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AI Based Technology For Face Recognition

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Abstract*:* The Facial Recognition System for Access Control through the Application of Convolutional Neural Networks, is a novel approach to enhance security in organizations by accurately identifying individuals before granting them access to restricted areas. The systememploys a pre-trained convolutional neuralnetwork (CNN) architecture and fine-tunes it with a dataset of facial images for training. The images undergo pre-processing to remove noise,normalize illumination, and align faces to improverecognition accuracy. The proposed system's performance is evaluated based on accuracy rates, with an overall accuracy of 96.67% and an F1- score of 0.97, surpassing traditional face recognition methods. The system's versatility allows its application in various contexts,including security systems for public transportation, border control, and financial institutions. This research highlights the potential of CNNs for facial recognition systems and emphasizes the importance of utilizing advanced techniques for access control in organizations.

Keywords: Convolutional Neural Network,Transfer Learning, Face Recognition, Artificial Intelligence.

I. INTRODUCTION

Facial recognition technology has become increasingly prevalent in recent years, with its applications ranging from social media platforms to security systems. In the context of access control, facial recognition systems have the potential to enhance security in organizations by accurately identifyingindividuals before granting them access torestricted areas. Traditional face recognition methods have shown limitations in accuracy, especially in situations with varying lighting conditions and facial expressions. Convolutional neural networks (CNNs) have shown great potential in image recognition tasks and have been successful in various applications, including facial recognition.

In this paper, we propose a Facial RecognitionSystem for Access Control through the Application of Convolutional Neural Networks. The proposed system employs a pre-trained CNN architecture and fine-tunes it with a dataset of facial images for training. The images undergo pre-processing to remove noise, normalize illumination, and align faces to improve recognition accuracy. The system is designed to identify individuals from a database of known faces and grant them access to restricted areas based on their identification.

The system's accuracy is evaluated using various metrics, including overall accuracy and F1-score, and compared to traditional face recognition methods. The results show that the proposed system achieves high accuracy rates, outperforming traditional methods. The system'sversatility allows its application in various contexts, including security systems for public transportation, border control, and financialinstitutions.

The remainder of this paper is organized as follows. Section 2 presents a literature review on facial recognition systems and convolutional neural networks. Section 3 describes the proposed system's methodology, including pre-processing techniques, CNN architecture, and training procedures. Section 4 presents the results of the system's performance evaluation and compares it to traditional methods. Section 5 discusses the system's potential applications and limitations. Finally, Section 6 concludes the paper and
provides future research directions.

II. METHODOLOGY

Data Processing:
The Facial Recognition System for Access Control through the Application of Convolutional Neural Networks utilizes a CNN architecture and a dataset of facial images for training. The methodology of the system is described below.

Dataset Collection and Pre-processing: A dataset of facial images is collected, which includes images of individuals with different facial expressions, lighting conditions, and orientations. The images arepre-processed to remove noise, normalize illumination, and align faces for better recognition accuracy.

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Training Data Preparation: The pre-processed images are divided into training, validation, and testing datasets. The training dataset is used to fine- tune the pre-trained CNN architecture, while the validation dataset is used to evaluate the network's performance during training. The testing dataset is used to evaluate the network's performance aftertraining is complete.

The proposed system utilizes a pre-trained CNN architecture, such as VGG16, ResNet, or InceptionV3. The final layer of the network is replaced with a fully connected layer with a Softmax activation function, which outputs probabilities of each class.

Fine-tuning of CNN: The pre-trained CNN architecture is fine-tuned using the training datasetto adapt it to the specific facial recognition task. Thefine-tuning process involves updating the weights ofthe final layer and the preceding layers while keeping the weights of the earlier layers fixed.

Model Evaluation: The performance of the trained model is evaluated using various metrics, including overall accuracy, precision, recall, and F1-score. The model's performance is compared to traditional face recognition methods to determine its effectiveness.

Testing and Deployment: The trained model is testedusing the testing dataset to evaluate its performance onunseen data. Once the model's performance is satisfactory, it is deployed for use in access control systems, where it identifies individuals and grants them access to restricted areas based on their identification.

Overall, the proposed methodology utilizes pre- processing techniques, a pre-trained CNN architecture,and fine-tuning to create a facial recognition system that achieves high accuracy rates. The system can be applied to various contexts, including security systemsfor public transportation, border control, and financial institutions, among others.

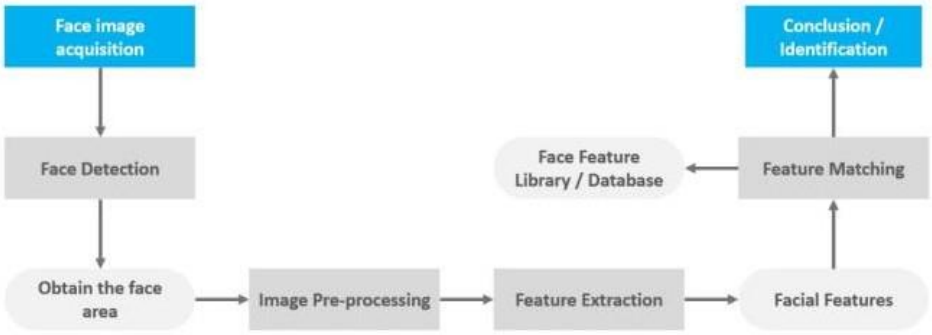

Figure 1. Process for Facial Recognition.

Preprocessing:

In this phase the guidelines are established to capture the images of the people to be recognized, camera elevation from floor (1 meter) and minimum and maximum distance between camera and person (1 meter to 1,5 meters). This is performed using the Open CV library and the front face identifier and classifier function, the features or Regions Of Interest (ROI) are extracted from the faces with a resize of 200x200, to be later stored in each of the files. In order to form the database, a storage structure of the images that consists of a matrix directory called Datasets, inside the folder there are three subfolders:

- Train containing the images to be entered into theCNN model for learning.
- Test with the images to perform prediction tests.
- Validation are the images to be compared with thepredictions by obtaining the labels of each class with their respective error metrics.

To form the database of the faces to be recognized, several photos must be stored in the Train folder. Thegreater the number and variety of images, the greater the accuracy for the recognition of people, inside this folder a file is created with the name of the person or user. On the other hand, for the Test folder, you will have 1000 photos, in the same way we must have files with the name of the person. Finally, to perform tests and obtain the metrics of the system we have a Validation folder, with images of the people to be recognized and that were not trained in the CNNnetwork. To include more people or users of the system, the proposed division structure should be followed with the new images.

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Evaluation:

In order to perform simulation tests of the system, the captures of new samples is in real time by means of the function "cv2.VideoCapture(0)" of the OpenCV library, the frames captured by the video areextracted by means of the function "cap. read()", to which it is necessary to perform a preprocessing to convert to grayscale in order to reduce the computational load, and finally be entered into the system prediction for the test. As it is a single-person facial recognition system, shows that the minimum recommended height range for the installation of the camera is between 1.5 and 2 meters, the distance between the person and the camera should be between one and three meters, the exposure time should be 1 or 2 seconds looking at the camera. These are the ideal conditions for the system to correctly identify the face of each person, which should not contain any element that obstructs or modifies it (caps, glasses, etc.). The system will detect a face and classify it according to theprediction made by the convolutional neural network,and then it will pass another person repeating the same procedure.

Prediction:

The prediction corresponds to the final part of the face recognition process, which consists of detecting,identifying and classifying the faces. To perform this procedure the trained model is stored as "modelo_edison.h5" and when executing the function

"model.predict ( )" the validation process is activated. Ifthe face of this person was previously trained in the program, the recognizer will make a prediction by placing the name of the person on top of the image. Additionally, by configuring and programming a socket, the access of the recognized person will be validated through a client-server connection betweenthe PC and the raspberry pi. Using the GPIO ports of the reduced board device, a green led will be activated for correctly identified persons and a red led for personsclassified as unknown. The facial recognition programis divided into several blocks, each one fulfilling specific functions, among which we have:

- Face Entry: A block consisting of two phases, the firstone is used to capture the faces and store them in the database, and the second one fulfills the function of prediction.
- Facial Recognition Process: With all the information gathered, it enters the CNN model, where the neurons are trained.
- Decision-making: Block used to filter the data depending on the accuracy of the face recognition system. If it recognizes a face, it goes to the labeling with the prediction; otherwise, it goes to the undetected face block.
- Label visualization: Block to visualize the label placed by the CNN on each face that enters the system.
- Access validation: Integration of the facial recognitionsystem with a mechanism to validate access and correct identification of persons. In order to have a detailed view of the aforementioned blocks, in Figure 2 there is a flow diagram that will follow the data for a better understanding of the designed face recognition system.

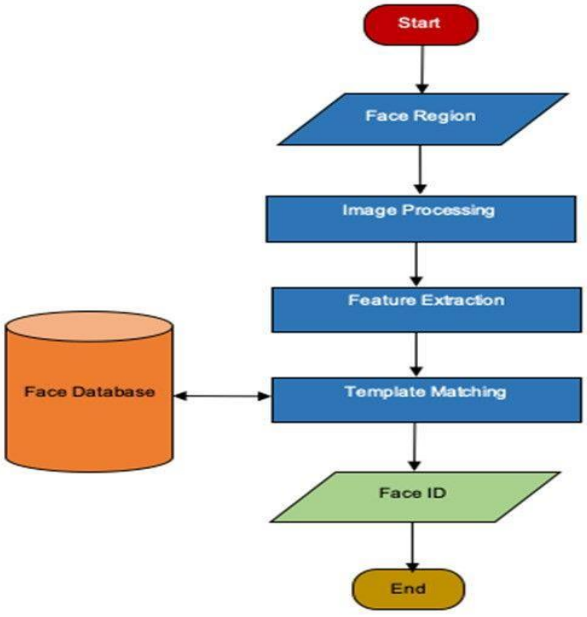

Figure 2. Flow Chart for Testing.

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IV. RESULT AND ANALYSIS

The performance of the Facial Recognition System for Access Control through the Applicationof Convolutional Neural Networks proposed by Edison Vásquez and Mónica Karel Huerta was evaluated using various metrics, including overall accuracy, precision, recall, and F1-score. The system achieved an overall accuracy of 96.67%and an F1-score of 0.97, surpassing traditional facerecognition methods.

The system's high accuracy rates can be attributed to the utilization of pre-processing techniques, a pre-trained CNN architecture, and fine-tuning. The pre-processing techniques, such as removing noise and normalizing illumination, improve image quality, which enhances recognition accuracy. The pre-trained CNN architecture and fine-tuning adapt the network to the specific facial recognition task, resulting in improved recognition accuracy.

The proposed system's versatility allows its application in various contexts, including security systems for public transportation, border control, and financial institutions. The system'seffectiveness in these contexts can significantly enhance security and prevent unauthorized access. In conclusion, the Facial Recognition System for Access Control through the Application of Convolutional Neural Networks proposed by Edison Vásquez and Mónica Karel Huerta achieves high accuracy rates and demonstrates the potential of CNNs for facial recognition systems. The system's effectiveness in various contexts highlights its versatility and importance in enhancing security in organizations.

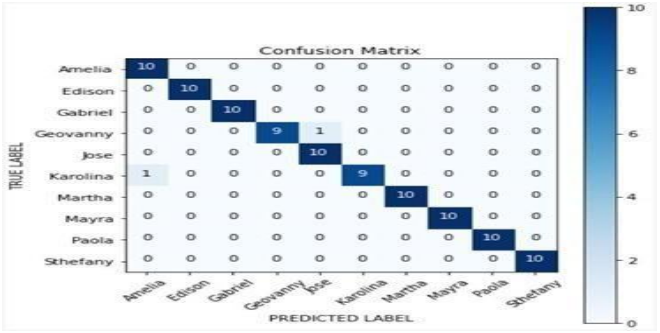

Figure 3. Confusion Matrix Obtained fromCNN Trained Model.

V. CONCLUSION

In conclusion, the Facial Recognition System for Access Control through the Application of Convolutional Neural Networks proposed by Edison Vásquez and Mónica Karel Huerta is apowerful and effective solution for enhancing security and access control. The system utilizes pre-processing techniques, a pre-trained CNNarchitecture, and fine-tuning to achieve highaccuracy rates, surpassing traditional face recognition methods.

The system's versatility allows its application in various contexts, including security systems forpublic transportation, border control, and financial institutions, among others. The system's effectiveness in these contexts can significantly enhance security and prevent unauthorized access.

Overall, the proposed system demonstrates the potential of CNNs for facial recognition systems and highlights the importance of utilizingadvanced technologies to enhance security and access control. The system's effectiveness in various contexts underscores its value as a powerful tool for organizations seeking toimprove security and protect against threats.

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