Logo Recognition using SURF Features and kNN Search Tree

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*equal contribution

Abstract— In the contest of brand value and identity, the logo represents the company and gives strong impact on its reputation. So it is quite challenging to recognize a logo to maintain its standard level while designing. In this work, only SURF features are considered for logo recognition on gray scale image data. kNN search tree algorithm is used to get the nearest neighbors distance of SURF features between two different images. The percentage of matching features is calculated to recognize logo successfully. This percentage matching measurement of different data sets leads to recognize the logo of any organization undoubtedly when reference image dataset contains that logo.

Index Terms Feature Extraction, kNN Search Tree, Logo Recognition, Nearest Neighbor, SURF, SURF Features

1 Introduction

Logos Logos are a critical aspect of business marketing. As the company's major graphical representation, a logo anchors a company's brand and becomes the single most visible manifestation of the company within the target market. For this reason, a well-designed logo is an essential part of any company's overall marketing strategy. There are millions of companies worldwide with millions of logos. The companies usually spend huge time and money to make their logos unique than others to make their own brand value. So it becomes quite challenging for the logo designers to fulfill their clients' demand and to maintain the standard of the logo. In order to define the standards of designing logo, features of a logo are big issue and in this purpose logo recognition is a big factor.

Corporate logos are intended to be the "face" of a company. They are graphical displays of a company's unique identity, and through colors and fonts and images they provide essential information about a company that allows customers to identify with the company's core brand. Logos are also a shorthand way of referring to the company in advertising and marketing materials; they also provide an anchor point for the various fonts, colors and design choices in all other business marketing materials. The objective of the thesis is to visualize the related similar components that already belonged in the existing logos which will be helpful for the designer to make an identical, unique logo for an organization. It will be also helpful for the clients of the logo to get proper ideas that if the logo is designed as a master piece or it is copied by any other logos.

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Logo recognition is extent to which a consumer can correctly identify a particular product or service just by viewing the product or service's logo, tag line, packaging or advertising campaign.

Some researchers have worked for recognizing logo by using algebraic and differential invariants [1], positive and negative shape feature [2], Zernike moment [3], string-matching technique [4–6], template matching [7], combined measure [8] and interactive feedback [9]. Using techniques already used for face detection and recognition and fingerprint detection so we can design and develop a method for identifying Logos of different companies and organizations.

Previously, SIFT features are used to recognize a vehicle logo [13] [14].In this paper, a logo recognition method is introduced by using SURF features. SURF: "Speeded Up Robust Features" is a performing scale- and rotation-invariant interest point detector and descriptor.

SURF leads to a combination of novel detection, description, and matching steps. It is shown in experimental results [16] on a standard evaluation set and on imagery obtained in the context of a real-life object recognition application. SURF's strong performance is shown in both. For that reason, SURF features are used to recognize a logo.

In this paper, kNN search tree is used for searching the nearest neighbors of the matched features to recognize a logo. It is used earlier in face recognition [17]. kNN is a simple algorithm that stores all available cases and classifies new cases based on a similarity measure (e.g., distance functions). kNN is used in statistical estimation and pattern recognition [18].

2. SURF Features and KNN Search Tree

In our proposed logo recognition method, SURF features are considered. To know about SURF features, it is essential to understand what a feature is, how features are classified and which features are considered to be SURF features. After getting the concepts of the SURF features how the features can be detected is also an important fact to understand this logo rec-

International Journal of Scientific & Engineering Research Volume 6, Issue ʃN0̇ɯ2Ì×ÛÌÔÉÌÙ-2015
ISSN 2229-5518

ognition method. kNN search tree is used in this method to find the distance between two nearest neighbors of the features.

2.1 SURF (Speeded Up Robust Features)

SURF is a performing scale and rotation-invariant interest point detector and descriptor which outperforms repeatability, distinctiveness and robustness, yet can be computed and compared much faster.

It is achieved by-

- relying on integral images for image convolutions
- building on the strength of the leading existing detectors and descriptors (using a Hessian matrix-based measure for the detector and a distribution based detector
- simplifying this methods to the essential

2.2 Procedure of SURF Features Detection

To detect SURF features,the detectSURFFeatures function is used which implements the Speeded-Up Robust Features (SURF) algorithm to find blob features.

2.3 kNN (k-nearest neighbor) search using a kd-tree

A KDTreeSearcher (KDTreeSearcher model objects store results of a nearest neighbors search using the Kd-tree algorithm) object represents kNN (k-nearest neighbor) search using a kd-tree. Information are stored by search objects about the data used, the distance metric and parameters, and the maximal number of data points in each leaf node. This object cannot be created for sparse input data. The search performance for this object, compared with the ExhaustiveSearcher object, tends to be better for smaller dimensions (10 or fewer) and worse for larger dimensions.

2.4 Limitation of kNN search function

For all of the features in the image, two nearest neighbors in the dataset are found and computed the distance to each neighbor by kNNSearch function. The nearest neighbors are returned by kNNSearch function, even if none of the features are a close match [11].

3 PROPOSED METHOD

In this work, an image collection of logos is taken as dataset and feature points are detected from the image of the logo and they are displayed. All of the features of the image of the dataset are combined into a feature dataset by initializing a KDTreeSearcherObject. An image is load that contains the object to be identified and the object is selected by specifying a bounding box that encloses the object is considered as a query image. Features points in query image are detected and displayed. For all of the features in the query image, two nearest neighbors are found in the dataset and the distance is computed to each neighbor. The kNNSearch function is used to return the nearest neighbors even if none of the features are a close match. A ratio of the two closest neighbor distances is done to throw away the bad matches. So to understand total procedure, it is divided into two subparts which are described in detail step by step in Proposed Algorithm section and later on it has been graphically shown by Flow Chart.

Step1: Preparing the collection of images to search
The set of reference images is read which containing a different logo. Multiple views of the same object could be included in this collection in order to capture hidden or occluded areas.

Step 2: Detection of the feature points in image collection
Feature points in first image are detected and displayed. Two purposes are served by use of local features. By this the search process is made more robust to changes in scale and orientation which reduces the amount of data that needs to be stored and analyzed.

Step 3: Building feature dataset
All of the features from each image are combined into a matrix. This matrix is used to initialize a KDTreeSearcher object from the Statistics Toolbox™. This object allows for fast searching for nearest neighbors of high-dimensional data. In this case, a nearest neighbor of a SURF descriptor may be another view of the same point.

Step 4: Choosing Query Image
An image that contains the logo is loaded to be identified and the logo is selected by specifying a bounding box that encloses the object.

Step 5: Detection of feature points in query image
Features points in query image are detected and displayed.

Step 6: Searching nearest neighbors for the query image
For all of the features in the query image, two nearest neighbors are found in the dataset and the distance to each neighbor is computed. The nearest neighbors are returned by the kNNSearch function, even if none of the features are a close match. To throw away those bad matches, a ratio of the two closest neighbor distances is used. This technique is described in more detail in [11].Using histc, the number of features is counted that matched from each image. An index interval is constituted by each pair of indices, in the index intervals below, that corresponds to an image. The strength is visualized with which each image in the collection matches the query image. Size of each image below is proportional to the number of matching features. It is observed that the image containing the desk is still considered a strong match. It is an outlier that is eliminated in the next step.

Step 7: Eliminate Outliers Using Distance Tests
Many of the SURF features detected in the query image have no matching feature in the dataset. To prevent false matches, it is important to remove those nearest neighbor matches that are far from their query feature. The poorly matched features can be detected by comparing the distances of the first and second nearest neighbor. If the distances are similar, as calculated by their ratio, the match is rejected [1]. Additionally, ignore matches that are far apart [12].

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ISSN 2229-5518

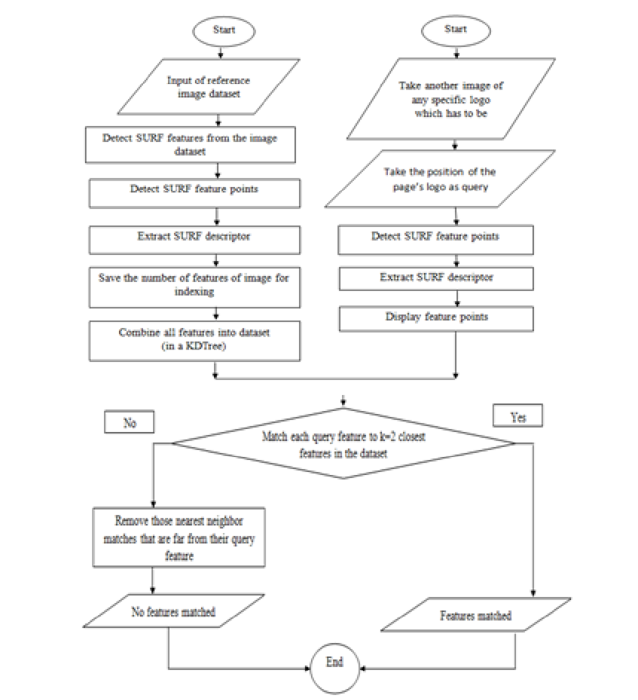


Fig. 1. shows the flow chart of our proposed method description.

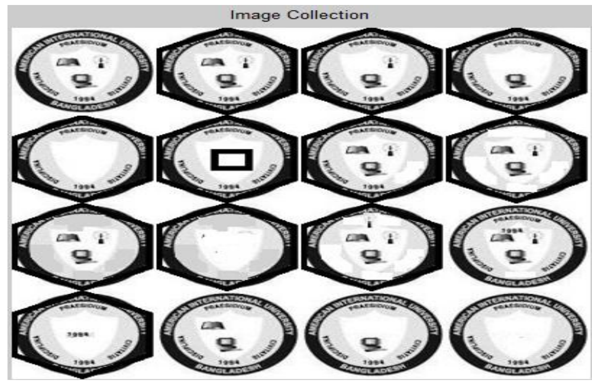
4 EXPERIMENTAL RESULTS AND EVALUATION

To implement this work, Matlab is used. Some of the results are shown here. Various dataset are used for this experiment. From these only one dataset is shown to show how this experiment is worked really.

This implementation is begun with a collection of logo images of AIUB institute where the original institute's logo is present and left of them are the edited version of the original copy. At the end of this experiment, original AIUB logo is recognized successfully. In the edited versions of the original copy, some components are missing or/and new components are added. It is shown in Table 1.

From Table 1, the original logo is placed on the left most position of first row. It is noticeable that left other images are edited copies of the original logo containing extra components which are not present in the original image. In the edited copies of the original image one or more components are missing or one or more than one component is missing existing in original copy.

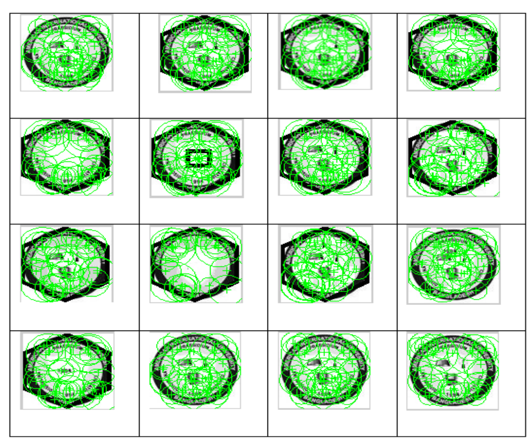
TABLE 1
REFERENCE IMAGE DATASET I



Same logo modified in Table 1 by:

- ✓ Elimination of the components (one, two or more) of the original copy of the reference image.
- ✓ Addition of the hexagon shape outside of the round border of the logo, a square shape inside the logo and copying component of logo and insert inside the logo.
- ✓ Elimination of the components and addition of the hexagon shape outside of the round border of the logo at the same logo.
- ✓ After taking reference image dataset, strongest SURF feature points of each of the image collection are detected by proposed method and shown in Table 2.

TABLE 2
SURF FEATURE DETECTION OF THE REFERENCE IMAGES



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ISSN 2229-5518

All of the features for each image of Table 2 are combined into a matrix. This matrix is used to initialize a KDTreeSearcher object from the Statistics Toolbox™ to build a SURF feature dataset. This object allows for fast searching for nearest neighbors of high-dimensional data.

Afterwards, an image is taken where the original image of the logo is situated. The position is taken where the image contains the logo and it is defined by a rectangular box which is shown in Fig 2.

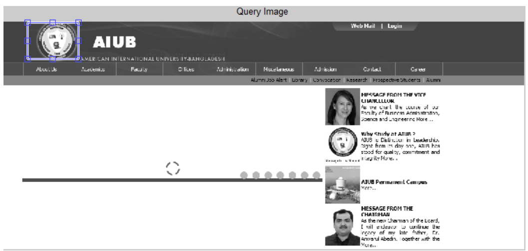


Fig. 2. AIUB webpage containing AIUB logo at the left corner of the image defined by a square

Fig 3 is considered as a query image. From the query image, strongest SURF feature points are detected by same procedure as it is done for reference image and shown in Fig 3.

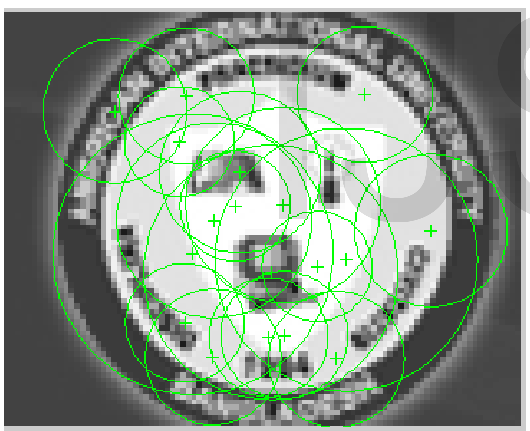


Fig. 3. AIUB webpage containing AIUB logo at the left corner of the image defined by a square

The strongest SURF feature points from the query image are detected. The kNN search function is used to find two nearest neighbors in the dataset for all of the features in the query image. The distance to each neighbor is computed.

Using Matlab function histc (stands for Histogram Count); the number of features is counted that matched from each image of Table 2. Each pair of indices, in the index intervals below, constitutes an index interval that corresponds to an image and shown in Fig 4.

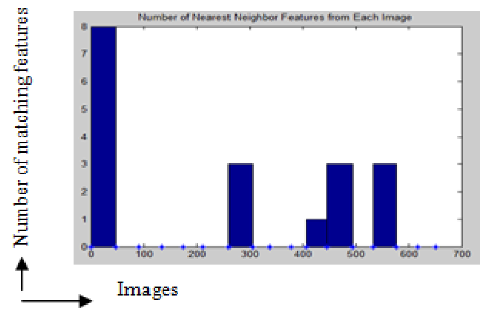


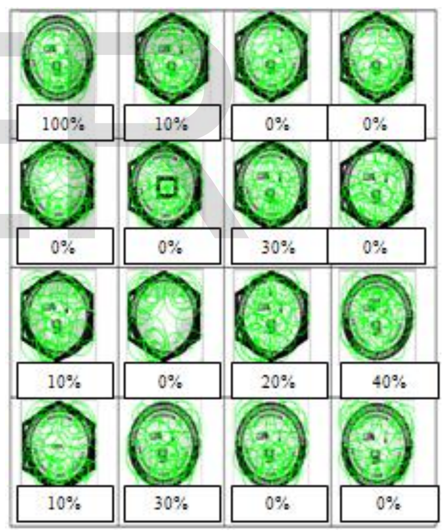
Fig. 4. The number of features is counted that matched from

The strength is visualized by the percentage of each image in the collection matches the query image in Table 3.

If the features of the query image are present or how much portions are similar to the stored feature dataset from Table 2 can be understood from Fig 4 and Table 3.

TABLE 3

PERCENTAGE OF MATCHING FEATURES OF THE QUERY IMAGE TO THE REFERENCE IMAGE DATASET



The kNNSearch function is used to return the nearest neighbors by using k=2, even if none of the features are a close match.

Nearest neighbor distance ratio means:

1) Calculation of the distances from the descriptor in one image to the 1st and 2nd nearest neighbors in the second image.

d1 = d (desc1_img1, descA_img2); d2 = d (desc1_img1, descB_img2).

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ISSN 2229-5518

2) Calculation of distance ratio R = d1/d2. If R < 0.6, then match is probably good. It is done because "nearest" descriptor will be got in the second image, no matter how bad it is – it is checked with ratio.

Ratios are shown by multiply with 100 to avoid the fractional section.

To throw away those bad matches, a ratio of the two closest neighbor distances is used. The poorly matched features are detected by comparing the distances of the first and second nearest neighbor. If the distances are similar, as calculated by their ratio, the match is rejected. Additionally, matched features that are far apart are ignored.

The final output if the query image is already in the image collection in Table 1 is cleared in Fig 5 by showing the largest icon for the matched features and thus how the logo is recognized.

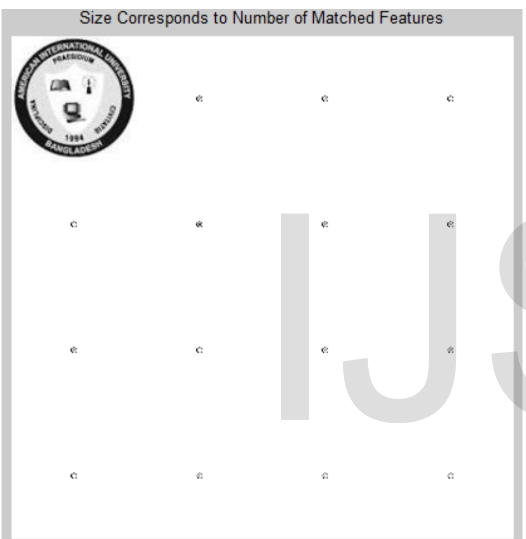

Fig. 5. The matched nearest neighbors that are far from their query feature are removed

From this result, it is shown that the first logo image of reference image dataset from Table 1 is recognized as AIUB logo.

This implemented proposed technique is applied to a different example for evaluation of our performances which follows all the same procedures as done previously.

Fig. 6. Collection of reference images dataset II

Fig. 7. Detection of feature points from Fig 6

To test the result of this proposed technique, logos of Beats industry and Baisakhi TV are considered as their appearances are much similar.

Comparison is done by getting the similar features. If any logo is matched to other logos, some design aspects can be modified to get the brand value, quality to establish a grade in this variety of logo design.

In Fig 6 two logos (Beats, Baisakhi TV) are considered as reference image collection. Features of the reference images are detected. Feature points of the reference image collection are shown in Fig 7.

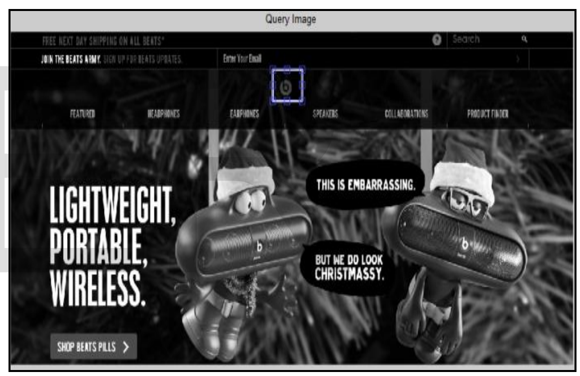

Fig. 8. Choose query image from Beats's website

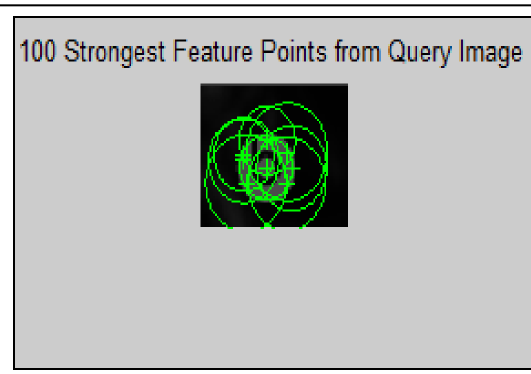

Fig. 9. Detection of feature points from query image

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ISSN 2229-5518

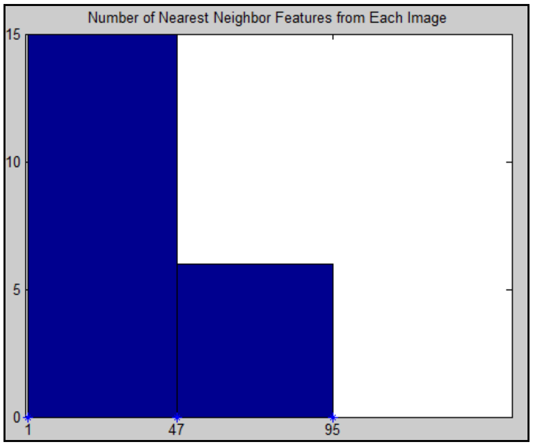

Fig. 10. Matched numbers of features

Logo of Beats industry is taken from Beats's website to which the image collection is compared. From the website Beats's logo is selected by specifying a bounding box that encloses the logo in Fig 8 and considered it as query image. Features points in query image are detected and displayed in Fig 9.Using histc, the number of features that matched from each image is counted in Fig 10. An indexintervalis constituted by each pair of indices, in the index intervals in Fig 11, constitutes that corresponds to an image.

Fig. 12. Logo completely matched to the stored features after eliminating false matches

The strength with which each image in the collection matches the query image is visualized in Fig 11. The percentage of the matching features is visualized in Fig 11.The poorly matched features are detected by comparing the distances of the first and second nearest neighbor and that are removed in Fig 12.
From this example, it is shown that the first logo of the reference image collection in Fig 6 is completely matched to the query image. So it is established that the first logo of reference image collection is Beats's logo. So logo recognition is done.
Again if the percentage of the matching features is noticed, the second logo has about 50% similar features that a Beats's logo owns. So the design of the logo can be modified to get the identical view.

5 DISCUSSION

In this work, only gray scale images are considered. In our experiment reference image dataset contains few number of logo images. The percentage of matching features can be improved in a large reference image.

In the implementation of this logo recognition technique, logos are compared to measure its level of standardization. It is measured by the amount of the similarities among the set of the logos, about the percentage of matching of a specific logo with other set of logos successfully. Moreover, logo of any organization can be recognized undoubtedly if we have large reference image dataset.

More training example would lead to better recognition result. Here, proposed method is considered only SURF features; Later on different features can be included. In this paper, kNN searching algorithm is used to find the distance, different algorithm can be applied and comparison of different algorithm can be done in further work.

6 CONCLUSION

In this work a new technique of logo recognition is provided. Our technique can understand the similarities among the set of logos clearly. Only the SURF features are considered in this work which gives a clear concept that how can a logo be recognized. It measures the matching percentage of a specific logo based on these SURF features with other set of logos successfully. It will be able to assist the designers to create a new concept for logo designing by this technique. It also can be helpful for logo evaluation and maintaining the standard level of logo designing.

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International Journal of Scientific & Engineering Research Volume 6, Issue ꞁ2Ì×ûÌÔÉÌÛ-2015
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