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Human Authentication System Using Deep Learning Techniques

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Abstract: **Through the use of convolutional neural networks (CNNs), a deep learning approach, this research seeks to improve security by enabling people to authenticate themselves in front of a camera. The system shows the name and other details of an authorized user after identifying them from a pre-existing database. But in the event that a person is recognized as unauthorized, the system makes use of pre-trained algorithms to forecast and present the person's age, gender, and emotional state. The technology additionally includes a beep sound to notify security workers of unlawful attempts. This dual functionality collects useful demographic information on unauthorized attempts in addition to strengthening security measures by limiting access to authorized users exclusively. With increased security and user privacy guaranteed, the project responds to the growing need for reliable and effective authentication mechanisms in contemporary applications.**

Keywords **– CNNs, Deep learning, Haar cascade classifier**

1. INTRODUCTION

Addressing the Project Area: Security of physical locations and digital services relies on the field of human authentication methods. Sophisticated methods like machine learning and biometric authentication are getting more prevalent as traditional approaches change. The objective of this study is to make use of deep learning to develop a smart facial recognition system. Deep learning allows computers to recognize faces from images in an approach similar to recognizing the faces of humans, but with greater speed and accuracy. With the use of this technology, we are able to confirm whether someone is authorized to access or enter an address. The system will immediately verify the user's authenticity and publish their personal data if it already has their data saved. What makes our technological advances distant, still, is the fact that it does far more than just detect people it recognizes. It won't instantly block anyone it doesn't recognize once it sees them. Instead, it makes an educated guess regarding their gender, age, and perceived mood depending on its advanced technology, and it will alert an administrator by beeping. This is useful since it gives additional information about all those who tried to get inside and their psychological state, which could prove essential for purposes of security.

Deep learning: Neural networks based on artificial intelligence are the foundation of deep learning, a subfield of machine learning. It possesses a capacity to identify sophisticated hyperlinks and patterns in data. We are unable to expressly implement anything in deep learning. a combination of the availability of huge data sets and improvements in computer technology, it has increased in prominence in recent years. partly because of the reality that neural networks with deep learning, or artificial neural networks (ANNs), are the foundation of them (DNNs). These neural networks, especially are created to learn from vast amounts of data, are designed upon the structure and functioning of real synapses in the cerebral cortex of humans. the context of the current endeavor, that we employ the use of deep learning to develop a integrated facial identification system. This implies that technology can recognize individuals by looking at images of their facial features. In order to do this, we employ an instance of deep learning technique called convolutional neural network networks (CNNs). These neural networks can reliably detect faces after learning from an extensive number of photographs. The method we use is able to forecast details regarding individuals it is unfamiliar with. As an example, it is possible to determine their age, the gender, and additionally the way they felt. This contributes to our entire system more intelligent and more protected. Face Recognition: The recognition of facial features utilizes techniques for recognizing along with authorize humans according to their distinctive looks. This functions through examining trends within appearance images, including glance distance from one another, nasal structure, as well as jawbone. Recognition systems that recognize faces can be utilized for an array of objectives, which includes access and security management, monitoring, in addition verifying one's identity in technological applications. Algorithms such as these collect countenance images using pictures or video broadcasts and

then compare them to a collection containing recognized faces in order to identify whether they correspond. In the past few years, developments in deep neural networks and computer science have greatly improved the recognition of facial features the technology's reliability and precision. Yet, is concerned regarding confidentiality, prejudices and safety concerns persist, resulting in constantly debates and disputes with regard to ethical and legal implications.

2.LITERATURE SURVEY (Related Works)

Gil Levi et. al [1] proposed Age and Gender Classification using Convolutional Neural Networks. With this study, we're seek to close the discrepancy among automated recognition of faces capabilities and estimation of age and gender methods. To achieve this objective, we follow the successful precedence set by relevant facial identification systems: Recognizing faces addresses disclosed over the past decade demonstrate that the use of deep convolutional neural networks (CNN) may result in substantial advances [3]. We exhibit comparable advantages using a fundamental network structure intended to accommodate for the limited availability of right age and gender classifications in available face data sets.

Octavio Arriaga et. al [2] proposed Real-time Convolutional Neural Networks for Emotion and Gender Classification. The research presented here suggests and executes an overall CNN architecture platform to create an instant CNN program. The algorithms have been verified using a real-time expression detection system that identifies individuals and labels emotion in human-level reliability. They provide two alternatives and assess either based on precision of testing as well as the number of parameters. The two models were developed with an objective to achieve the best possible efficiency relative the amount of variables proportion. Following offering an overview of the instruction methodology installed, they will conduct assessments using established reference datasets. Drawbacks: Some Female subjects mistakenly classified as males and Some Male subjects mistakenly classified as females

Rapid object Detection using a Boosted cascade of Simple is proposed by Paul Viola Mitsubishi [3]. The article presents a deep learning approach to visual recognition of objects which can analyse photographs swiftly and achieve excellent identification rates. The initial step was the launch of an innovative depict description called by the term "The integral Image," that allows the detector's detection characteristics to be estimated quickly. The second approach is an AdaBoost-based approach to learning it chooses just a handful of important visual characteristics among a greater number to generate highly effective classifiers. The last modification involves combining complex classifiers in a "cascade" to remove areas of background but concentrate on potential object-like areas. Initial studies indicate a front initial experiment demonstrated that a frontal face classifier constructed from 200 features yields a detection rate of 95% with a false positive rate of 1 in 14084

Face Detection and Recognition Using OpenCV is introduced by M. Khan et. al [4]. Face Detection and Recognition Recognition of faces and image/video detection through OpenCV is an increasingly prevalent topic of informatics investigation. In real time recognition of faces is a compelling discipline that addresses a rapidly evolving problem. The principle behind the PCA (Principal Component Analysis) facial recognition algorithm is suggested here. Key component analysis (PCA) is a method of statistics that comes under the umbrella of the field of factor analysis. The Principal Component Analysis (PCA) attempts to reduce the dimension of the space of features required to effectively characterize the information beyond the present enormous amount of space. The broad 1-D pixel vector generated from a two-dimensional image of a face in compressed primary spatial features is intended for recognizing facial features via the use of the PCA. A self-space.

Lihong Wan et. al [5] proposed Recognition of faces utilizing convolutional neural network (2017), A novel approach for face recognition under two distinct circumstances has been laid out using convolutional neural networks (CNN) and subspace learning. The activation vector of the CNN architecture's fully connected layer was calculated via the feature extractor of the VGG-Face highly sophisticated CNN architecture, that has been trained on an enormous database. subsequently, two separate subdomain methods for learning, linear discriminate analysis (LDA) and whitening principal component analysis (WPCA), are presented in environments with a number of samples per dependent as well as just one sample per subject, respectively. Algorithms applied comprise convolutional neural network design and principal component analysis. Drawback: CNN does not detect object spot and orientation.

X. Ren et. al [6] introduced Face modelling method using Dlib (2017) Face modelling method using Dlib, proposes a gradient enhancement approach. It computes the real form of a global optimization model, as well as the shape of training patterns for linear least squares fitting. To accomplish autonomous localization of face feature points, the model is used to test regression estimation of sample feature point placements as well as form optimization. as well as a regress cascade learning approach. There has also been research into the relation between the regularisation parameter and the overfitting issue. Simultaneously, affine synthesizes data when there is insufficient data.

Peng et. al [7] proposed Face Recognition Technology (2020), A Brief Description of Face Recognition Technology. The method of face recognition utilizes a person's facial features to recognize them. Individuals gather their facial images, which are then eventually automatically analysed by image recognition technology. An overview of many studies related to recognizing faces is provided in this article. The paper highlights multiple phases of development for facial detection systems of all kinds. It provides face recognition databases, general assessment standards, and face identification research for scenarios from real life. It provides an outlook on facial recognition from the future. Future study efforts should concentrate on recognition of facial features, as it offers an extensive range of intriguing prospective uses. Algorithms used: Principal component analysis Linear discriminate analysis Support vector machine Neural networks Drawbacks: It cannot recognize rotated angled and occluded faces.

From the above literature it is inferred that an integrated system is very much needed to implement effective security system for not only authentication, but also an integrated information gathering system is badly needed, when an unauthorised user is identified.

3. METHODOLOGY OF PROPOSED SYSTEM

To fulfil the research gaps discussed in the above section a "*Human Authentication System Using Deep Learning Techniques"* is proposed. When compare to existing systems Age, Gender and Emotion prediction for the unauthorized user is the main strength of this proposed system. This is mainly implemented in five phases that are listed below.
Phase-1: Capturing image from webcam.
Phase-2: Face Detection
Phase-3: Face Recognition
Phase-4: Age & Gender prediction
Phase-5: Emotion prediction

Phase-1: Capturing image from Webcam.

Our input is determined by faces detected through the webcam.

Phase-2: Face Detection using Haar Cascade Classifier

For detecting faces in images, the 38-layer by layer cascaded classifier employed by the facial identification system pursuant to consideration is a sophisticated framework developed specifically for identifying of front upright face. It was a pre-trained model and by careful consideration, each one of the 4916 carefully labelled faces within the facial training collection has been scaled and aligned to a base resolution of 24 by 24 pixels and 9544 images were carefully reviewed to eliminate any facial characteristics before these non-face sub windows were utilized in training. These faces were extracted from a diverse range of images obtained through a random crawl of the World Wide Web.

Phase-3: Face Recognition

For recognizing features in images, the face recognition library uses a network of convolutional neural networks (CNN) of dlib which was already pre-trained model. The CNN crew was trained to identify faces and determine their locations within the interior of the photographs. Libraries which are used in face recognition are dlib, NumPy and Scikit-learn.

Phase-4: Age & Gender prediction

We utilized both the "age_net.caffemodel" and "gender_net.caffemodel" pretrained models along with their respective deploy files ("deploy_age.prototxt" and "gender_deploy.prototxt") to predict the age and gender of individuals from images. In previous literature they used Adience benchmark dataset to train their models which consists of approximately 26,000 images of 2,284 subjects. These images were collected from online sources, reflecting real-world conditions with highly unconstrained viewing conditions. Each image is annotated with age and gender labels and utilized a five-fold, subject-exclusive cross-validation protocol for age and gender classification tasks, ensuring robust evaluation of the models' performance. The network comprises of only three convolutional layers and two fully- connected layers with a small number of neurons to extract the features of the input image.

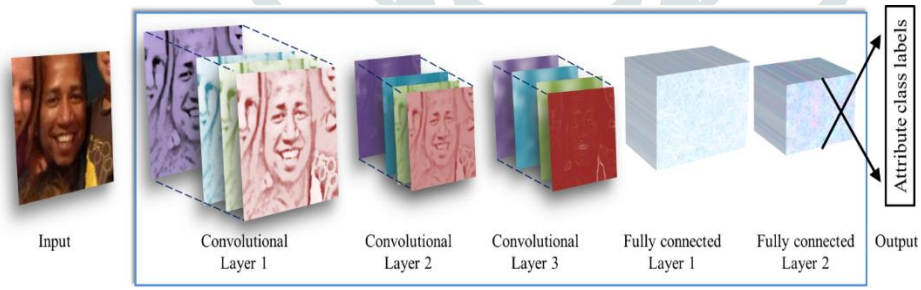

Fig 3.1: Illustration of CNN architecture for age and gender prediction

Phase-5: Emotion Prediction

We have utilized a pre-trained model for emotion prediction to integrate it in our system to make our system more secure, the model used here is "emotion_model.hdf5" and it uses the FER-2013 dataset for training the model the set of images of faces labelled using range of emotions that includes happy, sad, angry, etc. This model comprises of four residual depth wise separable convolution layers as shown in the Fig 3.2

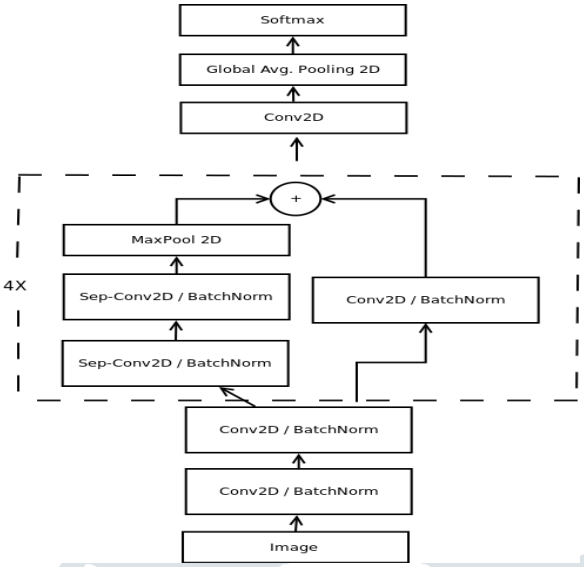

Fig 3.2: Network architecture for emotion prediction

4. RESULTS ANALYSIS

To test the performance of proposed system, all the modules are implemented using python 3.8.1 and is executed using Jupyter as IDE on desktop system with 16GB RAM and i7 processor with 4.6GHz processor speed. Proposed Human Authentication system captures the user video through web cam with 1080 pixels. The captured video is divided into sequence of frames and are supplied as input to the proposed architecture. The main three stages of execution of Proposed system is as follows:

- Initially. Capture faces from web cam
- Then, load every individual authorised user image(s) in separate directory/folder as shown in Fig 4.1.
- Finally, Captured images given as input to the system
  - If face is recognised as authorised system will display his/her name as shown in Fig 4.2.
  - If Not Authorised user
    - System will display Age Gender and Emotion of the User as shown in Fig 4.3.

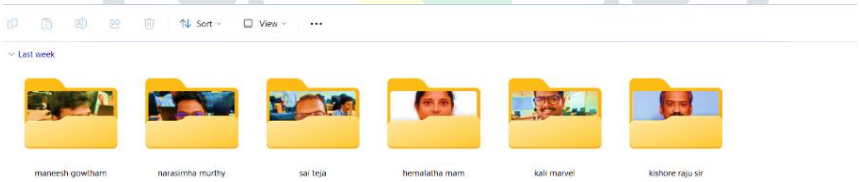

Fig 4.1: Existing authorized users images stored in Folders

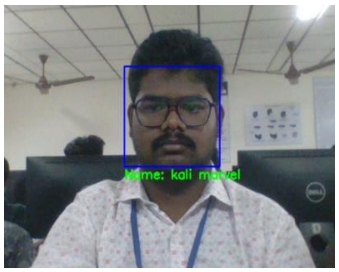

Fig 4.3: Recognition of authorised user

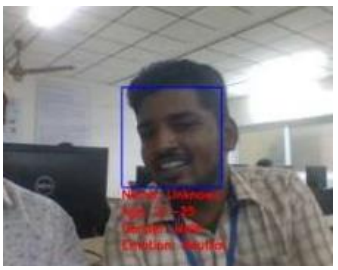

Fig 4.3: Recognition of unauthorised user

Table 1 : Performance metrics of different modules in proposed method

System Modules	Accuracy	Recall	Precision	F1 Score
Face Recognition	90%	90%	90%	90%
Age Prediction	86%	89%	94%	93%
Gender Prediction	95%	95%	95%	94%
Emotion Predictior	94.4%	71%	73%	75%
Average	**91.35%**	**86.25%**	**88%**	**88%**

After conducting experments, it is evident that the face recognition achieved an accuracy rate of 90% using the dlib library , The reduction of accuracy by 10% is because of hardware limitations such as CPU and GPU effecting the accuracy of the face recognition process. The age and gender prediction both uses the same CNN algorithm as discussed in phase-4 in section-3, it was found that both Age and Gender performance is between the range of 86-95% as shown in the Table 1 and the defficiency in this algorithm is may be impacted by using few convolutional layered architecture of the pre-trained model [Fig 3.1] as it doesn't extract required features. For emotion prediction , it uses Guided back-propagation visualization of mini-Xception model and it produces 94.4% of accuracy and the major reductions are come across other metrics. It is concluded that the overall accuracy[91.35%] of this proposed system as mentioned in the Table 1.

5. CONCLUSIONS

Based on the experiments conducted, it is concluded that the system offers a robust and versatile solution with an average accuracy of 91.35% for various applications, including security and personalized user experiences. By integarting Age and Gender and Emotion prediction models with Face Detection the proposed human authentication system posses considerable impact on security system. Moreover, Age and Gender prediction models achieved an accuracy of 86% and 90% respectively. Regarding Emotion prediction, neraly 95% accuracy is achieved. Finally, it is concluded that it can be used in various security needed places such as offices , colleges for security reasons . For further any implementations and refinement we can use this system and modify for our needs.

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