype vectors. It chooses the smallest distance to make a decision.

4. MINIMUM DISTANCE CLASSIFIER

The minimum distance Classifier is used to classify unknown image data to classes which minimize the distance between the image data and the class in multi - feature space.

$$M = \frac{1}{N} \sum x_j \quad \text{where } j= 1,2,3,\ldots\ldots w \quad \text{(Eq. 1)}$$

Where N is the number of pattern vectors from class w1 and the summation is taken over these vectors. W is number of pattern classes. Using the Euclidean distance to determine closeness reduces the problem to computing the distance measures:

$$D_j (X) = \| X - M_j \| \quad \text{where } j = 1, 2, 3, \ldots\ldots, W \quad \text{(Eq. 2)} \quad [16].$$

III.   THEORETICAL BASICS OF THE PROPOSED CLASSIFIED SYSTEM

This section shows a theoretical basic of the techniques that can be used in this paper as a proposed system classifier.

1. PROPOSED SYSTEM ENVIRONMENT:

The proposed system application is programmed using visual studio 2008 (visual basic.Net). Therefore, we will use the Arc Engine   (. NET Developer KIT) to give the language Visual basic.Net possibility of dealing with the ESRI ArcMap GIS. The lands classification tool which is the proposed system application tool, it was added to ArcMap GIS as a new GIS dll this file contains the application classes code for the proposed system and also, the application interface windows codes to be run into ArcMap GIS software, it become a portable application; it can be used by any machine which has installed ArcMap GIS software.

The selected monument land has covered by polygon vector layer previously. The land is represented by real world satellite image in the raster layer (a map of Babylon archeological city was selected). The user is entered monument information to the database, as shown in figure (3) where the proposed system which explains the practical work stages, and figure (4) shows the combination of raster and vector layers in ArcMap GIS.
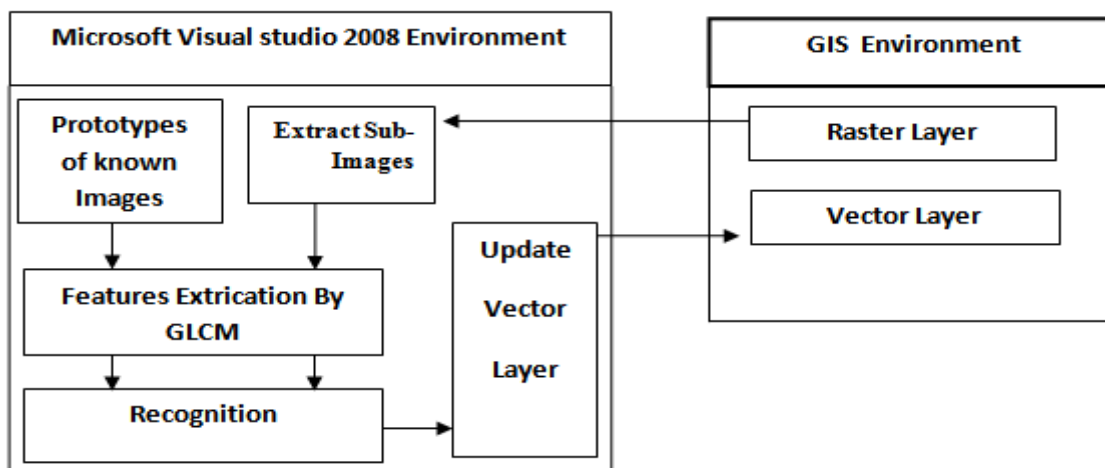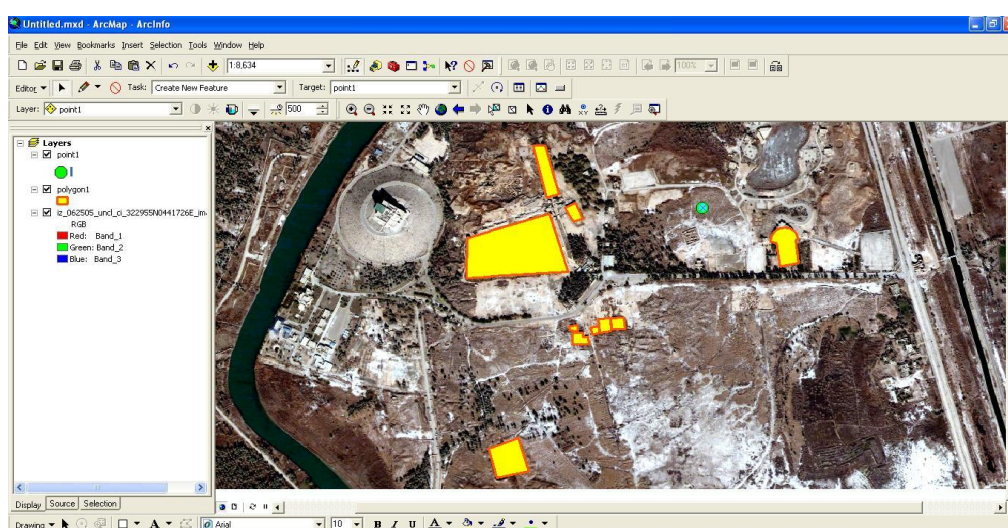
Figure (3) : proposed system.

Figure 4: The combination of raster and vector layers in ArcMap GIS.

2. Extract Sub-image from Raster Layer

One polygon (monument) has been selected, the system need to investigate the lands around this polygon for flat area to built a rest area for visitors or built a museum or any thing else, the system use some techniques to do that. while the raster and vector layer are identical with their spatial reference UTM zone, the system gets the polygon angles points where its edge line are crossed to extract the centroid of the polygon which represent the centroid of the monument area in raster image . The system calculate the maximum distance from centroid point to edge line crossed points, the system will adds 20 meters to that distance, this new value represents the new centroid to clip an image window with size of (256 x 256) pixels,

Figure (5): polygon and centroid of the polygon

The system will rotate around the selected monument to clip a new image window with the angle of 45°

3. Texture Feature Extraction

The proposed system used Gray Level Co-occurrence Matrix GLCM technique to find the statistic textural feature for each image that has been clipped from raster layer. The output from the previous stage are used in the current stage, Mathematically, those features can be represented as follows[9][18].

■ Angular Second Moment

$$ASM = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \{P(i,j)\}^2 \quad \ldots\ldots\ldots\ldots(Eq.\ 3\ )$$

■ Entropy

$$ENTROPY = -\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} P(i,j) \times log\big(p(i,j)\big) \quad \ldots\ldots(Eq.\ 4\ )$$

■ Contract

$$CONSTRAST = \frac{1}{(N-1)^2} \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (i-j)^2\ P(i,j) \quad \ldots\ldots(Eq.\ 5\ )$$

■ Homogenous

$$IDM = \sum_{i=0}^{N-1} \sum_{j=o}^{N-1} \frac{1}{1+(i-j)^2} P(i,j) \quad \ldots\ldots\ldots\ldots(Eq.\ 6\ )$$

■ Correlation

$$Correlation = \frac{\sum_{i=0}^{N-1} \sum_{j-0}^{N-1} (i-\mu_i)(j-\mu_j)}{\sigma_i \sigma_j} \quad \ldots\ldots\ldots\ldots(Eq.\ 7\ )$$

■ Dissimilarity

$$Dissimilarity = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} p(i,j)|i-j| \quad \ldots\ldots\ldots(Eq.\ 8\ )$$

■ Variance

$$Variance = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} p(i,j)(i-u_i)^2 \quad \ldots\ldots\ldots(Eq.\ 9\ )$$

■ Standard deviation

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} \big(\sum_{j=1}^{N} P(i,j)-u\big)^2}{N-1}} \quad \ldots\ldots\ldots(Eq.\ 10\ )$$

Then each land image has vectors of eight feature for each land object extracted by the system and for each land image saved in database , this calculated vector of textural features will be saved temporally in the system database buffer to be used in the next stage to classify the land image to which class it belongs.

4. Classification

The proposed classification system used the Minimum distance classifier to classify the new extracted sub-image . This can be done by gets the vector of features for sub-image extracted by the system and compared with the vectors of objects in database to get the smallest distance between extracted sub-image and that images in database .

The Euclidean distance between two points or tuples, say, X1 = (x11, x12, …… , x1n) and X2 = (x21, x22, ….. , x2n).

The minimum value will be taken and then the system can repeat these processes until it recognize the flat area near the selected object.

IV. EXPERIMENTAL RESULT

This section will present the results that have been achieved from executing the proposed system's phases and its stages that described in previous sections. The system have polygon vector map and point vector map.

1. Image Samples Extraction Resulted from Raster Image:

The system extracts eight sub-images samples from raster layer around the selected polygon with a distance from the centroid of that polygon and an angle about 45o around it, these eight samples will be illustrated in figure (6).

Sub-image No. 1   Sub-image No. 2   Sub-image No. 3   Sub-image No. 4

| Sub-image No. 5 | Sub-image No. 6 | Sub-image No. 7 | Sub-image No. 8 |

2.   Texture Feature extraction Results:

This section shows the results of the features extraction stage for eight sub-images around the selected object extracted from the raster image and the features of sub-images in database, these features calculated from GLCM with angles (0o, 45o, 90o and 135o) and the result are tabulated in table (2).

Table (2): GLCM textural features for sample No.7, flat area.

Feature/angles	Angles 0	Angles 45	Angles 90	Angles 135
Energy	0.24399907	0.2396224	0.262362126	0.240016427
Entropy	4.5620215	4.6436559	3.8355068	4.672825986
Contrast	516.4635826	866.7356668	508.9173228	908.16387795
Homogeneity	0.440905189	0.4339167	0.96935537	0.43420926
Correlation	0.970929	0.9513671	0.971606659	0.94957795
Dissimilarity	6.429133858	8.196050688	2.871432	8.61232776
Variance	36300.216658	36127.8886	37976.2681	35970.9556
Standard deviation	190.526147	190.073377	189.937537	189.660105

3.   The Classification Results of The System

The main classification results are shown in point vector layer maps within ArcMap GIS. The point layer in figure (7) illustrate the vector map layer with one point created by user with attribute table that contains a random coordinates.

When the Euclidean distance measure is implemented at the eight samples features and the five classes features to determine each samples

to which class is belong to as shown in figures below which illustrate that sample number 7 belongs to class of the flat area that classification system has searched for and then specified,   the figure (8) to (11) shows the Energy, the Homogeneity, the Contrast and the Correlation Features comparison,
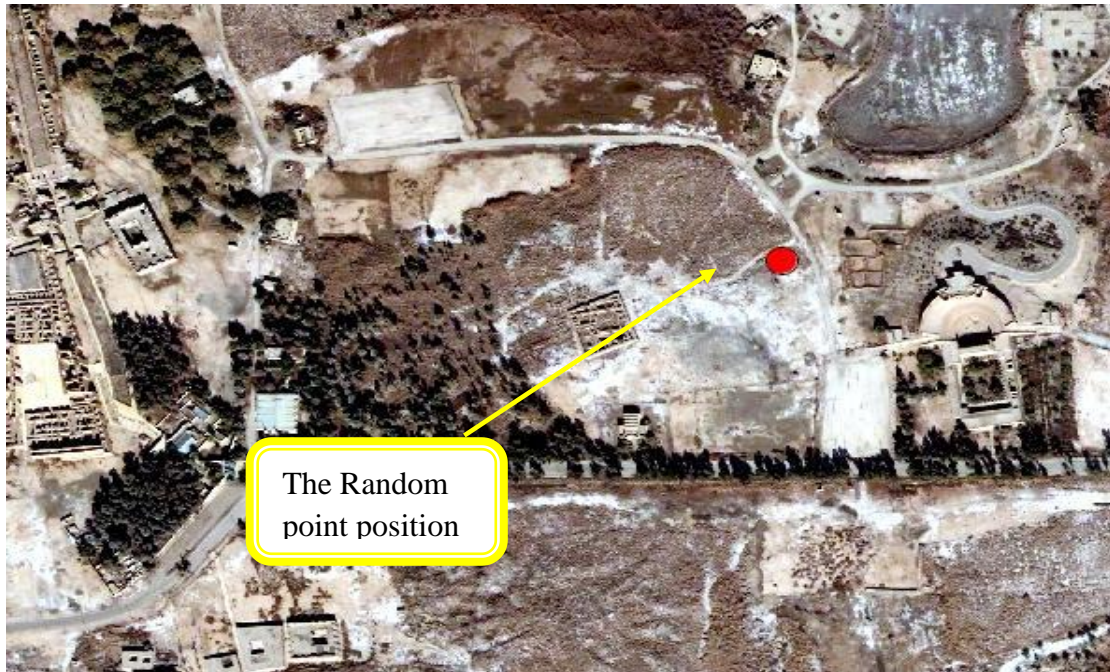
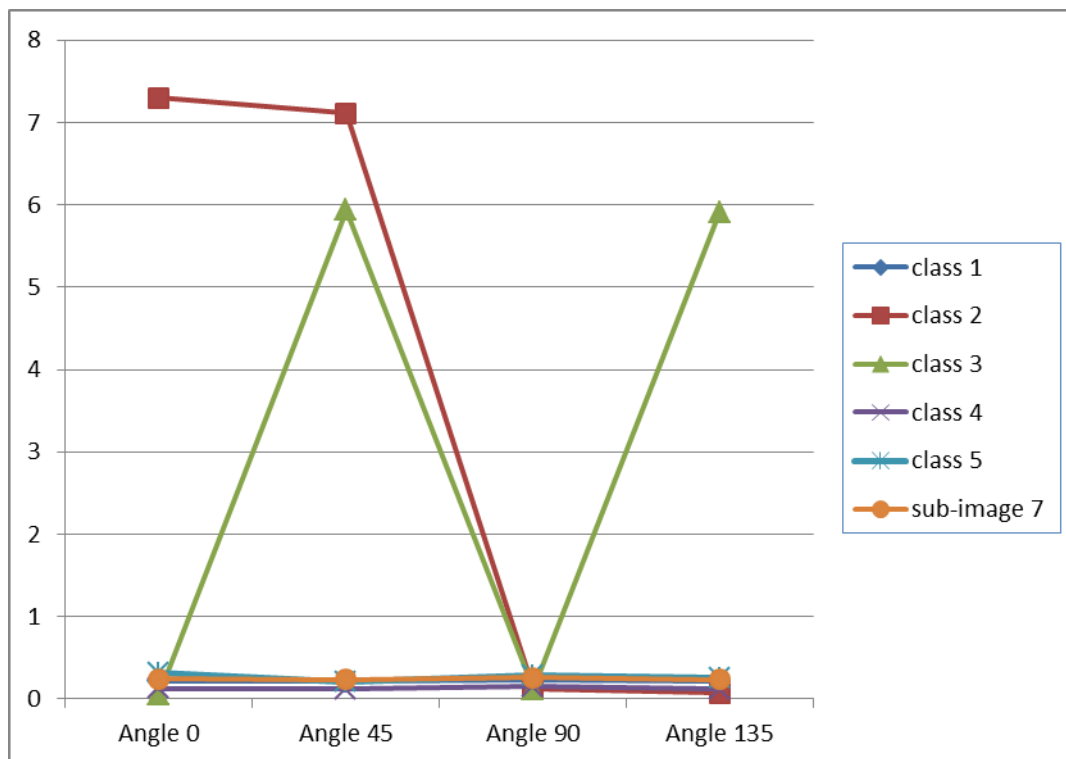Fgure (7): represent the vector map layer with one point at a random location
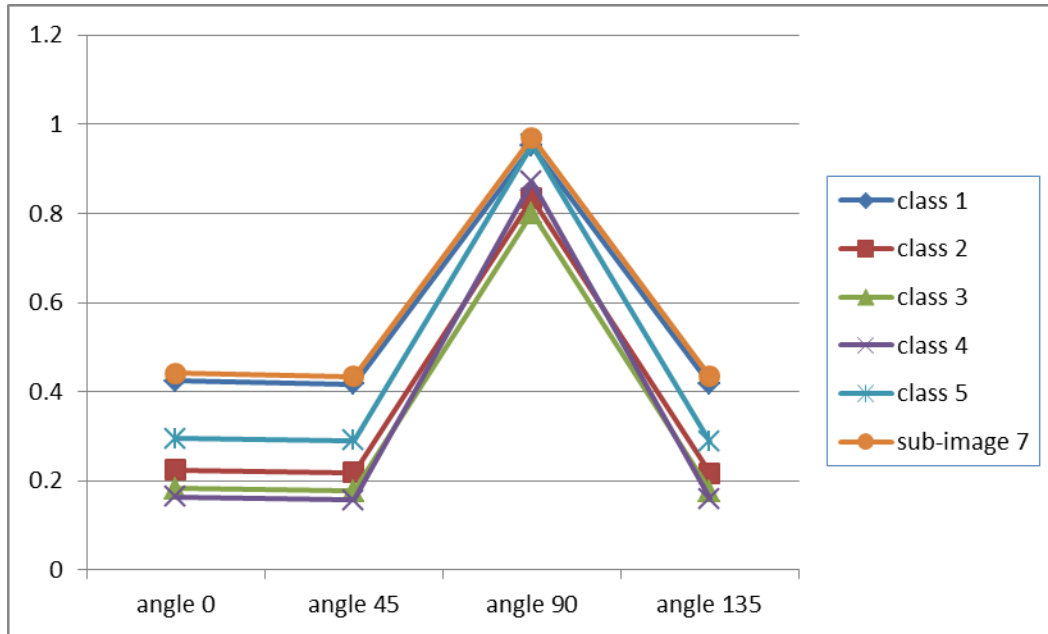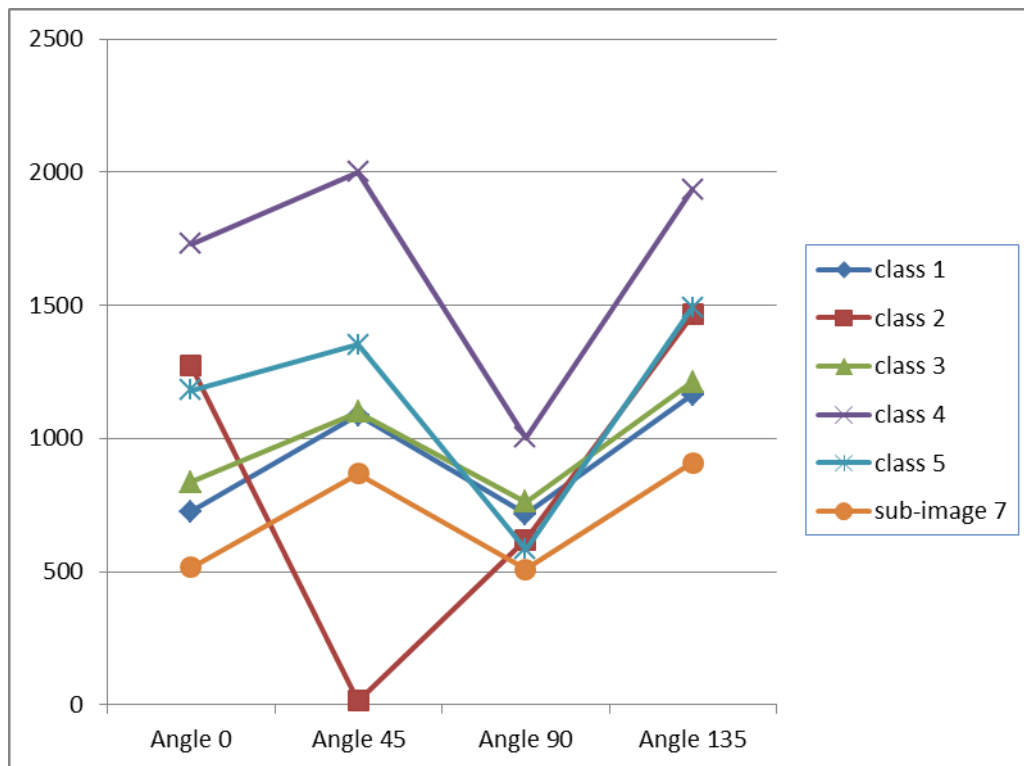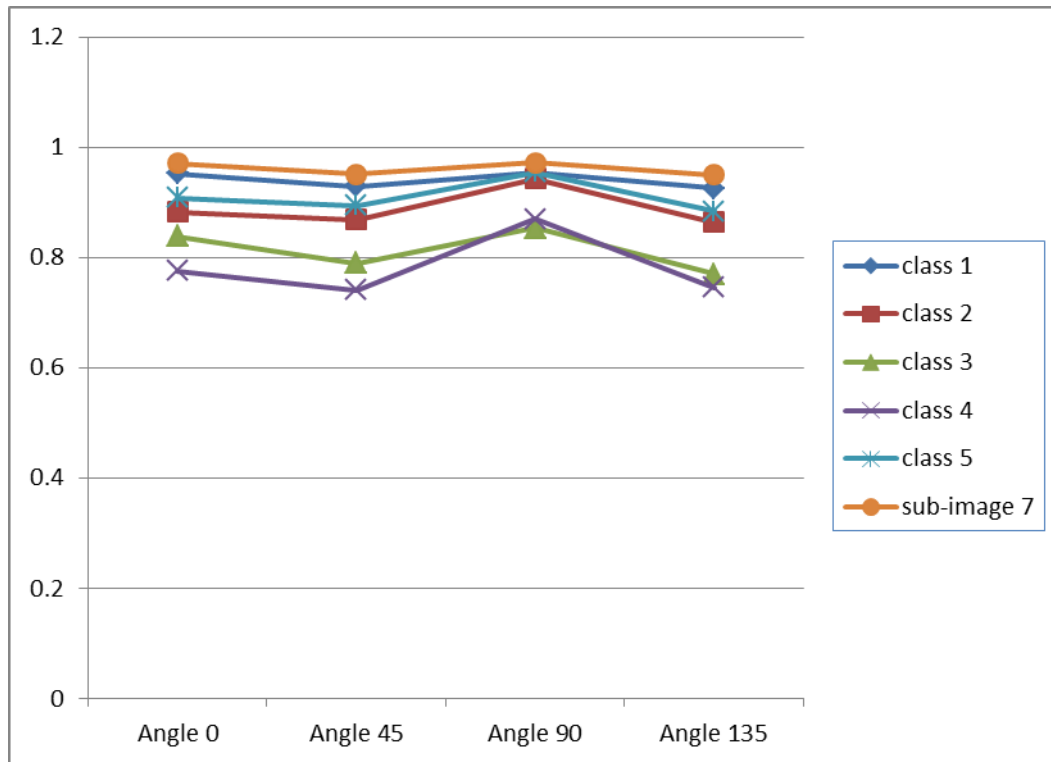

Figure (8): Energy Features comparison

Figure(9): Homogeneity Features comparison

Figure(10): Contrast Features comparison

Figure(11): Correlation Features comparison

Then the system will choose the sample that has a minimum distance to class 1 , When the classification system found it then the point vector layer is updated to the new location. This was done by the system automatically. The system which takes the coordinates of the centeroid of selected sample and made it as a new coordinates for point in point layer map and move it to the new location as shown in figure (12), this location will represent the pest area.

Figure (12): The point layer after the system updated

V. CONCLUSIONS

There is a way to create custom commands with VBA in ArcGIS. we can create a new button, tool, combo box, or edit box (collectively named UIControls), then attach code to the control's events, such as what happens when we click a button. After we have created it, we can drag this new control onto a toolbar. The advantages of GIS include its database manner of data management, its capability to overlay and integrate different spatial information, and its powerful tools and functions for image analysis, spatial analysis and modeling Thus, it well

suited for image classification The results indicate that co-occurrence matrix approach is also an effective method in angle 90o evaluation of textures.

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