

# UTTARANCHAL UNIVERSITY JOURNAL OF CURRENT ADVANCES IN ENGINEERING

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# CONTENTS

S.No.	Title	Page
1.	Dual-Tree Complex Wavelet Transform based Image Fusion <i>Mukul Tiwari</i>	01
2.	An Adaptive Technique based on Separability Index to Classify PALSAR data <i>Pragati G.N. Ghildiyal</i>	09
3.	Cloud Computing: Overview and Research Issues <i>Divya Kapil, Jitendra Kumar Gupta</i>	21
4.	Image Encryption using Pixel Shuffling method in DOST and complex Wavelet Domain <i>Nidhi Singh</i>	31
5.	A review of latest security approaches for cloud based Storage (CBS) System <i>Pankaj Chaudhary, Kapil Joshi, Subhashish Goswami</i>	37
6.	An Extensive Survey on Query by Image Content Techniques <i>Vijaylakshmi Sajwan</i>	44
7.	Distributed Database Management using Pipeline Concept in Cloud Computing <i>Monika Jain</i>	54
8.	Multiclass Object Classification using Neural Network based on Wavelet Transform <i>Brajveer Singh</i>	63
9.	Mobile Robot Navigation in Dynamic Environments <i>Punit Kumar, Dr. Amit Kumar Bansal, Dr. Sanjeev Gill</i>	70
10.	A Multimodal Approach to enhance the Performance of a Biometric System using Eye color, Face and Ear <i>Sanjana Yadav, Archana Singh</i>	77

# Dual-tree Complex Wavelet Transform based Image fusion

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**Abstract:** The images are degraded in many forms such as blurring, noisy and so on. But much information from similar images can be used to enhance the images. With this motivation a scheme is proposed based on the image fusion in dual tree complex wavelet transform. The similar images are performed using DCT and PCA in dual tree complex wavelet domain in proposed methodology. The proposed method is compared with some existing schemes and analyzed with some observations. The quality of output images are observed in terms of MSE and PSNR. From result analysis, it is clearly concluded that proposed method gives better outcomes in comparison to some existing schemes.

**Keywords:** Wavelet Transform; image fusion; Dual-tree complex wavelet transform.

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## 1. Introduction

In the last decade significant growth is achieved in current image processing systems, mainly due to the increased variety of image acquisition techniques and because of this image fusion algorithm is a prime focus for researchers. Image fusion is a procedure that aims at the integration of disparate and complementary data to enhance the information present in the source images as well as to increase the reliability of the interpretation. This process leads to more accurate data interpretation and utility.

The composite images produced by this scheme preserve those details from the input images that are most relevant to visual perception. The method is tested by merging parallel registered thermal and visual images [1].

In [2-5] introduced a novel design for personal authentication and for vehicle security using fusion system. Wavelet transform is used for feature point extraction using HAAR mother wavelet. In [6-8], they provided a method for evaluating the performance of image fusion algorithms. They use them on the output of a number of fusion algorithms that have been applied to a set of real passive infrared (IR) and visible band imagery.

In [9-11], work presents a model to support medical diagnosis through the fusion of abnormality/normality in medical brain images, in order to help to specialist as a previous step in the brain pathology, radio graphical and clinical diagnosis. In [12], the actual image is separated from its background and it computes threshold for



every pixel. This method converts grayscale image into binary i.e. image with only black or white colors. The most essential thresholding operation will be the selection of a single threshold value. All the grey levels below this value are classified as black i.e. 0, and those above white as 1.

With the motivation from existing methods, the proposed scheme is designed to get the enhanced image from degraded images. This paper has the following structure: section 2 is about wavelet transform, section 3 gives information on the proposed algorithm employed for the fusion process, section 4 represents the results and discussion and section 5 concluded the paper.

## 2. Dual Tree Complex Wavelet Transform

For the DWT small changes in the input may cause large changes in the wavelet coefficients. Furthermore aliasing occurs due to down sampling. Inverse DWT cancels this aliasing provided if the wavelet and scaling coefficients are not changed. The other disadvantage of DWT is its poor directional selectivity (e.g., inability to distinguish between  $+45^\circ$  and  $-45^\circ$  spectral features).

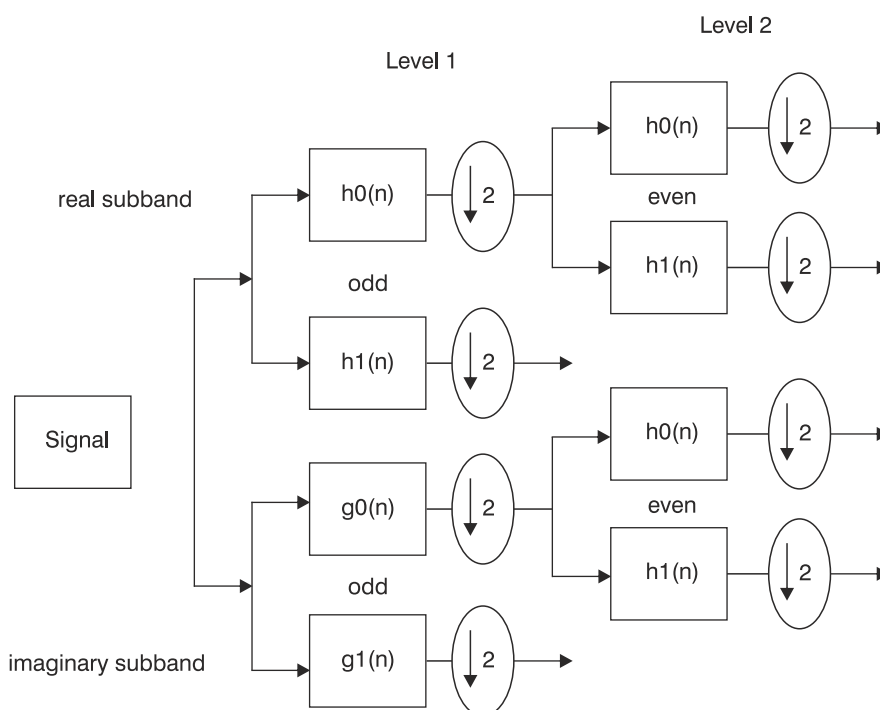


Figure.1. DT-CWT working principle for 1D signal

These problems of Real DWT can be solved by using complex wavelets. However, a further problem arises in achieving perfect reconstruction for complex wavelet decomposition beyond level 1. To overcome this, Kingsbury proposed the DTCWT, which allows perfect reconstruction while still providing the other advantages of complex wavelets [13]. DT-CWT provides N multi scales, can be implemented using separable efficient Filter Banks as shown in Fig.1. Here two sets of Filter banks are used, consists of low pass and high pass filters.

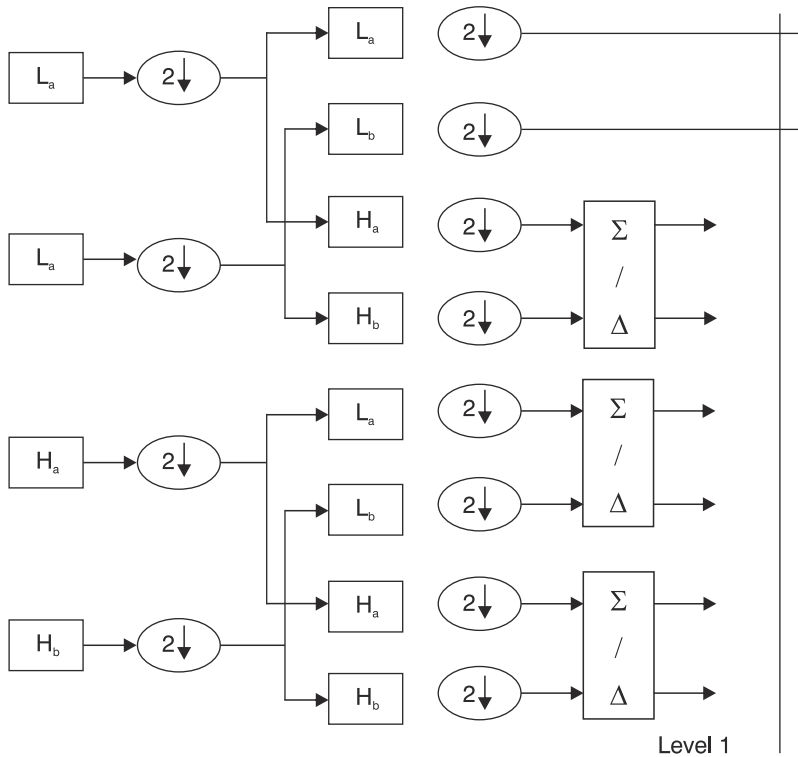


Figure.2. Decomposition of DT-CWT for 2D image

The sub band signals of the upper DWT can be interpreted as the real part of a complex wavelet transform, and sub band signals of the lower DWT can be interpreted as the imaginary part. Equivalently, for specially designed sets of filters, the wavelet associated with the upper DWT can be an approximate Hilbert transform of the wavelet associated with the lower DWT. Then designed, the dual-tree complex DWT is nearly *shift-invariant* and *strong directional* in contrast with the critically-sampled DWT.

2D DTCWT produces six high-pass subbands as well as two low-pass subbands at each level of decomposition, L represents low-pass filters and H represents high-pass filters. Each filtering operation is followed by a downsampling by two. Six



directional wavelets of DTCWT are obtained by taking sum (  $\Sigma$  ) and difference (  $\Delta$  ) of high-pass subbands which have the same pass bands.

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### 3. Proposed Architecture of Image Fusion

We have proposed a new approach for efficient and reliable image fusion in multi-focus images, which is a challenging task due to blurring effect.

The first aspect of this work is to use Dual Tree Complex Wavelet transform, where multiscale/multistage analysis and extraction of features oriented in different directions are possible. The decomposition level of the wavelet transform is decided by the imagery details which we need. In this work first level decomposition is satisfactory to preserve the details. The Second and important aspect of this work is to extract the features from *low frequency sub bands and high frequency sub bands using DCT and PCA*, respectively.

The proposed scheme is processed by using following steps:

- Step 1:** Two input images (A and B) are taken which are defocused.
- Step 2:** Over the both images, perform Dual-tree Complex Wavelet Transformed (DT-CWT).
- Step 3:** Applied Discrete Cosine Transform (DCT) over the approximation parts of both input images.
- Step 4:** Computed average pixel by pixel of both DCT coefficients obtained by step 3.
- Step 5:** Applied Inverse Discrete Cosine Transform (IDCT) to obtain filtered approximation part.
- Step 6:** Performed PCA over the detail parts (LH1, HL1, HH1, LH2, HL2 and HH2) of both input images.
- Step 7:** Obtained principal components (PCs) of the detail parts are multiplied with their respective sub bands.
- Step 8:** Both modified detail parts are added with their respective subbands to obtain filtered detail part.
- Step 9:** To obtain fused image, applied inverse DT-CWT over filtered approximation parts (obtained from step 5) and filtered detail parts (obtained from step 8).

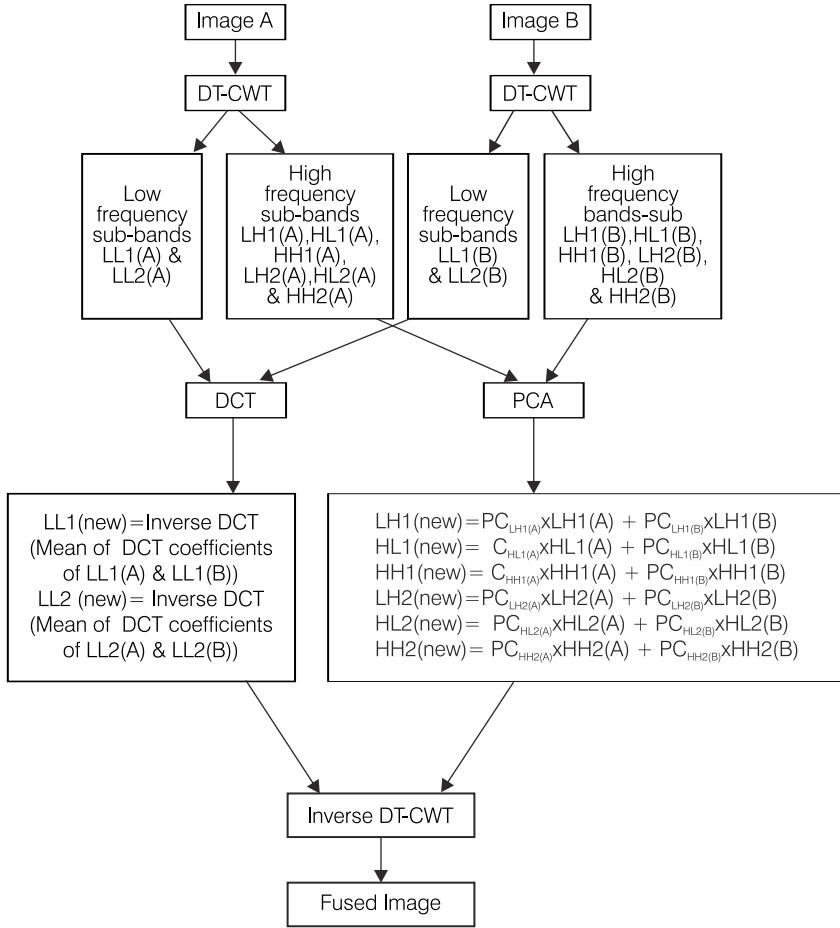


Figure 3: Block diagram for proposed method

#### 4. Results of Experiment and Analysis

The proposed method is tested on various images of size  $512 \times 512$ . The results are tested using images as shown in figs. 4(a)-(b), 5(a)-(b) and 6(a)-(b). In fig. 4-5, the images 4(a) and 5(a) are highly concentrated on the right part and 4(b) and 5(b) highly concentrated on left part. Whereas in fig. 6 (a) the image is focused on the front leaves and 6(b) is focused on background leaves. The noisy images are obtained by adding salt and pepper noise. Over the input images, the fusion is performed based on wavelet transform using DCT and PCA as discussed in proposed methodology. The resultant fused images of proposed scheme are shown in figs. 4(c), 5(c) and 6(c). The visual quality of results is good in compare of input images. To measure the quality of proposed scheme in terms of MSE and PSNR, the results are compared with existing schemes, as shown in table 1. For comparison, the existing schemes are DWT with maximum, DWT with minimum, DWT with average and DWT with PCA.



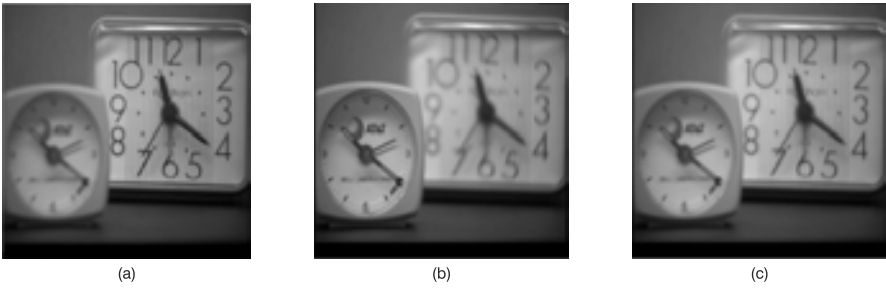


Figure 4: Clock images: (a) first input image (b) second input image (c) fused image

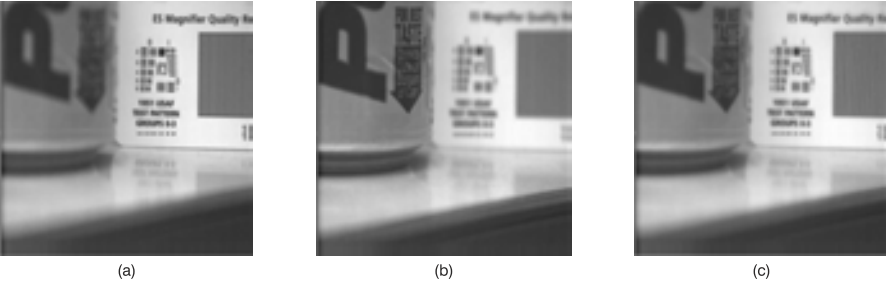


Figure 5: Pepsi images: (a) first input image (b) second input image (c) fused image

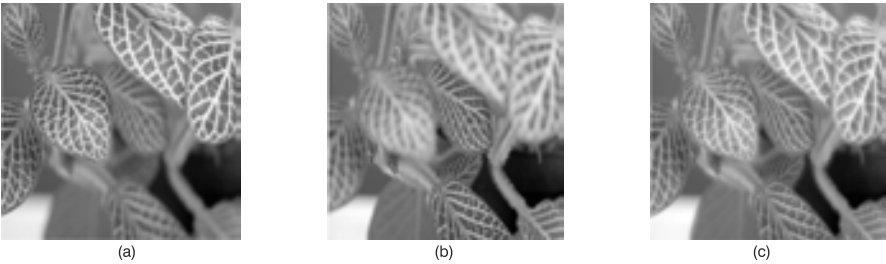


Figure 6: Leaves images: (a) first input image (b) second input image (c) fused image

Table 1: PSNR and MSE

Input Images	Fusion methods	PSNR with first input image	PSNR with second input image	MSE with first input image	MSE with second input image
Clock (512x512)	DWT + maximum method	34.9095	33.1916	29.4956	29.4652
	DWT + minimum method	33.1948	34.9022	29.3432	29.8347
	DWT + average method	36.9722	36.9722	29.3258	29.1681
	DWT + PCA	36.9504	36.9990	29.2635	29.3533
	Proposed Method	37.0060	37.0430	27.2674	28.4981

Input Images	Fusion methods	PSNR with first input image	PSNR with second input image	MSE with first input image	MSE with second input image
Pepsi (512x512)	DWT + maximum method	35.9001	37.0010	29.7677	29.0838
	DWT + minimum method	36.9859	35.8987	29.8237	29.7623
	DWT + average method	39.4204	39.4204	29.4861	29.8622
	DWT + PCA	39.4366	39.3109	29.2871	29.2701
	Proposed Method	39.5406	39.5101	28.1517	27.7077
Leaves (512x512)	DWT + maximum method	28.6968	31.3334	30.2371	29.364
	DWT + minimum method	31.3337	28.6891	29.7118	29.3623
	DWT + average method	32.8258	32.8258	30.3012	29.8324
	DWT + PCA	32.8058	32.8384	29.3254	29.3124
	Proposed Method	33.5267	33.4085	27.3244	26.1463

Peak Signal to Noise Ratio (PSNR) is the ratio between the maximum possible value of a signal and the power of distorting noise that affects the quality of its representation. The PSNR is usually expressed in terms of the logarithmic decibel scale. Higher PSNR value indicate high quality image and our approach is to increase the PSNR.

$$PSNR = 10 \log_{10} \left( \frac{255^2}{MSE} \right)$$

$$MSE = \frac{1}{mn} \sum_{x=0}^{\infty} [I(i,j) - P(i,j)]^2$$

Where,  $I(i,j)$  is the input image of size  $m \times n$  and  $P(i,j)$  is processed image.

## 5. Conclusions

In this research work, attention was drawn towards the current trend of the use of multi-resolution image fusion techniques, especially approaches based on discrete wavelet transforms and Dual Tree Complex Wavelet Transforms. The proposed scheme is applicable for similar images, which differ in terms of focus. The fusion is performed over the defocused images as proposed in scheme. The proposed scheme is based on the combination of transform and spatial domain, which provides



more informative results. In comparison to existing schemes, the proposed scheme gives better results in terms of MSE and PSNR.

The number of decomposition levels in the Multi-resolution analysis has a great impact on image fusion performance. However, using more decomposition levels do not necessarily implies better results. Therefore methods for selection of optimized number of decomposition levels can be explored.

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# An adaptive Technique based on Separability Index to classify PALSAR data

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**Abstract** - In this paper, we have developed an adaptive technique based on separability/separate index for classification of PALSAR data.

First of all this paper investigate the effect of sample size on accuracy assessment. Further, we have utilized minimum distance to

mean classifier and studied the sample size varying from 20 to 500. A comprehensive analysis was made for different polarized

images, i.e., HH, HV, VV and their combinations i.e., HH-HV, HV-VV, HH-VV, and HH-HV-VV. Further, to increase the

Classification accuracy, separability/separate index, which tells about the idea of class separation in different polarization, was analyzed. A

decision tree based on separability/separate index was developed and adaptive statistical approach based on mean and standard deviation

was used to classify PALSAR data. Good overall accuracy and class wise accuracy was observed with this adaptive technique

**Keywords** - Polarimetric Synthetic Aperture Radar, Supervised classification, Minimum distance to mean, Separability Index, Decision Tree Algorithm, Genetic Algorithm.

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## I. INTRODUCTION

The motivation behind this research is the study of improved monitoring of land covers. Synthetic aperture radar (SAR) is nothing but a microwave sensor that sends the electromagnetic pulses from the space borne platform to the ground which in return produces return signals that can be recorded. SAR is used for the surveillance activities.

Radar polarimetry has been gaining appreciation from so many researchers since 1980's. It is used in the field of remote sensing and we have achieved the first class results [1]. When selective sampling methods are used in rather than the use of random selection of samples, both the performance of mean classifier and the reduction in classification variance are improved [2].

In supervised type of classification technique, the knowledge of location along with the identity of some land cover type say urban, vegetation and water is kept in advance. These areas are located in remotely sensed data and are called "training sites" [3]. A considerable research has been done showing that fully polarimetric SAR systems can discriminate various land covers when checked with the single as well as dual polarimetric SAR data [4] [5]. SAR provides an exclusive all-weather mapping facility for topographical information as well as for ground cover categorization. Classification is one of the most widely used algorithms for extracting information from remotely sensed images. In recent decades PolSAR images due to their rich information content from environment has become one of the most useful remote sensing data sources [6]. It is based on the decision rule of minimum distance that calculates the spectral distance between the dimension vector for the candidate pixel and the mean vector for samples taken. Then the assignment of class which shows the minimum distance is done [7]. The performance of the classifier is depending on the data that is being used. So we need to know about the data so that the further advancements can be done. It may require a lot of practice, experimentation and experience. The best suited classification method is selected to get done with the specific task [8].

## A. Study Area and Data Used

The investigation has been done for the regions of Roorkee city which is located in the state of Uttarakhand, India. The centre latitude of the selected location is found to be 29°51'45"N and longitude is 77°52'51.03"E. The investigated area has been chosen for its diverse land cover classes say urban, vegetation and water. The developed classification algorithm has been performed on fully polarimetric PALSAR L-band data. The data have six different modes of polarization out of which HH, HV, VV depicts linear polarization and LL, LR and RR depicts circular polarization.

## B. Ground Truth Collection

A ground truth survey needs to be carried out to collect the region of interest (ROI) points. Some points have been chosen from Google Earth imagery and others have been collected by field survey. 100 ROIs have been used as reference ROIs for classifying images for different polarization. Then for the accuracy assessment of classification, different sample ROIs are used. On the basis of ground truth information, three classes are identified: urban, vegetation, and water. All these points are listed in Table I.

TABLE I. GROUND TRUTH SURVEY POINTS

CLASS	REFERENCE ROI	SAMPLE ROI
URBAN	100	20,50,70,100, 125,150,175, 200,500
VEGETATION	100	20,50,70,100, 125,150,175, 200,500

CLASS	REFERENCE ROI	SAMPLE ROI
WATER	100	20,50,70,100, 125,150,175, 200,500
TOTAL	300	60,150,210, 300,375,450, 525,600,1500

## II. METHODOLOGY

In this study, supervised minimum distance to mean classified technique is applied to different polarized images and their combinations (HH, HV, VV, HH-HV, HH-VV, HV-VV, and HH-HV-VV). Evaluation of the performance of different polarized images for different sample size is done.

In the second part, different land covers say urban, water and vegetation are classified on the basis of image statistics. Basically, Separability Index Criterion has been introduced in which the separability between class pairs is evaluated and based on that the feature selection for each class is done.

Followed by this the calculation of complete image statistics for all the linear and circular polarization (HH, HV, VV, LL, LR, RR) is done. These image statistics are minimum, maximum, mean and standard deviation. Based on these statistical measures, decision tree algorithm is developed and classification is done. Genetic algorithm is used which is a search and optimization method which works by mimicking the evolutionary principles and chromosomal processing in natural genetics. It is basically a calculus free optimization technique.

## III. RESULT AND ANALYSIS

### A. Effect of Sample Size on Accuracy

To analyse sample size on accuracy assessment, minimum distance to mean (MDM) classifier was used. The accuracy assessment is evaluated varying from 20 to 500 ROI. Initially for sample size of 20 ROI, MDM classification was applied on single polarized images i.e., HH, HV, VV and the overall accuracies were 68.33%, 76.66%, and 68.33% respectively. Classification was then applied on the combinations i.e., HH-HV, HV-VV, HH-VV, and HH-HV-VV. The overall accuracies were 70%, 71.66%, 70%, and 71.66% respectively. Highest overall accuracy was obtained for HV polarized image.

Similarly, the accuracy assessment is done for sample size: 50, 70, 100, 125, 150, 175, 200, and 500 and the results are recorded. Fig. 1 shows the classified image for HV polarization. And Fig. 2 shows the change in accuracy with the change in sample size for different polarizations and their combinations. It is observed that after a certain value of sample size, there is no such appreciable difference in the overall accuracy. In other words we can say that after a certain sample size value, the overall

accuracy is approximately constant. It clearly means that the optimum size for accuracy assessment is 175. Therefore, sample size such as 1000 or more will provide approximately the same accuracy value as sample size of 175.

## B. Adaptive classification based on Separability Index

Separability Index Criterion has been used for proper segregation of polarization indices and each class from the other classes. This methodology does not require prior assumptions for developing classification algorithm. Or we can say, training sites are not required for the purpose of development of classification algorithm. Separability Index is a measure to check how efficiently the classes can be segregated from each other or in other words, it checks the separability between class pairs. So on the basis of separability index, the accuracy assessment is done. Separability Index is given by Eq. 1.

$$SI_{ij} = \frac{\mu_i - \mu_j}{S_i - S_j} \quad (1)$$

Where  $\mu_i$  and  $\mu_j$  are the mean of class  $i$  and  $j$  respectively and  $S_i$  and  $S_j$  are standard deviation for class  $i$  and  $j$  respectively.

Table II shows the values of separability index and Fig. 3 shows the graphical representation of separability index of class pairs.

Based on the image statistics, Decision Tree classification algorithm is developed using best polarization index for each class. The mathematical formulation has been formed for those indices in terms of image statistics. These expressions are used for development of Decision Tree Classification. Here the parameters  $n_a$ ,  $n_b$  and  $n_c$  varies from 0.25 to 3 with the step of 0.25. Table III shows the complete image statistics values.

Change in  $n_a$ ,  $n_b$  and  $n_c$  changes the overall accuracy as shown in Fig 5(a), 5(b), and 5(c) respectively. Curve fitting technique is used to establish a relationship between overall accuracy  $n_a$ ,  $n_b$  and  $n_c$ .

Changes in  $n_a$  affect the classification accuracy of water which also affects the overall accuracy as shown in Fig.5(a)

A quadratic equation between OA and  $n_a$  was established as given by Eq 2.

$$OA_w = 1.819 n_a^2 + (-16.34) n_a + 78.61 \quad (2)$$

The coefficient of determination (R-Square) is 0.96 and Root Mean Square Error is 1.968

The relationship between OA and  $n_b$  is shown in Fig. 5(b) given by Eq. 3.

$$OA_u = -3.144 n_b^2 + 13.94 n_b + 56.49 \quad (3)$$

The coefficient of determination (R-Square) is 0.98 and Root Mean Square Error is 0.6205

The relationship between OA and  $n_c$  is shown in Fig. 5(c) given by Eq 4.

$$OA_r = 1.529 n_c^2 + (-8.624) n_c + 73.94 \quad (4)$$

The coefficient of determination (R-Square) is 0.99 and Root Mean Square Error is 0.28

To evaluate the value of  $n_a$ ,  $n_b$  and  $n_c$ , minimization problem given by Eq 5 is solved with genetic algorithm.

Use of Genetic Algorithm for optimization helps in calculating the optimized values.

$$Y = \min [OA - (OA_u + OA_r + OA_w)] \quad (5)$$

Solving the minimization problem with Genetic Algorithm,  $n_a$ ,  $n_b$  and  $n_c$ , are 0.251, 2.218 and 0.254 respectively.

Substituting these values of  $n_a$ ,  $n_b$  and  $n_c$ , in decision tree classifier given by Fig. 4, the classification of PALSAR image was done. The classified image is shown in Fig. 6 and accuracies for different class are given in Table IV. The overall accuracy is 85.14%.

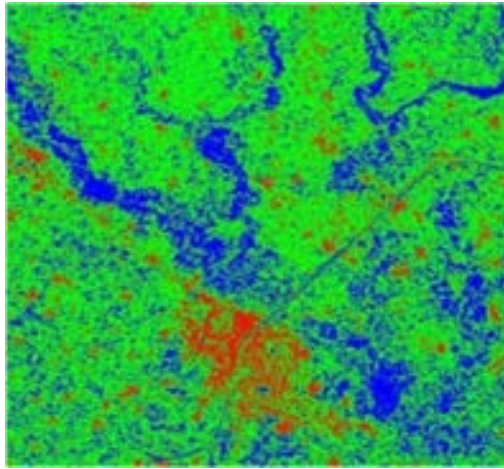
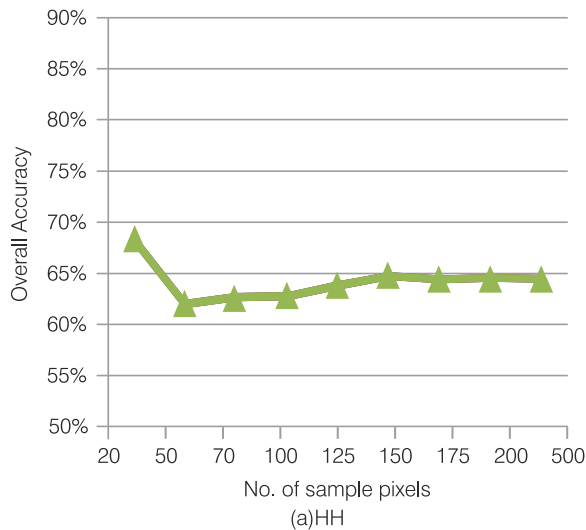
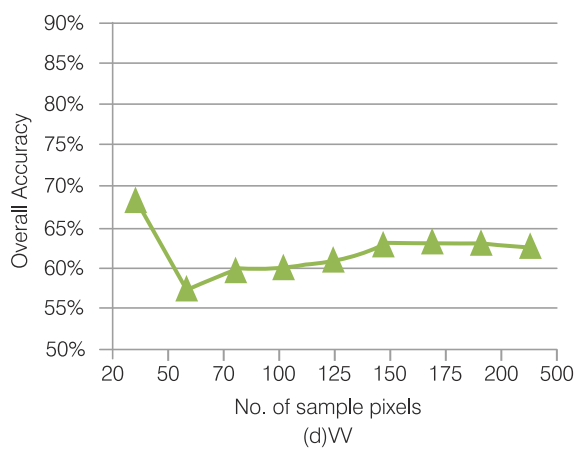
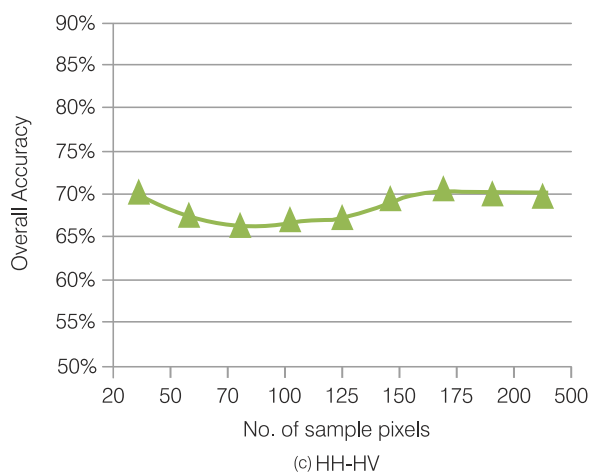
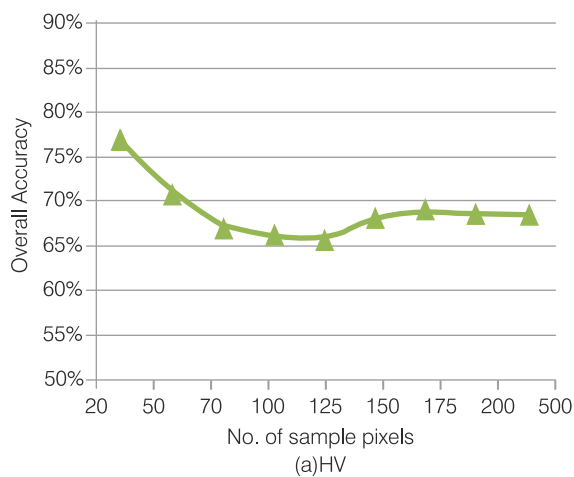
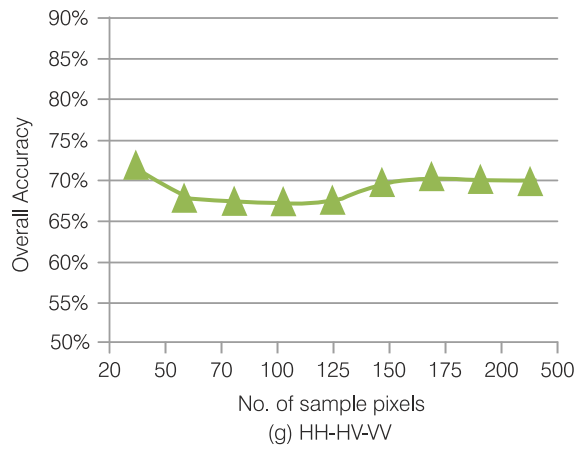
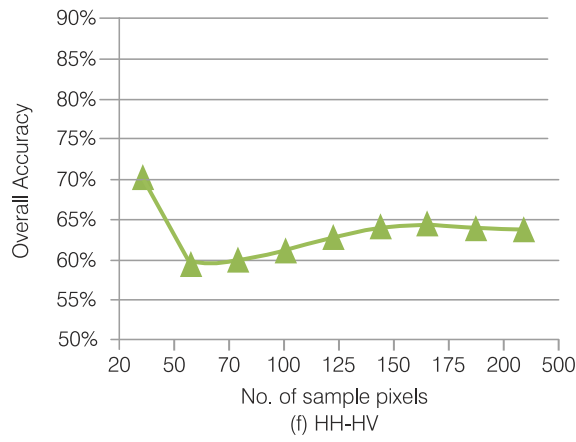
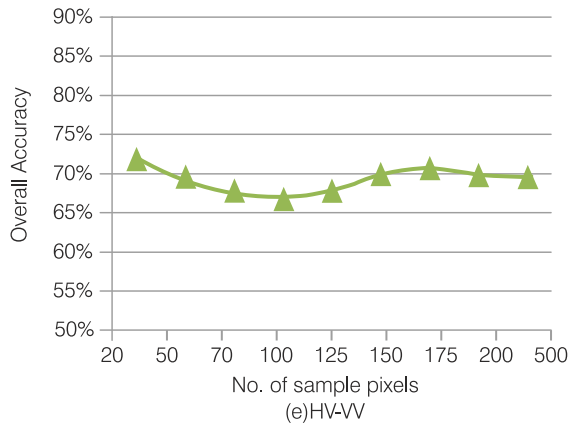


Fig.1. Classified Images using MDM technique for HV polarized image









**Fig. 2.** Graphical representation of overall accuracy for (a) HH polarization (b) HV polarization (c) VV polarization (d) HH-HV polarization (e) HV-VV polarization (f) HH-VV polarization (g) HH-HV-VV polarization

TABLE II. SEPARABILITY INDEX

	URBAN- VEGETATION	VEGETATION- WATER	WATER- URBAN
HH	0.96	0.68	1.60
HV	1.56	2.74	4.71
VV	0.89	0.36	1.26
LL	1.30	3.18	5.16
LR	1.18	0.53	1.59
RR	1.52	3.70	6.02

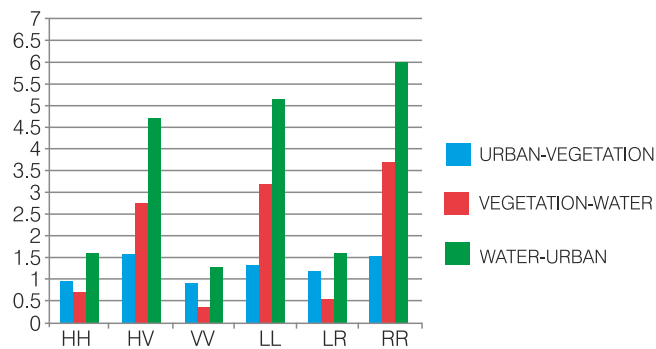
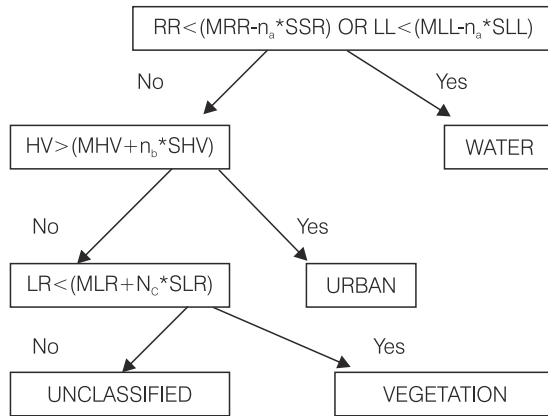


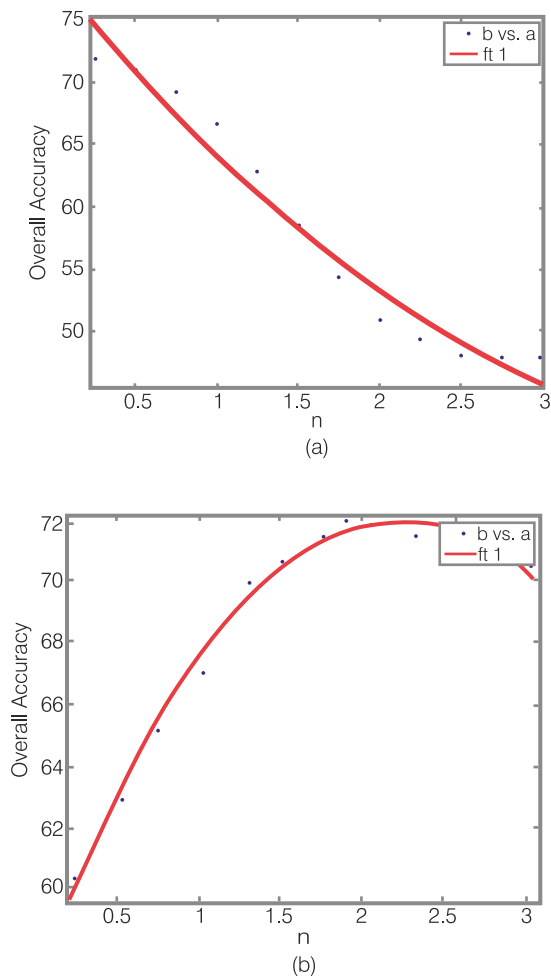
Fig.3. Graphical representation of separability index of class pairs

TABLE III. STATISTICS OF WHOLE IMAGE FOR POLARIMETRIC INDICES

Feature	Min	Max	Mean	Standard deviation
HH	-33.782	6.989	-15.384	3.462
HV	-42.100	-3.304	-24.732	4.543
VV	-36.496	6.989	-15.763	3.258
RR	-36.188	6.578	-20.558	3.965
LR	-33.838	6.989	-16.245	2.580
LL	-35.271	6.270	-20.635	3.891



**Fig.4.** Decision Tree where MRR is the mean of RR image and SSR is the standard deviation of RR image. MHV is the mean of HV image and SHV is the standard deviation of HV image. MLR is the mean of LR image and SLR is the standard deviation of LR image



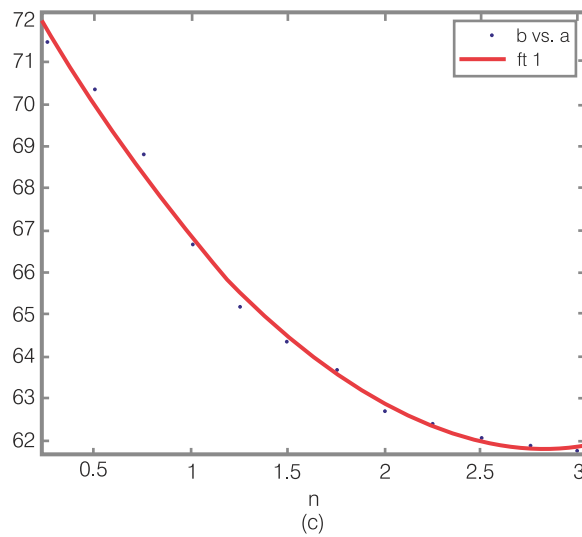


Fig.5. Curve Fitting Plots (a) when navaries (b) when nb varies (c) when nc varies

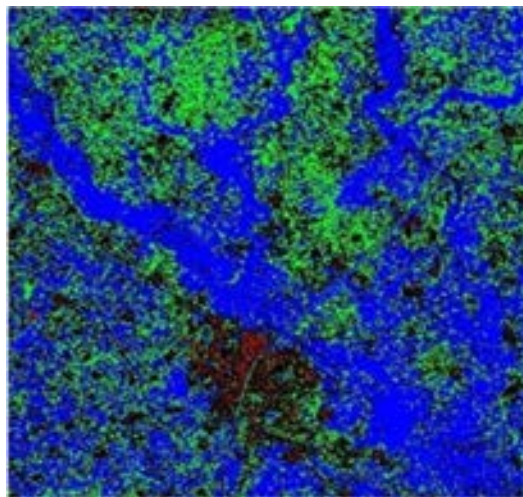


Fig.6. Decision Tree Classification image

TABLE IV. CONFUSION MATRIX FOR OVERALL ACCURACY ASSESSMENT

Class	Producer Accuracy (percent)	User Accuracy (percent)	Producer Accuracy (Pixels)	User Accuracy (Pixels)
Urban	96.51	86.91	166/172	166/191
Vege- tation	60.71	73.91	17/28	17/23
Water	72.82	84.27	75/103	75/89

Overall Accuracy = (258/303) 85.1485%

## IV. CONCLUSION

In this paper, first of all we have analysed the effect of sample size on accuracy assessment and subsequently developed an adaptive approach for classification of PALSAR images based on separability index. It was observed that for smaller sample size, the overall accuracy is quite high but as the sample size is increased, the overall accuracy decreases but after sample size of 175, it is approximately constant. This sample size can be considered as optimum sample size for evaluation of accuracy. Further separability index was used to analyse the class separability in different polarized images. Based on separability index, a decision tree was developed which only utilizes the image statistics such as minimum, maximum, mean and standard deviation to classify the images. Based on the image statistics, optimum parameters were evaluated with Genetic Algorithm to decide the final decision criterion for each class. The classified result shows good overall accuracy of 85.14%.

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# Cloud Computing: Overview and Research Issues

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**Abstract** - The computational world has become very large and complex. Cloud is an emerging technology in the world of Information Technology. Cloud computing offers IT capabilities as services. Cloud based services are on demand, scalable, device independent and reliable. Cloud computing is built on the virtualization concept. Virtualization separates hardware from software and has benefits of server consolidation and live migration. Virtualization is the process that turns the hardware bound entity into a software based component in the form of virtual machine. In this paper we present an overview of cloud computing and also describe about its key technology "virtualization". We are also presenting research challenges in cloud computing.

**Keywords** - Cloud Computing, Virtualization; Virtual machine.

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## I. INTRODUCTION

IT resources have become more powerful, cheaper, and can be accessed from anywhere due to Internet and also the processing and storage technologies development. Cloud

computing is the latest evolution of computing for hosting and delivering services over the Internet. Cloud computing is not a new idea, after launching of the Amazon EC2 [1], cloud computing buzz began in 2006. Cloud computing delivers application and IT capabilities as a service over the Internet using third party. Resources (CPU, storage etc.) are delivered as general utilities that are leased and released by user over Internet in pay-as-you-go and on demand basis. It is very attractive for business owners who can start from small and increase resources only if there is rise in service demand. Many different businesses and organizations have adopted the concept of the cloud computing. Cloud computing enables consumer and businesses to use application without installation and they can access their files on any computer through Internet. Cloud computing delivers software (application) as a service, infrastructure as a service, and platform as a service. Examples are Amazon's EC2 [1] Google's App Engine [2], Microsoft Azure [3], IBM SmartCloud [4] etc. The definition of cloud computing is standardized by NIST (National Institute of Standards and Technology) [5] as,

"Cloud computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, server, storage, application, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

Cloud model is composed of five essential characteristics: On-demand self service, Broad network access, Resource pooling, rapid elasticity and measured service. It consists of three service models and four deployment models which are defined and agreed in the NIST.

### **Essential characteristics:**

- **On-demand self service:** It ensures that a consumer can one-sidedly provision computing capabilities such as server time and network storage automatically without requiring human interaction with each service provider.
- **Broad network access:** It gives access to capabilities available over the network through standard mechanisms.
- **Resource pooling:** It pools computing resources to serve multiple consumers. Different physical and virtual resources dynamically assigned and reassigned according to consumer demand. Examples of resources include storage, processing, memory, and network bandwidth.
- **Rapid elasticity:** It is used to elastically provision and release capabilities or resources. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.
- **Measured service:** Cloud system control and optimize resource used by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). For both, the provider and consumer of the utilized service, resource usage can be monitored, controlled, and reported, and also provide transparency.

### **Advantages of Cloud Computing**

Most often, what makes organizations consider the cloud is the reduced cost. As customers are charged per execution-hour or gigabyte of storage, they do not need to worry about hardware maintenance and upgraded costs or the additional cost that comes with underutilized physical systems. The use of virtualization allows for easy scalability, whether by duplicating instances or by changing the amount of CPU and memory available on a virtual machine. Mobility has several advantages. The location and placement of resources in the cloud is not a factor in accessing the information. A benefit is that the execution environment and data can be placed closer to the location of highest demand. The cloud computing environment moves the administration of the physical systems to the cloud provider, creating a central administration of cloud services. This allows customer's IT departments to focus on their organizations solutions. Most cloud providers have several locations where they host customer data. This distributed approach to resources creates system redundancy. If portions of the resources go down, it will have minimal affect on the other resources.

## Disadvantages of Cloud Computing

The biggest operational disadvantage is the lack of interoperability between providers. This has occurred mainly as organizations have built their cloud and are keeping the structure, architecture, and framework private. Even though many cloud providers' market 99% or more service availability, many applications are not well suited for use in the cloud. Two application types include those of high-availability and real-time environments. When data is stored on the cloud, there is an expectation that it is frequently backed up to alternate locations. This is not always the case.

Organizations that do not have separate and distinct data back-up locations from the cloud provider alternate locations for back-up data are at risk of losing their business data and potentially customers if things go wrong. The biggest concerns with the cloud are security and privacy.

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## II. CLOUD COMPUTING MODEL

### A. Service Model

In cloud computing everything is provided as a service (XaaS). Services may be in the form of hardware, software, storage, platform, infrastructure database and many more.

NIST presented three major categories of services, known as service model which are given below:

1. **Software as a service (SaaS):** Software (application) is delivered over Internet. Software, which runs on provider's cloud infrastructure, is delivered to multiple clients (on demand) through web browser over the Internet. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings. Examples are: Google Docs and Salesforce.com.
2. **Platform as a service (PaaS):** Platform is provided to the client to build (develop, test, deploy) the applications. The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications. Examples are Microsoft Azure and Google App Engine.
3. **Infrastructure as a service (IaaS):** It offers users elastic on demand access to resources (server, storage, networking) through service API. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications and possibly limited control of select networking components such as host firewalls. Cloud providers typically bill IaaS service on a usage basis, cost reflects the amount of resources allocated and consumed. Amazon EC2 is good example of IaaS.

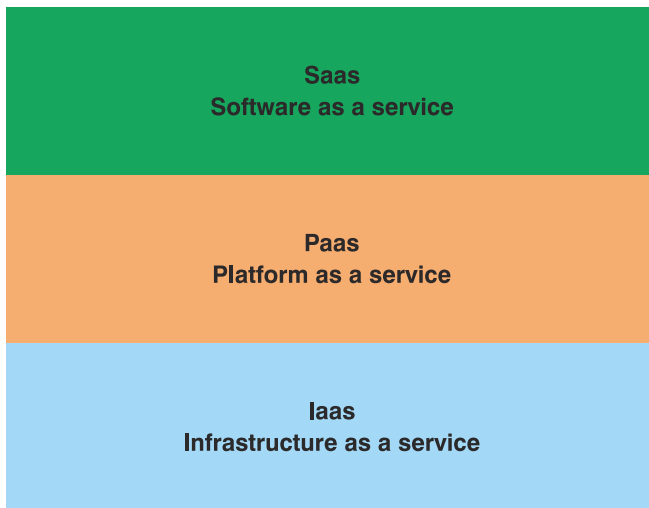


Figure 1.1 Service Model

## B. Deployment Model

NIST has given four deployment models which decides the user criteria means under which model who can access the services. Deployment model is shown in figure 1.2.

1. **Public Cloud:** Cloud infrastructure is provided to the public, it is a mega scale infrastructure. Public cloud run by the third parties e.g. Amazon, Google which provides their services to users via Internet. A public cloud is available for public as pay-as-you-go manner, not limited on the basis of users.
2. **Private Cloud:** It is also known as internal cloud. Cloud infrastructure is provisioned by a single organization which has full control over the applications run on infrastructure for specific use. Private cloud has no restriction of network bandwidth, security.
3. **Hybrid Cloud:** It is composition of two or more distinct cloud infrastructure. It allows, an organization can run some application on internal infrastructure and other can be run on public cloud. Hybrid cloud environment has multiple internal and/or external providers. It offers more flexibility than both public and private cloud.
4. **Community Cloud:** Cloud infrastructure is provisioned by a specific community. Multiple organizations make cloud infrastructure and share it. They also share policies, requirements and values. Cloud infrastructure is hosted by third party vendor or could be hosted by one of the organizations within community.

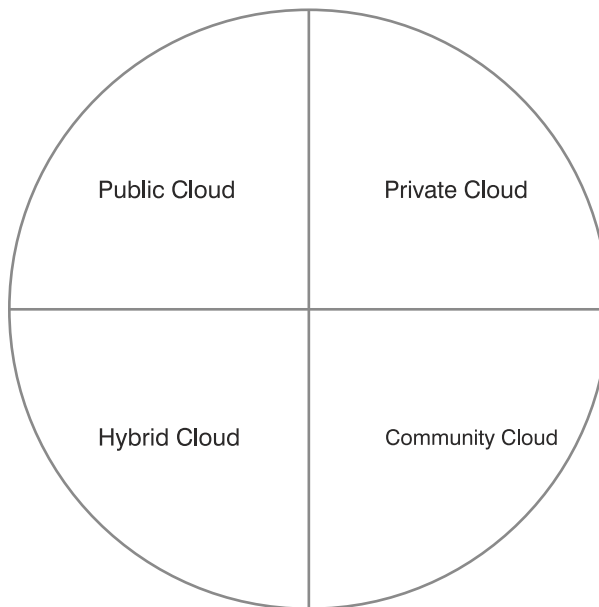


Figure 1.2 Deployment Model

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### III. VIRTUALIZATION: THE KEY TECHNOLOGY OF CLOUD COMPUTING

Virtualization technology was developed by IBM in 1960 to maximize the utilization of hardware resources. The powerful and expensive mainframe computers were underutilized. Virtualization is the abstraction of the physical resources needed to complete a request and underlying hardware used to provide service. It splits up a physical machine into several virtual machines.

#### 1.2.1 Virtual Machine

A virtual machine can be defined as, "*It is a software implementation of a computing environment in which an operating system or program can be installed and run*". [6]

Virtual machines run operating systems add sometime called virtual server. A host operating system can run many virtual machines and shares system hardware components such as CPUs, controllers, disk, memory, and I/O among virtual servers [7]. Virtualization runs the entire virtual machine including its own operating system, called guest operating systems on another operating system, called host operating system. The real machine is essentially a host system with no virtual machines. The real machine operating system accesses hardware components by making calls through a low-level program called the BIOS (basic input/output system).

#### History

Virtual machines have been in the computing community for more than 40 years. Melinda Varian [8] introduces virtual machine technology, starting with the Compatible Time-Sharing System (CTSS). Varian described the creation, development, and use of



virtual machines on the IBM OS/360 Model 67 to the VM/370 and the OS/390. In 1973, Srodowa and Bates [9] demonstrated how to create virtual machines on IBM OS/360s. The 1980s and early 1990s brought distributed computing to data centers. Centralized computing and virtual machine interest was replaced by standalone servers with dedicated functions: email, database, Web, applications. The virtual machine was created on the mainframe. It has only recently been introduced on the mid-range, distributed, x86 platform. Technological advancements in hardware and software make virtual machines stable, affordable, and offer tremendous value, given the right implementation. Virtualization provides increased efficiency and a reduction in physical resources. It can be defined as [10], "Virtualization is a framework or methodology of dividing the resources of a computer into multiple execution environments, by applying one or more concepts or technologies such as hardware and software partitioning, time-sharing, partial or complete machine simulation, emulation, quality of service, and many others."

Examples of popular virtualization software are VMware ESX / ESXi [11], Virtual PC [12], Xen [13], and Microsoft Hyper-V [14], KVM [15], Virtual-Box [16]. VirtualBox and KVM are commonly associated with linux environments. Virtualization has ability to run multiple operating systems concurrently on single physical host as shown in Figure 1.3 and Figure 1.4. Virtualization technology organizes the computing resources flexibly and it unscrambles the hardware and software architecture dependency. Virtualization technology also facilitates resource sharing, cost efficiency, fault tolerance, application isolation, portability. Virtualization products differentiate themselves by how they virtualize the environment. There are several different ways environments can be virtualized. These virtualized environments are being monitored and executed by a software component that manages all virtual machine executions known as the virtual machine monitor or hypervisor. The main advantage of virtualization is to provide better resource utilization by running multiple VMs on a single physical host. The main advantage of virtualization is to provide better resource utilization by running multiple VMs on a single physical host. Virtualization provides benefits of consolidation and virtual machine migration. Virtual machine migration avoids the process level problem such as residual dependencies [17], a process dependency on its original (source) node. It has many benefits like load balancing, energy saving. Virtualization provides benefits of consolidation and virtual machine migration. Virtual machine migration avoids the process level problem such as residual dependencies [17], a process dependency on its original (source) node. It has many benefits like load balancing, energy saving. Hypervisor separates the hardware resources and provide the virtual machines (VM). VMs act like real physical machines; they use their virtual hardware resources. The hypervisor is also commonly referred to as a host (or dom0 of Xen nomenclature). The virtual machines are referred to as guests (or domU's for Xen, where U is an integer larger than 0, each referring to a different virtualized guest). VMware and Xen provide the capability to live migrate virtual operating systems through the tools VMotion and XenMotion respectively.

### **1.2.2 Types of Virtualization**

There are two main types of virtualization:

## Server Virtualization

This is the most common type which splits up a single physical server into several virtual servers. In server virtualization, virtual machine can be created on the host operating system, using hypervisor or it can be directly created on the hardware. For this purpose two types of hypervisor type-1 or bare metal and type-2 or hosted are used.

**Type I (Bare Metal):** In this type, VMM (Virtual Machine Monitor) is installed as a primary boot system on the hardware. Bare metal hypervisors run directly on the hardware and control the hardware and manage the guest operating system i.e. VMM has full control over all virtual machines. Examples are: Citrix XenServer [18], VMware ESX/ESXi, KVM, and Microsoft Hyper-V hypervisors.

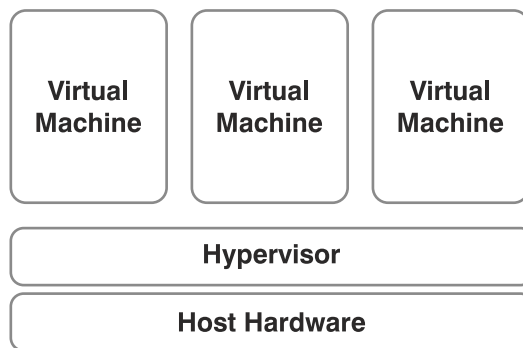


Figure 1.3 Bare-Metal Virtualization

**Type II (Hosted):** In this type hypervisors run within conventional operating system environment. Hypervisor is installed on the host operating system. Above hypervisor layer guest operating systems or virtual machines are installed. Examples are: VMware Workstation [19] and VirtualBox.

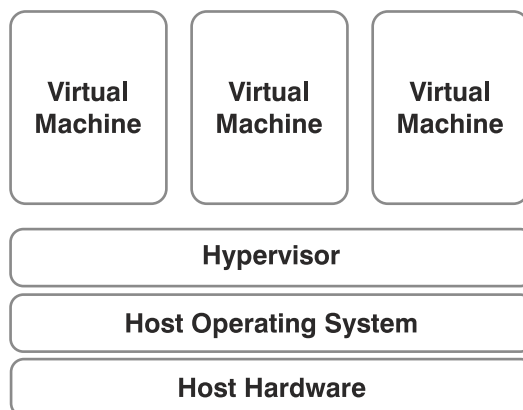


Figure 1.4 Hosted Virtualization

## Advantages of virtualization

- **Efficient use of hardware:** The typical conventional server runs only one major application (e.g. Exchange) and might be using only 10-15% of its processing capacity. Virtualized hardware works hard and is more cost effective, particularly if it is running many virtual servers.
- **Better and cheaper backup and disaster recovery:** A virtual computer can be backed up very easily as an "image" - unlike conventional backups, which require complex and often expensive software. The images can be restored onto dissimilar hardware, unlike conventional backups, which often can't. The image can be brought up almost instantly. This provides a working service while the primary computer is restored, and dramatically reduces downtime. It's also very fast and easy to roll back a computer to a previous version, instead of having to fix it in, say, the case of a virus infection.
- **Better management:** Virtual computers can be centrally and efficiently managed. Central administration and "locked-down" desktop environments dramatically reduces support costs. Software can be installed and updated quickly and automatically across a virtual network. Virtual test machines can be created almost instantly so that testing can be done without any disruption of live machines.
- **Ability to set up and test new machines:** This can be done easily and with no disruption to live services.
- **Less network infrastructure:** Fewer physical machines mean less physical infrastructure - meaning lower purchase costs and less maintenance.
- **Lower power and cooling costs:** This is particularly relevant to data centres organizations with many servers.
- **Lower co-location costs:** Fewer physical servers take up less space, slashing collocation costs. This has allowed the hosted application industry (e.g. hosted Exchange, hosted QuickBooks) to fly.
- **Better security:** Virtualization can provide centralized and secured computing environments. Desktop virtualization takes data off individual workstations and laptops, removing the risk of data loss through physical theft or loss of desktop machines.

## Disadvantages of virtualization

- **Single point of failure:** If a virtualized server fails, the entire organization can be paralyzed. If a company uses virtualized desktops and the central hosting server goes down, users can literally do nothing on their desktops compared with conventional desktops where users can keep functioning even if the network is down, and a single desktop failure doesn't impact anyone else. This is a significant downside and no virtualized system should be put in place without proper contingency planning.
- **More powerful hardware needed:** Virtualization uses fewer servers, and uses them better, but because they need to be more powerful, the reduction in total hardware costs may not be as dramatic as expected.

- **Greater demands on the network:** Network and bandwidth requirements will be greater. If the virtualized server is hosted remotely, adequate and redundant bandwidth are needed, and this can push running costs.
- **Complexity:** Virtualization increases complexity on a computer, making it harder to manage and troubleshoot, particularly if it is not properly set up and documented. Without good automation tools, a virtual server can be almost impossible to manage.
- **Potential security problems:** Some sources feel that security can be more difficult to manage on a virtualized system. New forms of attack could target the virtualization software itself - though so far this has not happened.
- **Third-party support issues:** Some vendors may not be willing or able to support their software if it is running on a virtual server.
- **Lower tolerance for poor management:** Operators of virtualized systems have to manage and document virtual environments properly. If they do not, they could end up with a messy jumble of virtual machines that can be costly in terms of time and unnecessary licences.

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## IV. RESEARCH CHALLENGES IN CLOUD COMPUTING

Cloud computing is emerging technology which is being adapted by big organizations as well as by small organizations. Due to complex and hybrid cloud computing architectures, many challenges arise. The research on cloud computing is still at an early stage. Many existing issues have not been

fully addressed, while new challenges keep emerging from industry applications. Some of the challenging research issues in cloud computing are given below:

- Service Level Agreements (SLA's)
- Cloud Data Management & Security
- Data Encryption
- Migration of virtual Machines
- Interoperability
- Access Controls
- Energy Management
- Multi-tenancy
- Server Consolidation
- Reliability & Availability of Service
- Common Cloud Standards
- Platform Management

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## V. CONCLUSION AND FUTURE WORK

In this paper, we present an overview of cloud computing. We also present its advantages and disadvantages and service and deployment model. We focus on its key technology "virtualization" and its types. Cloud computing is digital era technology

which still has many research challenges which we mentioned in our paper. We believe that there are still several areas in cloud computing that require researcher's attention. In future we will have a detail study about cloud computing issues.

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# Image encryption using Pixel shuffling method in DOST and complex wavelet domain

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**Abstract:** Images are encrypted to provide the secure transmission over the network. To encrypt, image processing concepts play very important role. With this motivation, this paper is proposed image encryption in discrete orthonormal Stockwell transform (DOST) and complex wavelet domain. For image encryption, pixel shuffling method and Arnold transform is used in DOST domain. The proposed methods are compared and analyzed the performance using mean error, PSNR and Entropy difference. The obtained results are better in compare to existing methods.

**Keywords:** Arnold transforms; block shuffling; wavelet transform.

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## 1. Introduction

In digital science, images are widely used to transmit over the internet. Some of the organizations need the secure transmission as well as encrypted data. In case of images, the data are more need to secure, because image contains many objects, like line, circle and so on. Every object has own significance. So we have to take care for image encryption.

Various methods [1-5] have been explored for image encryption. In spatial domain, pixels are directly manipulated by shuffling the position of the pixels. However, this can be resolved by many efforts. For that, transform domain is very popular to encrypt the images.

Wavelet transform is one of the popular domain, where image is decomposed into low and high frequency components. These components are separately used for encryption. DES, RSA and many other cryptography algorithms can be used for image encryption. But to high complexity, these algorithms are not so popular [6]. An encryption scheme which runs very slowly, even may have higher degree of security features would be of little practical use for real time processes [7-8]. Other than, Arnold transform and pixel shuffling methods are very popular because of their simplicity and accuracy of decryption.

The digital images have certain characteristics such as: redundancy of data, strong correlation among adjacent pixels, being less sensitive as compared to the text data i.e. a tiny change in the attribute of any pixel of the image does not drastically

degrade the quality of the image and bulk capacity of data etc [9-10]. Dual tree complex wavelet transform also popular to give better directional information in compare to wavelet transform.

With this motivation, this paper has the following structure: section II is about discrete orthonormal Stockwell transform (DOST), section III gives information on the proposed algorithm employed for the encryption process, section IV represents the results and discussion and section V concluded the paper.

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## 2. DOST

The DOST [11] is a pared-down version of the fully redundant ST transform. In the sense of multiresolution, less temporal resolution is required for a lower frequency band based on the sampling theorem. As discussed in the previous chapter, the ST has redundantly stored an equal amount of data in each low frequency band as in each high frequency band, despite the fact that the Nyquist criterion indicates that these two bands have very different sampling requirements.

The 2-D ST is a separable transform, as is the 2-D DOST. For a better comparison between the coefficients, the plot of the coefficients is in log-scale. Figure 1 shows the logarithm of the magnitude of the 2-D DOST coefficients for a popular example image, Lena. As we can see, the coefficients decay very quickly, which makes the DOST a powerful tool for image compression and other applications. Moreover, the DOST coefficients decay in a consistent way. As you can easily observe from the log-scale magnitude plot, there are still small "Lenas" on each corner of the plot. And even for the square and rectangular blocks inside the plot, where frequency bands with respect to different spatial axes of the image overlap, the stretched "Lenas" are still visible. Figure 2 gives the impression of how the DOST coefficients distribute in an ordered 2-D expression.

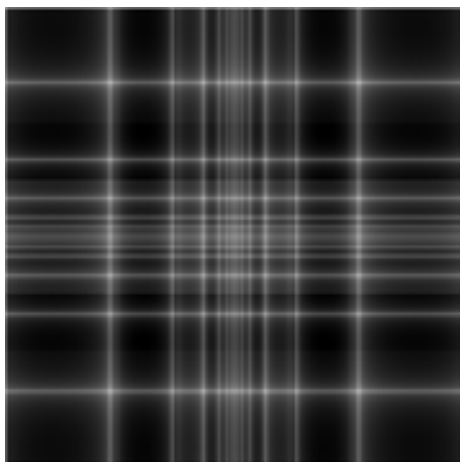


Figure 1: Logarithm of the DOST coefficients of an image with one white dot.





Figure 2: Lena and the logarithm of its DOST coefficients.

### 3. Proposed Architecture of Image Encryption

The overview of proposed scheme is summarized in the following steps where block-wise Arnold map and pixel chaotic shuffle is used. DOST based Dual-tree complex wavelet transform is also used as secured structures so that the original information of edges may not loose.

The following steps are processed as:

**Step 1:** Perform Dual-tree complex wavelet transform to obtain two approximations and six detail parts.

**Step 2:** Approximation and detail parts of image are processed using DOST.

**Step 3:** Apply Arnold equation for each DOST coefficients of Approximation parts where Arnold transformation is used, as given below:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \times \begin{bmatrix} x \\ y \end{bmatrix} \mod n$$

**Step 4:** Over the detail parts, DOST is performed and encryption is applied using pixel chaotic shuffle method, as given below.

- a) Initial values are selected to create chaotic variable sets.
- b) A sequence is generated of each dost coefficients.
- c) Transfer 2D matrix into 1D.
- d) Perform the shuffle function circularly in random times.

**Step 5:** Apply Inverse DOST and inverse dual tree complex wavelet transform to reconstruct the images.

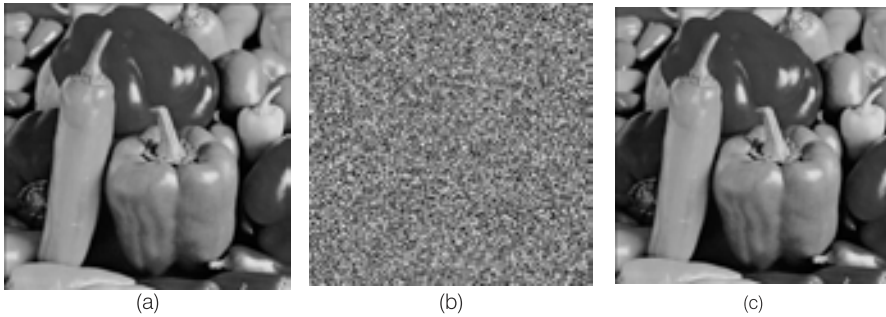
### 4. Results of Experiment and Analysis

The results are obtained on images with size 512 x 512 using proposed method.

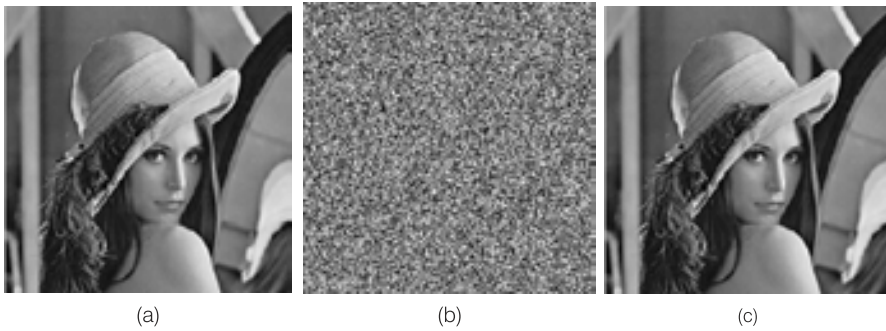
The Stockwell transform (ST) provides a continuous and infinitely differentiable kernel

function and a full decomposition over the spatial-frequency domain. The orthonormal version of the Stockwell transform is the Discrete Orthonormal Stockwell transform (DOST) discussed earlier, which gives a spatial-frequency decomposition with no redundancy. In this paper, we use an image compression experiment to demonstrate the advantages of the DOST by analyzing the peak signal to noise ratio (PSNR), MSE and Entropy difference.

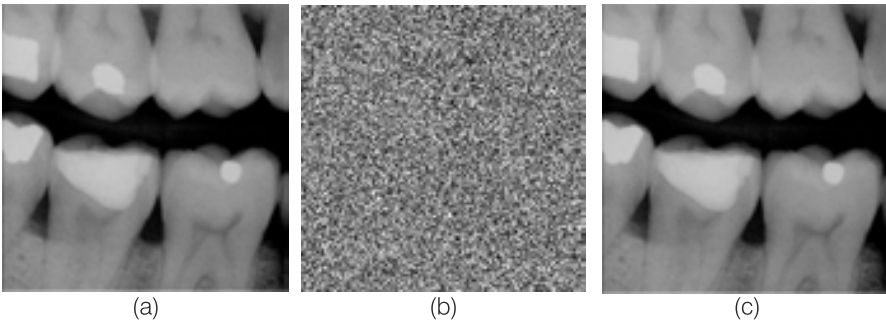
Results are shown in fig 3, fig 4, fig 5 and fig 6. Original images are fig 3(a), fig 4(a), fig 5(a) and fig 6(a). Encrypted images are fig 3(b), fig 4(b), fig 5(b) and fig 6(b) and Decrypted images are fig 3(c), fig 4(c), fig 5(c) and fig 6(c).



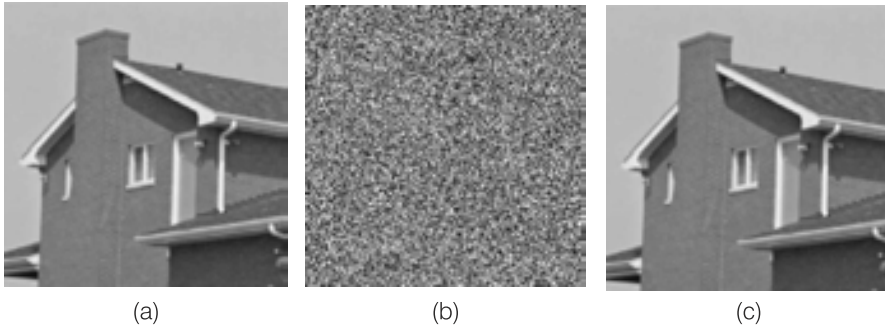
**Figure 3:** (a) Original Peppers: Jellyfish (b) Encrypted image and (c) Decrypted image



**Figure 4:** (a) Original image: Lena (b) Encrypted image and (c) Decrypted image



**Figure 5:** (a) Original image: Teeth (b) Encrypted image and (c) Decrypted image



**Figure 6:** (a) Original image: House (b) Encrypted image and (c) Decrypted image

To measure the performance of proposed methodology, PSNR, Mean error and entropy difference (ED) for original and decrypted images are calculated and given in Table 1, 2 and 3. To measure the performance of proposed methodology, a comparison is done with some standard existing schemes. The higher value in PSNR indicates better results. While, Mean error and ED represents best which contains less value.

From table 1,2 and 3, we can analyze that the value of mean error and entropy difference is very less, near to zero. It means our decrypted image is almost same as original image.

**Table 1:** PSNR, Mean error and ED of method [2]

Input Images	PSNR	Mean error	Entropy difference (ED)
Peppers	38.03	0.0414	0.4245
Lena	38.12	0.0226	0.8121
Teeth	38.12	0.0932	0.3351
House	37.91	0.0854	0.5351

**Table 2:** PSNR, Mean error and ED of method [2]

Input Images	PSNR	Mean error	Entropy difference (ED)
Peppers	38.11	0.1256	0.2452
Lena	37.22	0.2352	0.3214
Teeth	37.66	0.1468	0.5232
House	37.23	0.1356	0.2335

**Table 3:** PSNR, Mean error and ED of proposed method

Input Images	PSNR	Mean error	Entropy difference (ED)
Peppers	41.13	0.0123	0.1356
Lena	40.12	0.0763	0.7889
Teeth	40.77	0.0233	0.0123
House	39.99	0.0231	0.0567

## 5. Conclusions

The proposed method is used the concept of the dual tree complex wavelet transform and DOST with Arnold and pixel shuffling method. A comparison is also done with some standard existing schemes. From experimental analysis, it can be clearly said that proposed method gives better results. The advantages of DOST and dual tree complex transform also make strong the proposed method.

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# A review of latest security approaches for Cloud Based Storage (CBS) Systems.

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## Abstract:

With the rapid development in emerging technology and business paradigm, Cloud Computing has taken commercial computing by storm. Cloud computing platforms provide easy access to a company's high-performance computing and storage infrastructure through web services. We consider the problem of building a secure cloud storage service on top of a public cloud infrastructure where the service provider is not completely trusted by the customer. We describe, at a high level, several architectures that combine recent and non-standard cryptographic primitives in order to achieve our goal. We survey the benefits such architecture would provide to both customers and service providers and give an overview of recent advances in cryptography motivated specifically by cloud storage.

**Key words:** cloud computing, cloud storage, architecture, cryptographic key, token.

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## I. INTRODUCTION

Software testing Cloud computing portends a major change in how to store information and run applications. Instead of running programs and data on an individual desktop computer, everything is hosted in the "cloud"-a nebulous assemblage of computers and servers accessed via the Internet. Cloud computing lets you access all your applications and documents from anywhere in the world, freeing you from the confines of the desktop and making it easier for group members in different locations to collaborate. Advances in networking technology and an increase in the need for computing resources have prompted many organizations to outsource their storage and computing needs [3].

This new economic and computing model is commonly referred to as cloud computing and includes various types of services such as: infrastructure as a service (IaaS), where a customer makes use of a service provider's computing, storage or networking infrastructure; platform as a service (PaaS), where a customer leverages the provider's resources to run custom applications; and finally software as service (SaaS), where customers use software that is run on the provider's infrastructure [2].

Cloud infrastructures can be roughly categorized as either private or public. In a private cloud, the infrastructure is managed and owned by the customer and located on premise (i.e., in the customers region of customer data is under its control and is only granted to parties it trusts. In a public cloud the infrastructure is owned and managed by a cloud service provider and is located on premise (i.e., in The service provider's region of control). This means that customer data is outside its control and could potentially be granted to untrusted parties [1].

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## 2. SECURITY SERVICES

To address the concerns outlined above and increase the adoption of cloud storage, we argue for Designing a virtual private storage service based on recently developed cryptographic techniques. Such a service should aim to achieve the best of both worlds by providing the security of a private cloud and the functionality and cost savings of a public cloud [2].

**Confidentiality:** the cloud storage provider does not learn any information about customer data.

**Integrity:** any unauthorized modification of customer data by the cloud storage provider can be detected by the customer, while retaining the main benefits of a public storage service: Availability: customer data is accessible from any machine and at all times [4].

**Reliability:** customer data is reliably backed up. Efficient retrieval: data retrieval times are comparable to a public cloud storage service [3].

**Data sharing:** customers can share their data with trusted parties. An important aspect of a cryptographic storage service is that the security properties described above are achieved based on strong cryptographic guarantees as opposed to legal, physical and access control mechanisms [4].

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## 3. ARCHITECTURE OF A CRYPTOGRAPHIC STORAGE SERVICE

At its core, the architecture consists of three components: a data processor (DP), that processes data before it is sent to the cloud; a data verifier (DV), that checks whether the data in the cloud has been tampered with; and a token generator (TG), that generates tokens that enable the cloud storage provider to retrieve segments of customer data; and a credential generator that implements an access control policy by issuing credentials to the various parties in the system (these credentials will enable the parties to decrypt encrypted files according to the policy).

### 3.1. A Consumer Architecture

Consider three parties: a user Alice that stores her data in the cloud; a user Bob with whom Alice wants to share data; and a cloud storage provider that stores Alice's data. To use the service, Alice and Bob begin by downloading a client application that

consists of a data processor, a data verifier and a token generator. Upon its first execution, Alice's application generates a cryptographic key [3].

We will refer to this key as a master key and assume it is stored locally on Alice's system and that it is kept secret from the cloud storage provider. Whenever Alice wishes to upload data to the cloud, the data processor is invoked. It attaches some metadata (e.g., current time, size, keywords etc) and encrypts and encodes the data and metadata with a variety of cryptographic primitives [4].

Whenever Alice wants to verify the integrity of her data, the data verifier is invoked. The latter uses Alice's master key to interact with the cloud storage provider and ascertain the integrity of the data. When Alice wants to retrieve data (e.g., all files tagged with keyword urgent") the token generator is invoked to create a token[3].

The token is sent to the cloud storage provider who uses it to retrieve the appropriate (encrypted) files which it returns to Alice. Alice then uses the decryption key to decrypt the files. Data sharing between Alice and Bob proceeds in a similar fashion. Whenever she wishes to share data with Bob, the application invokes the token generator to create an appropriate token, and the credential generator to generate a credential for Bob. Both the token and credential are sent to Bob who, in turn, sends the token to the provider. The latter uses the token to retrieve and return the appropriate encrypted documents which Bob decrypts using his credential.

### **3.2. An Enterprise Architecture**

In the enterprise scenario we consider an enterprise MegaCorp that stores its data in the cloud; a business partner PartnerCorp with whom MegaCorp wants to share data; and a cloud storage provider that stores MegaCorp's data. To use the service, MegaCorp deploys dedicated machines within its network. Depending on the particular scenario, these dedicated machines will run various core components [3].

Since these components make use of a master secret key, it is important that they be adequately protected and, in particular, that the master key be kept secret from the cloud storage provider and PartnerCorp.

If this is too costly in terms of resources or expertise, management of the dedicated machines (or specific components) can alternatively be outsourced to a trusted entity. In the case of a medium-sized enterprise with enough resources and expertise, the dedicated machines include a data processor, a data verifier, a token generator and a credential generator.

To begin, each MegaCorp and PartnerCorp employee receives a credential from the credential generator. These credentials will reflect some relevant information about the employees such as their organization or team or role [3].

Whenever a MegaCorp employee generates data that needs to be stored in the cloud, it sends the data together with an associated decryption policy to the dedicated machine for processing [2].

The decryption policy specifies the type of credentials necessary to decrypt the data (e.g., only members of a particular team).

To retrieve data from the cloud (e.g., all files generated by a particular employee), an employee re requests an appropriate token from the dedicated machine. The employee then sends the token to the cloud provider who uses it to find and return



the appropriate encrypted files which the employee decrypts using his credentials [3].

Whenever MegaCorp wants to verify the integrity of the data, the dedicated machine's data verifier is invoked. The latter uses the master secret key to interact with the storage provider and ascertain the integrity of the data [3].

Now consider the case where a PartnerCorp employee needs access to MegaCorp's data. The employee authenticates itself to MegaCorp's dedicated machine and sends it a keyword [3].

The latter verifies that the particular search is allowed for this PartnerCorp employee. If so, the dedicated machine returns an appropriate token which the employee uses to recover the appropriate (encrypted) files from the service provider [3].

It then uses its credentials to decrypt the file. Similarly to the consumer architecture, it is imperative that all components be either open-source or implemented by someone other than the cloud service provider.

In the case that MegaCorp is a very large organization and that the prospect of running and maintaining enough dedicated machines to process all employee data is infeasible, consider the following slight variation of the architecture described above. More precisely, in this case the dedicated machines only run data verifiers, token generators and credential generators while the data processing is distributed to each employee [3].

- (1) Each MegaCorp and PartnerCorp employee receives a credential;
- (2) MegaCorp employees send their data to the dedicated machine;
- (3) The latter processes the data using the data processor before sending it to the cloud;
- (4) the PartnerCorp employee sends a keyword to MegaCorp's dedicated machine ;
- (5) the dedicated machine returns a token;
- (6) the PartnerCorp employee sends the token to the cloud;
- (7) the cloud uses the token to find the appropriate encrypted documents and returns them to the employee.

More precisely, in this case the dedicated machines only run data verifiers, token generators and credential generators while the data processing is distributed to each employee.

- (1) Each MegaCorp and PartnerCorp employee receives a credential;
- (2) MegaCorp employees process their data using their own data processors and send them to the cloud;
- (3) The PartnerCorp employee sends a keyword to MegaCorp's dedicated machine;
- (4) The latter returns a token;
- (5) The employee sends the token to the cloud;
- (6) The cloud uses the token to find the appropriate encrypted documents and returns them to the employee. At any point in time, MegaCorp's data verifier can check the integrity of MegaCorp's data [3].



## **4. BENEFITS OF A CRYPTOGRAPHICALLY SECURED STORAGE SERVICE**

### **1. Confidentiality Assurance**

In a cryptographic storage service, the data is encrypted on- premise by the data processor(s). This way, customers can be assured that the confidentiality of their data is preserved irrespective of the actions of the cloud storage provider. This greatly reduces any legal exposure for both the customer and the provider [4].

### **2. Geographic restrictions**

In a cryptographic storage service data is only stored in encrypted form so any law that pertains to the stored data has little to no effect on the customer. This reduces legal exposure for the customer and allows the cloud storage provider to make optimal use of its storage infrastructure, thereby reducing costs [4].

### **3. Subpoenas**

In a cryptographic storage service, since data is stored in encrypted form and since the customer retains possession of all the keys, any request for the (unencrypted) data must be made directly to the customer [4].

### **4. Reducing Risk of Security Breaches**

Even if a cloud storage provider implements strong security practices there is always the possibility of a security breach. If this occurs the customer may be legally responsible. In a cryptographic storage service data is encrypted and data integrity can be verified at any time. Therefore, a security breach poses little to no risk for the customer [3].

### **5. Data retention and destruction**

In many cases a customer may be responsible for the retention and destruction of the data it has collected. If this data is stored in the cloud, however, it can be difficult for a customer to ascertain the integrity of the data or to verify whether it was properly discarded.

A cryptographic storage service alleviates these concerns since data integrity can be verified and since the information necessary to decrypt data (i.e., the master key) is kept on- premise. Secure data erasure can be effectively achieved by just erasing the master key [3].

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## **5. Implementing the Core Components**

The core components of a cryptographic storage service can be implemented using a variety of techniques, some of which were developed specifically for cloud storage.

### **5.1. Searchable Encryption**

At a high level, a searchable encryption scheme provides a way to encrypt a search index so that its contents are hidden except to a party that is given appropriate tokens. More precisely, consider a search index generated over a collection of files

(this could be a full-text index or just a keyword index). Using a searchable encryption scheme, the index is encrypted in such a way that

- (1) Given a token for a keyword one can retrieve pointers to the encrypted files that contain the keyword; and
- (2) Without a token the contents of the index are hidden. In addition, the tokens can only be generated with knowledge of a secret key and the retrieval procedure reveals nothing about the files or the keywords except that the files contain a keyword in common [4].

#### **5.1.1. Symmetric searchable encryption**

SSE is appropriate in any setting where the party that searches over the data is also the one who generates it. The security guarantees provided by SSE are, roughly speaking, the following:

1. Without any tokens the server learns nothing about the data except its length.
2. Given a token for a keyword  $w$ , the server learns which (encrypted) documents contain  $w$  without learning  $w$ .

#### **5.1.2. Asymmetric searchable encryption (ASE)**

ASE schemes are appropriate in any setting where the party searching over the data is different from the party that generates it [3].

The security guarantees provided by ASE are the following:

1. Without any tokens the server learns nothing about the data except its length.
2. Given a token for a keyword  $w$ , the server learns which (encrypted) documents contain  $w$ .

#### **5.1.3. Efficient ASE (ESE)**

ESE schemes are appropriate in any setting where the party that searches over the data is different from the party that generates it and where the keywords are hard to guess.

#### **5.1.4. Multi-user SSE (MSSE)**

MSSE schemes are appropriate in any setting where many parties wish to search over data that is generated by a single party.

### **5.2. Attribute-based Encryption**

It allows the specification of a decryption policy to be associated with a cipher text. A user can then encrypt a message under a public key and a policy.

Decryption will only work if the attributes associated with the decryption key match the policy used to encrypt the message. Attributes are qualities of a party that can be established through relevant credentials [3].

### **5.3. Proofs of Storage**

A proof of storage is a protocol executed between a client and a server with which the server can prove to the client that it did not tamper with its data. The client begins by encoding the data before storing it in the cloud. From that point on, whenever it wants to verify the integrity of the data it runs a proof of storage protocol with the server.

The main benefits of a proof of storage are that

- (1) they can be executed an arbitrary number of times; and
- (2) the amount of information exchanged between the client and the server is extremely small and independent of the size of the data.

Proofs of storage can be either privately or publicly verifiable. Privately verifiable proofs of storage only allow the client (i.e., the party that encoded the file) to verify the integrity of the data. With a publicly verifiable proof of storage, on the other hand, anyone that possesses the client's public key can verify the data's integrity.

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# An Extensive Survey on Query by Image Content Techniques

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**Abstract** - Query by image content is one of the valuable areas of research in digital image processing. Query by image content is an advance and speedy method of information retrieval. The advancement of social networking medium, so grand set of digital images are changed and uploaded every day. To access the huge collection of database, all the ancient seeking method like Yahoo, Bing, Google are based on the textual glossary of keywords. In this mechanism, all the images are manually annotated with keywords and retrieved using text based search. Hence fulfilments of these systems are not good enough. Hence we need new approach. These approach effortless to grasp the data and can easily approach the data. The QBIC is an approach to get back the images on the ground of naturally derived feature such as colour, texture and shape. It needs digital processing and test to naturally generate description precisely from the media data. QBIC is one of the rising technologies which will affect the socio and economic condition of India and world. In this paper, we survey some of the technical aspect of Query by image content and also we discuss the advantage and disadvantage of QBIC approach.

**Keywords** - QBIC, Texture, colour, shape, feature extraction

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## I. Introduction

In the present time swift development of internet, private networks and development of multimedia technologies, many digital images are transmit every day. The immense number of images has mannered increasing challenges to computer system to store and manage data expertly and fluently. The grouping of large image databases for a departure of application has now expedient. Even the medical and satellite imagery databases have been inducing more and more users in different professional fields [1]. Expertly attaining desired image from large and discrete image database is now urgency. so users are not contented with text based image accessing methods. Query by image content (QBIC) is a technique that helps to access and arrange digital images from large collection of databases by using the image feature. The target of QBIC is to oversight the use of textual description. QBIC is such approaches that will the data handling and the user can easily access the data. So in QBIC, retrieving of images based on affinity in their content like colour, texture, shapes are lower level feature of images.

"Content based" is a process in which search will analyse the substantive contents of the image other than the metadata such as keys, tags and description linked with images. Here the 'Content' refers to the colour and texture knowledge that can be imitative image itself.

The Query by image content has become imperative because most web based image search engine depends merely on metadata and this outcome lot of false detection in the results [2] [3]. Deprivation in text based image retrieval; Query by image content was popularized.



## **II. QUERY BY IMAGE CONTENT**

### **(QBIC) TECHNOLOGY**

Query by image content (QBIC), well known as Content Based Image Retrieval (CBIR) and Content Based Visual Information Retrieval (CBVIR) is the application of computer vision technique to the image retrieval problem, that is the problem of seeking for digital images in huge databases. Query Based Image Content is denying to regular concept based approaches. Unlike keywords based approaches visual based features for Query based image content are extracted from the image itself. The term content might refer to colour, texture, shapes and any other knowledge that can be extracted from the image itself. QBIC is desirable because searches that based purely on metadata are dependent on explanation character and fullness. Having humans manually annotate image by introducing keywords or metadata in large database can be time exhausting and may not capture the keywords desired to describe the image. The interpretation of the validity of keywords images search is intuitive and has been not well defined. It is said in [4] that, there are two retrieval approaches: text-based and content-based. In the text based technique, the images are manually annotated by text. There are two limitations of this approach. One is human labour at considerable level is required for manual annotation. Second is the inaccuracy in annotation due to the subjectivity to the human perception. To overcome these disadvantages in text based retrieval system, Query by image content retrieval system (QBIC) is introduced. It is stated by [5], QBIC is a technique which uses optical detail of image such as colour, texture, shape etc. images are reclaim on the basis of likeness in features where the detail of the query image are compared with feature from the image database to resolve which images match equivalently with given feature It is asserted by [6] the QBIC has three essential bases: Optical features eradication, multidimensional indexing, and retrieval system design. Optical features can be in addition classified as; general features and discipline specific feature. The order includes colour, texture and shape feature. Although the latter is application dependent and may include for example, human faces and finger print. The figure 1 shows the image retrieval system architectural

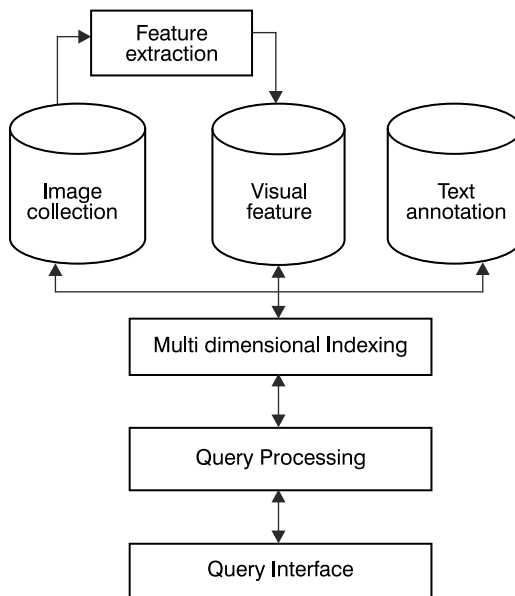


Fig. 1 An Image Retrieval System Approach

The method content based image retrieval derived in the year 1992, and first fabricated by T. Kato. He initiated this approach when he is dealing with experiments that containing the retrieval of images from small database by using their optical component. The approach, tool and algorithm that are used in QBIC originate from pattern recognition, signal processing, linear system and machine vision [8]. Databases are indexed with descriptors derived from the optical feature of the image. Mostly QBIC system are concerned with close queries where the target is to find images optically similar to described target image. Lots of system the target of QBIC approach is to reflect human concept of image likeness as well as feasible [9].

### A. Queries by image content process

QBIC contains six main stage of: image procurement, image pre-processing, content drawing, alikeness matching, resultant retrieval image and user interface and comment.

- 1) Image procurement: It is the first step of the mechanism to gain a digital image from the image database. The image database is collection of n number of images depends on the user range and choice.
- 2) Image preprocessing: It is the mechanism of improving the image in its presentation and better description. It includes drawing, analysis and awareness of image coding, filtering, normalization, segmentation, and object identification. Image segmentation is the method in which image is divided into multiple parts, through this process we get set of significant regions and objects [9].
- 3) Likeness matching: In this method information about each image is stored in its feature vectors for computation process and these feature vectors are distinguished with the feature vector of query image which helps in calculating

the likeness. This stride involves the matching of the above declared content to yield a result that is visually with the use of similarity measure method called as distance method. There are discrete distance methods feasible such as Euclidian distance, Canberra Distance, City Block Distance [10].

- 4) Resultant retrieved images: It is the practice that seeks the previously maintained information to catch the matched images from the databases. The resultant image will be the similar having same and closet content as that of the query image [11].
- 5) User interface and comment: It is the step which controls the display of the outcomes, their ranking, the type of user interaction with chance of elevating the search through some automatic or manual preferences scheme etc
- 6) Content extraction: Content extraction is the basis of Query based image content. There are two types of visual content in QBIC. Like
  1. Primitive Feature: Colour, texture, and shape come under this.
  2. Domain Specific: This is application specific and may include human faces, finger print etc.

## **B. Colour**

Colour is the vital content in retrieving the digital image. Colour space is used to show the color images. The RGB space is where the gray level intensity is represented as the sum of red, green, blue. There are many method to access the color feature like color histogram, color moment etc.

Color histogram is the commonly worn method for color content extraction in digital image. It is one of the most common methods for forecasting the content of image. The huge benefit of color is speed and low memory. Color histogram method is invariable to rotation but it is not invariable to scaling. It is also diverge with the angel of view. Color moments are mainly used for color indexing. The other profit of color moment is: They are good under lightning conditions, the necessity of their storage very low.

Comparison between query image and database image is adapted through the use of some metric which drives the distance or similarity between two histograms. We can use other color feature representation like color moment and color sets have been applied [12].

## **C. Texture**

Texture is second important content of image. Texture representation can be divided in two categories: Structural and Statistical

- 1) Structural Method: It include morphological operator and adjacency graph depict texture by analyzing structural primitives and their placement rule. It works more effectives when applied to texture which are very regular.
- 2) Statistical Method: It include Fourier power spectra, Co-occurrences metrics, shift invariant principal component analysis (SPCA), Tamura feature, world decomposition, Markov random field, fractal model, and multi resolution filtering techniques such as Gabor and Wavelet transform, characterize texture by the statistical distribution of the image intensity.



The six optical contents were coarseness, contrast, directionality, line alikeness, regularity and roughness [13]

#### **D. Shapes**

In image accessing, shapes do not refer to the shape of image but to the shape of particular region that is being sought. Shapes will general be driven first applying segmentation or outline discloser in image. Shapes depiction can be classified in two categories.

- 1) Boundary based which use only the outer boundary of the shape.
- 2) Region based which uses the entire shape regions.

The most profitable characteristics for these two categories are Fourier descriptors and Moment Invariant.

#### **E. Segmentation**

According to [15] in computer vision, image segmentation is the method of portioning digital image into multiple parts. The aim of segmentation is to intelligible or change the representation of an image into something that is more relevant and simple to examine. Image segmentation is generally used to detect object and boundaries (lines, curve etc.). We can just say that image segmentation is the method of allowing a label to every pixel in an image such that pixel with the same label share certain visual characteristic.

The result of image segmentation is a set segment that collectively cover the whole image, or set of contour extracted from the image. Each of the pixels in the boundary is identical with respect to some characteristic or computed property such as color, texture or intensity. Neighboring boundary is significantly dissimilar with respect to the same characteristics [15].

#### **F. Content level**

Most of the researcher obtains affirmation that there is multiple level of content. For example, color, luminance are known as low level content and physical object(like animal, person) are observed as high level content Texture and pattern might be observed as mid level content. However there is no broad agreement about how many levels of content can be recognized by a human, how many type of content there are in each level, or how the content of a specific image might be classified into types and level [16].

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### **III. APPLICATION OF QBIC**

There are various uses of QBIC. Like

1. Shapes identification: identification of Crack and fault in industrial automation.
2. Investigation: face recognition system, Copy right on the Internet.
3. Medical diagnosis: Improve MRI and CT scan understands ability.
4. Journalism, advertising media, fashion graphic design.
5. Art galleries, museums and archeology, trademarks database.
6. Cartography: Synthesis of weather map, map making from photographs.



7. Remote sensing: Various information system, weather forecast, , satellite images.
8. Digital Forensics: Finger prints matching for crime prevention
9. Engineering and Architectural design.
10. Radar Engineering: It helps to detect and identification of target.

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## IV. LITERATURE SURVEY

In [17] NPRF technique is used. This technique has high capability and potency of QBIC in coping with the large scale image data. In terms of capability, the repetitions of feedback are shortened substantially by using the exploration pattern identified from the user query log. It supports a huge set of downloaded images.

In [18] histogram refinement approach is introduced. It lay down additional constraint on histogram based matching. It is called color coherence vector (CCV) which partitions each histogram bucket based on spatial coherence. . CCV's can be computed at over 5 images per second on a standard workstation. Histogram refinement can be used to distinguish images whose colour histograms are indistinguishable.

In [19] new and efficient technique to retrieve images based on sum of the values of Local Histogram and GLCM (Gray Level Co-occurrence Matrix) texture of image sub-blocks to enhance the retrieval performance. Then the color and texture features of each sub-block are computed.

In [20] novel technique for Content-Based Image Retrieval (CBIR) that employs both the color and spatial information of images is proposed. A maximum of three dominant color regions in an image together with its respective coordinates of the Minimum-Bounded Rectangle (MBR) are first extracted. Next the improved sub-block technique is used, in which the total horizontal and vertical distances of a region at each location where it overlaps.

In [21] image sub-block is roughly identified by segmenting the image into partitions of different configuration. The colour and texture features of the identified regions are computed from the histograms of the quantized HSV colour space and Gray Level Co-occurrence Matrix (GLCM) respectively. The shape features are computed from the Edge Histogram Descriptor (EHD). Modified Integrated Region Matching (IRM) algorithm is used for finding the minimum distance between the sub-blocks of the query and target image.

One of the image retrieval approaches is based on Quadrant

In [22] Motif scans from segmented blocks inside an image are the primary notion extract image features. We exploit recursive quadrant segmentation in images and stratify hierarchical regions for matching comparison. Region in the same stratum hold an identical credit, which is used for similarity metric. A peak inspection technique is also added in the QMS matching metric to enhance performance.

In [23] developed an efficient technique for finding the images. In order to find an image, image has to be represented with certain features. An image is partitioned into sub-blocks of equal size as a first step. Colour of each sub-block is extracted by quantifying the HSV colour space into non-equal intervals and the colour feature is

represented by cumulative histogram. Texture of each sub-block is obtained by using gray level co occurrence matrix. A one to one matching scheme is used to compare the query and target image.

In [24] author has proposed that an image and its complement are partitioned into non-overlapping tiles of equal size. The features drawn from conditional co-occurrence histograms between the image tiles and corresponding complement tiles, in RGB colour space, serve as local descriptors of colour and texture. An integrated matching scheme based on most similar highest priority (MSHP) principle used.

In [25] Content-based retrieval of (image) databases has become more popular than before. Algorithm development for this purpose requires testing/simulation tools, but there are no suitable commercial tool on the market. A simulation environment for retrieving images from database according histogram similarities is presented in this paper. This environment allows the use of different colour spaces and numbers of bins. The algorithms are implemented with MATLAB. Each colour system has its own m-files. The phases of the software building process are presented from system design to graphical user interface (GUI).

In [26] authors design and implement a concept-based image retrieval system using feature information, more specifically, edge histogram description. The general edge histogram framework is a novel index mechanism which allows us to describe a content of images. Authors implemented the concept-based image retrieval by employing the knowledge base. Since the knowledge base can specify the relationships among concepts and edge description templates for the related images, it is likely that images can be displayed.

In [27] Efficient content based image retrieval has been proposed in this study by combining shape and colour features and relevance feedback. In this era of digital communication, images are everywhere and these images consist of shape and colour. For true image representation it is necessary to represent the shape correctly semantically. Only in this case accurate matching and retrieval can be performed. For correct image search and retrieval, the proposed method has been proved to be efficient and having better performance with the help of experimental results..

In [28] a new approach for semantics-based image retrieval is proposed. This approach used colour-texture classification to generate the codebook which is used to segment images into regions. The content of a region is characterized by its self-saliency and the lower-level features of the region, including colour and texture. The context of regions in an image describes their relationships, which are related to their relative-saliencies. High-level (semantics-based) querying and query-by-example are supported on the basis of the content and context of image regions.

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## V. CONCLUSION

QBIC is rapid evolution technology with large potential. The objective of this survey is to support an overview of the functionality of Query by image content. This paper provides an extensive survey on content extraction in various QBIC systems and texture analysis with distinct application. Distinct content with their method of representation are reviewed. The area of QBIC is a composite research area that

requires expertise of both computer vision and database. There is numerous application of QBIC in every fields of life like blood cell detection, criminal investigation, image search, archaeology, image search, social networking site, satellite, etc. The field shows to be producing interesting and genuine result, even though it has so far led to less commercial applications.

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# Distributed database management using pipeline concept in cloud computing

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## Abstract

Cloud computing in a distributed environment where many resources and much information can be shared with the help of many protocols. But still cloud computing environment is a challenging role to manage data base. Pipelining is an approach to search the parallel information from distributed environment. In this paper distributed database information is going to provide with the help of pipeline concept in cloud computing environment. Pipeline concept is helpful to get fast information from cloud server to client and also vector pipeline provide the information in the distributed way to client and the server.

**Keywords:** data, distributed database, pipelining, cloud computing.

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## 1. Background

During the last several decades, dramatic advances in computing power, storage, and networking technology have the human race to generate, process, and share increasing amounts of information in dramatically new ways. As new applications of computing technology are developed and introduced, these applications are often used in ways that their designers never envisioned. New applications, in turn, lead to new demands for even more powerful computing infrastructure.

We refer to the hardware and software environment that implements this service-based environment as a cloud-computing environment. Because the term "cloud computing" is relatively new, there is not universal agreement on this definition. Some people use the terms grid computing, utility computing, or application service providers to describe the same storage, computation, and data-management ideas that constitute cloud computing.

Regardless of the exact definition used, numerous companies and research organizations are applying cloud-computing concepts to their business or research problems including Google, Amazon, Yahoo, and numerous universities. This article provides an overview of some of the most popular cloud-computing services and

architectures in use today. We also describe potential applications for cloud computing and conclude by discussing areas for further research.

### **1.1 Introduction to Cloud Computing**

Cloud computing is the delivery of computing services over the Internet. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations. Examples of cloud services include online file storage, social networking sites, webmail, and online business applications. The cloud computing model allows access to information and computer resources from anywhere that a network connection is available. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications.

### **1.2 Why cloud services are popular**

Cloud services are popular because they can reduce the cost and complexity of owning and operating computers and networks. Since cloud users do not have to invest in information technology infrastructure, purchase hardware, or buy software licenses, the benefits are low up-front costs, rapid return on investment, rapid deployment, customization, flexible use, and solutions that can make use of new innovations. In addition, cloud providers that have specialized in a particular area (such as e-mail) can bring advanced services that a single company might not be able to afford or develop.

### **1.3 Amazon Approach to Cloud Computing**

Amazon is best known for selling books online, but they are also actively investing in services that allow developers to take advantage of their computing technology. Amazon Web Services provide developers use of open APIs to access Amazon's vast infrastructure in a manner vaguely reminiscent of timeshared computing. By using these APIs, developers can create interfaces and access the computing infrastructure provided by Amazon on a fee-based schedule, with the ability to grow as needed. Software developers, start-up companies, and established companies in need of reliable computing power are members of a large and growing crowd using Amazon services.

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## **2. Cloud server-client communication**

### **2.1 Ensuring cloud computing performance on data communications networks:**

#### **Part 1**

In this article, we'll define specific communications reference points (RPs) within cloud computing networks so that software designers and network architects can better understand and address specific problems. Each RP presents unique requirements and challenges for creating, maintaining, and managing connectivity. Creating proper communication paths on the network and configuring them correctly at these RPs, or interfaces, will maximize cloud performance. The communication RPs will be defined individually; for each RP we will analyze the type and characteristics of the data

communicated, describe the expected traffic patterns at the RP, and discuss the reliability requirements, the need (or lack thereof) for real-time traffic delivery, quality of service (QoS), and other characteristics.

## 2.2 Defining reference points

Let us consider and define specific communication paths between each pair of communicating elements and specify a reference point for each such path. To identify RPs for cloud communications we identify four primary communication paths. These are:

1. Client Device to Application Server
2. Application Server to Application Server
3. Application Server to Middleware Server

Based on the diagram below, the communications RPs we identify are:

4. Client to Server (Reference Point #1 and #6)
5. Application Server to Application Server (Reference Point #2)
6. Server to Middleware Server (Reference Point #3 and #7)
7. File Server to File Server (Reference Point #4 and #8)
8. File Server to Array Server (Reference Point #5)

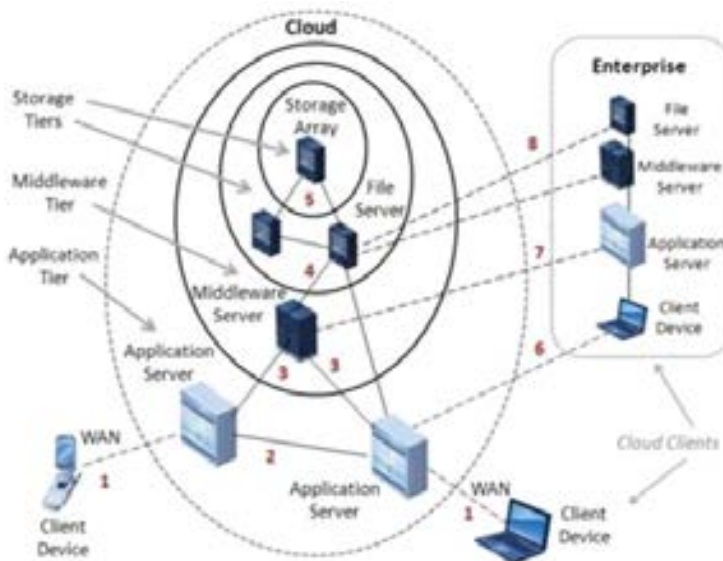


Figure 1. Reference points in a cloud computing network.



Standards-based mechanisms exist that provide the QoS guarantees and performance monitoring for cloud computing applications. Applying these standards to the cloud computing model relatively straightforward. Carrier Ethernet demarcation and aggregation devices are two examples of technology that incorporates the features needed for the high bandwidth and service control necessary for wide-scale cloud deployments.

## **2.3 Ensuring cloud computing performance on data communications networks:**

### **Part 2**

In Part 1 of this three-part series on cloud computing, we introduced you to the concept of reference points (RPs) as a means for software designers and network architects to better understand and address specific problems in the cloud communications infrastructure. Now let's look at one of the most common communication paths within the cloud, the client-to-server reference point, and the challenges faced in delivering a high quality of experience for cloud service users. The client-to-server RP corresponds to communication between a client device and the application server in the cloud. These reference points are labeled 1 and 6 in the diagram I shared with you (see figure 1).

This type of communication happens through the access network, consisting of a combination of intermediate broadband access devices (i.e., cable, DSL, fiber, wireless), switches, routers, and possibly other communication devices. For the public Internet access case (RP1), the communication is likely to happen over an unmanaged network with limited control over quality of service (QoS). For the enterprise case (RP6), communication is likely to happen over a managed network with controlled QoS and other characteristics.

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## **3. Server-to-server-communication**

Server-to-server communication occurs among the application servers within the cloud. This communication happens in very specific and well-defined scenarios. The server-to-server RP is shown at point 2 in the figure above.

An example of server-to-server communication is when the application uses multiple geographically distributed machines to work together to accomplish certain intensive computing tasks. This is sometimes called clustered applications. Often these computers are collocated, and therefore the high bandwidth they require is relatively inexpensive to provision in a data center environment.

### **3.1 Migration Scenario: Migrating Backend Processing Pipeline to the AWS Cloud**

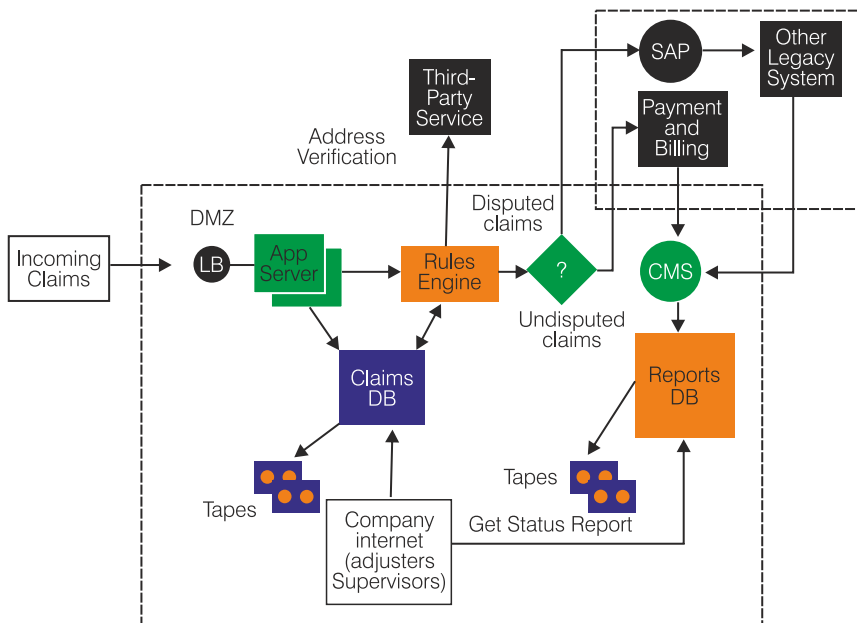


Figure2: Company Carchitecture (Before Migration)

## 4. Data management on cloud server using pipelining concept

### 4.1 Motivation for Migration

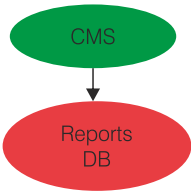
Company C would like to reduce its IT infrastructure investment and cut costs by lowering the total cost of ownership (TCO), and reducing the overall spend on IT administration and storage. Company C has a steady demand for claims processing throughout most of the year. Occasionally, the company gets a surge of claims that needs to be processed, and this puts strain on the current infrastructure. Hence, the company would like to scale on-demand servers without having to provision for peak capacity due to the sunk costs associated with purchasing additional servers upfront.

### 4.2 Cloud Assessment

As a first step company conducted a business assessment of the products and analyzed all licensed products. They found out that AWS has teamed with most of the software and technology vendors who are offering equivalent EC2- based "pay-as-you-go" licensing. During the financial assessment, the company also calculated they would save, hundreds of dollars every month in storage costs by just moving the data from tape drives to Amazon S3 for data backup purposes. The company will be able to use most of the internal system management tools without any major modifications. They learned that the cost of implementing and maintaining a parallel infrastructure to achieve business continuity will be quite less as the "hot site" simply consists of an array of EC2 instances with mounted EBS volumes and a set of pre-configured AMIs.

4.3 Proof of Concept

To validate the technology and familiarize themselves with the AWS platform, the team decided to move the application server, database, of CMS system to the cloud. They moved the the Reports DB and file repository first to Amazon RDS .



4.4 Data Migration

All the old archived data on tape drives were copied to hard drives and shipped to AWS using the Amazon Import/Export Service, which uploaded all data to designated Amazon S3 buckets. Backup of all the new data was handled by a PowerShell script that invoked a scheduled task performing the full database backup to Amazon S3 using command line tools (See Figure 2). In moving the central claims database, the team used standard SQL Server migration tools to move the databases to SQL Server based Amazon EC2 instances. Additional backups were performed using EBS snapshots.



Figure 3: Data Migration from Tape to Amazon S3 using Amazon Import/Export Service

4.5 Application Migration

The Data Migration and Application Migration phases were executed in parallel. The goal of the application migration phase was to create an identical setup (clone) of the claims processing system in the cloud

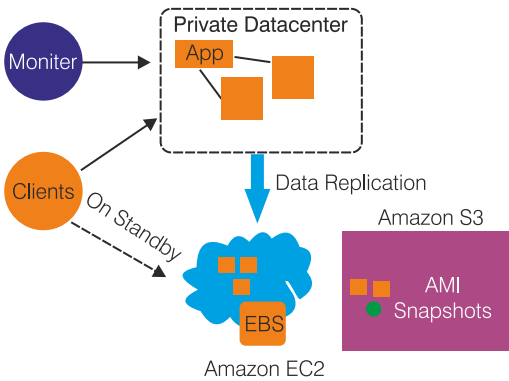


Figure 4

## **5. Methods of distributed database management using pipelining**

### **5.1 PODS Pipeline Data Model**

The PODS Pipeline Data Model provides the database architecture pipeline operators use to store critical information and analysis data about their pipeline systems, and manage this data geospatially in a linear-referenced database which can then be visualized in any GIS platform. The PODS Pipeline Data Model houses the asset information, inspection, integrity management, regulatory compliance, risk analysis, history, and operational data that pipeline companies have deemed mission-critical to the successful management of natural gas and hazardous liquids pipelines.

The PODS Relational Model is implemented on either an Oracle or SQL Server RDBMS, and is therefore GIS-neutral. The PODS ESRI Spatial Implementation is essentially identical in content to the PODS Relational Pipeline Data Model, but was specifically developed as a geodatabase for implementation on the ESRI platform.

This pipe-centric approach to managing pipeline data in a single data repository, a PODS database, helps pipeline owners to collect, verify, manage, analyze, update, maintain, and deliver all the information about their pipelines quickly and reliably to applications and end-users. Since the data records are linked to the pipe segment, re-route, change of service, asset transfer or sale, abandonment, removal, repair, and replacement are all managed within the PODS database.

### **5.2 Distributed query engine pipeline method and system**

A distributed query engine pipeline architecture comprises cascaded analysis engines that accept an input query and each identifies a portion of the input query that it can pass on to an execution engine. Each stage rewrites the input query to remove the portion identified and replaces it with a placeholder. The rewritten query is forwarded to the next analysis engine in the cascade. Each engine compiles the portion it identified so that an execution engine may process that portion. Execution preferably proceeds from the portion of the query compiled by the last analysis engine. The execution engine corresponding to the last analysis engine executes the query and makes a call to the next higher execution engine in the cascade for data from the preceding portion. The process continues until the results from the input query are fully assembled.

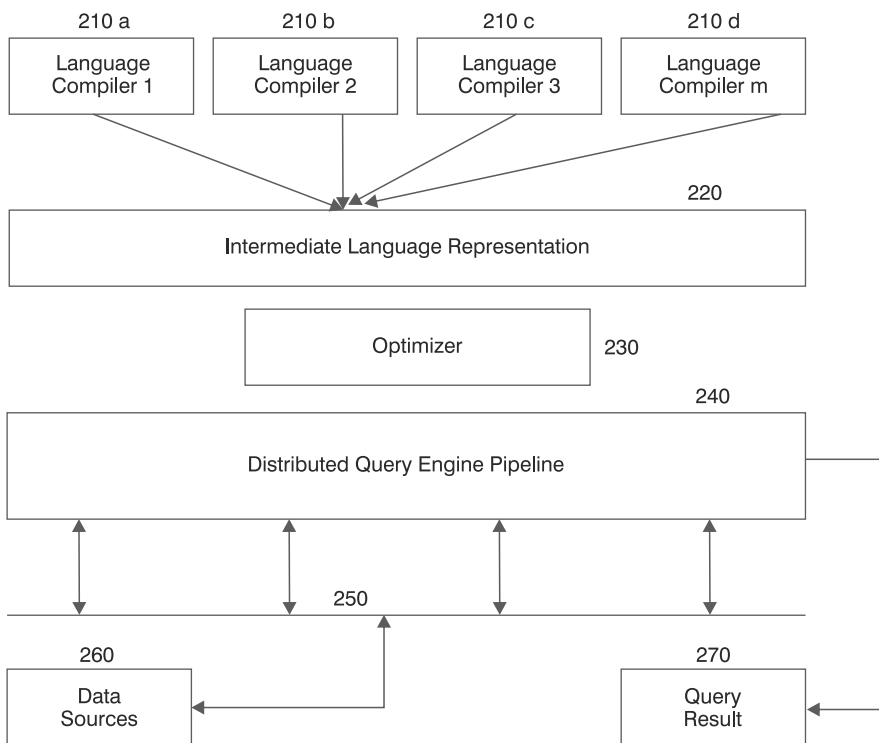


Figure 2

## 6. Futurework

Communication technologies are key enablers of cloud computing. Protocols, traffic management, and control of wide-area communications are rapidly evolving. The reference points defined above are offered to facilitate discussion about communications within the cloud. Applying industry standard techniques to these reference points can assure cloud network designers and application developers robust application performance on cloud networks. More work is being done on cloud communications protocols. As cloud networks grow, new separations will occur between and among cloud elements. New cloud elements will arise. New and specialized APIs to connect cloud elements will be developed.

## 7. Acknowledgements

This paper is an extended version of a position paper contained in the informal SCM proceedings. It was discussed at the workshop. The authors gratefully acknowledge the contributions of the workshop participants.

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# Multiclass Object Classification Using Neural Network Based on Wavelet Transform

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**Abstract** - This paper presents a method for object classification based on wavelet features. The object to be classified is first decomposed with wavelet transform. To reduce the computational cost and improve the efficiency the feature set generated by discrete wavelet transform (DWT) is reduced by the application of principle component analysis (PCA). The feature set is processed by neural network classifier to classify it into one of the given classes. The proposed methodology is evaluated using a dataset having five different types of objects. The results demonstrated that proposed methodology has yielded an accuracy of up to 95%.

**Keywords** - Classification, DWT, PCA, neural network.

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## I INTRODUCTION

Multiclass object classification is one of the major problems in image processing. Object classification helps in information retrieving by dividing the image into the sub images. The classification processes may include preprocessing, feature extraction, selection of training process, selection of suitable and sufficient number of training samples and accuracy assessment. The multiclass object classification is the set of features, which extracted from the images and processed with neural network. A feature which display some image property numerically. It decreases the size of the dimension of the sample space by extracting the most differentiating information. Discrete Wavelet Transform (DWT) may reduce the size of feature space [4]. There are two types of classifier: Supervised and Unsupervised. In supervised classification, user is needed to collect the data samples and these data samples are broken into training sample and testing sample. The classification system is trained using training samples. The accuracy of results depends upon how the class of object is determined accurately.

In this paper, supervised classification has been developed using discrete wavelet transform and principal component analysis technique over the artificial neural network. In Unsupervised classification, the result depends upon the software analysis of image without user providing the sample data.

## II. DWT

DWT is the most popular technique, which adopted in multiclass object classification. Wavelet transform decomposes a signal into a set of basis functions. These basic functions are called as wavelets. An image is decomposed into four components LL, LH, HH, HL on applying level one 2-D DWT. LH, HL, and HH are the finest scale horizontal, vertical, and diagonal wavelet coefficients of the image respectively while LL is the approximate image. The DWT is implemented by applying a series of filters. Figure 1 [2] depicts that input image is filtered through low pass and high pass analysis filters respectively. The output is sub sampled by a factor of 2. The analysis and synthesis process results in the decomposition of the signal into low and high frequency bands.

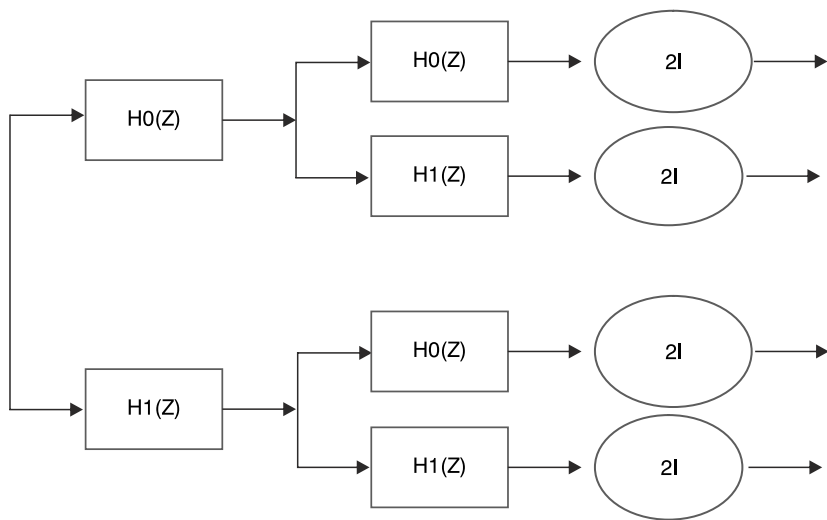


Fig. 1. 2-D wavelet decomposition of an image

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## III. PCA

PCA is one of the most popular statistical techniques used in the signal processing for the information reduction. Principal Component Analysis supports the eigenvector properties for the determination of selected object orientation. The task of feature extraction is to extract most relevant information from the original data and represent it in lower dimensionality space. Extraction of important features is a critical part of the image classification process [4]. The image features can be divided into four categories [5] visual features, statistical features, algebraic features, and transform coefficient features. Visual features include edges, contours, texture etc. Histogram is an example of statistical image features. The algebraic features represent the intrinsic attributes of the image. Principle component analysis (PCA) which is based on Kohonen Leave (KL) transformation is most widely recognized method for algebraic feature extraction. The objective of PCA is to reduce dimensionality preserving the



randomness as much as possible [8]. This procedure provides a set of eigenvalues and eigenvectors. Only a few eigenvalues are able to represent the most important characteristics of the image. The PCA approach is widely recognized and used for feature extraction. However if image is large the size of data vector is large and covariance matrix becomes very large making it unfeasible the computation of eigenvectors and Eigen values.

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#### **IV. BACK PROPAGATION NEURAL NETWORK**

Back propagation neural network was introduced in 1970 by David Rumelhart, Geoffrey and Ronal Williams. BP neural network now became a solution for different types of problems in many fields. It is inspired by biological Neural Networks[7]. Back Propagation Neural Network is a multilayered feed forward network trained according to the error[10].

Back Propagation Neural Network can be used to learn and it makes a great deal of mapping relation of input and output model. A neuron has three basic elements. A set of synapses or connecting links each of which is characterized by a weight where subscript  $j$  refers to the input end and subscript  $k$  refers to neuron at other end of the link. It has an adder which performs the weighted sum of the input signals. The third element is the activation function for limiting the amplitude of the output neuron.

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#### **V. RBF NEURAL NETWORK**

A Radial Basis Function (RBF) neural network has an input layer, a hidden layer and an output layer. The neurons in the hidden layer contain Gaussian transfer functions whose outputs are inversely proportional to the distance from the centre of the neuron [9].

1. Input layer-For each predictor variable, it consists of one neuron in input layer. Input neuron exists the range of neuron values given by the median. After that input neurons enter the values to each neuron in hidden layer.
2. Hidden Layer- A set functions given by the hidden layer constitute for input patterns on arbitrary basis. The hidden layers are also called as radial centres and it represented by a vector. The conversion from input space to hidden space is non linear, where as conversion from hidden space to output space is linear.
3. Summation layer- The value provided by the neurons of the hidden layer is multiplied by the weight along with the neurons( $W_1, W_2, \dots, W_n$ ) and passed to the summation layer that adds the value of weight and output neuron.

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#### **VI. PROPOSED METHODOLOGY**

An image classifier using RBF artificial neural network has been developed. The implemented method can automatically detect objects in the given image [6]. The method is tested for the images containing the single object only. Firstly the input

image is smoothed to remove the noise contents in it[1]. After smoothing operation the image is decomposed in subband images by applying DWT[3]. The feature vector obtained so is fed to RBF neural network to perform the face recognition. The detailed methodology is given below.

- Convert the input image to gray scale image
- Normalize the size of the image
- Apply Gaussian filter to smoothen the image to reduce the noise contents in images.
- Apply 2-D DWT to decompose the image into subband images.
- Now obtain features from the decomposed images. To extract the most relevant features, PCA is used.
- The features obtained from the images are arranged in a vector called feature vector.
- The feature vector is used as input to RBF artificial neural network.
- Create an artificial neural network with input neurons as per the size of the feature vector.
- The number of neurons in input layer is equal to the number of elements in the feature vector, The number of neurons in the output layer is equal to the number of classes of the objects.
- Train the RBF ANN using the training samples.
- When training is over, the system is ready to perform classification. Now test samples are used to evaluate the performance of the ANN based classifier.

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## VII. OBJECT DATASET

The dataset consists of images of five different objects like aero planes, Motorbikes, Cars, Human Faces and Guitars. Out of the available images of each object are used for the training of the network and rest are used for the testing and experimenting process. Some of the images of each object are shown in these figures.



Fig. 1: Airplane dataset



Fig. 2. Motorbike dataset



Fig. 3. Car dataset



Fig. 4. Guitar dataset



Fig. 5. Human face dataset

## VIII. EXPERIMENT AND RESULT

The results of the object classification are reported in this section. In this section, we demonstrate the experimental results of the proposed method in terms of confusion matrix[12]. The proposed object classification technique has been tested on a dataset created that consists of five objects: Airplane, Motorbike, Car, Face, and Guitar.

Confusion matrix for the proposed method as obtained by back propagation neural network is given in Table1[6]. The accuracy is measured in terms of overall accuracy (OA) and class wise accuracy (CA). It is observed from the results that OA of 91.7% is achieved. Considering class wise accuracy best results was obtained for object "Bike". The accuracy for object "Face" is not found good as it is less than 85%.

**Table 1:** Confusion matrix (back propagation)

	<b>Airplane</b>	<b>Bike</b>	<b>Car</b>	<b>Face</b>	<b>Guitar</b>	<b>OA (%)</b>
Airplane	45	0	4	1	0	91.7
Bike	0	47	0	1	2	
Car	1	1	44	0	0	
Face	0	0	0	40	2	
Guitar	2	0	0	6	44	
CA (%)	93.7	97.9	91.7	83.3	91.7	

The confusion matrix for RBF neural network is given in Table 2 [11]. The performance of RBF is lower than back propagation neural network. The OA is 87.5%. Similar to previous experiment the best accuracy was achieved for object "Bike" and lowest accuracy was noted for object "Face". For object "Guitar" comparable results were obtained in the two experiments.

**Table 2:** Confusion matrix (RBF)

	<b>Airplane</b>	<b>Bike</b>	<b>Car</b>	<b>Face</b>	<b>Guitar</b>	<b>OA (%)</b>
Airplane	40	1	3	1	0	87.5
Bike	0	46	2	0	0	
Car	2	1	42	2	0	
Face	3	0	0	38	4	
Guitar	3	0	3	7	44	
CA (%)	83.3	95.8	87.5	79.2	91.7	

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## IX. CONCLUSION

This paper presented a multiclass object classification method based on wavelet features. The proposed method was evaluated for a database containing five different objects. The classification was performed using two different types of neural network classifiers. The proposed method produced good accuracy under the tested scenario. The backpropagation neural network produced the best results.

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# Mobile Robot Navigation in Dynamic Environments

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## ABSTRACT

Service robots which act in environments populated by humans have become very popular in the last few years. A variety of systems exists which act for example in hospitals, office buildings, department stores, and museums. Furthermore, several multi-robot systems have been developed for tasks which can be accomplished more efficiently by a whole team of robots than just by a single robot.

These tasks include surface cleaning, deliveries, and the exploration of unknown terrain. Whenever teams of mobile robots are operating in the same environment their motions have to be coordinated in order to avoid congestions or collisions.

At the same time the robots should perform their navigation tasks in a minimum amount of time. Thus, sophisticated path planning techniques are needed that fulfill these requirements. Since the joint configuration space of the robots is typically huge and grows exponentially with the number of robots, existing path planning methods for single robot systems cannot directly be transferred to multi-robot systems.

Many existing path planning methods for multi-robot systems are decoupled, which means that they first plan paths for the individual robots independently. Afterward, they check if the robots would get too close to each other if the paths were executed. In such a case the paths are recomputed to avoid these conflicts.

Many decoupled methods assign priorities to the individual robots. These priorities define an order in which the paths of the robots have to be recomputed. By computing the path of a robot, the paths of the robots with higher priority are considered as fixed. This way, the size of the search space is extremely reduced. Most of the existing prioritized decoupled methods use a fixed priority scheme (order of the robots). However, the order in which the paths of the robots are recomputed has a serious influence on whether a solution can be found at all and on how efficient the solution is for the overall multi-robot system.

In the first part of this paper we present an approach which searches in the space of all priority schemes to find an order of the robots for which a solution to the path planning problem can be computed. During the search, we utilize constraints between the priorities of the robots which are automatically derived from the task specification. After an appropriate priority scheme has been found, our technique tries to improve it

by using a hill-climbing strategy. Our search method can be used to find and optimize paths generated by any prioritized path planning technique. In several experiments with a real-robot system as well as in simulation we show that our approach produces efficient solutions even for difficult path planning problems.

The second part of this paper is focused on robots acting in environments populated by humans. These systems can improve their behavior if they react appropriately to the activities of the surrounding people and do not interfere with them. In contrast to a multi-robot path planning system, the future movements of people are not known. Therefore, the robots have to be able to detect people with their sensors, to identify them, and to learn their intentions in order to be able to make better predictions of their future behavior. In this thesis we present an approach to learn typical motion patterns of people from sensor data using the EM algorithm. Furthermore, we describe how the learned patterns can be used to predict future movements of the people. Afterward, we explain how this knowledge can be integrated into the path planning process of a mobile robot. Finally, we introduce a method which automatically derives Hidden Markov Models (HMMs) from the learned motion models. These HMMs can be used by a mobile robot to predict the positions of multiple persons even when they are outside its field of view. To update the HMMs based on laser-range data and vision information we apply Joint Probabilistic Data Association Filters. In practice, the robot becomes uncertain about the positions of people if it does not observe them for a long period of time. We therefore propose a decision-theoretic approach to determine observation actions that are carried out while the robot is executing its tasks.

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## INTRODUCTION

Service robots are envisioned to coexist with humans and to fulfill various kinds of tasks. In the last few years there has been a substantial progress in the field of service robots. A variety of mobile robots that are designed to operate in environments populated by humans has already been developed. These robots, for example, have been deployed in hospitals, office buildings, department stores, and museums. Existing robotic systems are already able to perform various services such as delivery, education, providing tele-presence, cleaning, or entertainment.

Furthermore, there are prototypes of autonomous wheelchairs and intelligent service robots which are designed to assist people in their homes<sup>1</sup>. In this chapter we depict four examples of existing robotic systems. First we assume a cleaning robot which is designed to clean large surfaces, for example in supermarkets or airports [Hefter, 2004]. Secondly, we talk about a robot that has been developed within the EU project WebFAIR [2004]. The goal of this paper is to build an interactive tele-presence system which provides individual access to exhibitions and trade-fairs by the Internet. Again we depict an entertainment robot [Sony, 2003] and another one depicts one of the robots installed at Swiss EXPO 2002 [Swiss Federal Institute of Technology Lausanne, 2002], which guided the visitors through a part of the exhibition.

Since some tasks can be carried out more efficiently by a team of robots than by just a single one, multi-robot systems have become popular. Application areas for multi-



robot systems are for example surface cleaning, delivery tasks, the exploration of unknown terrain<sup>2</sup> and robotic soccer (a scene from the 4-Legged. Whenever teams of mobile robots are operating in the same environment their motions have to be coordinated in order to avoid deadlocks and congestions or even collisions. At the same time the robots should perform the navigation tasks in a minimum amount of time. Thus, sophisticated path planning techniques are needed to fulfill these requirements.

The path planning techniques for single robot systems (see e.g. the book by Latombe [1991]) cannot be directly transferred to multi-robot systems. Planning the paths for teams of mobile robots is significantly more complex than the path planning problem for single robots. This is due to the fact that the search space of a composite planning problem is typically extremely large. More precisely, the size of the joint state space of the robots grows exponentially with the number of robots.

The existing methods for solving the problem of motion planning for multi-robot: The situation depicted in the left image shows a deadlock between two robots which can occur in a narrow corridor. The right image depicts congestion with several robots. In the second situation it would be better for robot 1 to make a detour and choose the way via the upper corridor. These two examples demonstrate that there is a need for coordinating the motions whenever a team of mobile robots is deployed in the same environment.

Robot systems can be roughly divided into two categories:

Centralized approaches combine the configuration spaces of the individual robots into one composite configuration space which is then searched for a solution for the whole composite system.

Decoupled approaches in contrast first compute separate paths for the individual robots independently. Then they try to solve existing conflicts based on the independently computed paths. Conflicts are situations in which robots would get too close to each other if the paths were executed.

There are two important criteria to evaluate path planning methods:

1. Completeness: Is the path planning system able to compute a solution to any multi-robot path planning problem for which a solution exists?
2. Optimality: Is the solution as efficient as possible considering the whole team of robots?

While the general centralized approach, which performs an unconstrained search in the composite configuration space, is able to find the optimal solution to any planning problem for which a solution exists, its time complexity is exponential in the dimension of the composite configuration space. Therefore, it can typically not be applied to real world systems since those systems have to act under serious time constraints. In practice it is necessary to use heuristics for the exploration of the huge joint state space or to constrain the configuration space. As a consequence, practical centralized approaches cannot ensure completeness and optimality.

Many decoupled methods use a priority scheme for the robots. This means that a unique priority is assigned to each robot. The robots are then processed in the order implied by these priorities. During path planning for one robot the paths of the robots with higher priority are considered. This way the size of the search space is reduced



to make the search tractable. Since all decoupled methods strongly restrict the search space they are generally incomplete and may also generate sub-optimal paths for the robots.

The order in which prioritized approaches compute the paths of the robots has a serious influence on whether a solution can be found and on the quality of the solution. No single prioritization will be sufficient for all possible multi-robot motion problems. In the first part of this thesis we present an approach to prioritized decoupled path planning that performs a hill-climbing search in the space of priority schemes. To find solvable priority schemes<sup>3</sup> even for large teams of robots, constraints derived from the task specification are used to guide the search. Extensive experiments on real robots and in simulation runs will show that our approach enables decoupled path planning methods to find efficient solution even for complex multi-robot problems.

In the second part of this work we focus on robotic systems operating in environments populated by humans. Such systems can improve their service if they react appropriately to the activities of the people in their surrounding and do not interfere with them. In contrast to path planning for a team of mobile robots the intentions and future trajectories of people are not accessible. Therefore, it is necessary that the robots can locate and track people using their sensors. Furthermore, the robots need to be able to identify and potentially learn intentions of people so that they can make better predictions about their future actions. In the past few years various approaches have been presented to track the positions of people and to predict their short-term motions. All these approaches assume that motion models of the people are given. A lot of research has already been focused on the problem of learning and recognizing behaviors or plans of humans. Additionally, systems have been developed to detect atypical behaviors or unusual events.

In this paper we present an approach that, in contrast to the previous approaches, enables a mobile robot

- To learn typical motion patterns of people from sensor data,
- To adapt its navigation behavior by predicting trajectories of people, and
- To utilize the learned motion patterns to maintain a belief about where the people are. Such capabilities can be useful in various kinds of situations. For example, they allow a robot to reliably predict the trajectory of a person so that it avoids blocking the path of that person. Furthermore, a home care robot can more robustly keep track of the person it is providing service to and this way increase the time it stays in the vicinity of the person, for example to support interactions [Chatila et al., 2002]. Thus, the knowledge about motion patterns of a person is quite useful for various tasks such as collision avoidance, strategic positioning, and verbal assistance.

The remainder of this thesis is organized as follows: In the following chapter we consider the problem of planning the paths for teams of robots. We present our approach to prioritized decoupled path planning that searches in the space of priority schemes. After this we focus on environments populated by humans

Hidden Markov Models (HMMs) from the learned motion patterns. These HMMs are used to estimate the positions of multiple persons and are updated based on observations made by a mobile robot.

## Multi-Robot Path Planning

Path planning is one of the fundamental problems in mobile robotics. As stated by Latombe [1991], the capability of effectively planning its motions is "eminently necessary since, by definition, a robot accomplishes tasks by moving in the real world."

The problem of coordinating multiple mobile robots has received considerable attention in the robotics literature. Whenever several robots are deployed in the same environment there is the need for coordinating their movements. Trajectories for the individual robots have to be computed such that collisions between the robots and static obstacles as well as between the robots among themselves are avoided. Especially in the context of multi-robot systems different undesirable situations can occur, such as congestions or deadlocks. As an example, consider the situation with three robots positions are depicted next. The starting positions of the robots are indicated by large circles whereas the small dots correspond to the goal locations. The lines are the individual optimal paths for the robots. Assuming that the corridors are too narrow to allow two robots to pass by; no path can be found for robot 1, if robot 3 enters the corridor before robot 1 has left it. In that case robot 3 blocks the way of robot 1 such that it cannot reach its designated target point G1. This example shows that there is the need of coordinating the motions whenever teams of robots are operating in the same environment.

The existing methods for solving the problem of motion planning for multiple robots can roughly be divided into two major categories [Latombe, 1991]: the *centralized* and the *decoupled* techniques. In the centralized approach the configuration spaces of the individual robots are combined into one composite configuration space which is then searched for a path for the whole composite system [Schwartz and Scharir, 1983, Tournassoud, 1986, Barraquand and Latombe, 1990, Barraquand *et al.*, 1992, McHenry, 1998]. Because the size of the joint configuration space grows exponentially with the number of robots, this approach, in general, suffers intrinsic scaling limitations. The major alternative are decoupled approaches [Erdmann and Lozano-Pérez, 1987, O'Donnell and Lozano-Pérez, 1989, Liu *et al.*, 1989, Buckley, 1989, Warren, 1990, Chu and Einarsson, 1992, Chai *et al.*, 1995, Souccar and Roderic, 1996, Azarman and Schmidt, 1996, Ferrari *et al.*, 1998, Leroy *et al.*, 1999]. Decoupled path planning systems first compute an individual path for each robot independently. Subsequently, they apply heuristics for resolving conflicts between the paths of different robots. Conflicts are situations in which the robots attempt to occupy the same location at the same time or in which they would get too close to each other.

A centralized path planning method which searches in the unconstrained composite configuration space is able to find the optimal solution to any planning problem for which a solution exists. Its time complexity, however, is exponential in the number of robots [Reif, 1979, Schwartz *et al.*, 1987]. Practical centralized approaches therefore either use heuristics to explore the huge joint state space, or constrain the configuration space to make the search feasible. As a result, they are typical neither complete nor optimal. Which means that they may fail to find a solution even if there is one and that the solution they generate may not be the optimal one?

As explained before decoupled planners first determine the paths of the individual robots independently and then employ different strategies to resolve

possible conflicts. To deal with the still large search space it is common practice to assign priorities to the individual robots [Erdmann and Lozano-Pérez, 1987, Buckley, 1989, Warren, 1990, Azarm and Schmidt, 1996, Ferrari *et al.*, 1998]. The planning step is then performed in accordance with these priorities. Thus, in the case of conflicts, prioritized approaches try to compute a new collision-free path for each robot given the paths of the robots with higher priority. Priority schemes provide an effective mechanism for resolving conflicts that is computationally extremely efficient. Since they strongly restrict the search space, all decoupled techniques are also incomplete and generate potentially sub-optimal solutions.

For decoupled methods the order in which prioritized approaches compute the paths are planned has a serious influence on whether at all a solution can be found and on how long the resulting paths are. To illustrate this, let us consider two examples. First is a situation in which no solution can be found if robot 3 has a higher priority than robot 1. Since then the path of robot 3 is planned without considering robot 1, it will enter the corridor containing its target location (marked G3) before robot 1 has left this corridor. Because the corridors are too narrow to allow two robots to pass by, robot 3 will block the way of robot 1 so that it cannot reach its target point G1. However, if we change the priorities and plan the trajectory of robot 1 before that of robot 3, then robot 3 considers the trajectory of robot 1 during path planning and thus will wait in the hallway until robot 1 has left the corridor.

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## CONCLUSION

We focused on mobile robots which share their workspace with humans or with other robots. While considering the problem of path planning for teams of mobile robots we assume the existence of a central system which computes collision-free paths for all robots. However, searching for the optimal path in the composite state space of all robots is generally not feasible since this joint state space grows exponentially with the number of robots. To make the search tractable we therefore consider prioritized approaches which assign a unique priority to each robot. The paths of the robots are successively computed in the order implied by the priority scheme and by taking into account the paths of the robots with higher priority. As we illustrated in various experiments, the order in which the paths of the robots are planned has a serious influence on whether a solution can be found at all and on how long the resulting paths are. We therefore developed a method which performs a hill-climbing search in the space of priority schemes. We interleave the search for an optimal priority scheme with the planning of the paths of the robots. To find solvable schemes even for large teams of robots, constraints derived from the task specification are used to guide the search.

We demonstrated in extensive experiments on real robots as well as in simulations that our approach enables prioritized path planning methods

- To seriously increase the number of planning problems which can be solved and
- To generate efficient solutions even for complex multi-robot problems.

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# A Multimodal approach to enhance the performance of a Biometric System using Eye color, Face and Ear

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## Abstract

Multimodal biometric system is the combination of more than one biometric traits to authenticate an individual. The traditional single-modal biometric systems use a single biometric feature like fingerprint, voice, gait, retina, face, hand geometry, signature etc, to recognize and authenticate an individual. The major problem with the single trait biometric system is that no single technology can be appropriate enough for all the applications of authentication. The factors like noise in sensed data, inter and intra class variations, security attacks etc, can affect the performance of Uni-modal biometric system making it less secure and less reliable. So combining multiple biometric traits of an individual rather than using a single trait, is a way to make the biometric authentication more acceptable and reliable.

Here, we have proposed a multimodal approach for integrating the soft biometrics (eye color) with face and ear to enhance the performance of identification and authentication system. The fusion of multiple biometrics helps to minimize the system error rates. Fusion methods include processing biometric modalities sequentially until an acceptable match is obtained. The system enhances the level of security by verifying the user using multiple traits.

**Keywords**-Multimodal Biometrics, Gray scale image, HOG Feature extraction, SVM classifier, Training, Testing.

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## I. INTRODUCTION

### Biometric System

Biometrics is a technological and scientific authentication method based on biology and used in information assurance (IA). Biometric identification authenticates secure entry, data or access via human biological information such as DNA or fingerprints.

Biometric systems include several linked components for effective functionality[1].

The biometric system connects an event to a single person, whereas other ID forms, such as a personal identification number (PIN), may be used by anyone[4].

Biometrics is used for security systems and replacement systems for ID cards, tokens or PINs. A key difference between biometrics and other systems is that biometric verification of physical information requires a person to be present, which adds a layer of security because other ID types can be stolen, lost or forged.

Any anatomical or behavioral characteristic that provides some information about the identity of a person, but does not provide sufficient evidence to precisely determine the identity can be referred to as a soft biometric trait. Personal attributes like gender, ethnicity, age, height, weight, eye color, scars, marks, tattoos, and voice accent are examples of soft biometric traits. Soft biometric information complements the identity information provided by traditional (primary) biometric identifiers such as fingerprint, face, iris, and voice. Hence, utilizing soft biometric traits can improve the recognition accuracy of primary biometric systems.

A biometric system includes the following components and features:

In a biometric system there is a sensor device that acquired the data and then converts it into digital format using any software to process further. The data acquired may be any behavioral (like human gait) or physical trait (like iris or fingerprints). An acquisition device, such as a microphone or scanner, captures the data.

After acquiring data, a signal processing algorithm for biometric system is used to generate a biometric template; those are further compared to the existing biometric database, in order to establish the person authentication. The database is encrypted usually to add a layer of security. A matching algorithm compares new templates with others held in the biometric system's data storage facility.

A decision is made based on the comparison result obtained using some matching algorithm between newly obtained template with those already existing in data storage of system.

Systems that consolidate evidence from multiple sources of biometric information (e.g., face, fingerprint, hand geometry, iris, etc.) in order to reliably determine the identity of an individual is known as multibiometric systems[8]. Multimodal biometric systems use multiple sensors or biometrics to overcome the limitations of uni-modal biometric systems. For instance iris recognition systems can be compromised by aging irises and finger scanning systems by worn-out or cut fingerprints. While uni-modal biometric systems are limited by the integrity of their identifier, it is unlikely that several uni-modal systems will suffer from identical limitations. Multimodal biometric systems can obtain sets of information from the same marker (i.e., multiple images of an iris, or scans of the same finger) or information from different biometrics (requiring fingerprint scans and, using voice recognition, a spoken pass-code)[6].

Multimodal biometric systems can fuse these uni-modal systems sequentially, simultaneously, a combination thereof, or in series, which refer to sequential, parallel, hierarchical and serial integration modes, respectively.[1] Fusion of the biometrics information can occur at different stages of a recognition system. These stages are Feature extraction, Matching score and then finally Decision making [3].



## II. RELATED WORK

Biometric recognition or, simply, biometrics refers to the automatic recognition of individuals based on their physiological and/or behavioral characteristics. By using biometrics, it is possible to confirm or establish an individual's identity based on "who she is," rather than by "what she possesses" (e.g., an ID card) or "what she remembers" (e.g., a password). In this paper, we give a brief overview of the field of biometrics and summarize some of its advantages, disadvantages, strengths, limitations, and related privacy concerns [2].

Muhammad imran. et. al. presented multimodal face and finger veins biometric verification system to improve the performance. They have showed multilevel score fusion of face and finger veins to provide better accuracy. Simulation results shows that proposed multimodal recognition system is very efficient to reduce the false rejection rate [7].

Shweta C. Dinde et. al. used multimodal biometric system. In this proposed work they have used two biometric as face and palmprint and fusion of these two biometrics has four at four different levels like sensor level, feature extraction level, matching score level and decision level. All fusion techniques carried out under clean and noisy conditions. For feature extraction we used two different algorithms as LDA (Linear Discriminant Analysis) and LPQ (Local Phase Quantization) for face and palm print respectively [9].

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## III. PROPOSED METHOD

The proposed system works as follows: First it captures the eye color and compares it with the existing Database. If result is not matched then the person is not recognized, but if the captured eye color is unique in existing database, it can recognize the person. On the other hand if the captured eye color is available in the existing database but not unique, the system moves to the next step, where the face of the subject is captured. Now the system performs feature extraction on the captured image of face. Again the system compares these extracted features of face with trained dataset. If results are matched the system can recognize the person but if the face features are not sufficient to validate the user, then the system takes a picture of ear pattern. Now the feature set of ears are extracted using HOG feature extraction, and again the comparison of captured image of ear is done with existing data base, if the captured image is able to identify the person then system returns the valid user, but if the image is found to be of another person than system does not authenticate the person.

The system majorly works in two phases

- (a) Training Database
- (b) Testing and validation

### Image Acquisition

Capture the images of eye, face and ear one by one .

## **Gray scale conversion**

Now convert the captured RGB images into gray scale images as it is easy to process with gray scale images rather than 3 components R (Red), G(Green) and B(Blue).

## **Training of Database**

Training data is the data on which the machine learning programs learn to perform correlation task like (classify, cluster, learn the attributes et al.) In case of trained network the error can be computed by computing the sum of squares error between output and target. Here we train our system for eye color, face pattern and eye pattern one by one.

Features simply represents the information relative to an image so we need to extract the features for dimensionality reduction.

There are many feature extraction methods in image processing but we have used HOG (Histogram of Oriented Gradient) feature extraction to extract features of face and ear.

### **HOG feature extraction algorithm:**

- The color image is converted to gray-scale.
- The luminance gradient is calculated at each pixel.
- To create a histogram of gradient orientations for each cell.
- Feature quantity becomes robust to changes of form
- Normalization and Descriptor Blocks
- Feature quantity becomes robust to changes in illumination

## **Testing and validation**

Testing data is data whose outcome is already known and is used to determine the accuracy of the machine learning algorithm based on the training data (how efficiently the learning happened). For classification purpose SVM classifier is used.

## **SVM Classifier**

Support Vector Machines (SVMs) are set of related supervised learning methods used for classification and regression [10]. They belong to the family of generalized linear classification. Special property of SVM is, it simultaneously minimizes the empirical classification error and maximizes the geometric margin. This SVM is called maximum margin classifiers. SVM is based on the structural risk minimization (SRM). SVM maps input vector to a higher dimensional space, where a maximal separating hyperplane is constructed. Two parallel hyperplanes are constructed on each side of hyperplanes that separate the data. The separating hyperplane is the hyperplane that maximizes the distance between two parallel hyperplanes and assumption is made that the larger the margin or distance between parallel hyperplanes the better the generalization error of the classifier will be [5][10].

The work flow of the proposed system is following



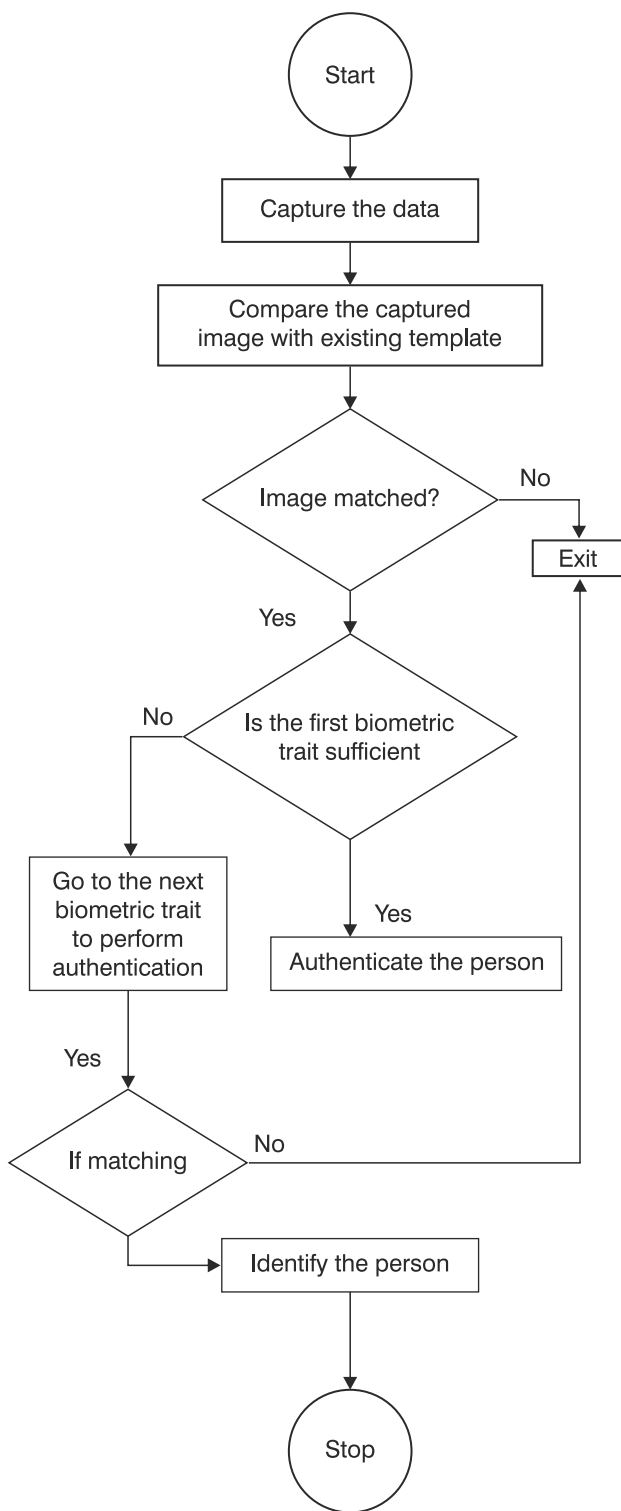


Fig 1. Flow chart of proposed work

## IV. RESULTS

Implemented system works in the following sequence

1. Training of database
  - Training for eye color
  - Training of face pattern
  - Training for ear pattern
2. Testing and Validation
  - Start camera and take a picture of eye
  - If more than one user found in database with same eye-color, take a picture of face.
  - Otherwise return the name of authenticated user from database else exit
  - If face features are not sufficient to validate the user, then take a picture for ear pattern Else return the name of authenticated user
  - With the help of ear features return the name of valid user from database and exit.

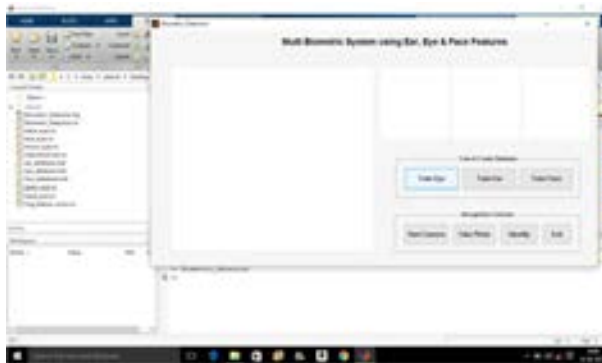


Fig. 2. GUI of the implemented system

Result 2:

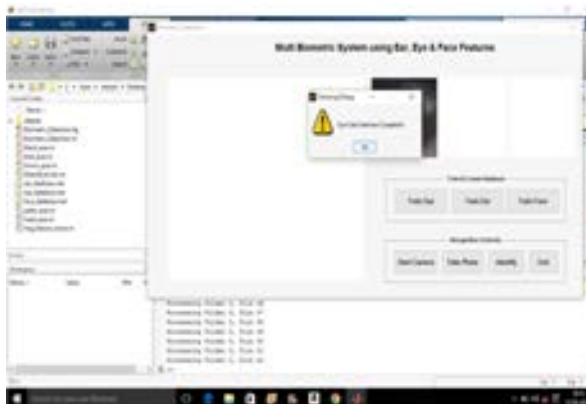


Fig. 3. Training of eye color

Result 3:

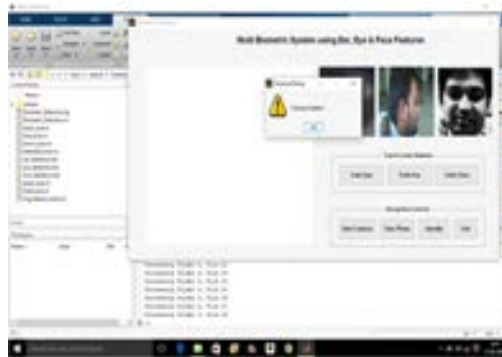


Fig. 4. Training of face

RESULT 4:

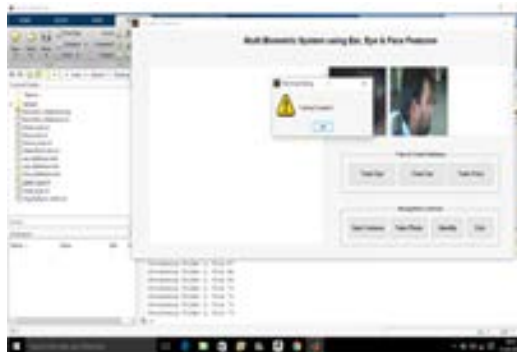


Fig. 4. Traininh of ear pattern

Result 5:

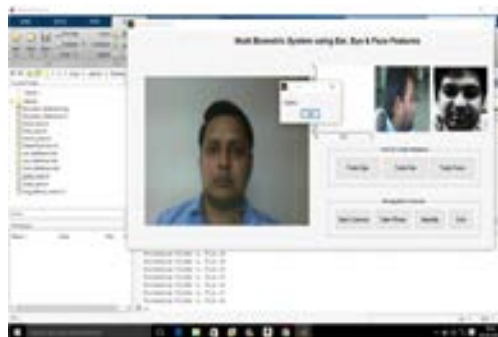


Fig. 5 User validation for authentic user

## Result 6:

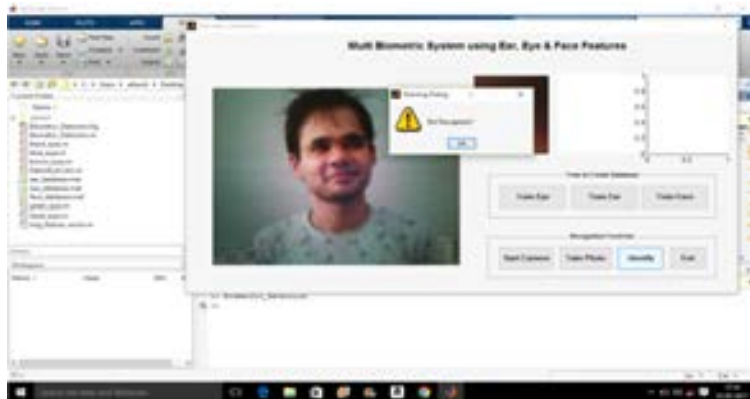


Fig. 6 Invalidation for user

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## V. CONCLUSION

Biometric traits are distinctive to every human personal and usually stay unchanged during the entire lifespan. These features make biometrics a promising solution for the authentication problem. This paper proposes a technique to make a robust multimodal biometric recognition system integrating eye color, face and ear. Combination of these three biometric traits is carried out to increase the performance of those systems which have shown the poor performance in single biometric system, like in our system eye color is soft biometric trait of low performance rate. The performance of here implemented system can be compared with each of these three biometrics features individually by plotting ROC curves. These curves will show that combination of multiple biometrics have significant improvement in recognition performance, as compared to the system that are implemented using single biometrics. It may also prevent forgery as it would be difficult for an imposter to compromise multiple traits simultaneously.

One of the limitations of proposed system is that database will be very large due to the storage of iris, face and ear pattern in memory, therefore extra storage space will be needed. Future work may be dedicated to reduce the complexity of the system, so that it can provide better results for increased security issues.

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