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Content Based Image Retrieval for Trademark Registration: A Survey

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Abstract: Trade practices are becoming very important for products and services in the form of brands. For the global recognition, companies are competing for establishing the brand name in the market. Every company wants to register it's unique trademark for brad name. As a result trademark are playing very important role now a days. Trademark registration and its evaluation for distinctiveness is thus becoming very tedious job for registration offices. Millions of trademarks already registered and millions of applications filed for trademarks registration are aggravating the problem of issuing the trademark certificates.

Trademark Image Registration is one of the important application area of Content Based Image Retrieval (CBIR).Trademark image registration, where a new candidate mark is compared with existing marks to ensure that there is no risk of confusion, has long been recognized as a prime application area of CBIR.. This article covers the various algorithms designed for trademark image retrieval and their results.

Keywords: Trademark, Registration, Retrieval

I. INTRODUCTION

With the rapid expansion of the Internet, both consumers and manufacturers have gained easy access to the global market. Understanding the new challenges and providing solutions have become a key factor for the long-term success of this market. In addition, there is increased pressure to find quick solutions for the existing problems in the marketing world. Protecting the unique identity of products and services in the market is one of them. Ensuring the uniqueness of trademarks is essential in this regard.

With the rapid increase in the amount of registered trademark images around the world, trademark image retrieval (TIR) has emerged to ensure that new trademarks do not repeat any of the vast number of trademark images stored in the trademark registration system.[20] Therefore trademark retrieval system should be designed to ensure this uniqueness of trademark images.

Trademarks are considered as valuable intellectual properties. They play very important roles for successful business or companies. The logos or trademarks are also very significant objects in consumer world applications, because they are specially designed marks to identify and represent not only the quality of actual products but also the reputation of companies, products and services. With the continuously increasing number of registered trademarks, how to avoid designing a new trademark similar to an existing the registered trademarks or logos becomes an important problem. To treat this problem developing an automatic and efficient content based trademark retrieval system is imperative. [21]

The rest of the paper is organized as follows:

The standard parameters used for the experimental evaluation of the results by the Trademark image retrieval systems are discussed in section II. Section III describes the various methods used for Trademark image retrieval systems. Related work done in the field of Trademark image retrieval is provided in section IV. Section V gives the challenges in Trademark registration system. Section VI concludes the paper.

II. STANDARD PARAMETERS USED FOR EVALUATION OF TRADEMARK IMAGE RETRIEVAL SYSTEMS

The standard parameters which are used for the experimental evaluation of the results by the Trademark Image retrieval Systems are precision, recall, Normalised Precision, Normalised Recall.[4][16], last-place ranking[16]. Precision is defined as number of retrieved relevant images divided by total number of retrieved images and the recall is number of retrieved relevant images divided by total number of relevant images in the database. [20] The Standard Deviation serves as an error-bar, while the precision is the major evaluation method. The criterion precision delivers the ability for hunting the desired images in user's mind and the coverage represents the ability for finding the accumulated positive images in a query session. The formulas for

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calculation of these evaluation parameters can be given as following:

$$\text{Precision} = \frac{\text{Number of retrieved relevant images}}{\text{Total number of retrieved images}}$$

$$\text{Recall} = \frac{\text{Number of retrieved relevant image}}{\text{Total number of relevant images in the database}}$$

Normalized precision:

$$P_{norm} = 1 - \frac{\sum_{i=1}^{n} \log(Ri) - \sum_{i=1}^{n} \log(i)}{\log \frac{N!}{n!(N-n)!}}$$

normalized recall :

$$R_{norm} = \frac{\sum_{i=1}^{n} Ri - \sum_{i=1}^{n} i}{n(N-n)}$$

last-place ranking : $Ln = 1 - \frac{Rl - n}{N - n}$

where Ri is the rank at which relevant image i is actually retrieved, n is the total number of relevant image and N is the size of the whole image collection, *Rl* is the rank at which the last relevant trademark is found.

III. .METHODS FOR TRADEMARK IMAGE RETRIEVAL

Trademark Image Retrieval system uses the visual contents of an image such as color, texture and shape to represent and index the image.

In typical Trademark Retrieval Systems the visual contents of the images in the database are extracted and described by multi dimensional feature vectors. Theses feature vectors of the images in the database form the feature database.

Trademark Image Retrieval methods can be broadly categorized as:

1) Color based trademark image retrieval
2) Texture based trademark image retrieval
3) Shape based trademark image retrieval

Color is one of the most important features of the image that can make possible the recognition of images by humans predominantly. Usually colors are defined in three dimensional color spaces. These could either be Red, Green, and Blue (RGB),Hue, Saturation, and Value (HSV) ,or Hue, Saturation, and Brightness (HSB). In a Trademark Retrieval system, color information of images is represented by color histograms. A color histogram is a type of bar graph, where each bar represents a particular color in the color space used. The bars in a color histogram are referred to as bins and they represent the x-axis. The number of bins depends on the number of color frequency bands present in an image. The y-axis denotes the number of pixels there are in each bin.

Texture is the innate property of all surfaces that describes visual patterns and each having the properties of homogeneity. It contains important information about the structural arrangement of the surface like clouds, leaves, bricks, fabric, etc. For describing the texture, three principles are used- i.e. Statistical, Structural and Spectral techniques.

(i) Statistical techniques characterize textures using the statistical properties of the grey levels of the points/pixels comprising a surface image. Typically, these properties are computed using the grey level co occurrence matrix of the surface, or the wavelet transformation of the surface.

(ii) Structural techniques characterize textures as being composed of simple primitive structures called “texels” (or texture elements). These are arranged regularly on a surface according to some surface arrangement rules.

(iii) Spectral techniques are based on properties of the Fourier spectrum and describe global periodicity of the grey levels of a surface by identifying high-energy peaks in the Fourier spectrum.

In the Shape Based Method, all properties are collected that capture conspicuous geometric details in the image. Shape may be defined as the characteristic surface configuration of an object. In objects distinguishing, one also considers the outline of the surroundings of the object. It can be represented in two categories.(i) Boundary based - Boundary-based shape representation only uses the outer boundary of the shape. This is done by describing the considered region using its external characteristics; i.e. the pixels along the object boundary (ii) Region Based- Region-based shape representation uses the entire shape region by describing the considered region using its internal characteristics; i.e. the pixels contained in that region.

IV. RELATED WORK IN TRADEMARK IMAGE RETRIEVAL SYSTEMS

Trademarks play an important part in industry and commerce. They identify the producer of a given product or service, and convey information to consumers about that producer’s reputation for quality and reliability. A company’s trademarks are a crucial element of its industrial property, and infringement can have serious consequences. In many countries, trademarks must be formally registered with the national patent office to gain legal protection. Each patent office thus has to ensure that all new trademarks are sufficiently distinctive to avoid confusion with existing marks. To do this, a patent office needs to maintain details of all existing trademarks in its registry, in a form that can be readily searched to identify any potentially conflicting trademark already in the registry. As registries grow, this task becomes increasingly difficult.

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Related work in Trademark Registration Systems designed in the last fifteen years is given as following.

J.P. Eakins et.al. (1997) [3] have described the evaluation of ARTISAN, a system designed to provide automatic retrieval of abstract trademark images by shape feature. They have designed their system after analyzing each image to characterize key shape components, grouping image regions into families which potentially mirror human image perception, and then deriving characteristic indexing features from these families. This system allowed the user to select alternative sets of shape features and similarity matching paradigms. For evaluation of the system a pilot database of 268 images was built. This database contained 231 randomly selected trademark images, plus four series of test images provided by the Trade Mark Registry. However, the prototype system was not able to offer reliable enough performance to form the basis of an image retrieval system which could be put into routine use. In particular, its ability to retrieve marginally similar images needed considerable improvement.

S. Alwis et.al. (1998) [4] have discussed the first phase of an ongoing research project aimed at implementing a trademark retrieval system using an associative memory neural network. Their work was presentation of a new integrated methodology for employing multiple interpretations from different analytical levels of images for image retrieval. They have extracted local features as well as features of the closed figures of images. In deriving alternative interpretations of the images, a segment level gestalt grouping method was used. The preliminary experiments were conducted on the performance of the system using a smaller image database of 210 trademark images which was having nine groups of perceptually similar images. Their future work suggested was to conduct further evaluation experiments on the performance of the system, with a larger and more diversified image database including more noisy and gray-level images.

John P. Eakins et.al. (1998)[6] proposed a system Artisan which segments all trademark images into components and derives all features used for similarity matching from these component boundaries. The entire segmentation and feature extraction process was automatic, requiring no human intervention at any stage. This system accepts trademark images in a standard bitmap format, processes these images to extract salient components, creates descriptions of these image components, and extracts and stores retrieval features from these descriptions. This allows visual query formulation, automatic feature matching, and results display. Artisan was consisting of the following modules.1) Extraction of region boundaries from bitmap images and approximation by straight-line and circular-arc segments.2) Reprocessing of boundary representations to remove anomalies caused by noise in the original image3) Construction of envelopes for proximal boundary families 4). Extraction and storage of global shape features. The scope of improvement in the work was to provide alphanumeric character recognition facilities to let the system handle trademarks containing both text and images

Young sum kim et. al. (1999) [7] have proposed a new trademark retrieval system based on the content or shape of the trademark. They designed a online graphical user interface for world wide web (WWW) which allowed a user to give a query in form of sketch or visual image to search for similar trademark in the database. A shape representation scheme invariant to scale and rotation was developed to measure the similarity between two trademarks using the magnitude of Zernike moments as a feature set. Performance evaluation was carried out with a database of 3,000 trademarks. To verify the results of their proposed similar shaped trademark retrieval algorithm some trademarks were applied as query images to a trademark database of 3000 images. Total time required for query execution was 0.6 seconds. Still the work needed in this system was the enhancement of graphical user interface in order to include relevance feedback.

S. Ravela et. al. (1999) [8] designed a system for multi-modal retrieval of trademark images. Images were characterized and retrieved using associated text and visual appearance. Retrieval for similar trademarks was done by typing a text query. Subsequent searches were performed by visual appearance or using both appearance and text information. Textual information associated with trademarks was searched using the INQUERY search engine. Images were filtered with Gaussian derivatives and geometric features were computed from the filtered images. Curvature and phase geometric features were used. Two images were said to be similar if they have similar distributions of such features. Global similarity was deduced by comparing histograms of these features. The system's performance was tested on a database of 2000 trademark images. The curvature-phase method was tested using two databases. The first was a trademark database of 2048 images obtained from the US Patent and Trademark Office (PTO). The images obtained from the PTO were large, binary and were converted to gray-level and reduced for the experiments. The second database was a collection of 1561 assorted gray-level images. This database was having digitized images of cars, steam locomotives, diesel locomotives, apes, faces, people embedded in different backgrounds and a small number of other miscellaneous objects such as houses. Experiments were carried out with both databases. The time per retrieval was of the order of milli-seconds. The issues needed to focus with this system were to scale the database up to about 600000 images, to incorporate user feedback or preferences of retrieved images and to combine text retrieval and image retrieval in a principled manner.

David Yuk-Ming Chan et. al. (1999) [9] have discussed two major problems about the current approaches to

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trademark image retrieval based on shape features. First, researchers often focus on using a single feature, e.g., Fourier descriptors, invariant moments or Zernike moments, without combining them for possible better results. Second, even if they combine the shape features, the weighting factors assigned to the various shape features are often determined with an adhoc procedure. Hence, they have proposed to group different shape features together and suggested a technique to determine suitable weighting factors for different shape features in trademark image retrieval. They have used supervised learning method for finding the weighting factors in the dissimilarity function by integrating five shape features using a genetic algorithm (GA) They have tested their learned dissimilarity function using a database of 1360 monochromatic trademarks. The searching time for each query was less then 1 second. The scope of future research in this work was to use more shape features like Zernike moments or edge angles to further improve the accuracy of retrieval.

Paul W.H. Kwan et. al.(1999) [11] have proposed an automatic retrieval method that addresses the problem of finding similar trademark images from a database when compared with an input. This method was based on evaluating the compatibility of relative relations among extracted image contour segments between the input and the registered images using relaxation matching. Experiments were performed on a database of 300 randomly selected trademark images (each 141 X □ 123 pixels) obtained from the Japan Patent Office's website for performance evaluation. Ten of them were selected as test images. To verify the effectiveness of the method, several types of "noises" were introduced to create variants of the test images. These include rotating, shearing, pixel shifting, shrinking, and adding/removing joint points from the image. The retrieval method was implemented and tested on a Pentium II 400MHz PC with 64MB memory. The software was written in C, while the module for the multi-stage joint points extraction was borrowed from earlier research developed in C++.Without any initial training, the method retrieved the 10 most similar images for a test image in 2.40 seconds on the average.

Zyga, K. et. al. (2000) [12] proposed the use of a two-stage method applying a generalized regression neural network to provide the necessary flexibility to cope with the variations like scaling, rotation. They have presented a method of tiling which increases classification accuracy. The issues of scale and rotation were discussed in relation to the network's interpolation capability, as well as several other points effecting overall accuracy.

This method was capable of interpolating between data sets upon which it was trained to predict the probability that a target logo was present in a test page, even when that logo was distorted in scale or rotation. The likelihood of detecting the logo was increased by dividing the target logo into tiles for training, and searching the test page in tile-sized regions. This work was extendible on an extensive and comprehensive test set.

G. Ciocca et. al. (2001)[13] have addressed the problem of how to efficiently and electively retrieve images similar to a query from a trademark database purely on the basis of low-level feature analysis. They have investigated the hypothesis that the low-level image features used to index the trademark images can be correlated with image contents by applying a relevance feedback mechanism. Relevance feedback was used to evaluate the feature distributions of the images the user has judged relevant, or not relevant. Then the similarity measure and query in order to better represent the user's particular information needs were dynamically updated. Experimental results were reported on a database of 1100 trademarks.

In the retrieval process when a query was submitted, the system reranked the database images by decreasing similarity with respect to the query, and then returns to the user, displaying the 24 most similar images. In subsequent iterations the user was able to mark some of these retrieved images as relevant, or not relevant. A new query vector was computed, taking into account the features of the newly indicated relevant images, and the overall evaluation of the dissimilarity function was updated, on the basis of the features of both relevant and non-relevant images. A new query was then submitted, starting a new iteration of retrieval. There was no limit to the number of images that can be selected as relevant or non-relevant, nor to the number of relevance feedback iterations. Each retrieval iteration had taken about 5 seconds. To measure the performance obtained by applying the relevance feedback mechanism a measure called effectiveness (efficiency of retrieval, or fill ratio), was used in this method. The future demand in this work was the integration of text-based image annotation to further increase retrieval effectiveness

Wing Ho Leung et. al. (2002) [14] have proposed a method to retrieve trademarks using query by sketches. The trademark images were first filtered to remove noise. Then each filtered image was segmented into regions based on pixel connectivity. Stroke tracing was performed to extract the sketch of the trademark. In this system the user was able to provide a query sketch that with those extracted sketches from the database trademark images in order to retrieve similar trademarks. The performance evaluation was done using a database of 2000 trademarks. The trademarks were classified into different groups based on similarity. To analyze the performance of their system for deciding whether an edge or skeleton should be extracted for each region. They first picked 154 trademarks out of 43 classes as queries and then examined the rankings of the trademarks from the same classes. The same queries were used under 3 different conditions for the sketch extraction: 1) when thinning alone was applied to each region to extract the

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skeleton strokes 2) when edge extraction alone was applied to extract the contour strokes 3) when a classifier was used to decide whether thinning or edge extraction should be performed for each region so that a sketch may consist of both the skeleton strokes and the contour strokes. The scope of future work in this method was to add more functions to the trademark retrieval system which will allow user to provide a more complex query.

Rajashekhar et. al. (2004)[15] have proposed a geometric approach to capture the shape and spatial relation attributes in binary images to build an efficient logo retrieval system. They extracted the shape feature by computing the morphological pattern spectrum (MPS) for various structuring elements. The spatial relation among the disjoint components in the logo image was described by defining a simple and computationally inexpensive spatial relation graph (SRG). The SRG was obtained by joining the centroids of the two largest components with the centroids of the rest of the components. The similarity measure was defined with respect to similarities in both shape and spatial relationship (MPS and SRG) for retrieval . A very good precision rate was obtained due to the joint shape and spatial relation features. Relevance feedback mechanism was used to obtain the weights for various components in the similarity measure. Future investigation needed was the logo retrieval problem in gray scale and colored logo databases.

Hui Jiang et. al. (2005)[16] have described a novel approach on the adaptive selection of visual features for trademark retrieval. They have considered five kinds of visual saliencies: symmetry, continuity, proximity, parallelism and closure property. The first saliency is based on Zernike moments, while the others are modeled by geometric elements extracted illusively as a whole from a trademark. After a query trademark was given, the system determined the features appropriate for retrieval by investigating its visual saliencies. To measure the similarity of geometric elements, they have proposed a maximum weighted bipartite graph (WBG) matching algorithm under transformation sets which was found to be both effective and efficient for retrieval. For testing they have used benchmark trademark database in MPEG-7 dataset for performance evaluation. They selected 50 trademarks from the database as query samples. The trademarks similar to these query samples were preselected manually. The numbers of manually preselected relevant trademarks for different query samples were ranging from 10 to about 50. The evaluation was based on the normalized recall precision measures, where three measures of retrieval performance used were normalized recall , normalized precision and last-place ranking Future work suggested was the incorporation of other feature extraction methods such as corner and texture detectors for more reliable interpretation of Gestalt principles by geometric features.

A.Cerri, M. et. al. (2005)[17] have suggested an approach to trademark retrieval, based on Size Functions, which are geometrical topological descriptors, conceived for formalizing qualitative aspects of shapes. A new, effective system for content–based trademark retrieval was proposed which involves Size Functions. Three different classes of shape descriptors were combined, for a total amount of 25 measuring functions. In order to assess the ability of the system in retrieving similar trademarks, a database of 1182 trademark binary images was used provided by the UK Patent Office. The results proved that there is promising effectiveness in retrieval on a database of trademark images using this method. Further investigation needed was the introduction of new measuring functions, in order to have a more complete description of shapes.

Euripides G.M. Petrakis et.al. (2006)[18] have extended the framework of image retrieval with relevance feedback on the Web by incorporating text and image content into the search and feedback process. Some of the most powerful relevance feedback methods were implemented and tested on a fully automated Web retrieval system with more than 250,000 logo and trademark images. They have described Naïve search, Accumulation, Integration and Differentiation, Term re-weighting and Falcon method in detail. Also compared their results. Their evaluation demonstrated that term re-weighting based on text and image content was the most effective approach. For evaluations, 20 queries were created on topics related to Linux and software. The results were obtained after 2 feedback iterations. The evaluation was based on human relevance judgments by 4 independent referees. Each referee evaluated a subset of 5 queries for all methods. Each query retrieved the best 30 answers. For each method the average precision and recall over 20 queries was computed. The scope of extension in the work was use of term re-weighting methods to work on image meta-data (e.g., user's log information) and combination of relevance feedback methods with link-analysis methods for assigning higher ranking to good quality images while preserving user's preferences.

Chia Hung Wei et. al. (2009)[20] proposed a trademark image retrieval system in their work to deal with the vast number of trademark images in the trademark registration system. The proposed approach starts with the extraction of edges using the canny edge detector, performed a shape normalization procedure, and then extracted the global and local features. The global features capture the gross essence of the shapes while the local features describe the interior details of the trademarks. A two-component feature matching strategy was used to measure the similarity between the query and database images. It was seen that the proposed method gives the better results with high Precision and recall values with 0.90 and 0.42 respectively. The drawback of this system was the proposed scheme was not sufficiently capable of relating the trademarks with similar

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semantic meanings but significantly different low-level features. In order to solve this problem the future scope in the work was incorporating relevance feedback into the proposed system.

Tatsuaki Iwanaga et. al.(2011) [21] have suggested a modified composite histogram approach for trademark image ranking and retrieval. The histogram represents the composition of distance and angle pair-wise histogram as a feature vector of trademark shape for retrieving similar registered trademarks. To do the similar trademark retrieval a similarity measure was provided based on the rank of the feature distance. Experiments were conducted on registered trademark databases. To demonstrate the performance of the proposed scheme, two kinds of experiments were performed. In the basic experiment, the query trademarks were selected from database. A sample query image was selected from one of the image category in the database. When the system run and the result images were returned, the user counted how many images were returned and how many of the returned images were similar to the query image. The evaluation measures used were Precision and recall.

Marçal Rusiñol et.al.(2011) [22]suggested an efficient queried-by-example retrieval system which was able to retrieve trademark images by similarity from patent and trademark offices' digital libraries. Logo images were described by both their semantic content, by means of the Vienna codes, and their visual contents, by using shape and color as visual cues. The trademark descriptors were indexed by a locality-sensitive hashing data structure aiming to perform approximate k-NN search in high dimensional spaces in sub-linear time. The resulting ranked lists were combined by using a weighted Condorcet method and a relevance feedback was used to iteratively revise the query and refine the obtained results. To conduct the experimental results, a collection of real trademark images downloaded from the Spanish Intellectual Property Office with their associated Vienna codes was used. This dataset composed of 30000 trademark images organized within 1350 different Vienna categories. In average, each trademark image was associated 2.17 Vienna codes. Another subset of 3000 trademark images was used as training set to run the k-means clustering algorithm to build both the shape and color descriptors. The mean average precision and recall were found to be 0.98 and 0.96 respectively.

Zhenhai Wang et. al. (2012)[23] have proposed a trademark retrieval algorithm combining the image global features and local features. They have extracted Zernike moments (ZMs) of the retrieved image and sort them according to similarity. Candidate images were formed. The scale invariant feature transform (SIFT) features were used for matching the query image accurately with candidate images. Experimental results shown that this method not only keeps high precision- recall of SIFT features and is superior than the method based on the single Zernike moments feature, but also improves effective retrieval speed compared to the single SIFT features. For evaluation, a standard image set "MPEG7 CE Shape-2 Part-B" was used as image database. This image database was containing 3621 shapes of mainly trademarks. It was organized as 4 sets for testing different types of robustness. They were for test of scale, rotation, perspective transform invariance.

V. CHALLENGES IN TRADEMARK REGISTRATION SYSTEMS

The previously designed systems for trade mark registration were focusing on global shape features or interior structure but with high computation complexity.

The major challenges in designing trademark registration system are (1) Interactive search, emergent semantics, or relevance feedback systems; and (2) Evaluation with emphasis on representative test sets and usage patterns. (3) Reducing the computation complexity and thus reducing the processing time.(4) To design a trademark registration system which will be robust against noise, blur, rotation, translation, scaling and stretching.

VI. CONCLUSION

Trademark image retrieval is an important application area of CBIR. In this paper various Trademark image retrieval, their dataset used and their results are discussed in detail. From the results of the various methods discussed, it can be concluded that to improve the retrieval performance of the Trademark image retrieval systems, researchers must have to design the techniques to increase the values of the standard evaluation parameters like precision, recall. The Relevance Feedback technique can be incorporated in CBIR system for Trademark image retrieval to obtain the higher values of the standard evaluation parameters used for evaluation of the CBIR system. Research can be done to improve the retrieval performance of the trademark registration system. Trademark registration system can be designed to meet the challenges like interactive search, emergent semantics, reducing the computation complexity and further processing time.

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