A Multi-Stage Approach to Secure Digital Image Search over Public Cloud using Speeded-Up Robust Features (SURF) Algorithm

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Summary
Digital image processing and retrieving have increasingly become very popular on the Internet and getting more attention from various multimedia fields. That results in additional privacy requirements placed on efficient image matching techniques in various applications. Hence, several searching methods have been developed when confidential images are used in image matching between pairs of security agencies, most of these search methods either limited by its cost or precision. This study proposes a secure and efficient method that preserves image privacy and confidentially between two communicating parties. To retrieve an image, feature vector is extracted from the given query image, and then the similarities with the stored database images features vector are calculated to retrieve the matched images based on an indexing scheme and matching strategy. We used a secure content-based image retrieval features detector algorithm called Speeded-Up Robust Features (SURF) algorithm over public cloud to extract the features and the Honey Encryption algorithm. The purpose of using the encrypted images database is to provide an accurate searching through encrypted documents without needing decryption. Progress in this area helps protect the privacy of sensitive data stored on the cloud. The experimental results (conducted on a well-known image-set) show that the performance of the proposed methodology achieved a noticeable enhancement level in terms of precision, recall, F-Measure, and execution time.
Keywords:
Image Features Detector; SURF Algorithm; Honey Encryption; Cloud Image Search

1. INTRODUCTION

With technology advancement in the era of Big Data, there is an increasing demand for data of different types, which results in significant increasing of data volumes day after day. The burden is put on the search engines to keep images in their local locations and not to bring them down to the client's browser. Nowadays image storage is outsourced in cloud storages due to the large size they occupied. Storing images in public clouds represent excellent choice for most organizations, doing so requires less management efforts and cheaper choice. On the other hand, retrieving confidential images may violate its privacy, and raises the owner concerns of being compromised [22, 16, 19]. Therefore, researchers working to develop technologies for secure image retrieval over the public clouds in an encrypted form that is difficult to penetrate. Image retrieval is an important process, through which images are retrieved from the database or from a specific system, and sometimes retrieval may need to be safe and confidential due to the importance of the image content. Retrieving process from encrypted images is one of the techniques being used to thwart hackers from penetrating the stored images in the cloud [24]. In encrypted images, it is important to hide the image content or any related type of data. In this paper, a method will use the Speeded-Up Robust Features (SURF) algorithm to retrieve images from cloud storages securely and efficiently. Information retrieval is an important field of the Information and Communication Technology ICT. Image retrieval falls under the umbrella of Information retrieval, and it is considered as one of the hot topics that attract researchers, because there are plenty of issues that need to be efficiently considered, like issues related to the contained features, for example colors, textures, shapes, spatial features, and many others. This process, which analyzes the images in terms of identifying important features, is called feature extraction [11]. In addition to that, images retrieval privacy and speed are another issue that needs to be efficiently presented. In this paper, the SURF algorithm will be used, to protect images content by encryption and mitigate images disclosure. Image search starts by collecting and storing image data in the search engine index to be used by the search engine. The search engine index keeps the results of the searched pages and queries which can be appear later the search engine query results. Moreover, query image begins by analyzing image content to extract the distinctive elements and compare them against the stored images in the database. Query image is the most important step when retrieving images, it depends on the content of the image to identify and retrieve the searched image of the query based on certain proportion of similarities. When it comes to the security and privacy of the retrieved images, no matter where the image is hosted, either locally in the Local Area Network LAN or remotely in the cloud storage, preserving the image security and privacy is a major concern. Doing so, images are encrypted

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before being transferred to the remote server by means of encryption methods. Some cloud implementations use specialized encryption devices called Remote Server to maintain image security and privacy and to assure certain level of high retrieval speed [11]. Most of the image security issues are related to remotely access images on the Internet, either images are stored on remote dedicated server or on the cloud storage, as the cloud is on-demand computer systems and resources that provide integrated services without being restricted to specific resources to facilitate the user; Services include storage space, such as: storing documents, images and music on remote servers, and wireless backups of IOS devices directly on I-cloud instead of relying on manual copies on MAC devices and synchronization. In addition to software processing, payment and remote printing, users can share photos, music and games by connecting accounts through Air Drop wireless [12]. Here, it appears the importance of using an efficient and secure image retrieving technique that utilizes a well-known algorithm like SURF to retrieve images from cloud storages. The rest of this paper is organized as follows. Section 2 discusses the related works. Section 3 explains the phases of the proposed methodology. Section 4 describes the experimental framework used to evaluate the performance of the proposed methodology. Section 5 finally presents the main conclusions. With technology advancement in the era of Big Data, there is an increasing demand for data of different types, which results in significant increasing of data volumes day after day. The burden is put on the search engines to keep images in their local locations and not to bring them down to the client's browser. Nowadays image storage is outsourced in cloud storages due to the large size they occupied. Storing images in public clouds represent excellent choice for most organizations, doing so requires less management efforts and cheaper choice. On the other hand, retrieving confidential images may violate its privacy, and raises the owner concerns of being compromised [22, 16, 19]. Therefore, researchers working to develop technologies for secure image retrieval over the public clouds in an encrypted form that is difficult to penetrate. Retrieving process from encrypted images is one of the techniques being used to thwart hackers from penetrating the stored images in the cloud. In encrypted images, it is important to hide the image content or any related type of data. In this paper, a method will use the Speeded-Up Robust Features (SURF) algorithm to retrieve images from cloud storages securely and efficiently.

Image retrieval includes analyzing the images in terms of identifying important features, which is called feature extraction [11]. In addition to that, images retrieval privacy and speed are another issue that needs to be efficiently presented. In this paper, the SURF algorithm will be used, to protect images content by encryption and mitigate images disclosure.

Image search starts by collecting and storing image data in the search engine index to be used by the search engine. The search engine index keeps the results of the searched pages and queries which can be appear later the search engine query results. When it comes to the security and privacy of the retrieved images, no matter where the image is hosted, preserving the image security and privacy is a major concern. Most of the image security issues are related to remotely access images on the Internet, as the cloud is on-demand computer systems and resources that provide integrated services without being restricted to specific resources to facilitate the user. In addition to software processing, payment and remote printing, users can share photos, music, and games by connecting accounts through Air Drop wireless [12]. Here, it appears the importance of using an efficient and secure image retrieving technique that utilizes a well-known algorithm like SURF to retrieve images from cloud storages.

Nawaz et al. [15], proposed advanced hybrid medical watermarking algorithm using SURF based on the Discrete Cosine Transform DCT. The researchers mentioned that digitization is an important means through which information is presented, and it facilitates the process of storing, copying, and disseminating information related to multimedia, that mean there are no restrictions on editing and copying on digital images as well as most types of data. This property opens the doors for various problems such as information penetration, copyright, and others. For this reason, that researchers claim that they have using a powerful new algorithm for blind watermarking, as it relies on SURF-DCT Perceptual Hashing. Their algorithm is based on the affine transformation feature matrix, as well as chaotic encryption technology, to process the watermark image. The researchers concluded that, they can effectively protect images by more than 90% by adopting the mentioned techniques.

Tehran & Angelover [21], based on indexing data and deep learning that is applied to plant biology and remote sensing. In this study, the researchers used the Content Based Image Retrieval (CBIR) technique; images were processed independently, with no regard to any relevant context, the search was performed between sub-sets of images. They used the Convolutional Neural Network (CNN) model to extract image features. Finally, a series of high-resolution remote sensing tests were performed to assess the accuracy and efficiency of their approach, and they compared their work with some other image retrieval techniques such as Multiple Feature Fusion (MFF) and Bag of Visual Words (BOVW). The results indicated that the proposed model is more efficient and more rapid than traditional indexing structures.

Dai et al. [4], presented a paper entitled "A Multi-branch Search Tree-Based Multi-Keyword Ranked Search Scheme Over Encrypted Cloud Data". The reason for the search came from the difficulty in effectively searching for data in the cloud, and this reason led to a great challenge. K-means algorithm was combined with a multi-branch tree structure. Alpha (α) filtering tree searches based on K-means clusters are suggested. As the index tree is created from the bottom up, greedy depth first algorithm is used to filtering documents that have no connection between the query vector and filtering vector. Moreover, α filtering can improve efficiency without reducing accuracy. Results after the experiment on real data showed that their proposed model improves the efficiency of searching for multiple keywords in an orderly manner, while preserving privacy, and at the same time ensuring the accuracy of the search results.

Du et al. [5], suggested a safe model for image retrieval while maintains the image privacy in a secure image and fast retrieval technique. The model relies on deep hash algorithm to searches for the index encryption and the 4D-hyper-chaotic systems. The model consists of four steps to control secure access for users, the searching process as follows: Firstly, the model safely retrieves the image data. Secondly, an improved 4D hyper-chaotic system was used to preserve privacy. Thirdly, the Deep Pair-wise Supervised Hashing (DPSH) algorithm was used to improve security retrieval. Fourthly, the Secure K-NN to perform index encryption is used. The researchers showed in their experiment results that their model has higher efficiency in image retrieval, better image recovery and more safety.

Moghimian et al. [13], proposed a method for retrieving images based on image content by merging multilevel bags from sets of visual words. They provided an image retrieval system that combines different types of image features; the system extracts the visual features of the image with the lower conceptual load. Then the features are collected and given areas of less dimensions using the automatic coding process. After conducting experiments, the results confirmed the efficiency of the proposed method on a group of individual features.

SURF could be used in different application and implementations, since it is fast, powerful, and often used algorithm to find images similarities and compare them to each other. SURF uses the Hessian matrix to be able to reach the important points. Whereas, using SURF shows superior performance in terms of time, durability, and accuracy Bay et al. [3].

Muhathir et al. [14] used the SURF with conjunction of the Support Vector Machine (SVM) algorithm to classify the fruit images. The results showed higher classification accuracy when compared to the previous work and as follow; the performance of the SURF with SVM Gaussian was 72%, when it is used with SVM Polynomial the accuracy value was 69.75% and finally with SVM Linear was 70.25% higher than the previous works.

Jadia and Chawla, [10], they used the SURF algorithm to categorize images and insulators detection. As they used them to classify ceramic and glass insulators, they rely on point features matching. In their work, they train the algorithm, and they could detect insulators in blurred images. In addition, SURF has excelled in discovering insulators that are also used efficiently in security and surveillance systems.

Makhfi in [6], used SURF algorithm to identify Arabic manuscripts to recognize patterns to search the content of handwritten documents, based on word spotting technology. After testing SURF algorithm on hundreds of pages of Arabic manuscripts, the results showed the superiority of SURF algorithm over the other algorithms that depend on word spotting.

The rest of this paper is organized as follows. Section 2 explains the phases of the proposed methodology. Section 3 describes the experimental framework used to evaluate the performance of the proposed methodology. Section 4 finally presents the main conclusions.

2. THE MULTI-STAGE APPROACH TO SECURE DIGITAL IMAGE SEARCH

This section presents the proposed method, which is based on a sequential image entry process, where all images are analyzed sequentially to extract its distinctive properties (features) using the SURF algorithm. After extracting the image properties, the image content is encoded and saved, this process continues until all images are encrypted and saved; meaning they are securely protected with encryption. In the same way, image retrieving is performed using the SURF algorithm to extract the encoded image properties (features). The query image features are compared with stored image features in the database to filter and select the most relevant images. After that, the similarities between the selected images and the inquired about image is shown, thus the image with the highest similarities with the query image is recovered and decoded from its encrypted format. This way, images are retrieved fast, safe, and accurate.

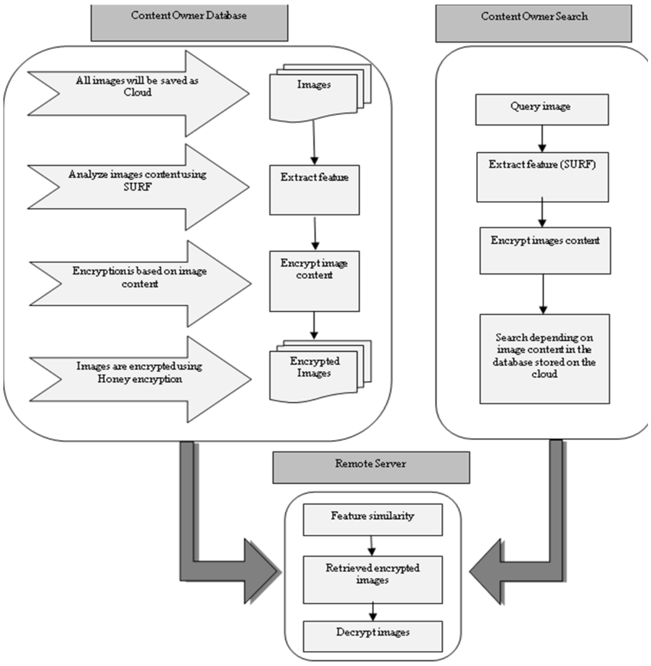


Figure 1: The proposed methodology

Looking to the image search from the content owner point of view, there are two types of content owners, namely, the content owner database and the content owner search. In the content owner database, images are stored in the Cloud, after which the images content are analyzed using SURF algorithm, and then images content are encrypted using Honey Encryption algorithm. For the content owner search, the image query performs the extract feature process using SURF algorithm. Then the content images are encrypted, after that, the encrypted images on the Cloud are searched, then the similar images are decrypted and retrieved as shown on Figure 1: The proposed methodology.

As show on Figure 1: The proposed methodology, which is represented the three phases of the methodology as follow:

2.1 Content Owner Database

The content owner database stage is the step to save the owner's photo collection on the cloud. The phase begins with the set of images that will be stored on the cloud, which will enter the stage of extracting its distinguishing features by using the SURF algorithm; it will reveal the points of interest by approximating the specific factor of hessian blob detection. It can be calculated using three correct operations using an integrated image, and its characteristic description is based on the sum of the wavered response in the Haar around the point of interest.

SURF descriptors were used to identify and distinguish objects, persons or faces, to reconstruct 3D viewing, to track objects, and to extract points of interest. Thus, each image is distinguished from the other within fixed measurements.

These images are then encoded based on their analysis content using the SURF algorithm. Then we produce an encrypted image using honey encryption and then they are encrypted. These are steps for each image stored on the cloud.

2.2 Content Owner Search Database

The content owner search database stage, by which the images will be retrieved from the cloud based on a query image. The phase begins with a query whose properties are analyzed by the SURF algorithm. Based on its standard attributes, we will classify the similar images and then encrypt the contents of these images. Based on the encoded content, the cloud will be searched for content that is already stored.

2.3 Remote Server

Phase of the image control to be retrieved; based on the second stage will identify similar features between the image of the query and images stored on the cloud. That is, the similar images will appear depending on the similar features, so the encrypted images will be retrieved and when they are obtained, the user will decrypt.

3. The Experiment Results

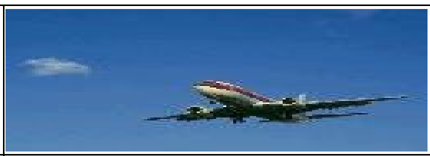
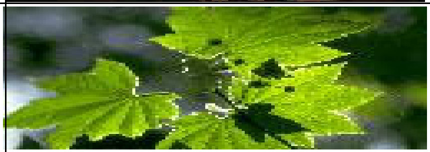
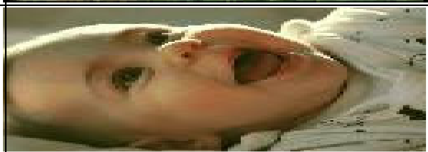
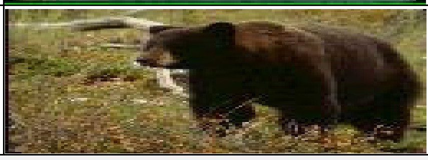
This section explains the experimental part of this study, which will be as follow: image set, the performance measures, implementation of the proposed methodology, and finally the results will be explained and discussed.

3.1 Image Set

To test our approach, we used a dataset of images prepared by Professor James Ze Wang [23]. The dataset is hosted in the Info-lab webpage at the Stanford university website. The dataset was prepared for research comparison purposes it contains 9907 images. In our work we used a subset of 500 images of the dataset to conduct the experiment, which represents the whole image set by taking 50 images from each category (Most of the images in each category have the same features and histogram). Table 1: IMAGES DATASET shows the used image set which is classified into ten categories as follow: Moth, Mountain, Construction, Foliage, Sunset, Flower, Child, Airplane, Racing Cars and Bears. In addition, the size of each image is 4 bytes, and it is of type JPEG.

Table 1: IMAGES DATASET ©InfoLab.

No.	Class Name	Class Image	No. of Images
1	Moth		50

2	Plane		50
3	Mountain		50
4	Building		50
5	Tree leaves		50
6	Sunset		50
7	Flower		50
8	Baby		50
9	Race Cars		50
10	Bear		50
Total			500

3.2 Performance Measure

There are many different performance evaluation approaches used in image processing algorithms. Among the most common used properties are Precision/Recall and F-measure in addition to others. These measures can be used to find the most appropriate input parameters values of image segmentation algorithms. In most cases, these measures are usually expressed as a compromise between two of them to determine the images quality assessment: Precision, Recall and F-Measure [9]. We used these factors as a performance measure in our study.

3.2.1 Precision

Precision is the positive predictive value PPV is used to measure the quality of related images instances images, as the proportion of accurately retrieved images in a set of positively classified images as shown defined in Equation (1). Precision measures the number of correct instances retrieved divided by all retrieved instances [7]:

$$\text{Precision} = \frac{\text{No. of Relevent Images Retrived}}{\text{Total no. of Irrelevant and Relevant Images Retrieved}} \ldots\ldots\ldots Equation\ (1)$$

3.2.2 Recall

The Recall is as sensitivity measure, which is a part of the relevant images retrieved instances of the overall relevant instances [7], and is defined as the fraction of the total amount of relevant instances that were retrieved, as defined in Equation (2):

$$\text{Recall} = \frac{\text{No. of Relevent Images Retrived}}{\text{All Relevent Retrived}} \ldots\ldots Equation(2)$$

3.2.3 F-measure

F-measure, also known as F-score or the harmonic mean of precision and recall, it measures the accuracy of the tested classifier, over the past years, it has been accepted as the most important mean to judge the boundary detector [8]. The F-measure is defined in Equation (3):

$$\text{F} - \text{Measure} = \frac{2 * (\text{Precision} * \text{Recall})}{(\text{precision} + \text{Recall})} \ldots\ldots\ldots Equation(3)$$

3.2.4 Time (Speed)

The time required for image retrieval is the time required to build the model based on the data, analysis, and calculation of the processes to be calculated.

We applied our algorithm methodology on the selected images dataset as clarified previously, the algorithm.

3.3 Implementation of the proposed methodology

Figure 2: Interface algorithm analysis results and similarity ratio shows the SURF analysis algorithm on the image and the image display after highlighting its standard elements and displays the similarity of the images in terms of the number of features and the proportion of similarities identified and retrieved. Precision and recall are offered. The proposed methodology was implemented by C # programming language, on a machine of type core i5 processor.

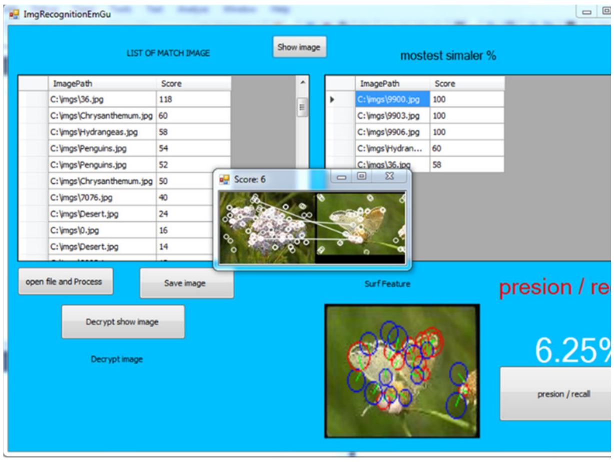


Figure 2: Interface algorithm analysis results and similarity ratio

4. Results

In this section we will explore the experimental results of our work, the results are listed below:

3.2.5 Precision

As example, Enhancement:

$$\text{Moth Class Precision} = \frac{0.85 - 0.65}{0.85} * 100\% = \mathbf{29}\%$$

The higher values of precision are better; so, it is noticeable from Table 2: Precision Recovery, the positive effect of SURF on the precision results where the precision with SURF were higher with all classes in the image set. The average enhancement of the precision for all classes was 21%.

The precision of the recovery results using SURF algorithm compared the standard techniques shows higher accuracy ratio in all groups. Where the highest value in Precision before using the algorithm was in the mountain class, and after using the algorithm the Bears class was the highest. The fourth column in table 2 represents the enhancement for the precision for each class. The optimization ratio of the image retrieval process was calculated without SURF algorithm and retrieval after the algorithm was used. The enhancement percentage of the precision will be calculated to the following equations [1, 2, 17, 18, 20]:

$$\text{Enhancement Precision} = \frac{\text{Precision with SURF} - \text{Precision without SURF}}{\text{Precision with SURF}} * 100\% \quad \ldots\ldots\ldots \textit{Equation } (4)$$

As example, $\text{Enhancement Precision } \textit{for Moth class} = \frac{0.85-0.60}{0.85} * 100\% = 29\%$

The higher values of precision are better; so, it is noticeable from Table 2 Precision Recovery, the positive effect of SURF on the precision results where the precision with SURF were higher with all classes in the image set. The average enhancement of the precision for all classes was 21%.

Table 2: Precision Recovery

No.	Class	Without SURF	With SURF	Enhancement
1	Moth	0.60	0.85	29%
2	Mountain	0.78	0.93	16%
3	Building	0.68	0.80	15%
4	Tree Leaves	0.74	0.90	18%
5	Sunset	0.57	0.74	23%
6	Flower	0.75	0.95	21%
7	Baby	0.73	0.92	21%
8	Plane	0.53	0.72	26%
9	Race Cars	0.65	0.82	21%
10	Bear	0.73	0.96	24%
Avg.		0.603	0.859	21%

The graphical representation of the precision results is shown on Figure 3: Precision Comparison; it represents the recovery results for precision with and without using SURF algorithm.

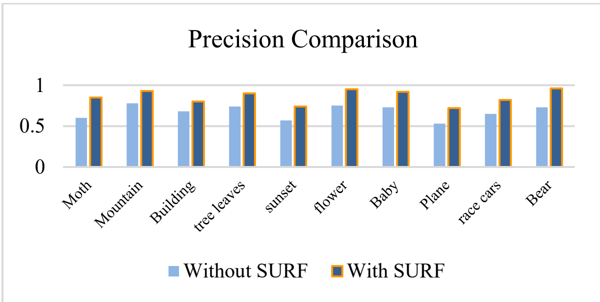


Figure 3: Precision Comparison

Figure 3: Precision Comparison shows is the graphical representation of the precision results; it represents the recovery results for precision with and without using SURF algorithm.

3.2.6 Recall

On the Recall results, we found as shown on Table 3: Recall Results, the recovery results for the recall standard with and without using SURF algorithm. The results show that when using the SURF algorithm, the recall ratio is almost double higher than not using the SURF algorithm and the recall ratio is better in all groups. Where the highest value was in recall before using the algorithm in the **Bears class**, and after using the algorithm the **Plane class** was the highest. The fourth column, represents the enhancement for the recall for each class, which can be calculated using the following formula [1, 2, 17, 18, 20]:

$$\text{Recall} = \frac{\text{Recall with SURF} - \text{Recall without SURF}}{\text{Recall with SURF}} * 100\% \qquad (5)$$

As example, $\text{Enhancement Recall } for\ Moth\ class = \frac{0.29-0.14}{0.29} * 100\% = \mathbf{52\%}$

The higher value of recall is better; so, it is noticeable from table 3 the positive effect of SURF on the recall results where the recall with SURF were higher with all classes in the image set. The average enhancement of the recall for all classes was **50%.**

Table 3: RECALL RESULTS

NO.	Class	Without SURF	With SURF	Enhancement
1	Moth	0.14	0.29	52%
2	Mountain	0.15	0.30	50%
3	Building	0.13	0.25	48%
4	Tree Leaves	0.11	0.27	59%
5	Sunset	0.2	0.23	13%
6	Flower	0.13	0.32	59%
7	Baby	0.10	0.29	66%
8	Plane	0.2	0.33	39%
9	Race Cars	0.10	0.27	63%
10	Bear	0.16	0.30	47%
Avg.		0.151	0.285	50%

Figure 4: Recall Results, is a graphical representation of Table 3: RECALL RESULTS are observed through tapes representing the recovery results for recall before using the surf algorithm and after using it.

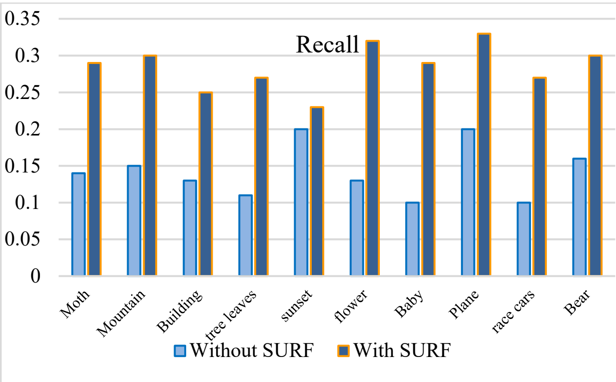


Figure 4: Recall Results

3.2.7 F-measure

Table 4: F-MEASURE RESULTS, show the recovery results for the f-measure standard without and with using the SURF algorithm. The results shown in the table indicates that when using the SURF algorithm, the f-measure ratio was higher ratio in all groups. The highest value was in the sunset class. After using the algorithm, the flower class was the highest. The fourth column in table represents the enhancement for the F-measure for each class, which can be calculated using the following formula [1, 2, 17, 18, 20]:

$$\text{F}-\text{Measure} = \frac{\text{F}-\text{Measure with SURF} - \text{F}-\text{Measure without SURF}}{\text{F}-\text{Measure with SURF}} * 100\% \quad (6)$$

As example, $\text{Enhancement F}-\text{measure } for\ Moth\ class = \frac{0.432-0.227}{0.432} * 100\% = \mathbf{47\%}$

The higher values of F-measure are better; so, it is noticeable from Table 4: F-MEASURE RESULTS the positive effect of SURF on the F-measure results where the recall with SURF were higher with all classes in the image set. The average enhancement of the F-measure for all classes was **46%**.

Table 4: F-MEASURE RESULTS

NO.	Class	Without SURF	With SURF	Enhancement
1	Moth	0.227	0.432	47%
2	Mountain	0.251	0.453	45%
3	Building	0.218	0.380	43%
4	Tree Leaves	0.191	0.415	54%
5	Sunset	0.296	0.350	15%
6	Flower	0.221	0.478	54%
7	Baby	0.175	0.440	60%
8	Plane	0.290	0.452	36%
9	Race Cars	0.173	0.406	57%
10	Bear	0.262	0.457	43%
Avg.		0.230	0.426	46%

Figure 5: F-Measure Results, is the graphical representation of the F-Measure recovery results Without and with using the SURF algorithm.

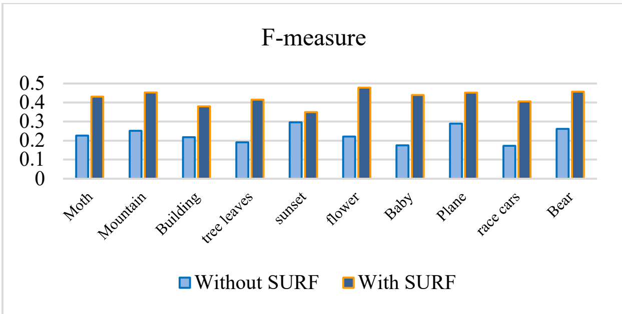


Figure 5: F-Measure Results

3.2.8 Average Retrival Time

When we experimented with the image groups, before and after using the algorithm, we calculated the time when the process was performed on both scenarios, the results is shown on Table 5: Average Retrieval Time, is obvious that we get fast image retrieval time. The fourth column in table represents the enhancement for the retrieval time for each class, which can be calculated using the following formula [1, 2, 17, 18, 20]:

$$\text{Retrieval Time} = \frac{\text{T with SURF} - \text{Time without SURF}}{\text{Time with SURF}} * 100\% \quad (7)$$

For example, $\text{retrieval time } for\ Moth\ class = \frac{459-695}{459} * 100\% = \mathbf{(51\%)}$ (The time is decreased)

The lower values of retrieval time are better; so, it is noticeable from Table 5: Average Retrieval Time, the positive effect of SURF on the retrieval time results where the time with SURF were higher with all classes in the image set. The average enhancement of the retrieval time was decreased for all classes by **52%**.

Table 5: AVERAGE RETRIEVAL TIME

NO.	Class	Without SURF	With SURF	Enhancement
1	Moth	695	459	(51%)
2	Mountain	688	487	(41%)
3	Building	738	483	(53%)
4	Tree Leaves	691	498	(39%)
5	sunset	767	439	(75%)
6	Flower	667	476	(40%)
7	Baby	721	523	(38%)
8	Plane	832	542	(54%)
9	Race Cars	898	589	(52%)
10	Bear	654	332	(97%)
Avg.		735.1	482.8	(52%)

Figure 6: Average Retrieval Timeis the graphical representation of the average retrieval time, it has observed by means of tapes that represent the results of the average time taken to calculate image retrieval speed when a query image is entered before and after the SURF algorithm is used.

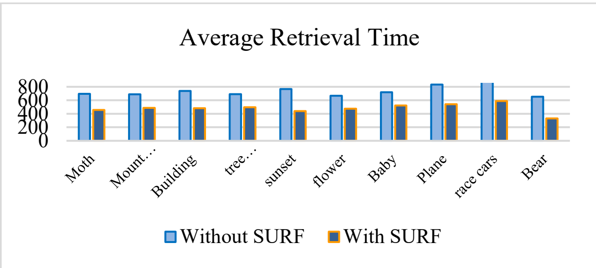


Figure 6: Average Retrieval Time

Figures 1, 2, 3, and 4 showed graphical representation of all experiments, which represents the rate of improvement on the recovery rate without and with using SURF algorithm. The representations show the improvement ratio of the four parameters in calculating the optimization ratio (Precision, Recall, F-Measure, and Time).

5. COMPARISON WITH OTHER METHODS

Table 6 Precision Comparisons shows the mean average precision values obtained from the experimental results and comparisons conducted on the image-set benchmark that prove the superiority of the proposed method with SURF over the literature studies [A, B....H].

Table 6 Precision Comparisons

Class	Mountain	Building	Flower
Proposed Method Without SURF	0.78	0.68	0.75
Proposed Method With SURF	**0.93**	**0.80**	**0.95**
Visual words integration SIFT-SURF [A]	0.62	0.73	0.89
IRIGA [E]	0.81	0.63	0.91
Color SIFT-EODH [F]	0.58	0.54	0.91
Spatial BoF [G]	0.42	0.53	0.71
SIFT-LBP [H]	0.46	0.43	0.83
HOG-LBP [H]	0.37	0.56	0.85

Note that the table presented the average precision for only three image categories from the image-set, because they are the shared studied categories in all state-of-the-art research. The proposed method with SURF resulted the highest the mean average precision values over all the other methods. However, Visual words integration SIFT-SURF shows the superiority with two image categories over the other methods and even the proposed Method without SURF.

Figure 7 is a graphical representation for table 6, which proves visually that the obtained average of precision values for the proposed method are higher than all other methods. Where the X-axis represents the precision and Y-axis represents the category of the tested images. [25-29].

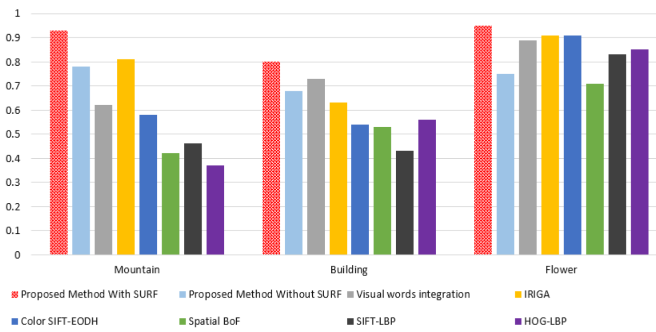


Figure 7Graphical Representation- Precision Comparisons

6. CONCLUSIONS

This paper included the design, implementation and testing of image retrieval from the cloud, using the SURF algorithm on encrypted images via Honey encryption. The analysis of the image content and the extraction of characteristic features were studied by the SURF algorithm, which in turn detects the points of interest, which is calculated using three correct operations using full images.

The image description is based on the total response to the point of interest. After they are discovered, they are saved after they are encrypted by Honey encryption. The image of the query will then follow the same steps. When the content is encrypted, it is compared with the images saved on the cloud, and the most similar images are retrieved. The effect of the algorithm on image retrieval from cloud was examined based on four criteria: Precision, Recall, F-measure, and Time build model.

Results were compared before and after use of the SURF algorithm. The results were for the precision average before using the algorithm (0.676) and after use (0.859). As for recall, the rate of the results before using the algorithm (0.142) and after use (0.285). The f-measure was before the algorithm was used (0.230) and after use (0.426). The average time to construct a model was before the algorithm was used (735.1 ms) and after using the algorithm (482.8 ms). Analysis of the results showed that after using the SURF algorithm it was better as accuracy in converged images, more secure and faster using the algorithm. The rate of improvement compared with the results rates indicated an increase in user benefit.

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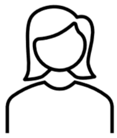

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