Shape Similarity Search Using XML and Portal Technology

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Abstract

This paper proposed an out-sourcing system to improve the shape recognition in terms of the accuracy, speed, and also the accessibility of such tool over the Internet. The proposed system will be implemented using XML and Java technology. It is the first web-based system to provide such shape-searching tool using the XML and out-source portal concepts. Users can either browse the shape and its similarities on the web or users can use the drawing tool to draw and search the shape. The proposed system will use a three-layers method to extract the features information of the shape and represent this information in an XML format. Then this XML value will be passed to registered web portals to search for any similar diagram using XML query. Query results will be returned and all matched results will be re-examined and ranked, hence the proposed system will return the best matched results to the user. The web-based system provides easy access for Internet user regardless of the operating platform.

Keywords: Semantic image, XML, Shape, Out-source.

1 Introduction

In any shape recognition retrieval systems, organization of the information stored is very important for accurate and efficient searching. Today, shape similarity search is no longer a new topic. In fact, many shape-searching methods are constantly being improved over the last decade. However, researchers are still not able to propose a very accurate of shape recognition system due to many common problems arise in area of image processing. These common problems are still not solved in the colour histogram analysis [1] and the edge finding technique in image recognition. These obstacles cause the in-accuracy in today's shape-searching systems.

In addition, to provide a more sophisticated shape-searching system, many software vendors have been improving the accessibility of search system from a stand-alone system to a global access of World Wide Web (WWW) environment [2]. This arises another problem. In the WWW environment, there consist of many images and image databases. However, each image database belongs to different system and each system uses very different techniques (that needs vary features for the query) for shape recognition. To be able to communicate with each database, this proposed system will use the XML (standard language) for querying different image databases. XML is used to achieve such goal because of its capability to provide a standard data format through Document Type Definition (DTD) [3]. In other words, different system can extract the image information from the XML file and

perform search individually based on the extracted data regardless of the different system application. With XML approach, most system can perform a search based on the image information presented in the XML format. Thus, the proposed system will be able to perform searching on most image databases that supports XML querying and returns more accurate results to the users.

The proposed system will only focus on providing common shape searching on company logo, registered logo and road sign. Thus, the system is required to provide users with a drawing tool. User can draw any shapes and search for other existing similar shape from any database. The drawing tool is implemented using Java. It allows users to draw 2-D shapes such as rectangle, circle, bezier curves and polygon. In addition, it also provides functions for diagram translation, scaling, rotation, object colouring and the feature – grouping function. Users can perform grouping on a several shapes into one shape.

This paper will first provide an overview of layer models and the query method designed in the system. Then, this paper will further explore each layer structure in depth details: first layer, second layer and third layer. Then it will discuss the overall advantages of the proposed system. Finally, it will also examine the limitation of the current system design and possible work for the future improvement.

2 Three-Layers Method

2.1 First Layer – Raw Shapes Information

The first layer consists of the raw information in the drawing. Users can use the tool to draw shapes. Different shape has different set of shape information which is describe by its DTD. Shapes are treated as objects on the canvas. Polygon object is represented by a set of coordinates (point x, y). Then the edges can be drawn from this set of points. The order of each point is used to keep the vector of each edge in correct direction. Circle shape is represented in terms of its central point and radius. In addition, the drawing tool allows user adding text comment on each drawing, which later can be used in the text-based search in conjunction with the shape semantic search to achieve a better results.

The following shows an example of the shape raw information presented in XML format. The example is a polygon shape.

```
<graph layer=raw>
 <object type=polygon id=1>
  <point x=10 y=10/>
  <point x=20 y=10/>
  <point x=20 y=0/>
  <point x=20 y=30/>
  <point x=10 y=30/>
 </object>
 <description>
  This is a house
 </description>
</graph>
```

Figure 1, Layer 1 XML format

However, one of the problems with above XML format is the generation of invalid shapes. For example the diagram in figure 2a, the polygon has five points. To represent the graph using the raw information, the system will produce invalid shapes where the outline of the shape crosses another part of the same shape causing "negative space" (enclosed triangle of P3, A and B) [4].

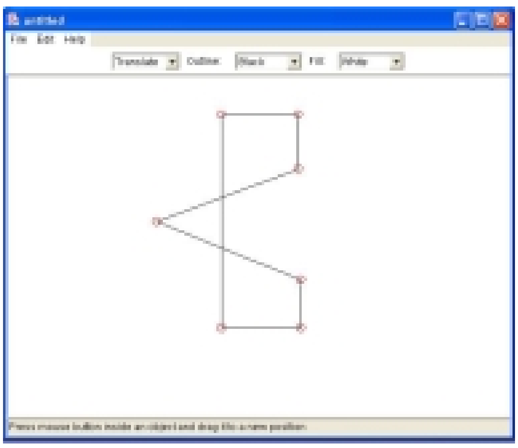


Figure 2, Invalid Shape

Although the raw information format may lead to generation of invalid shape, the raw shape layer is still very important because it presents the shape information in term of XML format that allows other system running on different shape-searching algorithms to use this information. In next section, we will discuss how the second layer overcomes this problem.

2.2 Second Layer – Group Recognised Shapes

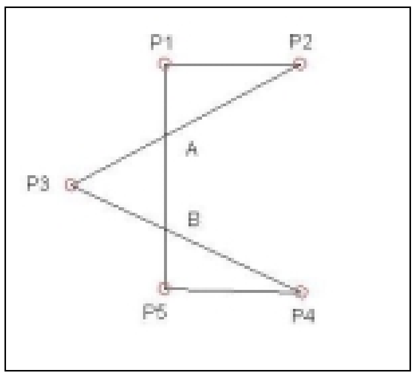
To improve the accuracy of shape searching in the other system, the proposed system introduced the grouping technique. The group recognition [5] is used to extract additional details between shapes in a graph. A group occurs when the boundaries of two or more shapes are in a close physical proximity, and they are possible actually under the touch, overlapping, or symmetric or fixed pattern family group. The following paragraph further explains the type of group recognition proposed in the system.

Two shapes are considered as touch relationship when there is only one intersection point of among each other. However, it is discovered that there are two kind of touch relationship existing in the system, which can be further divided into internal and external touch relationship. The internal touch relationship appears due to the problem of negative space (refer in fig.1), which one shape can further breaks down into smaller components. The external touch relationship occurs when individual shapes touching with each other. We discuss the touch relationship in details and follow by the grouping algorithm in the next section.

2.2.1 Internal Touch Relationship

When one shape itself has at least one edge intersects with another edge, this shape is considered to have an internal touch relationship. Then the whole shape breaks down into smaller shapes as components.

Consider the case in Fig. 3a, the edge (p1,p5) intersects the edge (p2,p3) and edge (p3,p4), and we assume the intersection points are called point A and point B respectively. The grouping algorithm will split the shape into three smaller shapes with the newly created point A and point B becoming the points of each shapes shown in fig. 3b. In this case, since the shape is internally touched with each other at points A and B only, the original shape features can be fully expressed by the children shapes. Thus the original shape will not be included in the layer two, but only with the components of the shapes. Furthermore, the number of shapes will always equal to the number of intersection points plus one.



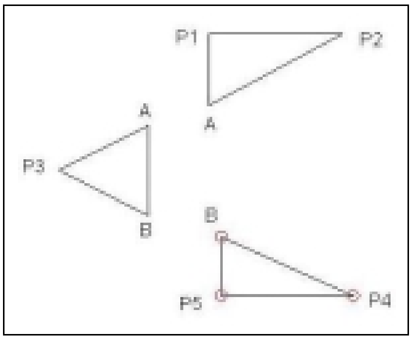


Figure 3, (a) Before the Group Algorithm of Internal Touch With Point (b) The result of Grouping Algorithm Deal with Internal Touch With Point

Next this paper will examine the internal touch behaviour as the edge internally touching each other. The same logic applies to the grouping algorithm, which breaks down the whole shape into components according to the internal intersection points. In addition, the external outline of the original shape actually represents a newly formed shape. In fact, any combinations of the internal shapes can represent meaningful outline. Hence, instead of putting only the internal components, it also includes all the combinations of each internal component. In fig. 4a, it shows the original shapes without grouping algorithm, and fig. 4b shows the results of the grouping algorithm. The result of the original shape will be re-ordered to produce new shapes without any internal crossing edges inside the object. Any shapes match the new combine shapes will be returned. This improves the shape-mapping and shape-searching capability.

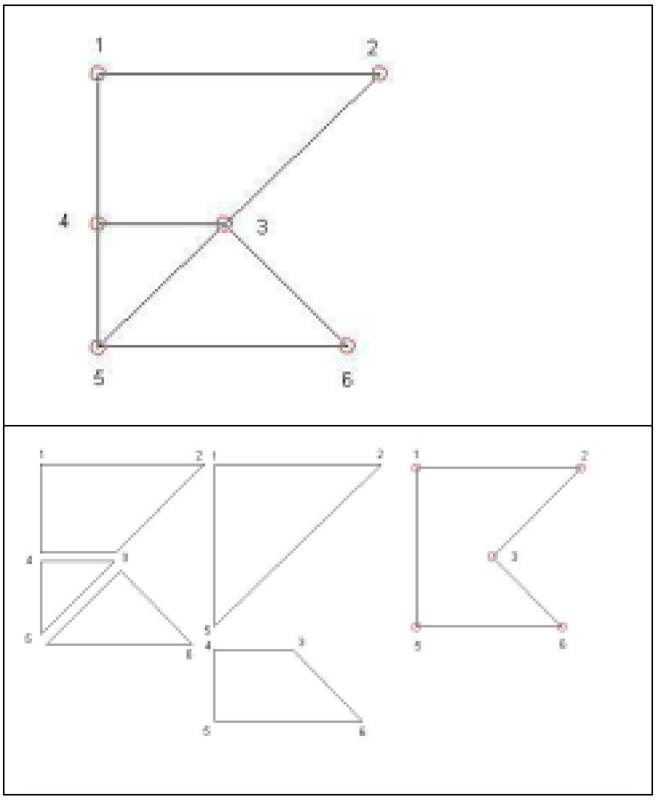


Figure 4 (a) Before the Group Algorithm of Internal Touch With Edge (b) The splitting result of the Grouping Algorithm with Edge Internal Touch

2.2.2 External Touch Relationship

Similar to the internal touch relationship, each individual shape can be intersected by a single point or the same edge. The grouping algorithm will vary depending on different type of intersection. Firstly, if the shapes are having external touch with each edge, the grouping algorithm will join all the related shapes together to form all the combinations of the shapes in this layer. Secondly, if two or more shapes intersect by a single point, we assume that the joined big shape is not significant to represent the main feature in the graph. Instead, the grouping algorithm will try to test the objects whether are in fixed ordered pattern, which contain the main feature of the graph. And we will discuss the symmetric or fixed ordered pattern family group in this paper later.

2.2.3 Overlapping Relationship

When there are two or more shapes completely or partially on top of another shape, we define it as overlapping relationship. Since all the combinations of the involved overlapping shapes may contain important features of the graph, the grouping algorithm will include all these shapes as the same as the edge touch relationship.

2.2.4 Symmetric or Fixed Ordered Pattern Family Group

As the human visual ability to judge the shape similarities is a very complicated process [4]. In fact, a group of shapes in close proximity can make up a human recognisable pattern, the significant pattern are such as the group in symmetry or in proper fixed ordered to form a rectangle or circle. [6]

Our proposed system are intending to recognise some of the simple pattern to be discovered from the graph, such as the boundary of the objects are form parallel outline or concentric arcs. For example, Fig. 5a shows two triangles are having the outer boundaries in parallel, which will bring up with a four corners rectangle. Additionally, Fig. 5b shows a set of triangles is put in properly order of a concentric arc.

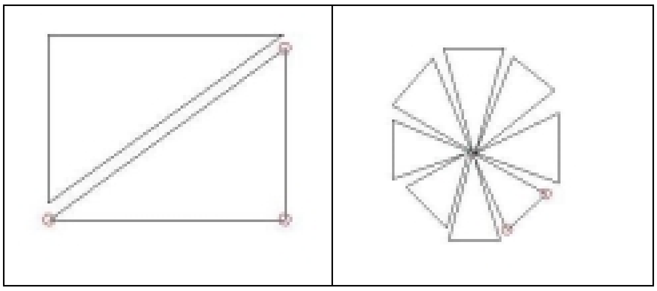


Figure 5, (a) Symmetrical Group Family (b) Fixed Ordered Pattern Family Group

2.3 Third Layer – Shapes Calculation

In the previous two layers, the shape representations are only represented in co-ordinates. Co-ordinates representation can provide accurate geometry of each shape in the graph. However, there are many algorithms that require the use of internal angles to compute the shape similarity. The internal angles representation is used to overcome the translation, rotation and scaling factor between shapes without involving any geometrical calculation. Thus, it helps to reduce the long computation time in the target server. Furthermore, the third layer can include the data regards the contour [7], minimum enclosing rectangles (MER) [8], colour and texture [9, 10] in each shape.

3 Conclusion

This paper proposed the shape similarity search system under the world-wide-web portal environment. The use of Java technology provides the features of platform-independent that allows user to access the query system on any platforms. In addition, using XML format provides the gateway for different systems to perform shape searching with various algorithms. The raw shape information provides the target server the ability to identify the plain details of each shape. The group-recognised information can optimise the shapes through the function of grouping and splitting. This greatly improves the features of shapes' touching, overlapping and grouping. These three layers representation is introduced to improve shape searching on the large scaled database systems in the Internet.

4 References

[1] Guojun Lu, Jason Philips (2001). Using Perceptually Weighted Histograms for Colour-based Image Retrieval. Monash University Australia.

[2] Guojun Lu, Ben Williams (1999). An Integrated WWW Image Retrieval System. *Fifth Australian World Wide Web Conference*

[3] N. Craswell, D. Hawking, A. Krumpholz, I. Mathieson, J. A. Thom, A.M. Vercoustre, P. Wilkins, M. Wu (2002). XML Document Retrieval with PADRE. *CSIRO Australia.*

[4] R. Smith, S. Warrington, F. Mill (1995). Shape Representation for Optimisation. *Genetic Algorithms in Engineering Systems: Innovations and Applications 12-14 September 1995, Conference Publication No. 414, IEEE, 1995.*

[5] J. P. Eakins, J. M. Boardman, and M. E. Graham (1998). Similarity Retrieval of Trademark Images. *April-June 1998.*

[6] Liu Wenyin, Wenjie Qian, Rong Xiao, Xiangyu Jin (2001). Smart Sketchpad – An On-line Graphics Recognition System. *2001 IEEE.*

[7] K. Y. Kupeev, H. J. Wolfson (1994). On Shape Similarity. *1994 IEEE* .

[8] A. D. Bimbo, P. Pala (1997). Visual Image Retrieval by Elastic Matching of User Sketches. *Feb 1997 IEEE*

[9] W. Niblack et al, (1993). QBIC Project: querying images by content, using colour, texture, and shape". *Proceedings of Conference on Storage and Retrieval for Image and Video Databases, 1-3 Feb. 1993, San Jose, California, US, SPIE Vol. 1908, pp.1908-1920.*

[10] S. K. Chan (1994). Content-based Image retrieval. *MSc thesis, National University of Singapore.*