A SURVEY ON FACE RECOGNITION

Project Report

Submitted in partial fulfillment of the requirements of the degree

Bachelor of Technology

in

COMPUTER SCIENCE AND ENGINEERING

By

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RAJIV GANDHI UNIVERSITY OF KNOWLEDGE AND TECHNOLOGIES,
ONGOLE CAMPUS, JANUARY 2023.

BONAFIDE CERTIFICATE

This is to certify that the project report entitled "A SURVEY ON FACE RECOGNITION" submitted by K.GIREESWAR - O170792, K.MAHATHI - O170762, P.GOWTHAMI – O170818, MD.ASHRAF PARVEZ – O170759, I. VENKATESWARLU – O170844, in partial fulfillment is a record of bonafide project work carried out under my supervision and guidance during the academic year 2022-2023.

We are indebted to Mrs. SIKHINAM NAGAMANI, our project guide for conscientious guidance and encouragement to accomplish this project.

We are extremely thankful and pay our gratitude to Mr. B. SAMPATHBABU, (I/C)HOD CSE, for his valuable guidance and support on the completion of this project.

The report hasn't been submitted previously in part or in full to this or any other university or institution for the award of any degree.

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APPROVAL SHEET

This report entitled "**A SURVEY ON FACE RECOGNITION**" submitted by K.GIREESWAR – O170792, K.MAHATHI – O170762, P.GOWTHAMI – O170818, MD.ASHRAF PARVEZ – O170759, I.VENKATESWARLU – O170844 is approved by **Mrs. SIKHINAM NAGAMANI** for the degree of Bachelor of Technology in **COMPUTER SCIENCE ENGINEERING**.

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DECLARATION

We declare that this written submission represents our ideas in our words and where others ideas or words have been included, we have adequately cited and referenced the original source. We also declare that we have adhered to all principles of the academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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With Sincere Regards,

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CONTENTS

CHAPTER -1

INTRODUCTION

Analysis of Face Recognition, here we are going to analyze how the machine learning algorithms are impacting the real world where predicting crime rate is one of the major applications where different types of machine learning algorithms are used in order to predict the crime rate more accurately and precisely.

Another real world application of machine learning is facial recognition, here different machine learning algorithms are used in order to analyze a certain persons face and verifying the person identification by making a matching similar facial patterns with the facial data stored of that person.

1.1 INTRODUCTION TO MACHINE LEARNING:

Machine learning is a subfield of artificial intelligence, which is broadly defined as the capability of a machine to imitate intelligent human behavior. Artificial intelligence systems are used to perform complex tasks in a way that is similar to how humans solve problems.

Machine learning is one way to use AI. It was defined in the 1950s by AI pioneer Arthur Samuel as “the field of study that gives computers the ability to learn without explicitly being programmed.”

Machine learning starts with data — numbers, photos, or text, like bank transactions, pictures of people or even bakery items, repair records, time series data from sensors, or sales reports. The data is gathered and prepared to be used as training data, or the information the machine learning model will be trained on. The more data, the better the program.

From there, programmers choose a machine learning model to use, supply the data, and let the computer model train itself to find patterns or make predictions. Over time the human programmer can also tweak the model, including changing its parameters, to help push it toward more accurate results.

Some data is held out from the training data to be used as evaluation data, which tests how accurate the machine learning model **is** when it is shown new data. The result is a model that can be used in the future with different sets of data.

1.1.1 WORKING:

The Machine Learning process starts with inputting training data into the selected algorithm. Training data being known or unknown data to develop the final Machine Learning algorithm. The type of training data input does impact the algorithm, and that concept will be covered further momentarily.

New input data is fed into the machine learning algorithm to test whether the algorithm works correctly. The prediction and results are then checked against each other.

If the prediction and results don’t match, the algorithm is re-trained multiple times until the data scientist gets the desired outcome. This enables the machine learning algorithm to continually learn on its own and produce the optimal answer, gradually increasing in accuracy over time.

1.2 FACIAL RECOGNITION

Face recognition is a biometric identification technique that uses unique characteristics of an individual's face to identify them. Most facial recognition systems work by comparing the face print to a database of known faces. If there's a match, the system can identify the individual. However, if the face print isn't in the database, the system can't identify the individual.

Facial recognition technology is often used for security purposes, such as identifying criminals or preventing identity theft. It can also be used for more mundane tasks, such as finding a lost child in a crowded place or identifying VIPs at an event.

Some facial recognition systems are equipped with artificial intelligence that can learn to identify individuals even if their appearance has changed, such as if they've grown a beard or gained weight.

1.3 WHY MACHINE LEARNING FOR FACE RECOGNITION

Face recognition techniques have constantly matured and evolved alongside the advancement in machine learning, deep learning, artificial intelligence, and other related technologies. For example, machine learning algorithms quickly find, capture, collect, analyze, and retrieve different facial features and nuances to match them with pre-existing images to form a connection. Machine learning in face recognition has already proved its mettle in various fields, including security and biometrics, but not limited to it.

Exactly how facial recognition works using machine learning is something slightly technical and goes beyond the scope of this introductory article on face recognition using machine learning. So for this article, let us consider the five broad problems that need to be solved by machines to successfully and correctly recognize a face.

Face Recognition is divided into three steps:

1. Face Alignment and Detection-The first step is to detect face in the input image. This can be done using a Haar Cascade classifier, which is a type of machine learning algorithm that is trained on positive and negative images. The machine must locate the face in an image or video. By now, most cameras have an in-built face detection function. Face detection is also what Snapchat, Facebook and other social media platforms use to allow users to add effects to the photos and videos that they take with their apps.

A challenge in the context of face detection I that often the face is not directed frontally to the camera. Faces that are turned away from the focal point look totally different to a computer. An Algorithm is required to normalize the face to be consistent with the faces in the database. One way to accomplish this is by using multiple generic facial landmarks. For example, the bottom of the chin, the top of the nose, the outside of the eyes, various points around the eyes and mouth, etc. A machine learning algorithm needs to be trained to find these points on any face and turn the face towards the center.

2. Feature Measurement and Extraction – Once faces have been aligned and detected, the next step is to extract features from them. This is where the Convolutional Neural Network (CNN) comes in. A CNN is able to extract high-level features from an image, which are then used to identify faces in a database.
3. Face Recognition – The last step is to match the extracted features with faces in a database. This is usually done using a Euclidean distance metric, which measures the similarity between two vectors.

Machine learning is transforming the way that governments prevent, detect, and address crime. Around the country, police departments are increasingly relying on software like the Santa Cruz-based PredPol, which uses a machine learning algorithm to predict “hot spot” crime neighborhoods – before the crimes occur. Police forces can use the software to plan officer patrol routes, down to half-city blocks. PredPol does not publish a complete list of the cities it serves, but is currently in operation in over 60 cities in America, including Atlanta and Los Angeles.

PredPol utilizes commonly-understood patterns for when, where, and how crimes occur, and formalizes those patterns using an algorithm that predicts locations where a crime is likely to occur in the near future. Studies show that crime tends to be geographically concentrated, but that these "hot spots" are often dispersed throughout a city. Using a machine learning model originally built to predict earthquakes, PredPol uses location, timing, and type of crime as input

CHAPTER -2

REVIEW OF LITERATURE

papers	Title	Objective	Methods	Parameters	Result	Limitations
Paper-1	A Noval Approach to face Pattern Analysis	In this Project they used FRS - DCT-SVM in order to find the patterns of a certain face and	1)FRS 2)DCT 3) SVM 4)PCA 5)Neural Network 6)ACNN	Facial Data of the person with different patterns	achieved an average accuracy of 98.346% by FRS-DCT-SVM using GA-RBF, which is better than	The testing time for the model is more than that for DCT-SVM, minimizing that and creating

		matching features			the those of the ACNN and CNN+SVM	own dataset of facial images will make it better.
Paper -2	Approaches to Facial Detection and Recognition with Machine Learning Techniques	In this Project the accuracy rate of various faces of certain person face matching is determined	1)CNN 2)Feed Forward Neural Network 3)k-Nearest Neighbors	Facial Data	achieved an accuracy of 91.67% by using the ORL dataset. By using a combination of a CNN and SVM achieved an accuracy of 97.50% by using the ORL dataset.	The Time usage for matching the persons face in order to verify that person is high and the faces dataset should contain more faces.
Paper -3	Multiview Image Matching	In this project they used the	1)Gaussian Filter	Different view of the same scene by using xbox 360	The results of image matching	produce a better level of accuracy

	Based on SURF (Speeded Up Robust Features) Method	SURF in order match a same scene with different photos	2)Hessian Matrix Determinants	camera	from three scenarios using the SURF (Speeded-Up Robust Feature) method produce an optimal average match. With the test data, four rotational change scenarios have no effect in matching with each other	of matching in taking the input image taken with a high level of density, a stable place of shooting from the lighting, as well as taking reduce the angle is too high, so that the match will be less too, and changes in scale that are too high so it is necessary to try with other image matching methods to

						further enhance the accuracy of the image

CHAPTER – 3

MATERIALS AND METHODOLOGY

There are various types of methodologies used in the Facial recognition and Crime Prediction, the methodologies which are used for the Facial recognition and Crime Prediction are mentioned below.

3.1 FACIAL RECOGNITION METHODOLOGIES:

3.1.1 FRS - DCT – SVM:

3.1.1.1 Principle:

A FRS starts working by using an input image (captured by a camera) in a 2D or 3D way. Then, this input image is compared with the available images in the database by analyzing the input mathematically without error. Facial recognition is used in some use cases, such as a second authentication factor, access to a mobile application, access to buildings, access to locked devices, and payment methods. Figure 1 describes the step-by-step procedure of the facial recognition system. In stage I, the image is input, and preprocessing is done. In stage II, face detection and face normalization are done. In stage III a, images are stored in the database after normalization, and in stage III b feature extraction is performed. Then, in stage IV a comparator is used to obtain features from the database and produce results.

Image Pre-Processing

Image pre-processing is the step taken before the training of the model and is used to enhance the speed of the detection process and minimize false positives [4,5]. It reduces the noise effect, color intensity, and background and provides a difference in illumination. Some basic pre-processing procedures include face detection and cropping, image resizing, image normalization, de-noising, and filtering

Face Detection

This scan identifies whether a captured/used image/video is of a human or not.

Face Normalization

Face normalization minimizes the amount of redundant information and the effect of useless things in the background, such as hair and clothes, to improve the recognition process. In [7], the authors proposed a technique for face normalization in which the normalization of geometry and the brightness of faces is done to improve the efficiency. Normalization ensures that the data distribution will be similar for all input parameters. It can be done by subtracting the mean per channel and subtracting the pixel per channel. 1.4. Feature Extraction Feature extraction involves a process of reducing the dimensionality in which division and reduction of the input data are performed to make manageable groups. Some of the features of an image are edges, corners, interest points, regions, ridges, shapes, and confidence.

Some of the traditional feature detection techniques are Harris corner detection the Shi-Tomasi corner detector, Scale-Invariant Feature Transform (SIFT) , Speeded-Up Robust Features (SURF), Features from an Accelerated Segment Test (FAST) , Binary Robust Independent

Elementary Features (BRIEF) , Oriented FAST, and Rotated BRIEF (ORB), and some are useful for deep learning, such as super point , D2-Net, LF-Net, PCA , and LDA

Recognition Result

Image recognition is used for identity verification purposes and to identify objects, places, people, and actions in images. Trained algorithms are used for the recognition process so that some hidden representations of features can be analyzed and applied for different objectives such as classification. The basic structure of a facial recognition system and issues related to face detection and feature extraction have been discussed. The steps of pre-processing, face detection, face normalization, feature extraction, and the use of a comparator have been explained in detail.

3.1.1.2 Procedure:

1. Divide the dataset into training and testing datasets.

2. Perform feature extraction using DCT, for which DCT coefficients need to be calculated for all training set images and normalized.

3. Calculate the RBF-SVM function by K(x, y) = exp(||x−y||^2)/ 2σ^2 , where the decision boundary will be decided by σ. RBF-SVM classifies benign from malignant cases.

4. Define the objective function input of the RBF hyperparameters and the output of a test score. Then, use the Genetic Algorithm for optimization (GA-RBF). It is an adaptive system; it automatically changes its organization, design, and association weights without human intervention and makes it possible to join a Genetic Algorithm with the RBF Kernel parameters.

5. A framework of robust capacities given as f = accuracy + 1 2σ 2 ∗ Number of generations, where accuracy is considered at an upgraded estimation of the optimized value σ and by taking several generations to find the optimized value.

6. Results.

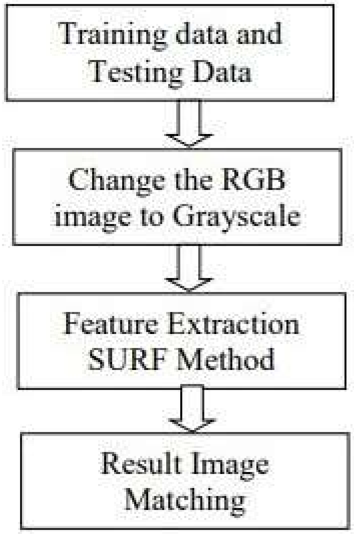
A Novel Approach on Face Pattern Analysis where they used a new framework, called FRS-DCT-SVM, that uses GA-RBF for face detection and optimization and the discrete cosine transform (DCT) to extract features.

The Result achieved was astounding with an average accuracy received by FRS-DCT-SVM using GA-RBF is 98.346.

3.1.2 SURF METHOD

3.1.2.1 Procedure:

The flowchart in this research is carried out in several stages, the first step is taking training data and testing data, then changing the RGB pixels to grayscale, then extracting features using SURF (Speeded-Up Robust Feature). The last stage displays images that have a match between one image to another.



1.Training Data and Testing data

Training data and testing data here are images that will be processed by the system. Training data and testing data are taken using a Kinect camera, each object is taken with a different point of view, the point of view in data retrieval starts from 1.5-1.30 turning angle in object retrieval. with a range ranging from 5-30 cm. The data from the image here has undergone a process in such a way as to test the capability of the system, starting from taking the viewpoint of the image, changing the scale of the image, and also changing the rotation with a certain angular rotation, as well as the distance of the object taking with the camera.

2.Change the RGB Image to Grayscale

At this stage training data and testing data will be changed from RGB (Red, Green, Blue) to grayscale Image. the value of the intensity of the RBG (Red, Green, Blue) will be divided by 3. So that the image will be grayscale.

3. Feature extraction

SURF Method Feature extraction with SURF (Speeded-Up Robust Feature) is carried out for the process of finding and determining the key point of an image to look for similarities between one image with another image. descriptors on the image that will be the basis of this research. the descriptor also to obtain information about changes in intensity, also extracts the absolute number of values from the response in each image

4. Result Image Matching

The end result of this process is in the form of the same descriptor between one image with another image, which has similarities and compatibility between training images and testing images.

Multiview Image Matching used this procedure and they got the results and limitations as described below:

The results of image matching from three scenarios using the SURF (Speeded-Up Robust Feature) method produce an optimal average match. With the test data, four rotational change scenarios have no effect in matching with each other. Meanwhile, changes in size or scale and angle of image capture are still at a poor level. There are several factors that influence the success of the system in matching images, such as the background of the image, the intensity of each image, the point of view in image capture, and the distance in image capture, and the quality of each input image in the image. System accuracy factor in detecting and matching key point orientation on each image also influences. A slight change in key point orientation can be deemed unsuitable by the system.

To produce a better level of accuracy of matching in taking the input image taken with a high level of density, a stable place of shooting from the lighting, as well as taking reduce the angle is too high, so that the match will be less too, and changes in scale that are too high so it is necessary to try with other image matching methods to further enhance the accuracy of the image

3.1.3 MGIMF

The MGIMF is abbreviated as multi-scale gradients and image matting.

3.1.3.1 MGIMF ALGORITHM

Input: Source images I1 and I2, number of scales k

Output: Merged image IF

1 According to the number of scales k, multi-scale gradient information is obtained from the source images I1 and I2;

2. Integrate the gradient information of each scale to obtain the focus measurement value Gn of each source image;

3. Compare the focus measurement values of the source images to get the approximate focus region Rn;

4. Perform median filtering and multiple skeleton extraction to determine the focus region Rdn ;

5. Divide each source image into three parts, and the segmentation result is Tn(x,y);

6. Perform robust image matting to obtain αn(x, y) for each source image;

7. Compare the alpha matte results of each source image to optimize the edges and obtain the final fusion decision map α(x, y);

8. Get the final fusion result IF based on the fusion decision map and source images.

3.1.3.2 FUSION METRICS AND RESULT

Since each person's subjective senses are different, it is inaccurate to make only a subjective estimation of the fusion results, so objective fusion metrics are also needed. In recent years, various fusion metrics have been proposed, but none of them is significantly better than others. Therefore, we need to use multiple metrics to comprehensively evaluate different fusion results. In this paper, four different indicators will be used to quantitatively evaluate the performance of the fusion results of different methods, namely mutual information (MI) , based on gradient metric (QAB/F) , based on structural similarity metric (QY) , and based on contrast metric (QC) . The definition of these four indicators is as follows. MI is the quality metric that compares the similarity of two images; it represents the contained information of the merged result of the source images. MI is defined as

$$MI = MI_{A,F} + MI_{B,F} ,$$

where MIA,F and MIB,F represent the amount of information in the source images contained in the fusion result, respectively. MI can be calculated as follows:

$$MI_{X,F} = \sum_{x,f} P_{X,F}(x,f) \log \frac{P_{X,F}(x,f)}{P_X(x)P_F(f)},$$

where PX(x) and PF (f) represent the normalized edge histograms of the source image X and the fusion result F, respectively; and PX,F (x, f) denotes the joint histogram of the source image X and the fusion result F. The larger the value of MI is, the more information will be contained in the fusion result of the source images, and the fusion performance will be better. QAB/F [55] is an image fusion index based on gradient. It measures the amount of gradient information transmitted from the source images to the fused image, and its calculation formula is as follows:

$$Q^{AB/F} = \frac{\sum_{x=1}^{W} \sum_{y=1}^{H} (Q^{AF}(x,y)w^A(x,y) + Q^{BF}(x,y)w^B(x,y))}{\sum_{x=1}^{W} \sum_{y=1}^{H} (w^A(x,y) + w^B(x,y))},$$

where W and H represent the width and height of the images, respectively. QAF (x, y) = QAF g (x, y)QAF α (x, y) is the edge and direction information of the pixel (x, y), weights w A(x, y) and w B(x, y) control the relative importance of QAF (x, y) and QBF (x, y), respectively. Moreover, a large value of QAB/F means that considerable edge information is preserved in the fused image and achieves a good visual effect

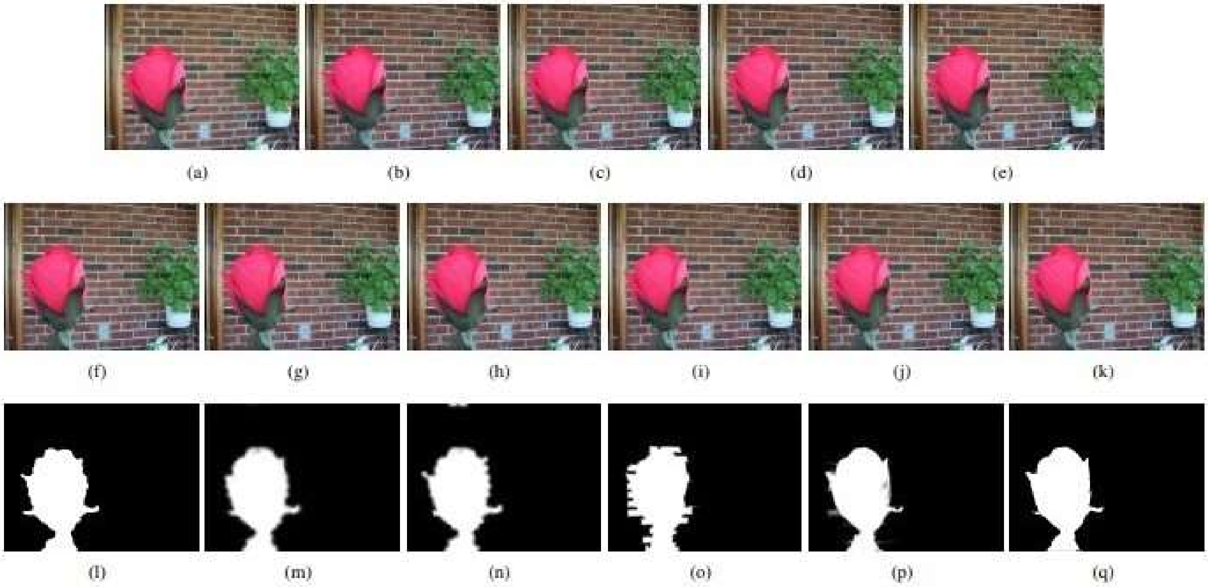
QY [56] is a fusion quality index based on structural similarity (SSIM) [58]. It measures the amount of structural information retained by the source image A and the source image B in the fused image F, which is defined as follows.

$$Q_Y = \begin{cases} \lambda(w)SSIM(A, F \mid w) + (1 - \lambda(w))SSIM(B, F \mid w), \\ \quad \text{for } SSIM(A, B \mid w) \geq 0.75, \\ \max(SSIM(A, F \mid w), SSIM(B, F \mid w)), \\ \quad \text{for } SSIM(A, B \mid w) < 0.75, \end{cases}$$

QC [57] is an image fusion index based on contrast. As human vision is sensitive to the contrast of the scene, QC compares the contrast characteristics of the source images with the fusion result. It can be calculated as follows.

QC (x, y) = λA(x, y)QAF (x, y) + λB(x, y)QBF (x, y), (21)

where QAF and QBF represent the contrast information transmitted from the source images A and B to the fused image F respectively; λA and λB represent the saliency maps of QAF and QBF respectively. The contrast based index QC is also the average of global quality map. The larger the QC value is, the more contrast information is transmitted from the source images to the fused image, and the fusion effect is better



Qualitative comparison of various image fusion methods on “flower” source images. (a) and (b): source images; (c)~(k): fusion results of SR, GFF, LP-SR, DSIFT, MSMF, BRW, BF, IM and the proposed MGIMF; (l)~(q): fusion decision maps of DSIFT, MSMF, BRW, BF, IM and the proposed MGIMF.

a multi-scale focus measurement method is proposed to effectively estimate the focus information of the source images. This method makes use of the feature of complementary information between different scales to better extract the gradient information of the source images for focus measurement. In order to obtain a better decision map, we use image matting technology to refine it. Then, make full use of the correlation between the source images to optimize the edge regions of the decision map and improve the accuracy of the estimation results. The proposed method can correctly distinguish small focused or defocused regions, and is robust to mis-registration. Qualitative and quantitative experimental results show that our method can achieve better performance than many other state-of-the-art fusion algorithms.

Algorithm	DSIFT	IM	LP-SR	MSMF	BRW	GFF	SR	BF	MGIMG
Average time(second)	5.1558	3.2519	0.2021	2.8276	1.6857	0.5991	205.7215	2.5739	3.8867

Comparison of the running time of nine fusion algorithms on the "Lytro" dataset, and each value represents the average running time of a specific algorithm on the dataset (unit: second).

CHAPTER – 4

RESULTS AND CONCLUSIONS

A various algorithms are examined and among them the most abundant methods are considered for comparison which includes FRS-DCT-SVM,SURF Method, MGIMF. Among these 3 method each has its own unique characteristics in order to provide the accuracy rate.

A Novel Approach on Face Pattern Analysis where they used a new framework, called FRS-DCT-SVM, that uses GA-RBF for face detection and optimization and the discrete cosine transform (DCT) to extract features.

The Result achieved was astounding with an average accuracy received by FRS-DCT-SVM using GA-RBF is 98.346

For SURF Method There are several factors that influence the success of the system in matching images, such as the background of the image, the intensity of each image, the point of view in image capture, and the distance in image capture, and the quality of each input image in the image. System accuracy factor in detecting and matching key point orientation on each image also influences. A slight change in key point orientation can be deemed unsuitable by the system.

MGIMF method makes use of the feature of complementary information between different scales to better extract the gradient information of the source images for focus measurement. In order to obtain a better decision map, we use image matting technology to refine it. Then, make full use of the correlation between the source images to optimize the edge regions of the decision map and improve the accuracy of the estimation results. The method can correctly distinguish small focused or defocused regions, and is robust to mis-registration. Qualitative and quantitative experimental results show that our method can achieve better performance than many other state-of-the-art fusion algorithms.

Among those methods we concluded that FRS-DCT-SVM that uses GA-RBF is the best because it is providing the accuracy rate of 98.346%.

CHAPTER – 5

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