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Iris Recognition System (IRS) in Biometric World

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Abstract: *Identity recognition through human iris organ is claimed as one of the famous biometric techniques due to its reliability promising higher accurate return as compared to other traits. Reviewing past literatures, poor imaging condition, low flexibility of model, and small size iris images dataset are the limitations needing solutions. In this paper,a proposed algorithm development flow and systematic analysis has been conducted to achieve high efficiency in the iris recognition task. A transfer learning method that does not involve iris segmentation phase is proposed to capitalize pre-trained Convolutional Neural Network (ConvNet) model introduced in the ImageNet Large Scale Visual Recognition Competition (ILSVRC) on iris recognition system. Both data augmentation and Bayesian optimization are also involved in optimizing the network and prevent it from overfitting. Simulation results showed the transferability of a pre-trained model on new target task is improved and meanwhile, the high recognition rate of the algorithm on small-size Institute of Automation, Chinese Academy of Sciences (CASIA) Iris-Interval V1 iris image dataset is achieved.*

Keywords: deep learning, ConvNet, transfer learning, iris recognition.

I. INTRODUCTION

Iris recognition is a type of biometric technology that enables a personto be authenticated automatically via his criteria through machines. Compared to other biometric traits, iris possess lesser false acceptance and rejection rate due to its high in universality, uniqueness, permanence, permanency, and stability.[1] Informative features of iris are being extracted from the raw image and those features are classified based on criteria. Correct prediction on the label indicates successful iris recognition. In the literature, ideal image acquisition conditions are assumed in most recognition systems in order to get a high recognition rate.[2] Mostof the open- source iris database in previous time are captured using near infrared (NIR) camera in close distance, along with the look and stare constraints condition so that the pigmentation of the iris image is revealed and clear texture to obtain.It saves a bundle of engineers' time in filtering the noise.

The strategies of this paper are as follows:

First, this project manages to eliminate the iris segmentation phase since in conventional IRS, its' failure can indirectly affect the recognition rate.

Second, transferability of pre-trained ConvNet model can be tested using support vector machine (SVM) classifier with transfer learning technique.

Third, a high-performance ConvNet model that able to run IRS task isdeveloped using transfer learning technique.

Forth, image augmentation, Bayesian optimization, and layer freezingtechniques are being applied for better model performances.

Almost all classical machine learning (ML) in IRS involves these elementary steps, including image acquisition, pre-processing, features encoding, and matching for user authentication or identification.[5] Iris segmentation in Figure 1 is the most crucial part in the IRS since the feature of the iris has to be extracted correctly to enable achieve high accuracy.

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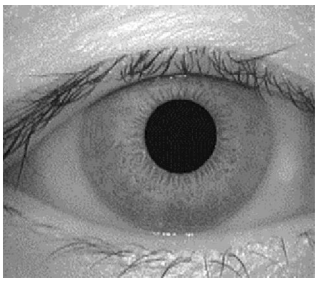
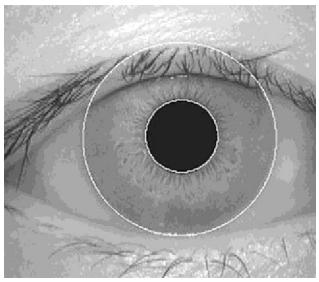

Figure 01: (a) Original iris image (b)segmented iris image

The boundary of iris is segmented after applying Circular Hough Transform method.

DL provides a flexible and scalable ML method that requires no more constraint on the feature extraction while training the algorithm, especially in iris recognition algorithm development. However, certain research results show that DL can underperform as compared to classical ML techniques sometimes. This result is difficult to predict and explained mathematically as DL is a black box concept.

II. LITERATURE SURVEY

Iris Recognition System (IRS) is a biometric technology that uses iris patterns for identifying individuals. The technology is based on the unique characteristics of the iris, which are determined by the complex arrangement of muscles, pigments, and other structures in the eye. Iris recognition systems have become increasingly popular in recent years due to their high level of accuracy and reliability.

A literature survey on Iris Recognition Systems reveals that there have been significant advancements in the field over the past few decades. The first IRS was developed in the early 1990s, and since then, numerous research studies have been conducted to improve the accuracy and reliability of the technology.

One of the major challenges in developing an effective IRS is dealing with the variability of the iris patterns. The iris is affected by various factors, such as aging, disease, and injuries, which can alter the appearance of the iris. To overcome this challenge, researchers have developed several techniques, such as wavelet-based feature extraction, texture analysis, and phase-based image processing, to enhance the accuracy of iris recognition systems.

Another area of research in the field of IRS is the development of new algorithms for iris recognition. Several algorithms have been proposed, including Daugman's algorithm, which is widely used in commercial iris recognition systems. Other algorithms include the local binary pattern (LBP) algorithm, the Gabor filter algorithm, and the adaptive thresholding algorithm. In addition to algorithm development, researchers have also focused on improving the performance of iris recognition systems in different scenarios. For example, researchers have developed techniques for iris recognition in low-light conditions, long-distance iris recognition, and iris recognition in unconstrained environments.

Overall, the literature survey reveals that Iris Recognition Systems have come a long way since their inception in the early 1990s. The technology has been widely adopted in various applications, including

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security systems, access control, and border control. Further research in the field is likely to focus on developing new algorithms and techniques to improve the accuracy and reliability of the technology in different scenarios

Objectives of Literature Survey

Identifying the current state of the art in iris recognition technology: A literature survey can provide an overview of the latest research and development in the field of iris recognition. This can include new algorithms, techniques, and applications of iris recognition technology.

Evaluating the performance of iris recognition systems: A literature survey can help to evaluate the performance of different iris recognition systems, including their accuracy, reliability, and speed. This can help to identify the strengths and weaknesses of different systems and inform the development of new systems.

Assessing the potential applications of iris recognition technology: A literature survey can help to identify the potential applications of iris recognition technology in different fields, such as access control, border control, and security systems. This can inform the development of new systems and solutions for different industries.

Identifying the challenges and limitations of iris recognition technology: A literature survey can help to identify the challenges and limitations of iris recognition technology, such as variability of iris patterns, environmental factors, and privacy concerns. This can inform the development of new solutions and techniques to overcome these challenges.

III. PROBLEM STATEMENT

The problem statement for Iris Recognition System (IRS) in the biometric world is that traditional identification methods, such as passwords and ID cards, are no longer reliable or secure enough in many applications. There is a need for a more secure and efficient identification method that can accurately identify individuals in different scenarios, such as access control, border control, and security systems.

While there are several biometric technologies available, including facial recognition and fingerprint recognition, iris recognition technology has emerged as a reliable and accurate method of identification. However, there are still challenges and limitations that need to be addressed to fully realize the potential of iris recognition systems.

One of the major challenges in developing an effective iris recognition system is dealing with the variability of iris patterns. The iris can be affected by various factors, such as aging, disease, and injuries, which can alter the appearance of the iris and affect the accuracy of the system.

In addition, there are concerns about privacy and data protection with the use of iris recognition systems. There is a need to ensure that personal information is protected and that the technology is used in an ethical and transparent manner.

Therefore, the problem statement for Iris Recognition System (IRS) in the biometric world is to develop an accurate, reliable, and secure iris recognition system that can overcome the challenges and limitations of the technology and ensure privacy and data protection for individuals.

IV. PROPOSED SYSTEM:

The proposed system for Iris Recognition System (IRS) in the biometric world is a reliable and efficient method of identification that uses iris recognition technology to accurately identify individuals in various scenarios, such as access control, border control, and security systems.

The proposed system consists of the following components:

- **Iris capture device:** A specialized camera or scanner is used to capture images of the iris. The device should be able to capture high-quality images of the iris in different lighting conditions and angles.

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- **Iris recognition software:** The captured iris images are processed using specialized software that extracts the unique features of the iris, such as the pattern of the iris and the texture of the iris surface. This data is then stored as a digital template for future identification.
- **Database:** The digital templates of the iris patterns are stored in a secure database. This database can be accessed by authorized personnel to verify the identity of individuals.
- **Verification process:** When an individual presents their iris for identification, the iris recognition software compares the digital template of their iris with the templates stored in the database. If there is a match, the system confirms the identity of the individual.
- **Privacy and data protection:** The system should be designed to ensure the privacy and data protection of individuals. This can be achieved by implementing strong security measures to protect the database and ensuring that personal information is not shared or used for other purposes.

Overall, the proposed system for Iris Recognition System (IRS) in the biometric world is a secure and reliable method of identification that can overcome the challenges and limitations of the technology and ensure privacy and data protection for individuals.

V. OBJECTIVES

The objectives of Iris Recognition System (IRS) in the biometric world include:

To develop an accurate and reliable iris recognition system that can identify individuals with a high degree of accuracy.

To overcome the challenges and limitations of iris recognition technology, such as the variability of iris patterns, environmental factors, and privacy concerns.

To ensure the security and privacy of personal information by implementing strong security measures and ensuring that data is not shared or used for other purposes.

To develop a cost-effective and scalable system that can be used in different scenarios, such as access control, border control, and security systems.

To promote the use of iris recognition technology as a reliable and efficient method of identification that can replace traditional identification methods, such as passwords and ID cards.

To improve the efficiency and convenience of identification processes by reducing the time and effort required for identification.

To enhance the safety and security of individuals by preventing unauthorized access and reducing the risk of identity theft.

Overall, the objectives of Iris Recognition System (IRS) in the biometric world are to develop a secure and reliable method of identification that can overcome the challenges and limitations of traditional identification methods and ensure privacy and data protection for individuals.

VI. METHODOLOGY

SVM: Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning. The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane, SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine. Consider the below diagram in which there are two different categories that are classified using a decision boundary or hyperplane; Example: SVM can be understood with the example that we have used in the KNN classifier. Suppose we see a strange cat that also has some features of dogs, so if we want a model that can accurately identify whether it is a cat or dog, so such a model can be created by using the SVM algorithm. We will first train our model with lots of images

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of cats and dogs so that it can learn about different features of cats and dogs, and then we test it with this strange creature. So as support vector creates a decision boundary between these two data (cat and dog) and choose extreme cases (support vectors), it will see the extreme case of cat and dog. In this dataset can be pre- tested using trained SVM classifier. The extracted features of the training dataset were extracted using activation on desire feature layer on either AlexNet or DenseNet201 pre-trained model.

ConvNet:

The steps of using transfer learning in re-training the entire ConvNet model are listed as follows:

Step 1: Choose on pre-trained ConvNet model and iris database.
Step 2: Optimize hyperparameters using Bayesian optimization.
Step 3: Select the number of layers freeze (optional).
Step 4: Retrain the ConvNet model with optimizing hyperparameters.
Step 5: Collect results in the form of data and figures.

VII. SYSTEM ARCHITECTURE

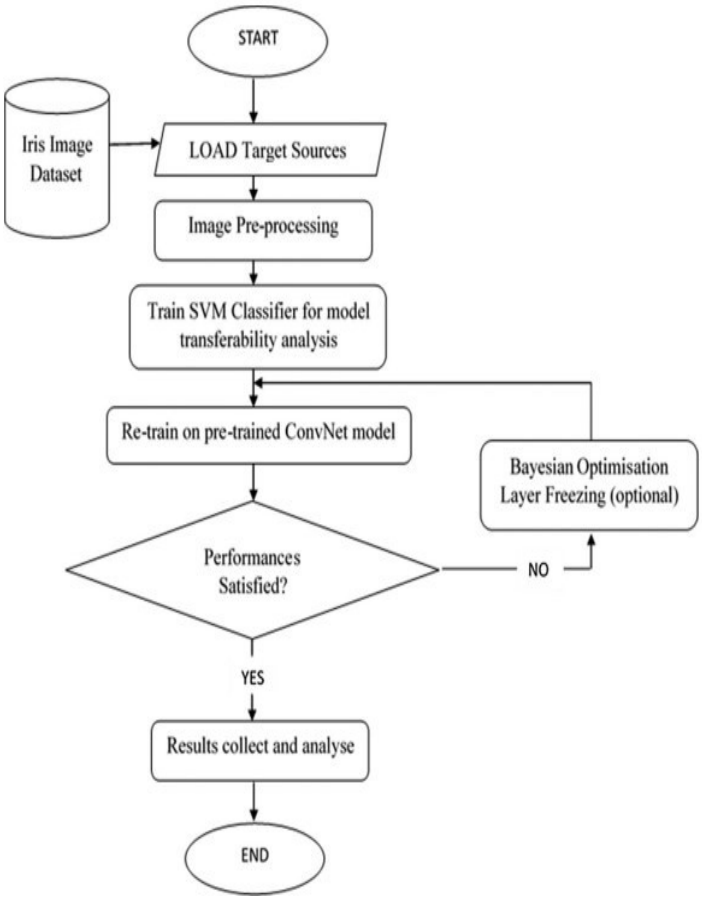

Figure 2: System architecture.

- **Iris capture device:** A specialized camera or scanner is used to capture images of the iris. The device should be able to capture high-quality images of the iris in different lighting conditions and angles.

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- **Database:** The digital templates of the iris patterns are stored in a secure database. This database can be accessed by authorized personnel to verify the identity of individuals.
- **User interface:** A user interface allows individuals to interact with the system by presenting their iris for identification. The user interface may be a physical device, such as a scanner or camera, or a software-based interface that allows individuals to upload images of their iris.
- **Verification process:** When an individual presents their iris for identification, the iris recognition software compares the digital template of their iris with the templates stored in the database. If there is a match, the system confirms the identity of the individual.
- **Security measures:** The system should be designed to ensure the security and privacy of personal information. This can be achieved by implementing strong security measures to protect the database and ensuring that personal information is not shared or used for other purposes.
- **Integration with other systems:** The system may need to be integrated with other systems, such as access control systems or security systems, to provide a comprehensive solution for identification and security.

VIII. CONCLUSION

In this project, the IRS with the proposed technique workflow was successfully developed using Python code. The developed system able to recognise the 108 class of input image inserted from target dataset, CASIA-Iris Interval V1 dataset. Proposed training method with transfer learning able to take existing algorithms as a benchmark instead of scratch. Before the algorithm retraining process, the model is pre-test using an extracted feature on the SVM classifier and does classification on the target dataset. This method aid to identify the transferability and select the suitable model. Based on the results, both AlexNet and DenseNet201 models able to achieve more than 80% accuracy and hence, it indicates the models' high transferability on the IRS. Data augmentation technique helps to transform original images of the target dataset and provides more different samples for the training procedure to solve the limited data size problem and help prevent the algorithm from over-fitting. By data augmentation works on training datasets, the overall accuracy rate of iris images on trained AlexNet model can be increased from 91.80% to 97.72%. In this case, both poor imaging conditions of input and flexibility of model can be solved.

IX. RESULTS

Iris Recognition System (IRS) is a biometric technology used for the identification and verification of individuals based on the unique patterns of the iris in their eyes. The iris is the colored portion of the eye that surrounds the pupil and is known for its distinctive and complex patterns.

IRS has gained popularity in the biometric world due to its high accuracy and reliability in identifying individuals. The technology uses specialized cameras to capture

images of the iris, which are then processed and compared to a database of known iris patterns. The system can quickly and accurately verify the identity of an individual based on their iris pattern, making it an ideal technology for high-security applications such as border control, banking, and government agencies.

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X. WORK PROGRESS

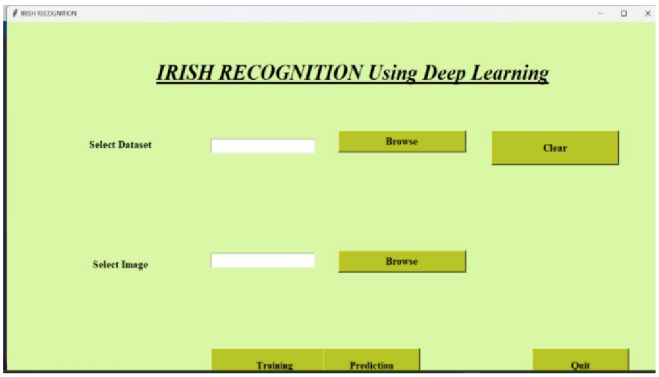

Figure 3: Home page

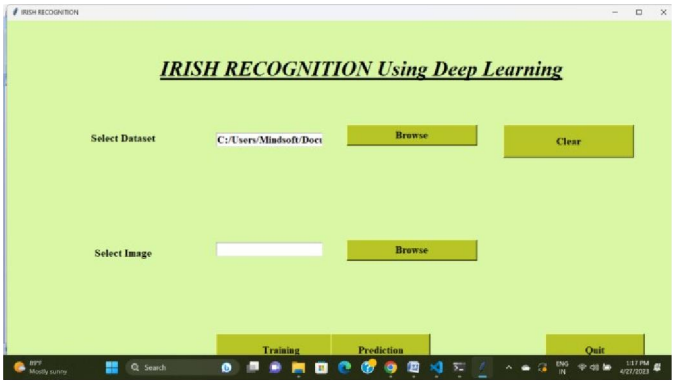

Figure 4: Selection of dataset folder

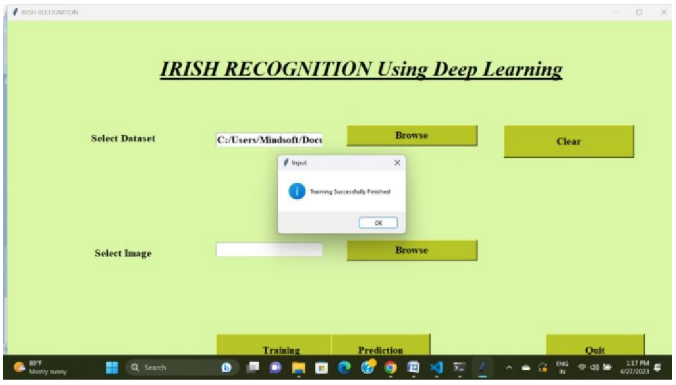

Figure 5: Training Dataset

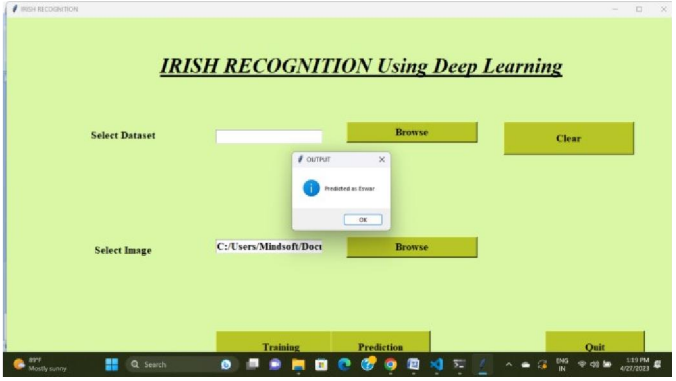

Figure 6: Prediction

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