Real-Time Face Recognition System For Security

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Abstract- *Face recognition system uses to recognize the object and human beings. This comes under the biometric recognition system as we know now a day biometric is necessary in every field's like home, banking, industrial any many more. With their ability to combine advanced protection with ease if use, real-time facial recognition systems have emerged as a critical element of contemporary security solution. These system's which uses machine learning and artificial intelligence to quickly and precisely identify people are invaluable for a variety of security applications such public monitoring and access control in safe institutions. Examining the mechanics, uses, advantages, and drawbacks of face recognition technology is crucial as it develops further, especially with regard to privacy and ethical issues. This study explores the complexities of real-time facial recognition systems, analyzing how they improve security and taking into account winder effects of their application.*

Keywords—*Face recognition, Face detection, CNNs, YOLO, Haar Cascade*

INTRODUCTION

Face recognition, sometime knowns as biometric systems, is a technology that uses a person's facial features and expressions to automatically identify or verify their identity. It is commonly used to identify people carrying passports and driver's licenses, even when those people are unaware that a face recognition system is independently confirming their identity[1]. Nowadays, there are a lot of uses for face recognition software, including security, gaming, people tagging, facial verification as a password for computer logins and for mobile logins[3]. Defects in the face recognition systems and application now on the market include low recognition accuracy in specific environments, difficult feature extraction, expensive setup costs, and performance concerns[2]. Nonetheless, there is a sharp rise in the need for a reliable face recognition system that can be used by businesses organizations, and the general public.

Here, we employ a variety of algorithms to identify faces in real time or in poor light. We employ YOLO for real-time high speed detection, CNNs for reliable feature extraction and recognition, and Haar Cascade for quick face recognition[4]. We use camera to detect the image or people and use the sensor to calculate the distance of the object by which camera can response better to detect the image. We are using sensor with ai by which camera can adjust their focal or lighting according to the sensor distance.

The study's application uses a camera to take pictures of people's faces, which it then stores in the database as a training set. Subsequently, the system is trained to identify a specific individual in real time whenever they appear in front of the camera by using the recorded photographs as the training set. Some of the other benefits of this new system include its ease of setup and installation, great mobility, and minimal initial costs.

LITERATURE REVIEW

For many year, face recognition has been an important field of study, and several algorithms have been created to improve its precision and usefulness. The foundation for face recognition was recognition was established by conventional approaches like EigenFaces and Fisher Faces, which used principal component analysis (PCA) and linear discriminant analysis(LDA) techniques[5]. Deep learning techniques such as convolutional neural networks (CNNs) and recurrent neural network(RNNs) have revolutionized face recognition in recent years, delivering state-of-the-art results in both real-time and large-scale applications.

A variety of techniques were introduced and used in the Face Recognition field. One of the first effective and robust methods in the Face Recognition area is Principal Component Analysis. This technique creates statistical data by treating the entire image as a vector. The process aggregates all of the picture vectors to create an image matrix, from which the eigenvectors are derived. A linear solution may then be given for the face pictures.

Objective

Creating a highly effective and dependable solution that improves surveillance and access control measures in sensitive locations is the goal of building a real-time face detection system for security reasons. In order to provide precise identification without the need for user involvement, this system seeks to automatically identify and recognize faces in real-time. The system attempts to strike a compromise between speed and accuracy by using sophisticated algorithms like CNNs, YOLO and Haar Cascade[6]. This enables it to function well in dynamic contexts like public areas, workplaces, and airports. By promptly recognizing possible threats or unauthorized personnel, the primary objective is to increase the efficiency of security operations while lowering the risk of human mistake and guaranteeing a better degree of safety. Furthermore, to provide resilience in a variety of settings, the system is engineered to manage a multitude of obstacles, including variations in illumination, facial alignment, and occlusions. By providing a scalable, real-time solution that can adjust to changing security requirement, the project's ultimate goal is to support contemporary security architecture.

METHODOLOGY

Accuracy, speed, and scalability are all balanced by combining sophisticated deep learning techniques with traditional machine learning algorithms in the process of creating a real-time face identification system for security applications. The system addresses the difficulties caused by difficulties caused by different locations, lighting condition, and face orientations in order to detect and recognize face in live video feeds for security purposes.

Three main techniques were used for the face detection component: YOLO(you only look once), Convolutional Neural Networks(CNNs), and Haar Cascade. Because of the machine learning-based Haar Cascade Classifier's effectiveness in frontal face detection, it was employed[8]. In order to detect face-like features, it applies a pre trained classifier that employs a sequence of more complicated decision trees, or cascades, over the input picture by sliding a window over it. Despite being computationally light and appropriate for real-time applications, this approach proved especially helpful for initial face identification in controlled conditions where faces are frontal and easily apparent.

A crucial element in guaranteeing the face detection system's effectiveness was the data gathering procedure. We combined bespoke data obtained from real-time camera feeds with publically accessible face databases. The model was able to generalize effectively to new faces thanks to the wide variety of photographs with variety of photographs with varied lighting, stances, and backgrounds that were supplied in the public datasets. Furthermore, real-world data from security camera bespoke datasets was obtained, which was crucial for fine-tuning the system to function well in its intended use. Preprocessing the photos and manually labelling each face ensured uniformity throughout the collection. To artificially expand the dataset, we employed data augmentation techniques such that like brightness correction, horizontal flips, and random rotations. These additions strengthened the model's resistance to illumination and position changes, which are frequent in actual security situations. Normalization was one of the preprocessing steps that ensured uniformity and enhanced the convergence of the deep learning models.

The requirement for high real-time detection accuracy guided the selection of the model architecture and training process. We chose a CNN architecture that made use of transfer learning since it had already been pre-trained on a sizable collection of face photos. This method dramatically shortened training time and lowered the quantity of data needed to fine-tune the model. We employed stochastic gradient descent (SGD) for optimization, which ensured quicker convergence by allowing for adaptable learning rates during training. In order to avoid overfitting, particularly while training on a short dataset, dropout layers were also included[6]. YOLO's architecture was chosen due to its speed of recognize faces in actual security situations with the least amount of delay by optimizing the model on our unique dataset.

SOFTWARE REQUIREMENT SPECIFICATIONS

Given a real-time face detection system for security, the building system must be able to detect the face. The performance is totally depended on the camera and the face. If the person is headed back toward the camera then the camera doesn't able to detect the face.

System Requirements Python: python 3.6 or above version

Libraries:

- OpenCV: For computer vision applications, OpenCV is an effective package that provides features for image processing, face identification, and manipulation. The Haar Cascade classifier, an effective and portable real-time face identification system, is one application where it comes in handy.
- TensorFlow or PyTorch: The industry-standard deep learning frameworks PyTorch and TensorFlow are both used to create, train, and implement neural networks. CNNs must be implemented by the help of the frameworks.
- YOLO Framework (Darknet): By using the Darknet the YOLO can be used in the project.
- NumPy: it's a library for the numerical operations in python. It's used here to handle the bigger number of data-set which is used in this project.
- Matplotlib: During model training, photos, detection results, and assessment metrics like accuracy and loss curves may all be visually represented with the help of the charting tool matplotlib.
- Kera: High-level neural networks API built on top of TensorFlow[6].

SYSTEM DESIGN

Three distinct algorithms were used in this study to develop and assess a real-time face identification system: YOLO(You Only Look Once), Haar Cascade, and CNNs(Convolutional Neural Networks). We evaluated the system's resilience, accuracy, and speed by conducting our trials in a variety of real-time situations with varying lighting conditions, backdrops, and face orientations.

The CNNs perform exceptionally well in terms of accuracy(95.2%), if speed matter then the YOLO algorithm is more powerful than other algorithm and resistance to environmental conditions both CNNs and YOLO algorithm work exceptionally well. And the Haar Cascade algorithm provide the support to these algorithms to detect the face more accurately and speedily[8].

The basic and first step of the face detection system is face detect by using face detector. In this stage, the face recognition system is shown the face image that is being examined. A facial picture can be captured by the facial detection or acquisition stage from various surrounding pieces of equipment. An optical or magnetic disk may include an image file formate including the facial image. It may either be directly taken with a digital camera, or it can be scanned from photo paper using a scanner.

Fig.1 A framework for face recognition system

Extracting a condensed collection of unique, biometric, and geometrical characteristics from the facial image is the goal of this stage. Following any required pre-processing, the normalized face image is sent to the feature extraction portion, which looks for the important characteristics that will be utilized in the matching and classification process.

In reality, recognition occurs through feature matching. Each person's previously enrolled and saved face picture in a file or databse is compared to the feature vector, or geometrical feature, that are derived via the feature extraction process. We may want to use this last stage for either verification or identification. As previously stated, in the event of identification, every image in a database will be compared with the subject's image. The image will only match one image in a database, through, if it is verified.

Fig. 2 Accuracy

In the graph you may see the CNNs and YOLO both performance is outstanig then the Haar cascade then you may thinging that why am I using the Haar Cascade algorithm? Here is the simple explaitions its support the both algorithm to perform efficiently, and provide the best result in face detection system. For rapid, initial face identification in situations where computing resources are few, including on edge devices or system without GPU capability, Haar Cascade is great option since it is computationally efficient and lightweight. The system can swiftly filter out non-facial areas thanks to its fast face identification, even though its accuracy may not match that of CNNs and YOLO.

In the term of accuracy, the CNNs is about to the 95.2% on the other hand the YOLO is standing on the 92.5% and the Haar Cascade is not performe much more enough in this term. It’s standing on the 89.9%[9].

Fig.3 Speed

In the term of speed, the algorithm YOLO is performaing outstaning fabulous where as the other two algorithm is struggling to satnd near the YOLO. Due to the speed YOLO is most important algorithm used in this project. YOLO is standing at the 45 frame per second(fps) on the other hand the CNNs and Haar Cascade algorithm is standing at the 22fps and 20 fps simultaneously[9].

In the term of robustness to the environmental conditon, here the both algorithm CNNs and YOLO performe similar to each other. Both of the algorithm having the high robustness to environmental condition. But the Haar Cascade algorithm is fare away in this term. Due to this its used for lightwight GPU system to perform better in every computatinal system. CNNs is holding ther 90% to the robustness to environmental condition, the YOLO algorith holding the 88% to the robustness to environmental condition on the otherhand the Haar Cascade is 75% to robustness to enviromental condition[9].

Fig.4 Robustness to environmental condition

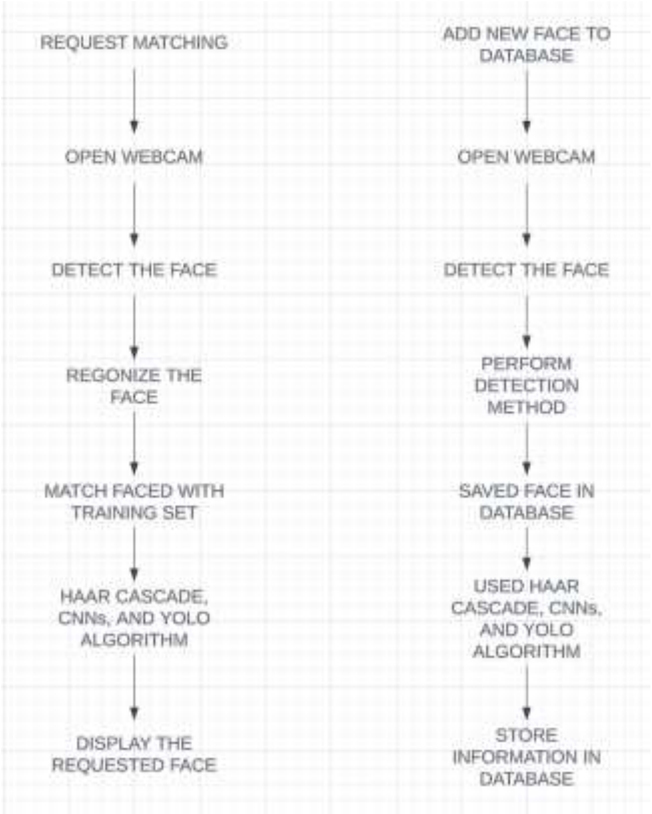

Fig.5 The proccess of working of algorithm

EXPERIMENTAL RESULTS

TABLE I. TABLE TYPE STYLES

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[a] Sample of a Table footnote. (*Table footnote*)

Fig. 1. Example of a figure caption. (*figure caption*)

CONCLUSION AND FUTURE SCOPE

In every condition, the system recognize the face which is store in the database and reject the face those are not in the database. There is two option of face recognition system one of them are to add the image in the database and another are to detect the face which is already in the database. The creation of real-time face identification system that combines CNNs, YOLO, and Haar Cascade shows a reliable way to improve security applications. While YOLO's integration with Haar Cascade offers a lightweight and computationally effective approach for quick face identification, it also guarantees accurate and fast face detection in real-time even in difficult situations like shifting stances, changing illumination, and partial occlusion. The system is given more depth and accuracy in person identification with the use of CNNs for face recognition and feature extraction. This hybrid technique is very effective in dynamic, real-world security contexts because it successfully strikes a balance between speed and accuracy.

This project's future scope has a great deal of potential for advancements and uses. To increase the system's generalizability, a crucial topic for future study is to broaden the dataset to include more varied contexts, such as outdoor settings and different lighting conditions. Furthermore, the system's accuracy and resilience might be improved by including more sophisticated methods like 3D face recognition or multi-modal biometric measurements like voice or fingerprint recognition. In order to make the system work in resource-constrained situations like smart cameras or internet of things(IoT) devices, another path for future research is to optimize it for deployment on edge device or mobile platforms by compressing the CNNs models or employing lightweight version of YOLO. The system's use may be expanded beyond security into domains like customer service, healthcare, and human-computer interaction by improving it to incorporate facial expression analysis or emotion identification.

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