An Approach for Extracting Viewpoint Patterns using Geometric Directions

Pavan Kumar K, S.V.N Srinivasu

Abstract*: Vast improvement in technology significantly increases in the collection of images in a huge quantity. Most of the technologies like IoT, sensors, scanners, point of sales, internet, etc. are gathering the data in the form of images. Image processing researchers introduces many algorithms to process the images and tried to extract information from the images. Due to the drastic development in data mining research give you an idea about the way for extracting the value from the data which helps to improve the business and image database is not an exception for this. Many researchers are trying to present the algorithm in the image mining area for extracting the value from the image data databases. Recently Wynne Hsu, Jing Dai, and Mong Li Lee introduced new type of patterns called viewpoint patterns which exhibit the invariant relationship between the objects. But the algorithm suffers from costly operation of building the object table at every level. We design a new algorithm for extracting the viewpoint patterns which builds the object table only once and uses this information at every level and our algorithm is based on the relationship between the objects only.

Index Choice: Image mining, viewpoint patterns, data mining, invariant relationship

I. INTRODUCTION

Since the inception of technology in hardware as well as software drive the society to sore huge amount of data in various formats. The technologies improvements in areas like Internet Of Things (IOT), Big Data, and sensors are generating huge amounts of data and most of the data is storing in the form of images. Image Analysis generally contains the tasks like pre-processing the images which includes object recognition, feature extraction, image classification, data management, image indexing and image retrieval, etc.

The image processing itself is not sufficient to extract the knowledge or hidden information from the images. Data mining helps in digging such knowledge from the images. Most of the works in image mining deals with finding the patterns in images based on absolute position of the objects in the image set. The recent trend in image mining is to discover the invariant relationship that exists over a set of images. Mining large set of images and finding the patterns based on absolute positional parameters may not convey critical information in the images, rather it is important to extract the relative spatial relationships among the set of images, the authors in [1] named these patterns as viewpoint patterns.

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In this paper we propose an efficient algorithm for extracting the viewpoint patterns using geometric properties. We assume in our algorithm the objects in images are preprocessed and each object is stored as a rectangle (which is constructed by covering the object). Our algorithm does not consider the rotations the objects towards orthogonal way.

The rest of the paper is organized in the following way: section 2 reveals the related work in the area, section 3 discusses on the viewpoint patterns and also it presents our proposed algorithm. Section 4 talks about the database scans over the database, section 5 discusses about the results, the conclusion of the paper is presented in section 6, and finally section 7 gives the directions for the future work.

II. RELATED WORK

Researchers are proposed may algorithms in image mining for the tasks of preprocessing [2, 3, 4] and the intention of preprocessing is to enhance the quality of the images. Researchers are also proposed algorithms for object recognition [5, 6, 7, 8, 9, 10] focusing on object bases segmentation, marker based segmentation, Contour based segmentation, etc. Feature extraction [11, 12], image classification [13, 14], image indexing and retrieval [15, 16, 17, 18, 19, 20, 21], etc, are the other areas in image mining.

Wynne Hsu, Jing Dai, and Mong Li Lee [1] introduced the new type of patterns in image databases and they named these patterns as viewpoint patterns. The authors used the distance (Pix) and orientation (Rad) as the measure in extracting the viewpoint patterns. Initially all the two object patterns are generated and they tried to generalize these 2-object patterns. They followed the level wise approach for extracting the viewpoint patterns at each level they constructed object table which is a very complex operation.3.1. Text font of entire document

III. DISCUSSION ON EXTRACTION OF VIEWPOINT PATTERNS

Wynne Hsu, Jing Dai, and Mong Li Lee [1] introduced the new type of patterns in image databases. They defined viewpoint patters as follows:
"Viewpoint patterns reveal the invariant relationship of one object from the point of view of another object [1]". Wynne Hsu et al., proposed an algorithm to extract the viewpoint patterns and they consider the absolute positions of the objects in the image databases are unique but there exist a fixed relationship between the objects in the image. The main

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motive of the extracting the viewpoint patterns is to reveal the spatial relationship between the objects in the image databases. In our algorithm we consider only the spatial relationship between the objects and our algorithm did not consider the absolute position of the objects. We consider the objects are in 2-D plane, means each object is identified by its position by using the X and Y coordinates only.

Figure-1shows the five different hall plans consisting of objects Television (T), Dining Table (D), Sofa (S), and Cot (C). Generally the data mining algorithms tries to exhibit knowledge like, which two objects are frequent, which three objects are frequent, etc. For example in the above image, if the user supplies a support threshold value of 2 then any frequent pattern mining algorithm [22, 23, 24] may produce the following results:

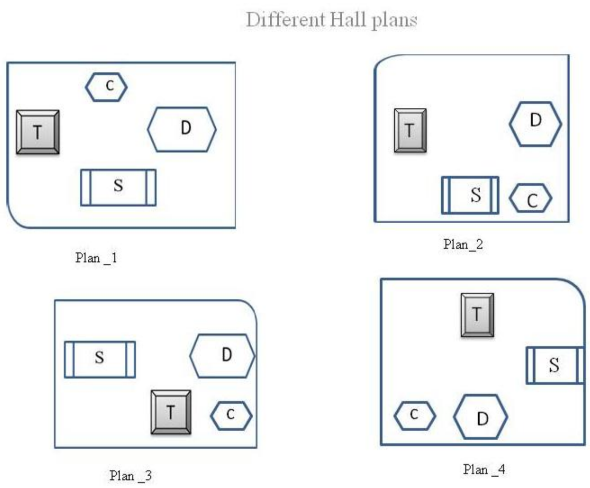

Fig 1: Four different hall plans

Frequent Itemset Length	Frequent itemsets
1	{C}, {D}, {S}, {T}
2	{C, D}, {C, S}, {D, S}, {D, T}
3	{C, D, S}, {C, D, T}, {D, S, T}
4	{C, D, S, T}

Table 1: Set of frequent objects in the figure 1

relationship between the objects. The order of items in the object can be extracted by using the sequential pattern mining algorithms [25, 26], but all the data mining algorithms did not consider the properties of objects, only the image processing algorithms consider the properties of objects. The relationship between the objects can be extracted by using the image processing algorithms and the data mining algorithms guides in selecting the objects in the images. Both the image processing and data mining techniques aids us to extract the viewpoint patterns.

Wynne Hsu, et al, [1] used the distance and orientation to find the object patterns, in this paper we use the eight-quadrant system to find as the basis for extracting the viewpoint patterns. In this paper we assume that every object in the image is bounded by the tight rectangle, means every object is stored by using two 2-D points, (x1, y1) and (x2, y2), where (x1, y1) is the top most left point of the rectangle and (x1, y2) is the bottom most right point. In this paper we consider the position of the object with the geometric point (x, y) (where x = (x1+x2)/2 and y = (y1+y2)/2), since the absolute position of the object is not required only we need to extract the spatial relationship between the objects. The following figure - 2 shows the eight quadrant system, illustrates how the special relationship between two objects can be identified.

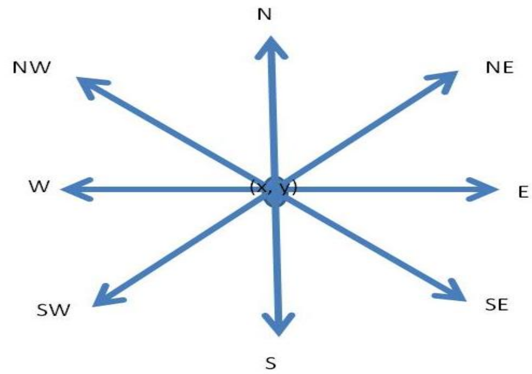

Fig. 2: Eight quadrant system.

In figure-2 the (x, y) is the object considering Oi position and correspondingly we identify any other objects Oj (where j ≠ i) position with respective to Oi and it may be W, or S, or N, or NE or NW or SE or SW. For simplicity we follow the following convention:

E is represented as 0
NE is represented as 1
N is represented as 2
NW is represented as 3
W is represented as 4
SW is represented as 5
S is represented as 6
SE is represented as 7.

Theorem-1: Two objects are in spatial relationship in two or more images if and only if the order of occurring of the objects in all the images is same.

Proof: Assume that considering the images i and j concluded that object O and P are in spatial relationship. If the object O occurs before object P in image-i and object P occurs before object O in image-j, means both the objects have opposite relationship in images i and j, concludes they are not in the same spatial relationship. Therefore, two objects are in spatial relationship if and only if the objects must follow same order in all the supporting images.

From theorem-1 it is evident that the objects in images are considered in the order of their presence in the images, in ordering the objects we consider the x-coordinate value, if there is any ties sort according to y-coordinate, and still ties are not resolved, randomly solves the tied objects in some order. For example in plan-1 in figure-the other objects and their relationships are as follows,

The orders of the objects are T, C, S and D:

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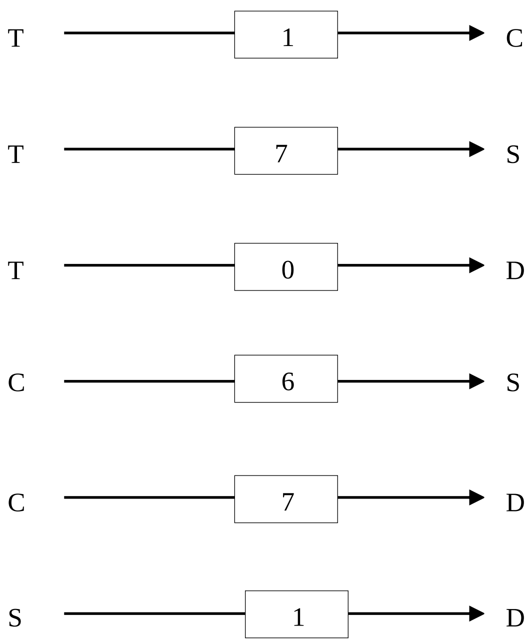

Fig. 3: Relationship between objects S in plan_1 in figure-1

Algorithm for extracting the viewpoint patterns (We illustrate our algorithm step by step by using the example image in figure-1)

Input: Preprocessed image database (Each object in image is stored as a rectangle)

Output: All the viewpoint patterns

1. Initially all the objects which are frequent (satisfies the user specified minimum support threshold) are identified by counting support of each object in the image database. These are all one length viewpoint patterns.

Assume that minimum support threshold is two for the image example database shown in figure-1. In our example image we have four objects and all the objects satisfies minimum support threshold of four.

L1 = {S, D, T, C}.

2. Build object table for each image to find the relationship between the ordered objects, by using the relationships shown in figure-2.

In building the objects table only the frequent objects needs to be considered. For our running example the following object table is constructed. In finding the relationships we use the source object is always in middle position (in figure – 2 it is mentioned as (x, y)).

Definition – 1 (Equivalence between objects): Two objects Oi and Oj are equal if and only if the absolute difference between their relationships (|(R(Oi, Oj) - R(Oj, Oi)|) is equal to four. In our running example in plan_1 the objects C and D are equal since,

R(C, D) = 7

R(D, C) = 3

| R(C, D) - R (D, C)| = 4

Note: The directions 4, 5 are not used since the objects ordered according to their presence.

S.No	Source Object	Destination object	Relation
1	T	C	1
2	T	S	7
3	T	D	0
4	C	S	6
5	C	D	7
6	S	D	1

Table-3a: 2-object table for plan-1

S.No	Source Object	Destination object	Relation
1	T	S	7
2	T	C	7
3	T	D	0
4	S	C	0
5	S	D	1
6	C	D	2

Table-3b: 2-object table for plan-2

S.No	Source Object	Destination object	Relation
1	S	T	3
2	S	C	7
3	S	D	0
4	T	C	0
5	T	D	1
6	C	D	2

Table-4a: 2-object table for plan-3

S.No	Source Object	Destination object	Relation
1	C	D	0
2	C	T	1
3	C	S	1
4	D	T	2
5	D	S	1
6	T	S	7

Table-4b: 2-object table for plan-4

3. The source and destination object pairs and the relation between them in 2-object table are considered as two length candidate viewpoint patterns.

For example (C, D, 7) is one two length candidate and (C, D, 2) is another candidate object.

4.Count the support of all the two length candidate objects, by using the 2-object table.

For example the support count of (T, S, 7) is three and the support count of (T, D, 0) is 2.

5. Remove the infrequent two length candidate objects and declare all the remaining candidate two length candidate viewpoint patterns as frequent viewpoint patterns.

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TABLE – 5: TWO LENGTH FREQUENT OBJECTS

S.No	Two length Frequent objects	Supporting images
1	(T, S, 7)	Plan_1, Plan_2, Plan_4
2	(T, D, 0)	Plan_1, Plan_2
3	(C, D, 2)	Plan_2, Plan_3
4	(S, D, 1)	Plan_1, Plan_2

6. Initialize k:=2
   - 6.1. Repeat
   - 6.2. k : = k +1
   - 6.3. Generate k-length candidate viewpoint pattern by merging the (k-1) length frequent viewpoint pattern with one two length frequent viewpoint pattern. Merging can be done by using the following rule:
     - *6.3.1.* Consider the k-1 length frequent viewpoint pattern ((A, B, i), (B, C, j), (A, D, l)… (C, W, p)), with two length frequent viewpoint pattern (X, Y, m) if and only if X must be a candidate object in any of the two length frequent viewpoint pattern in the k-1 length candidate frequent viepointw pattern.

6.4 Find the support of the k-length candidate pattern by using the following formulae.

Support (k-length candidate pattern) =

$$|(\textit{supporting images of } (k-1) \textit{length frequent viewpattern} \cap \textit{supporting images of } 2-\textit{length frequent viewpattern})|$$
|

6.5 Identify the k-length viewpoint pattern and is not a duplicate then update the supporting images of the new viewpoint pattern.

6.6 Until there are no k-length frequent viewpoint patterns

For example (T, S, 7) can be merged with (T, D, 0) to generate three length candidate viewpoint pattern ((T, S, 7), (T, D, 0)).

In our example the three length-viewpoint patterns are

S.No	Two length Frequent objects	Supporting images
1	((T, S, 7), (T, D, 0))	Plan_1, Plan_2
2	((T, S, 7), (S, D, 1))	Plan_1, Plan_2
3	((T, D, 0), (S, D, 1))	Plan_1, Plan_2

Table – 6: three length-viewpoint patterns

S.No	Two length Frequent objects	Supporting images
1	((T, S, 7), (T, D, 0), (S, D, 1))	Plan_1, Plan_2

Table – 7: four length-viewpoint patterns

IV. DATABASE SCANS

Two database scans are sufficient to extract all the viewpoint patterns. One scan is used to find all the one length viewpoint patterns and another scan is used for building the 2-object table. The support count of candidate viewpoint patterns of length more than two can be done using the 2-object table. Compare to Wynne Hsu, et al, [1], our algorithm do not require the cost of constructing object table at every level, it saves lot of time at the time of execution.

V. EXPERIMENTS

We run our algorithm on different synthetic image databases and the running time of our algorithm is shown below.

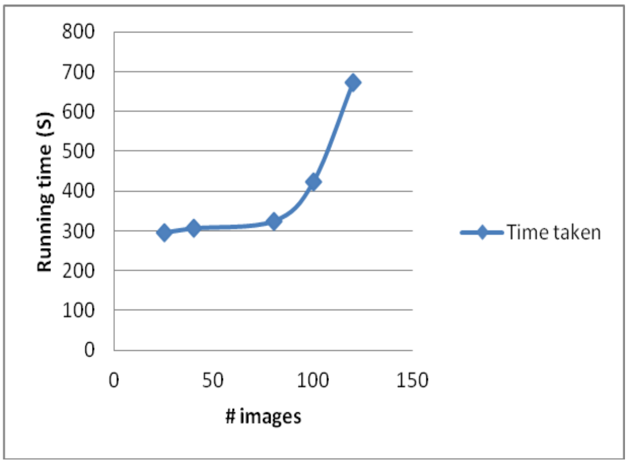

Figure – 4: Running time for extracting viewpoint patterns

The input for the algorithm is the set of images and each image preprocessed and converted into a table by specifying only the position of the object and is given as an input to our algorithm. The figure-4 suggests that our algorithm is scalable compared to the viewpoint pattern mining algorithm in [1]. We used different set of objects in each image.

VI. CONCLUSION

In this paper we tried to extract the viewpoint patterns from the image databases by using the direction as the basis. The algorithm takes only two scans on the database and it is more scalable. The algorithm extracts the spatial relationships between the objects by using the specified directions. The patterns extracted in this paper have lot many real world applications.

VII. FUTURE WORK

Our algorithm is sensitive to the rotations of the images. The algorithm can be improved by including the more directions and the algorithm requires some pruning strategies in eliminating the duplicate candidate patterns

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