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Comparison of cloud and edge computing based face recognition for security enhancement

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Abstract

The implementation of novel intelligent applications has resulted in security enhancement in the way information is managed. The processing, storing, and functional aspects of computer systems have all been impacted by this revolution. Cloud computing has become a widely adopted and extensively utilized concept. Unfortunately, there are still some obstacles that prevent the widespread use of cloud computing. Edge computing refers to a decentralized kind of computing that allows the processing of data at its source, extending beyond traditional centralized systems. This research study introduces an innovative and efficient approach for identifying human faces for access control and security monitoring using sophisticated deep-learning algorithms. The proposed approach employs the results of two models trained using VGG face and ResNet architectures, respectively. Integrating these models with the deep face model enhances the accuracy and reliability of facial recognition. The process involves extracting distinguishing characteristics from facial photos using pre-trained VGG face and ResNet models. Subsequently, the deep face model is used to merge the characteristics, hence permitting improved portrayal and recognition of facial features. The proposed methodology has been verified by empirical evaluations, which have shown its effectiveness in improving precision and robustness in tasks associated with human facial

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recognition. The work significantly enhances the advancement of deep learning techniques in the field of face recognition applications for security enhancement.

Subject Classification: *68M25.*

Keywords: *Deep learning, Transfer learning, Convolutional neural network (CNN), Cryptography and security, Smart surveillance.*

1. Introduction

The emergence of new intelligent applications has led to a significant revolution in information management. Over the last decade, there has been a notable transformation in the computer paradigms used. The notion of cloud computing is well recognized and highly favored, with organizations increasingly embracing it to enhance their agility, flexibility, and competitive resources. The widespread use of cloud computing and the increasing prevalence of intelligent devices and appliances pose significant challenges, despite their seemingly inevitable integration into all aspects of modern life. The limitations of a centralized model were exposed by the Internet of Things (IoT) [1]. Human identity detection: As described in reference [2], pertains to face features, fingerprints, iris patterns, speech patterns, and behavioral variables. The accurate identification and verification of human identity have substantial implications for safety and ease of use, including numerous applications including access control, surveillance, and personalized user interactions on digital platforms [3]. The challenge of attaining an ideal balance between security, confidentiality, and usability is a major problem in this field, considering the ongoing advancements in identity detection methods that are radically altering our relationships with technology as well as society [4].

The primary objective of this research is to include the variables of the previously trained model into the development of the new model. This method makes it possible to precisely parameterize the model, which eventually leads to an improvement in the overall effectiveness of the final model. The use of end-to-end feature extraction in conjunction with transferable learning strategies for face recognition is the distinctive characteristic of our method. The paper is organized in the following manner. Section 2 provides a summary of the literature studied. The approach used in this study is outlined in Section 3. Section 4 presents the findings and examinations, while Section 5 provides the final conclusions.

2. Literature Review

This section provides a comprehensive examination and evaluation of the existing literature pertaining to the chosen issue, elucidating how the findings and practical implications of these studies will contribute to the current investigation. In contemporary times, a multitude of scholars have conducted investigations about deep learning, using cloud computing [5] and edge AI [6]. The following studies are included as highlighted in the present context. Data aggregation strategy that ensures privacy preservation in the context of Mobile Edge Computing (MEC) supported Internet of Things (IoT) applications are presented in [7]. The recognition system model first creates a facial identifier to distinguish the identify of an individual. The article includes an extensive survey undertaken that investigates the influence of computing at the edge on the efficiency in IoT networking [8]. Edge computing is categorized into many architectural groups, and its performance is assessed by comparing network latency, bandwidth utilization, energy usage, and overhead. The primary objective of Cyber-Physical Systems for Service (CPSSs) aims to provide proactive, customized, and top-notch services to people. To accomplish this objective, it is crucial to create a cutting-edge service framework. Abbas et al. introduced a new approach to cloud-edge computation that incorporates Tensors, such as both cloud as well as edge layers [9]. This study offers an in-depth examination of cloud security, with a special emphasis on strategies for safeguarding multi-cloud service suppliers and their progress [10]. The research provided in [11] demonstrate some significant parallels and contrasts across the Cloud, the edge, including fog computing strategies for effective implementation of security measures designed to combat safety hazards and privacy infringements. The objective of this study is to evaluate the current cloud-based facial recognition services that are used for continuous safety and monitoring [12]. Deep learning is currently extensively used to tackle diverse issues in the domains of visualization and pattern recognition [13]. Technology that recognizes faces is increasingly being used to solve several social challenges, including personal identity and protection. Several facial recognition methods have been previously introduced, including Fisherfaces, the Eigenfaces, as well as LBPH.

3. Methodology

Our primary objective is to identify a model and methodology that lies between traditional and cloud-based training for models. The main

goal of this research is to reduce the time, and costs involved in hardware acceleration devices, while still maintaining the high effectiveness in developing CNN architectures [14]. During the final phase of the procedure, the model that was trained is integrated with the Deepface API. The Deepface initiative is an open-source endeavor spearheaded by an academic team associated with Meta Group. The objective of this research is to evaluate the whole procedure by running tests on just one image of the participant and analyzing the outcomes.

3.1 *Proposed Model*

The first model for classification employed in this research is a CNN (Convolutional Neural Network) using the VggFace framework. In the initial phase, the framework is trained using the chosen applications for authorization, using the appropriate dataset. The computational model will be trained using a cloud-based system with GPU capabilities. In this investigation, we employ the VGG-16 with ResNet networks taken from the Deepface library, using the identical dataset [15]. We assess the efficacy of both approaches and select the most ideal outcome. We have used a CNN combined with FaceNet as the second classification model. The

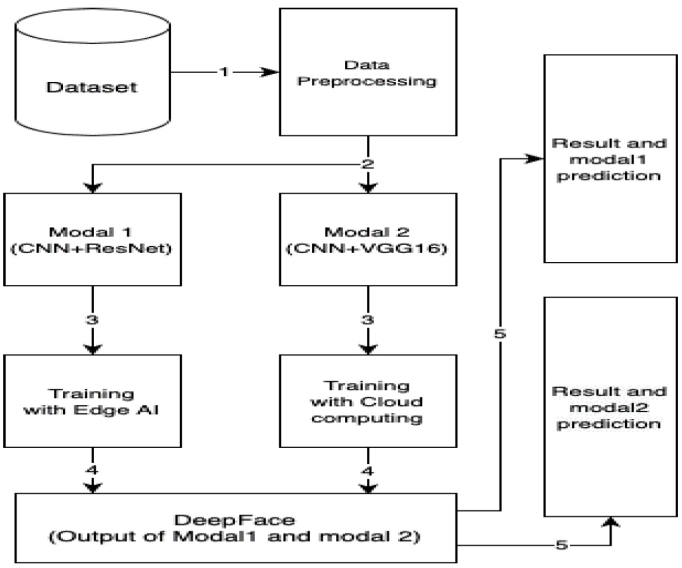


Figure 1

Design and structure of the suggested approach.

proposed model integrates the underlying CNN and ResNet, while also including deepface via integration. The objective of the model is to provide a full range of face information, including facial characteristics, emotions, age, and gender, by means of analyzing individual photographs.

The deep face application programming interface, or API, may be used to identify these specific characteristics. The model effectively integrates crucial information with a notable degree of precision. The dataset comprises foundational models, like ResNet, as seen in Figure 1. Subsequently, the procedure is completed to construct the model, including diverse classifiers among activation functions, such as Relu, sigmoid, SVM, as well as others. Nevertheless, when it comes to multiclass classification, the sigmoid activation function often produces superior outcomes. In Figure 1, a comprehensive depiction of the workflow of the model is shown. The suggested approach utilizes a dataset that includes derived and transformed data. This dataset will be used to train the model in this project. Additionally, OpenCV and image classification models like as FaceNet and VggFace are used in this process. FaceNet is an exclusive dataset that has been meticulously created and trained only for the aim of developing face recognition algorithms.

The entire set comprises over 500,000 datasets, with each dataset comprising several persons. It encompasses practically 10,000 unique individuals. The DeepFace dataset consists of an extensive assortment of millions of photographs that capture the facial characteristics of more than 2,600 humans. The collection contains an overall of 1242 raw images, which belong to 46 different persons. Furthermore, the dataset is going to be divided into pieces of 80% and 20%. CNNs are used to analyze image datasets to examine the outputs. CNNs are a specific kind of artificially generated neural network that is often used for tasks related to image and speech recognition. This specific model is very suitable for the recommended research since its integrated layer of convolution can efficiently reduce the dimensionality of images while maintaining data integrity.

Figure 2 displays a subset of enhanced photographs from the dataset. A collection of six photos depicting individual subjects has been developed, using various characteristics such as zoom, rotation, and shift. The architecture of the classes inside the structure will be separated based on the number of individuals included in the dataset.

Figure 2

Generated augmented images from dataset

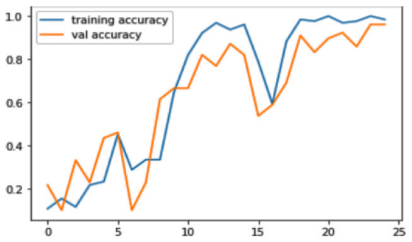
This research involves the examination of a sample including around 50 individuals and their corresponding input photographs. In this research, we have presented the previously indicated framework, expanding on the suggested modal architecture. Through the use of this architectural framework, we have developed a sophisticated training model that effectively integrates cloud and edge artificial intelligence methodologies. The foundation of our method was centered on the objective of augmenting the effectiveness of the human identification system. The objective of our study was to enhance the accuracy and efficiency of human identification recognition by integrating cloud and edge artificial intelligence (AI) approaches. The integration of technology in question exhibits the capacity to fundamentally transform the functioning of identification systems, presenting a dynamic and resilient solution that leverages the advantages of both cloud and edge computing paradigms.

4. Result and Analysis

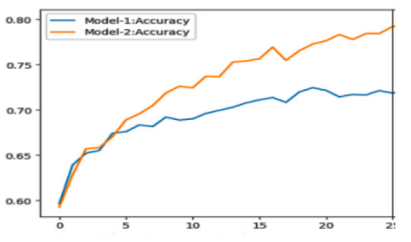
In the ultimate outcome, it was seen that both approaches, namely training the model with CNN and ResNet, and training the model with CNN and VGGFace, shown significant accomplishments, therefore highlighting the efficacy and potential of deep learning in the domain of face recognition. The last stage, as seen in Figure 1, is the creation of an expanded dataset of images. The dataset is subjected to augmentation using a specific library, where each picture is turned into several enhanced versions. The iterative nature of this procedure enhances and expands the dataset, ultimately resulting in the creation of the final dataset.

The classification approach generates a classification result. The classification outcomes of the face recognition models created using two distinct approaches, CNN with ResNet and CNN with VGGFace, are shown below, along with their corresponding classification findings. One

approach included training a model using CNN together with Residual Networks (ResNet), which achieved a high level of accuracy in classifying face pictures by combining the CNN and ResNet frameworks, it became feasible to extract intricate facial features and capture subtle changes in facial emotions, resulting in impressive recall and accuracy rates. The model demonstrated exceptional performance in several face recognition tests, accurately and precisely identifying individuals with little instances of inaccuracy. Upon implementing the second technique, which included constructing the model using CNN and VGGFace, we saw quite impressive outcomes. In general, both methods produced very robust outcomes in classification, underscoring the efficacy of combining CNN with ResNet and VGGFace for face recognition tasks. Figure 3 demonstrates that the precision of the initial model tends to improve as the number of epochs increases. Similarly, the chart generated from the given Table 1 illustrates the evolution of 'val_accuracy' and 'accuracy' with respect to epochs. The graph shown is a visual depiction derived using precise accuracy and validation accuracy data obtained from both cloud computing and edge computing platforms. As shown below.



a. Training Accuracy vs Validation Accuracy of model1



b. Accuracy comparison of model1 and model2

Figure 3

Accuracy comparison

The graph shows resemblance to the information shown in Figure 3, illustrating the precision of model1 and model2 in respect to the data outlined during different time periods. The graph has been generated using the data pertaining to comprehensive accuracy and validation accuracy. The training method will be executed on a cloud-based platform that is endowed with GPU capabilities.

Table 1

Final Accuracy: The evolution of 'Avg_Val_Accuracy' as Average Validation Accuracy and 'Avg_Accuracy' as Precise Accuracy for both edge and cloud based approaches.

Final Accuracy	Traditional - Approach	Cloud - Approach
Avg_Val_Accuracy	73.19%	71.6%
Avg_Accuracy:	85%	87.8%

The table and plot include empirical findings that give a comprehensive study of the results shown by the models in the field of human identification. Furthermore, the comprehensive nature of the evaluation, which considers both cloud computing as well as edge computing, highlights the flexibility of the frameworks in efficiently meeting various computational needs. These types of technologies are very versatile and hence suitable for a broad variety of applications. These applications include complex cloud-based identity verification processes and localized edge computing scenarios that need minimal latency.

6. Conclusions

The research analyses the procedure of determining human identities including its consequences for improving security systems. Furthermore, an assessment is conducted to compare the results of implementing a technique for creating human pictures in a sequential manner vs a concurrent manner in Cloud and Edge systems, respectively. This comparison is conducted to ascertain the efficacy of the direct technique. The performance achieved on the cloud infrastructure was found to be 2.25 times higher than the throughput achieved before. In addition, there was an 11.2 percent reduction in the quantity of bandwidth required, and execution time was reduced by 81 percent. One potential explanation for what has been seen is that it may be attributed to the reduction in the total amount of data, which is around 44 percent fewer than its original form. Overall, the combination of experimental findings shown via visual representations and tables demonstrates the effectiveness of the suggested models in the context of the human identifying system. Furthermore, this system can be effectively used for various security and authentication applications

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