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Back Propagation SIFT using Fuzzy Logic

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Abstract: ***Image retrieval basically deals with study of searching and browsing the digital images with large database To perform this task CBIR is widely being used. They are also known as Query by image content. But CBIR suffers from semantic gap problem. The aim of our work is to overcome this semantic gap problem by using backpropagation or relevance feedback method inspired by Fuzzzy Logic.SIFT is used for feature extraction process as it is invariant to uniform scaling, illumination and orientation changes.The proposed approach is named as backpropagation SIFT, as this approach asks the user to give some feedbacks on the results returned in the previous query round and constructs relevancy matrix. Then the Fuzzy Interface system refines its retrieval procedure based on the user's feedback. The proposed method is tested on database of Corel images which shows a significant improvement in average precision and recall rate.***

Keywords: Query by image content; Content based image retrieval; Scale invariant feature transform; Difference of Gaussian; Maximally stable extremal regions

I. INTRODUCTION

With the explosive enhancement in multimedia technology large amount of dataset is available on internet.So the process of retrieving required image from this huge dataset is main task in computer vision. There are basically two methods are used for searching and retrieving an image.First is text based image retrieval system that is based on textual information provided by humans manually. Human perception for the image is different and they can represent images according to content or by the background information. But representation of an image with text needs large effort and time consuming. Because of this new image retrieval method is emerged named as content based image retrieval. To overcome the limitations of the text-based approach, the second approach known as Content-Based Image Retrieval (CBIR) techniques are used. In a CBIR system, images are automatically indexed by visualizing their valued features such as color, texture, and shape. Visual feature can be categorized in two parts local features and global features. Initially CBIR algorithm uses the global feature to describe the image content by color [1, 2], texture [3], shape and structure [4]. Due to the compact representation and efficient implementation global features are used to identify the duplicity of images in large database but it is less efficient when background is clutter.

With introduction of SIFT feature local feature of image are now used for image representation [5]. Usually in local feature extraction two main steps are there, i.e. detection of interest point and local region description. Popular interest point detectors are Difference of Gaussian [5], MSER [6], Hessian affine detector [7], Harris-Hessian detector [8].

After interest point detection single descriptor or multiple descriptors [9] are used to describe the visual appearance of the local region centered at the interest point. Generally a descriptor should be invariant to rotation change and robust to affine distortion, addition of noise, and illumination changes, etc. Also with this it should also be distinctive so it can correctly compare a single feature with high probability against a large no. of features from many images. The most popular choice with the above merits is SIFT feature [5].

SIFT features that are extracted in regions of weak internal structure leads to poor distinctiveness and may degrade performance of image retrieval system. To identify and eliminate those features, Dong et al. defined a SIFT descriptor with 128 samples of a discrete random variable ranging from 0 to 255 and make use of the entropy as a measurement metric to filter SIFT features with low entropy [10].

II. LITERATURE SURVEY

An improved CBIR system based on CNN Alax Net Architecture for feature extraction was proposed that extracts 4096 features per image. They provide improved accuracy and precision on different datasets i.e 95% on corel, 97% on Caltech and 88% on Li-photography dataset [11]. CBIR using Fuzzy Color Histogram(FCH) and Moment Invariant(MI) was also proposed that uses the k means clustering algorithm and accuracy of 92.5 5 for single object images and 90% for multi object image are achieved [12]. A fusion framework by combining the Color Difference Histogram and Microstructure Descriptor was used to create a similarity matrix. A hypergraph with this similarity was constructed and combined with relevance feed back to improve retrieval performance [13]. Along with this a soft hypergraph was combined with adjacent structure (WAS) to improve CBIR [14] .Also the Offline Signature Recognition was proposed based on SIFT and SURF algorithm[15]. A circular relevance feedback method was also

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proposed to enhance the behavior of remote sensing image retrieval. In this an active learning algorithm was adopted to select samples from previous results [16]. A Discriminative semantic subspace analysis (DSSA) method was also introduced which can directly learn a semantic subspace from similar and dissimilar pair wise constraints . Compared with the popular distance metric analysis approaches, this method can also learn a distance metric but perform more effectively when dealing with high-dimensional images [17]. An effective sketch-based image retrieval approach with re-ranking and relevance feedback schemes also makes full use of the semantics in query sketches and the top ranked images of the initial results. The authors also apply relevance feedback to find more relevant images for the input query sketch. The combination of the two schemes results in the improved performance of sketch-based image retrieval.

Main drawback of existing CBIR system is semantic gap and intention gap problem [18] Intention gap is the disability of the user to express the visual information of image while semantic gap is associated with low level feature of the image. To remove the semantic gap problem we have used user relevance feedback provided by the user. To increase the precision fuzzy interference system is introduced.

III.PROPOSED SCHEME

In our work we have used SIFT algorithm for extracting the local features in an image in form of key points. Corel image dataset is used which consist of 990 images of 10 categories [19]. By using the fuzzy interference system the image retrieval results are improved. Fuzzy modelling in relevance feedback in CBIR allows the machine to learn both from the user and layout of the images. In Fig. 1 flow chart for proposed scheme is shown

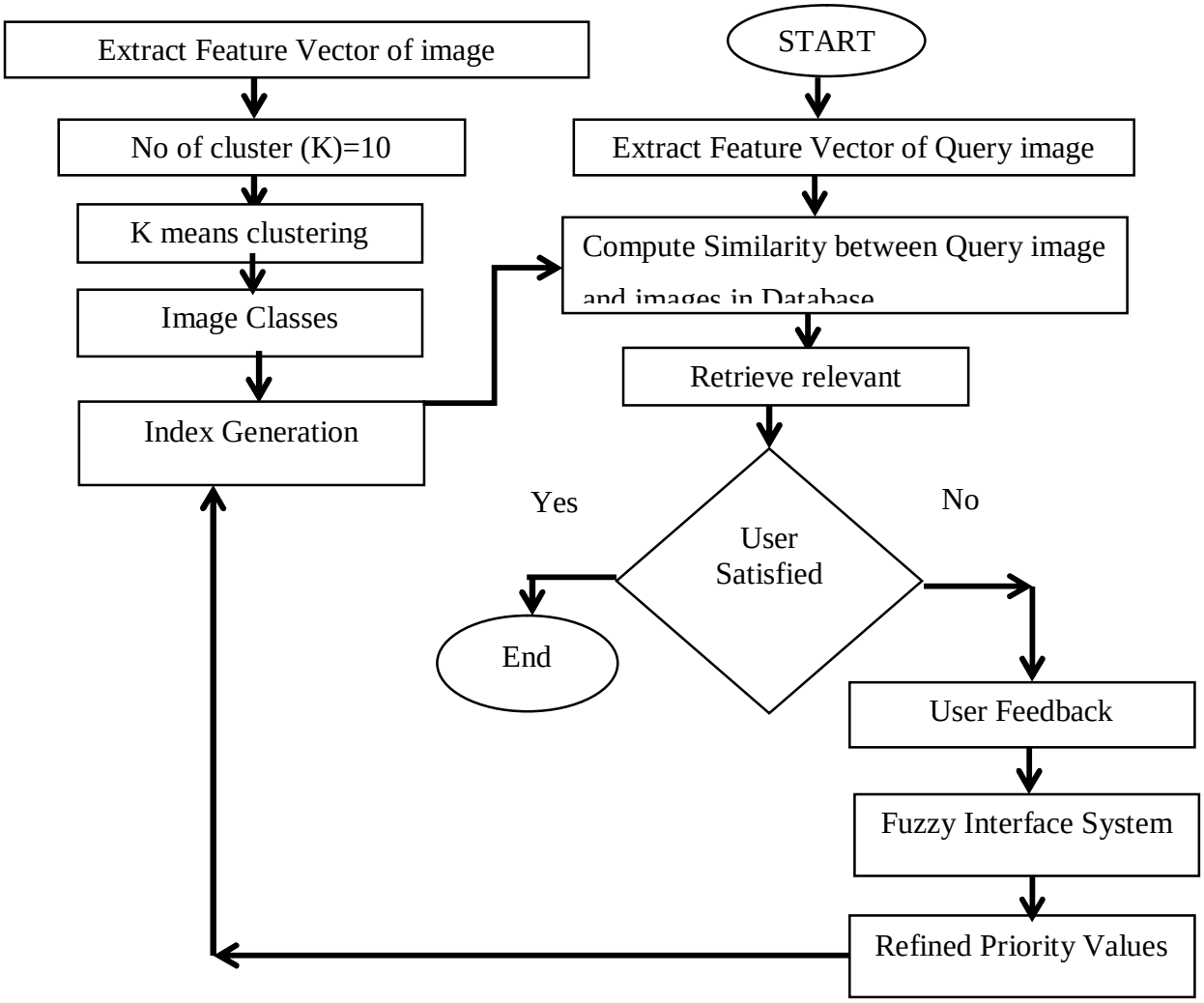


Fig. 1. Flow Chart for the proposed approach

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IV. FRAME WORK FOR PROPOSED APPROACH

Above research is done in three steps named as index generation by using k means clustering algorithm, Content based image retrieval using SIFT, relevance feedback using fuzzy interference system

A. Index Generation

Your Firstly the SIFT feature vectors of all images in dataset are obtained. SIFT feature vector of a particular image is of 128 dimensions; therefore we get a feature dataset ($\vec{F}$) of 150*128 dimensions. The feature vectors are categorized into 10 classes by K means clustering algorithm.

$$\vec{F}=[\vec{F}_i \,|\, \vec{F}_i \text{ is feature vector of } i^{th} \text{ image}, 1 \le i \le N \text{ for } N=150] \quad (1)$$

$$C=[C_j \,|\, C_j \text{ is the } j^{th} \text{ class of image}, 1 \le j \le M \text{ for } M=10] \quad (2)$$

Query image I_Q is classified into a category as determined by the nearest match. Equation 3 represents calculation of Euclidean distance

$$d_{F_Q F_{C_j}} = \text{sqrt}\left(\sum_{k=1}^{128} f_{Qk}^2 - f_{C_j k}^2\right) \quad (3)$$

where $d_{F_Q F_{C_j}}$ is Euclidean distance between query image and j^{th} class of image.

Here query image $I_Q \in C_j$; if $d_{f_Q f_{C_j}} = \min(D)$

B. Content Based Image Retrieval by SIFT feature

Further after category or class selection, query image is than compared with feature vector of images in that particular category or class by calculating the Euclidean distance shown in following equation.

$$d' = \text{sqrt}\left(\sum_{p=1}^{128} f_{Q_p}^2 - f_{C_j ip}^2\right) \quad (4)$$

where f_{Q_p} is the p^{th} component of query image and $f_{C_j ip}$ p^{th} component of i^{th} image in j^{th} class.

The images whose feature vectors are collateral with each other with a threshold value are retrieved

If $d' \ge 0.08$ (5)

Then $P_{I_{Cji} I_Q} = \text{HIGH}$ where $I_{C_j i} = i^{th} \text{image in } C^{th}_j \text{ class.}$

C. Relevance Feedback

When the identical images are retrieved, user is asked to provide the feedback. The feedback is submitted in form of terms of relevancy on a scale of ranging from 0-9. The degree of irrelevancy is passed to the proposed fuzzy interface system which figure outs the priority value of the image by considering both user feedback and layout of images. The priority value determines retrieval of image in next iteration. The steps taken to construct Fuzzy Interface system are summarized below:

1) *Step 1:* Defining Input and output variables Two input variables namely USER FEEDBACK and LAYOUT SIMILARITY and one output variable PRIORITY' is defined in Fuzzy Inference System.

TABLE I Fuzzy set operators

U	d'		
HIGH	HIGH	MEDIUM	MEDIUM
MEDIUM	MEDIUM	MEDIUM	LOW
LOW	LOW	LOW	LOW

2) *Step 2:* Defining fuzzy membership functions Gaussian membership and triangular membership functions are used respectively for input and output fuzzy variables.
3) *Step 3:* Constructing fuzzy rules If THEN rules are created using the deviation matrix (DM) as shown in Table 1.
4) *Step 4:* Defuzzification By using expected deviation**,** output of fuzzy rules are converted in crisp values with help of above fuzzy membership functions

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V. RESULTS

The experiments in this work are done on COREL dataset which contains 990 images. There are total 10 classes with each class having 99 images. These datasets are in the classes of Food, Buses, Elephants, Mountains, Beach, Buildings, Flowers, Africans, Horses and Dinosaurs. The proposed system is implemented on MATLAB 2015. The result when a flower image is given as a query is shown in following diagram using user's feedback. Performance can be evaluated by precision and recall rate.

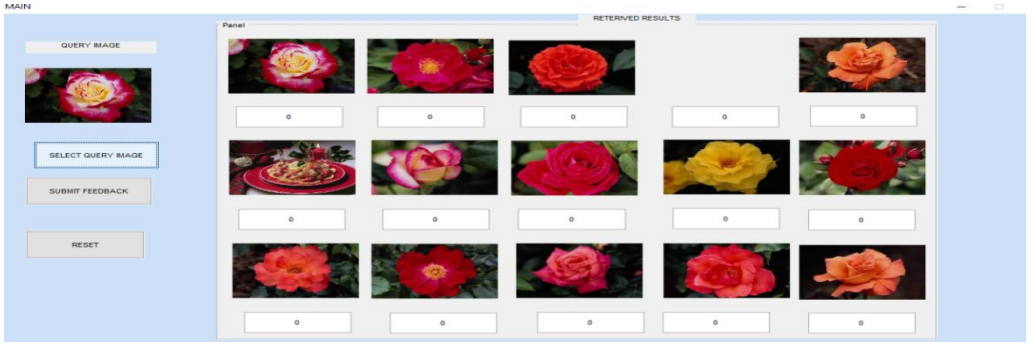


Fig.2. Feature extraction

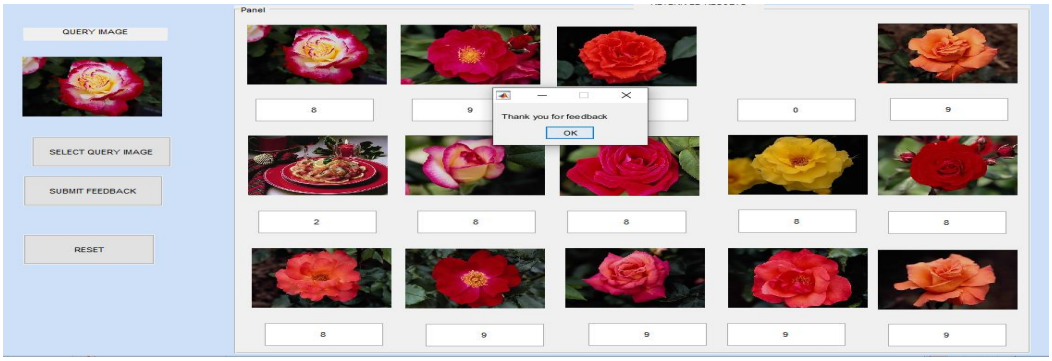


Fig. 3. Providing the feedback

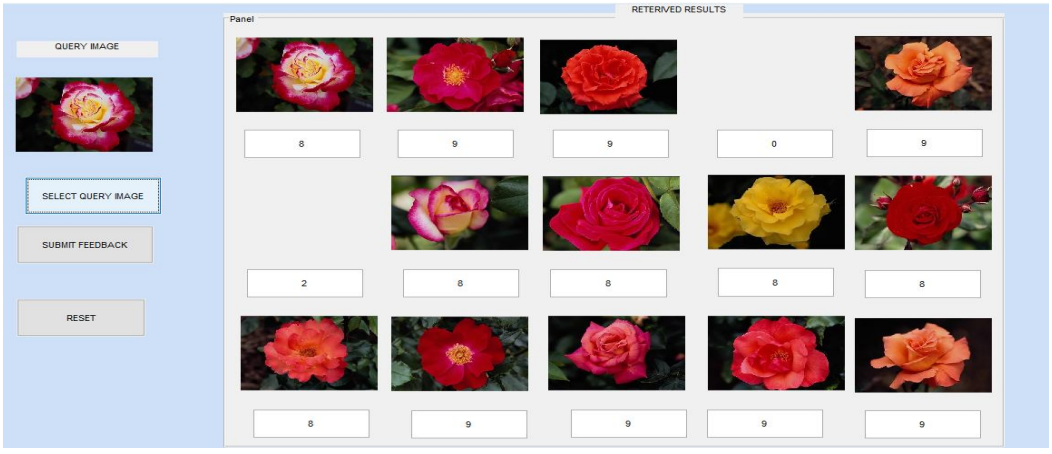


Fig. 4. Resulted images after feedback

$$\text{PRECISION} = \frac{\text{TOTAL NUMBER OF SIMILAR IMAGES RETERIVED}}{\text{TOTAL NUMBER OF RETERIVED IMAGES}}$$

$$\text{RECALL} = \frac{\text{TOTAL NUMBER OF SIMILAR IMAGES RETERIVED}}{\text{TOTAL NUMBER OF IMAGES IN DATASET}}$$

By using precision and recall we have shown final results for all category for proposed system along with the bar graph.

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TABLE III
Precision and recall rate for proposed work

	Classes/category in dataset	Precision	Recall Rate
1	Buses	1	0.933
2	Flower	0.9285	0.866
3	Horses	0.9230	0.800
4	Elephant	0.9166	0.733
5	Africans	0.9285	0.8666
6	Mountain	0.9230	0.800
7	Food	0.9285	0.866
8	Beach	0.8461	0.733
9	Buildings	0.9230	0.80
10	Dinosaur	0.9285	0.866

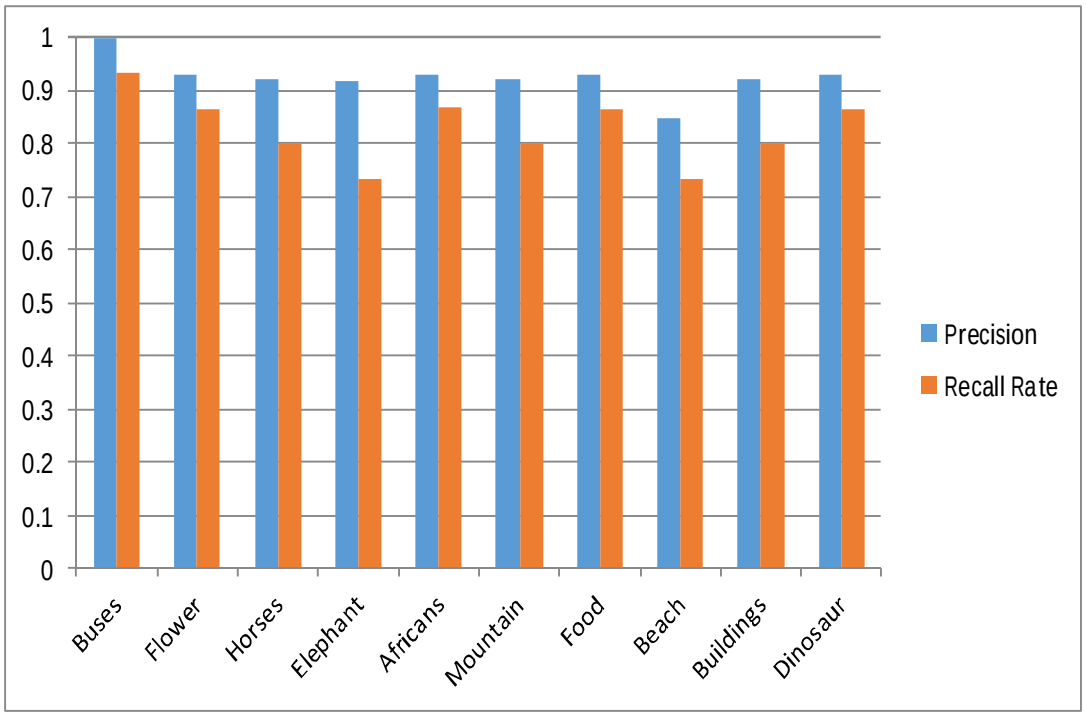


Fig. 5. Bar chart for precision and recall rate

Above Equations comprise the performance evaluation for precision, recall rate and f-measure for the input image. F-measure is approximately the average of precision and recall rate. Precision and recall rate is found with the number of retrieved images L=15.by using this technique we have also increased average precision up to 92.45%

VI. CONCLUSION AND FUTURE WORK

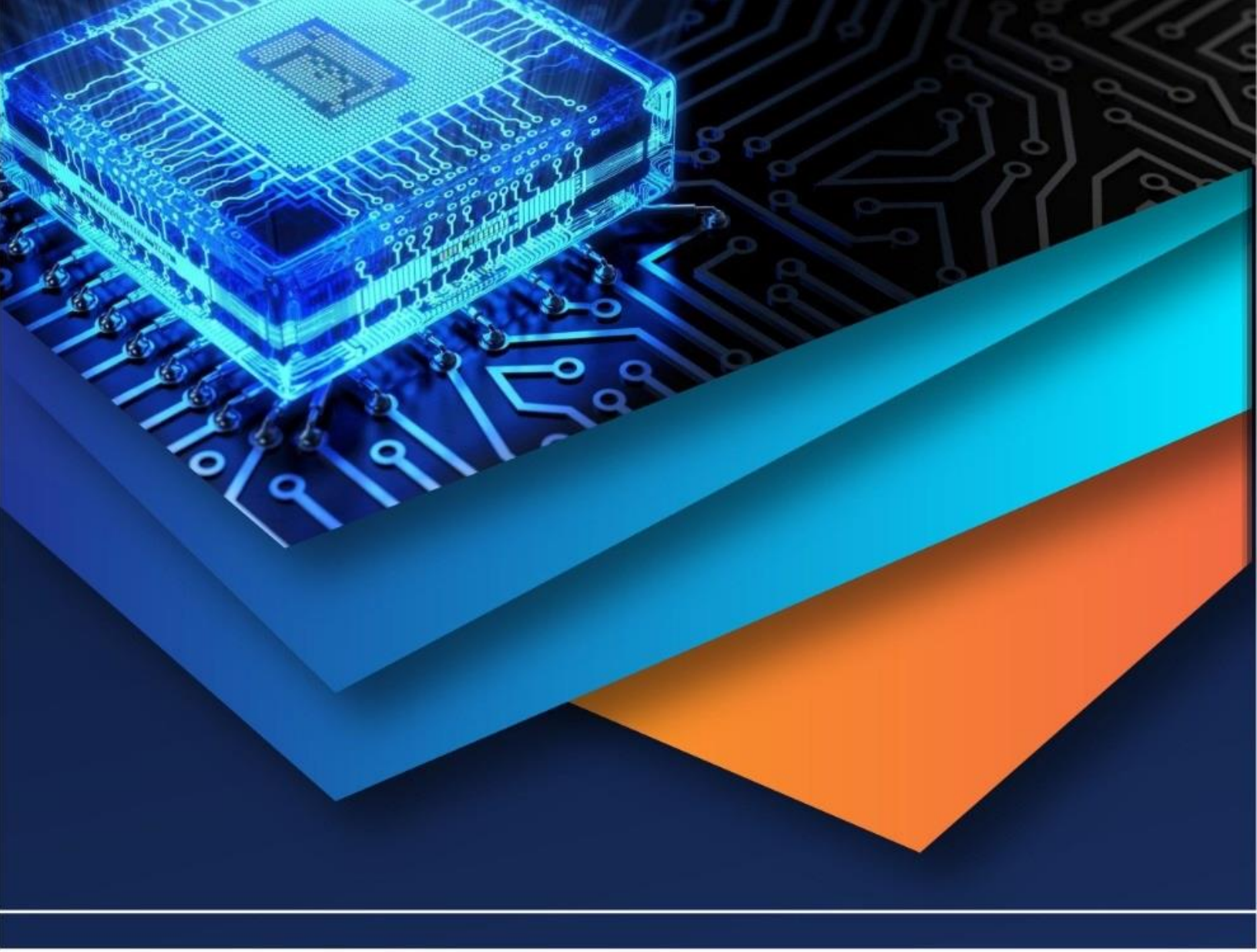
In this study SIFT is used to retrieve images features from database. These features are compared to features of remaining images in database similar images are returned. To improve the performance RF is utilized using fuzzy logic which targets at refining the retrieval result. Experimental result shows the proposed system effectively retrieved images shown in terms of precision and recall rate. Future research can be extended by adding Artificial Intelligence such as introducing bots so that feedback can be given without user's intervention. Cloud computing can also be used due to high computation process of feature extraction.

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