# Fusion of Visual and Thermal face recognition

Siya kiran Devharkar
Computer department of Anantrao Pawar College of Engineering and Research, Parvati, Pune. Savitribai Phule Pune University Pune.
siyadevharkar@gmail.com

Prof.Jitendra Musale
Computer department of Anantrao Pawar College of Engineering and Research, Parvati, Pune. Savitribai Phule Pune University Pune.
jitendra.musale@abmspcoerpune.org

Prof.Chetna Upasani
Computer department of Anantrao Pawar College of Engineering and Research, Parvati, Pune. Savitribai Phule Pune University Pune.
chetna.upasani@abmspcoerpune.org

Chaitanya Sanjay Andhale
Computer department of Anantrao Pawar College of Engineering and Research, Parvati, Pune. Savitribai Phule Pune University Pune.
chaitanyaandhale6@gmail.com

Rahul Sanjay Dhope
Computer department of Anantrao Pawar College of Engineering and Research, Parvati, Pune. Savitribai Phule Pune University Pune.
rahuldhope09@gmail.com

Pranil Dhanke
Computer department of Anantrao Pawar College of Engineering and Research, Parvati, Pune. Savitribai Phule Pune University Pune.
pranil50041@gmail.com

*Abstract*— **In present times, face recognition has become one of the best technologies for computer vision. Face recognition is always a very difficult task in computer vision, illumination, pose, and facial expression. Face recognition tracks target objects in live video images taken with a video camera. In this paper we proposed an automated face recognition system. This application is based on face detection, feature extraction, and recognition algorithms, which automatically detects the human face when the person in front of the camera recognizing him. We used KLT Algorithm, Viola-Jones Algorithm face detection which detect human face using Haar cascade classifier, however camera is continuously detecting the face very frame, PCA algorithm for feature selection. We apply a model combining to match the geometric characteristics of the human face.**

**Keywords-** Face recognition system, applications, information security, identification, mechanized automatic recognition.

## I. Introduction

Current technology development is witnessing veritably rapid-fir progress and the and is to make the lives of people more and more simple, similar to biometrics systems a pattern recognition system, through the us of different biometrics to identify a person, similar as fingerprints, retina scanning, iris scanning, and face recognition. mortal faces always play a pivotal part in operations similar to security systems, and credit and disbenefit card verification surveillance on related felonious public places. The main objective of this system is to produce a facial recognition system that can be emulated and ultimately overcome this capacity of humans. This system focuses specially on the mortal anterior faces. Multiple face recognition algorithms have been developed and each has its strengths. Most of the time we look at a face and can fit it incontinently if we're formerly familiar with the face. This natural capability, if possible, can be justified and can be used for real- life operations. At that time their war numerous face-discovery algorithms. The first on is an original face recognition system, which uses the facial features of a face to intimate the face with a person. The alternate approach or global face recognition system uses the entire face to fit a person. The blow two processes have been enforced on way by another algorithm. The neural network and its doable operations in the field of exploration The complications of facial features that take place over time. So, the idea of emulating this skill is that mortal brings can be veritably satisfying.

## II. Existing System

The objective of this algorithm is to detect object of face in real time and to keep tracking of the same object. Her we us the training samples images of other objects of your choice to be detect and track by training classifier. Face tracking is a part of the face recognition system. Her we can us some system algorithms to pick out specific, distinctive details about a human's face. This face detection process verifies whether the image is a face detect present or not. The detection process works on Haar Cascade classifier. Object Detection using Haar feature- based classifiers is an perfect object detect method process Paul Viola and Michael Jones. It is machine learning based approach where a cascade function is trained from images. It is used to detect objects in other images. Her we calculated, the first feature selected seems to

focus on the property that the region of the yds in often darker than the region of the nose and cheeks. The second feature chosen is based on the by is darker characteristics than the bridge of the nose.You do not need the same window that applies to your cheeks and other places.

## III. Proposed System

Systems design is a process that defines architecture, components, modules, interfaces, and data requirements. System design can be viewed as a system theory operation for product development. Face discovery technology that helps describe mortal faces in digital images and video frames. The object discovery technology that deals with detecting instances of objects in digital image and videos. The proposed automated recognition system can be divided into five main modules Image Capture A camera is placed down from the entrance to capture an image of the front of the student. And a further process goes for face detection. Face Detection and Facial Features The appropriate and effective facial detection algorithm constantly improves facial recognition. Several facial algorithms analogous as face- to- face geometry, construction methods, Face geometry- based methods, Feature Invariant methods, System Diagram Machin learning based methods. Out of all this methods Viola and Jonas proposed a frame that gives a high detection rate and is also presto. Viola- Jones detection algorithm is fast and robust. So we chose Viola-Jonas's face discovery algorithm, which uses Integral Image and AdaBoost learning algorithm as classier. We have observed that this algorithm yields better results in a variety of lighting conditions. PR-Processing lodging the face features is called-processing. Thisara- processes stop involves specifying the pulled facial image and converting it to 100x100. This improves the distinction of the image as it extends beyond the intensity of the image, making it indeed clearer and more constrained. Database Development As we choose a biometric- predicated system very existent is demanded. This database development phase consists of an image intern of each individual and lodging the biometric point, and also its enhanced using preprocessing ways and stored in the database. Post-Processing In the proposed system, after recognizing the faces of the person, the names are shown in a video affair. The result is generated by the exporting medium present in the database system. These generated records can be seen in real- time video. This ensures that people whose faces are not recognized correctly by the system have to check in the database. And thus, giving them the capability to correct the system and make it more stable and accurate.

## IV. Literature Review

Face recognition is a fundamental problem in the field of computer vision and pattern recognition, which has been widely studied over the past few decades. Abdullah Al-Murad [1] has developed a method for a higher recognition rate by applying a Bag of Words(Bow), Histogram of Oriented Gradients (HOG), and Image Pixels (IP) as facial image feature extractors with Support Vector Machin (SVM), Convolution Neural Network ( CNN), and Artificial Neural Network (ANN) classifiers. Bow, HOG, and IP war are used for image feature extraction. The testing was conducted from the publicly available AT&T face database.

K. Sarikha and K. Tangelo [2] have introduced a human face based on K-nearest neighbor (KNN) with (PSO). They introduced PSO–KNN for the first time for face recognition. Initially, the features were extracted using a local binary pattern. The metaheuristic optimization algorithms such as genetic algorithm, PSO, and ant colony optimization war investigated for feature selection. Finally, face recognition is performed using the proposed PSO– KNN algorithm.

Sarasi Kanakangi, Clinton Fook, and Sridhar Sridharan [3] have discussed the power of Long Short Term Memory (LSTM) Networks: unconstrained video-based face verification (Face Video Model) and spontaneous facial expression recognition (Exp Model) to exploit sequential information for facial analysis in the wild. They used deep learning techniques to improve face recognition and facial expression recognition accuracy on wild data. They experimented through both video-based face verification in the wild as well as spontaneous facial expression recognition

Mostafa Panchami [4] has presented a deep neural network that can learn face representations for each target individual for accurate video-based FR systems. The proposed Haart architecture employs an ensemble of DCNN to obtain a discriminative embedding of the facial regions of interest ROI. In particular, the network utilizes a trunk that shares weights with branches, and each branch is trained to compute features similar to Haar-like features.

Kasinski [5], Haar cascade classifiers are becoming not unusual in face-quit by detection. It characterizes an HCC-primarily based three-stage hierarchical face and by the detection device. HCC consists of 2500 advantageous facial expressions for identification of the face. Thru are 2900 images taken whir so there may be no call. Face detectors are equipped with a photo of 2500 left or right yds and the snapshots of the

eyestrain terrible sets. Overall advantageous 94 percent and fake-fantastic third percent are detected in facial detection. Eyes are detected at a fee of 88 percent with the simplest 1 percent false nick outcome. Primarily based on deep convolutional network techniques.

Zhang [6] adopted 3 ranges of deep convolutional networks that may predict the coarse-to-exceptional position of face and landmarks superbly. A current look has proven that during this discipline, deep getting to know methods can have vast effects. The writer has advised CNNs for detection consisting of trio tiers: idea network (p-not), refinement community (r-not), and output network (o-not). Experimental consequences unearth these strategies to exceed trendy techniques over multiple disturbing assessments whilst keeping efficiency in actual time.

Lang yd [7] counseled a singular CNN framework to boost the precision of detection at once making us of the uncooked color values of photo pixels with the aid of CNN. The primary factor senses rough bounding packing containers of capability by patches. The second step decides whether or not the tough bounding boxes belong to the yds and excludes the non-bonding boxes. 8300 by samples of various mild situations, resolutions had been received. Sooner or later, entire samples were split into training and validation datasets of 500 samples in step with magnificence inside the validation set.

[8] Because of his work, he is also known as the unofficial father of facial recognition technology. Not much of his work was published to the public because an unnamed intelligence agency provided the funding. Petr Hart continued the work of Bledsoe at Stanford Research Institute and experimented in 1996, in which computers outperformed humans consistently. But as computers grew powerful in 2010'sfacial recognition systems became more and more efficient.

Dib [9] is a toolkit in C++ that is used for making real-world machine learning and data analysis applications, it's written in C++ but also has Python bindings which can be easily used in Python. The face detector in this method is based on a Histogram of Oriented Gradient(HOG) and linear SVM. Dib is only good for the 'frontal face' as odd angles are not easily detected.n HOG, the distribution of the gradient is used as features are extracted by HOG then these features are passed through SVM. In HOG, the distribution of the gradient is used as a feature.

MTCNN was introduced as a Python library by Kaipen Zhang[10] in the paper "Joint Face Detection and Alignment Using Multi-task Cascading Convolutional Networks". It leverages a 3-stage neural network detector.

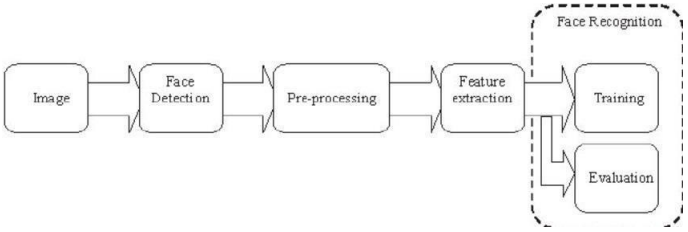
## V. Architecture

1. Initial preparation; During this phase, we get the input image ready, for face detection. This could involve resizing the image converting it to grayscale and applying filters to reduce noise.

2. Extracting features; In this step, we extract features from the input image that are crucial for detecting faces. This might involve tasks like calculating intensity gradients identifying edges and recognizing landmarks.

3. Determining face presence; Here we utilize the extracted features to determine whether the input image contains a face or not. We can employ techniques such as support vector machines (SVMs) neural networks or deep learning models for classification purposes.

4. Refining the results; After classification we. Improve the outcomes of our stage. This includes actions, like merging overlapping detections and eliminating positives.




i:-Architecture Diagram

1. Image Input: This is the primary level wherein the machine takes a photograph as enter. The picture may be a virtual image or a video body.

2. Face Detection: In this degree, the machine identifies the presence and place of a face within the picture. Various strategies can be used for face detection, such as Haar cascades or deep gaining knowledge of models.

3. Pre-processing: Once a face is detected, it desires to be pre-processed to enhance its best for the subsequent degrees. Pre-processing might also involve responsibilities like cropping the face, adjusting the light conditions, doing away with noise, and normalizing the image.

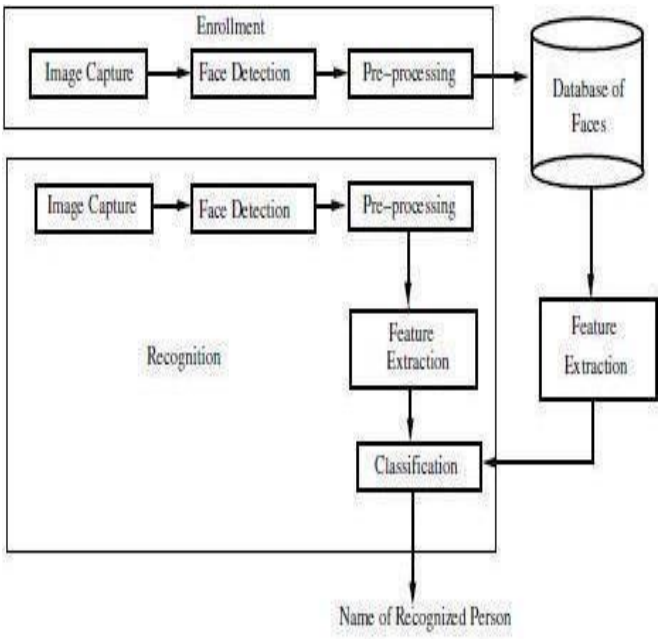
4. Feature Extraction: This degree involves extracting one-of-a-kind capabilities from the pre-processed face photo. These features can be edges, corners, and ridges

of the face, or greater abstract functions found out through a deep getting-to-know version.

5. Training: The extracted features are then used to educate a system getting to know the version. The version learns to recognize distinctive faces based on those features.

6. Evaluation: Finally, the performance of the face recognition gadget is evaluated. This commonly includes testing the device on a hard and fast of pix that were no longer used throughout training and measuring how correctly it recognizes faces.

## VI. Flowchart




Flowchart for image recognition

1. Capturing Images
To ensure identification a camera is positioned at a distance, from the entrance to capture an image of the student's face. This image then undergoes processing for face detection.

2. Detecting Faces and Facial Features
To achieve recognition various advanced algorithms are employed. These algorithms encompass techniques such, as analyzing geometry employing construction methods utilizing feature invariant methods, and leveraging machine learning approaches. Among these techniques, Viola and Jonas proposed a framework that offers both detection rats and speedy processing.

3. Pre-Processing
Extracting the face features is called pre-processing. These pre-process avoid involves specifying the extracted facial image and transforming into 100x100. Histogram Equalization is the most commonly used Histogram Normalization technique. This improves the contrast of the image as it extends beyond the intensity of the image, making it even clearer and constraint.

4. Database Development
As we choose a biometric-based system every individual is required. This database development phase consists of image capture of each individual and extracting the biometric feature, and then it is enhanced using pre-processing techniques and stored in the database.

5. Post-Processing
In the proposed system, after recognizing the faces of the person, the names are shown in a video output. The result is generated by the exporting mechanism present in the database system. These generated records can be seen in real-time video. This ensures that people whose faces are not recognized correctly by the system have to check in the database. And thus, giving them the ability to correct the system and make it more stable and accurate.

## VII. Algorithm

| Algorithm | Result |
|---|---|
| Multi-biometric system | This system is able to capture raw data from facial properties, sound properties, touch behavior, mouse dynamics, and keystroke patterns during utilization of the e-learning platform |
| Skin grabbing, Gabor filter, and PCA | Accuracy can be improved easily by using hybrid techniques for face detection and recognition in real time. This also reduces operating time, even though the system is complicated |
| Ad boost algorithm and a set of Ohara wavelet-like features | Produces a high level of accuracy in terms of face detection and can minimize the risk of false detection errors. In addition, this study also added a command to display pop-ups as a warning of the process of not finding a defective human face. This is the basis of e-learning in real-time |
| CNN | Can valuate input images low at resolutions to immediately reject non-face areas and |

| | |
|---|---|
| | carefully process challenging areas at higher resolutions for accurate detection |
| 3WPCA-MD | Shows that the resulting accuracy reaches 96% and 3WPCA-MD method is able to increase speed in the Face recognition process with milliseconds (ms) an average of 5-7 |
| 3WPCA | In this study explained that 3WPCA is able to produce facial recognition accuracy up to 98% by implementing it into the attendance system based on face recognition so that it can be used to anticipate fake face. |

## VIII. Research Methodology

1. Data Collection:
- Gather a diverse and representative dataset of facial images. This dataset should include variations in lighting, post, expression, ethnicity, age, and other relevant factors.

2. Preprocessing:
- Prepare the data by normalizing images, resizing, and standardizing lighting conditions. This step is crucial for data consistency.

3. Feature Extraction:
- Choose appropriate feature extraction methods, such as Eigenfaces, Dishracks, Local Binary Patterns (LBP), or Convolutional Neural Networks (CNNs). Extract relevant features from facial images.

4. Model Selection:
- Select a suitable face recognition model or algorithm. Common choices include Eigenfaces, Dishracks, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), deep learning approaches (e.g., CNNs), or a combination of these.

5. Testing and Validation:
- Evaluate the system's performance using a separate test dataset. Masur accuracy, precision, recall, F1 score, and other relevant metrics.

6. Performance Improvement:
- Fine-tune the model and preprocessing steps to improve recognition accuracy. This may involve data augmentation, hyperparameter tuning, or ensemble methods.

7. Ethical Considerations:
- Address ethical concerns related to privacy, consent, and fairness when collecting and using facial data.

8. Implementation:
- Implement the face recognition system in a real-world application or as part of a broader project, considering computational resources and scalability.

9. Evaluation:
- Continuously monitor and evaluate the system's performance in real-world scenarios. Make necessary adjustments and improvements.

10. Documentation:
- Document your research findings, methodologies, and results. Shard your work through research papers, presentations, or open-source code.

## IX. Application

1. Security and Access Control:
-Facial Authentication: Face recognition is commonly used to score physical and digital access, such as unlocking smartphones, accessing restricted areas, and logging into accounts.
-Surveillance: Law enforcement agencies and businesses use face recognition to monitor public spaces and identify individuals of interest, enhancing security and public safety.

2. Retail and Marketing:
-Customer Analytics: Retailers can use face recognition to analyze customer demographics, emotions, and behaviors in storms, helping them optimize store layouts and product placement.
-Personalized Marketing: Tailoring advertisements and promotions to individuals based on their demographic information and past shopping behaviors.

3. Healthcare:
- Patient Identification: Ensuring the correct patient is receiving care by matching their face with their medical records, reducing medical errors.
- Monitoring Health: Detecting health conditions through facial analysis, such as monitoring vital signs or identifying specific medical conditions (e.g., skin diseases).

4. Banking and Finance:
- Identity Verification: Offering scur and convenient biometric authentication for online and mobile banking services.
- Fraud Detection: Identifying and preventing fraudulent transactions and account takeovers.

5. Education:

- Student Attendance: Automatically recording student attendance by recognizing their faces, reducing manual record-keeping.
- Security on Campus: Enhancing campus security by restricting access to authorized personnel.

9. Airport and Travel:

-Passport Control: Streamlining immigration processes by automating passport and identity verification.
- Baggage Claim: Ensuring passengers pick up their luggage by matching their faces with their travel documents.

## X. Conclusion

In this paper, the importance of face recognition and its numerous applications, algorithms, methods, and face databases are discussed. Two major feature extraction methods for face recognition (Appearance-based and Model-Based). Appearance-Based includes PCA, LDA, ICA, and Model Based includes EBGM and 3D Morphable Modl. Different feature extraction methods with its previous work are discussed. Distance Measurement such as Euclidean Distance, City Block, and Mahala Nobis Distance are important for recognition process, the Distance Measurement methods are discussed. Several face recognition databases are available and can be used to test the system performance.

## XI. Future Scope

The future scope for face recognition systems is incredibly promising, as this technology continues to evolve and advance. With the increasing need for secure and convenient authentication methods, face recognition is poised to play a significant role in various industries. One key area of growth is in security and law enforcement, where it can aid in identifying and tracking individuals in real-time, enhancing public safety and criminal investigations in the world of the purchaser era, we can anticipate face reputation to turn out to be even extra incorporated into our each day lives, simplifying duties like unlocking smartphones, accessing non-public facts, and making bills. Additionally, the healthcare quarter can benefit from face reputation for affected person verification and tracking. As artificial intelligence and device mastering algorithms enhance, we can also anticipate better accuracy and efficiency in face reputation, making it greater reliable and applicable in areas including retail for personalized purchaser reports and advertising and marketing. Ethical and privacy worries will remain vital issues, but as the era matures, we can anticipate improved regulation and responsible usage to cope with those problems. Overall, the future of face reputation structures holds incredible potential in shaping diverse components of our lives, making them more secure, convenient, and efficient.

## XII. Reference

[1] Deshpande, N. T., & Ravishankar, S. (2017). Face Detection and Recognition using the Viola-Jones algorithm and Fusion of PCA and ANN. Advances in Computational Sciences and Technology, 10(5), 1173-1189.

[2] Kavia, M. Manjeet Kaur, (2016). “A Survey paper for Face Recognition Technologies”. International Journal of Scientific and Research Publications, 6(7).

[3] Ohel, M. R. M., & Ohel, M. S. R. PCA Algorithm for Human Face Recognition.

[4] Kasar, M. M., Bhattacharyya, D., & Kim, T. H. (2016). Face recognition using neural network: a review. International Journal of Security and Its Applications, 10(3), 81-100.

[5] Mikhaylov, D., Samoylov, A., Minin, P., & Egorov, A. (2014, November). Face Detection and Tracking from Image and Statistics Gathering. In Signal-Image Technology and Internet-Based Systems (SITIS), 2014 Tenth International Conference on (pp. 37-42).

[6] Liu, Z., & Wang, Y. (2000). Face detection and tracking in video using dynamic programming. In Image Processing, 2000. Proceedings. 2000 International Conference on (Vol. 1, pp. 53-56). IEEE.

[7] IEEE ,Boda, R., & Priyadarsini, M. J. P. (2016). Face Detection and Tracking Using KLT And Viola Jones. ARPN Journal of Engineering and Applied Sciences, 11(23), 13472-1347

[8] M. Turk and A. Pentland, Eigenfaces for recognition, Journal of Cognitive Neuroscience, 3(1), pp. 7186, 1991.

[9] H. Lu, K. N. Platanista’s, and A. N. Venetsanopoulos, Mica: Multilinear principal component analysis of tensor objects, IEEE Trans. on Neural Networks, 19(1):1839,2008.

[10] Harguess, J., Aggarwal, J.K., A case for the average- half-face in 2D and 3D for face recognition, IEEE Computer Society.