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*Review Article*

# Improved Model for Age and Gender Recognition Using deep Learning Techniques

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**Abstract:** Age and gender recognition using deep learning techniques has gained significant attention due to its potential applications in various domains, such as human-computer interaction, surveillance systems, and personalized marketing. With the rapid usage of Artificial Intelligence (AI) based systems in different fields, we expect that such decision making capability of these systems match as much as to the human capability. Researchers continue to examine different methods to enhance its performance. Due to superior performance of Convolutional Neural Networks (CNNs) based approaches have been widely used in recent years for facial analysis. The proposed work employing a comprehensive dataset, the model exhibits superior accuracy in predicting both age and gender attributes. This research work delves into the intricate relationship between facial features and age-gender classification, exploiting convolutional neural networks (CNNs) to capture intricate patterns in facial images. Two-level CNN architecture includes feature extraction and classification itself. The feature extraction process extracts a feature corresponding to age and gender, and the classification process classifies the face images according to age and gender. The Proposed method achieved better result comparison to others model. UTK Face dataset is used for the experimental purpose

**Keywords:** CNN, Gender Classification, Face Detection, Machine Learning, Deep Learning, Convolutional neural network (CNN), Pre-processing, Feature Selection.

## 1. INTRODUCTION

The advent of deep learning techniques has revolutionized various domains, with computer vision standing at the forefront of transformative applications. Among the myriad tasks within computer vision, age and gender recognition from facial images hold paramount significance in fields ranging from security and marketing to human-computer interaction. Accurate determination of these demographic attributes has broad implications

for personalized services, targeted advertising, and public safety. This research addresses the pressing need for an enhanced model in the realm of age and gender recognition, utilizing cutting-edge deep learning methodologies.

Contemporary age and gender recognition systems often face challenges in achieving high accuracy, especially in the presence of diverse facial expressions, lighting conditions, and age variations. To surmount these limitations, this study proposes an improved model that harnesses the power of deep learning to extract intricate patterns from facial images. Neural networks, particularly convolutional neural networks (CNNs), have demonstrated exceptional capabilities in image analysis, making them instrumental in discerning nuanced features crucial for age and gender classification.

The foundation of this research lies in the recognition of the intricate relationship between facial features and age-gender attributes. We acknowledge the multifaceted nature of this task, where subtle cues in facial structures contribute to accurate predictions. Leveraging an extensive dataset that encompasses diverse age groups, ethnicities, and genders, our model is trained to discern and learn the inherent patterns embedded in facial images. Through this comprehensive approach, we aim to mitigate biases associated with age and gender recognition systems, ensuring the model's applicability across a broad spectrum of demographic groups.

One of the key innovations presented in this research is the incorporation of a novel attention mechanism within the deep learning architecture. This mechanism enables the model to dynamically focus on discriminative regions of the face, refining its attention to features crucial for accurate predictions. By emphasizing relevant facial components during the learning process, the model becomes adept at capturing subtle variations in facial expressions and aging patterns, ultimately enhancing its predictive capabilities.

The significance of this research extends beyond theoretical advancements, finding practical applications in numerous domains. From bolstering security measures through facial recognition systems to tailoring marketing strategies based on demographic profiles, the implications are far-reaching. Additionally, the model's proficiency in human-computer interaction scenarios contributes to the development of more intuitive and responsive technologies, fostering a seamless integration of artificial intelligence into daily life.

This research introduces an advanced model for age and gender recognition, addressing the limitations of existing systems through the integration of state-of-the-art deep learning techniques. The subsequent sections delve into the technical details, experimentation, and validation processes, offering a comprehensive exploration of the model's efficacy and potential impact on diverse real-world applications.

## 2. REAL AGE ESTIMATION

Age estimation is a long-studied research topic among computer vision researchers. Most of the researchers considered human age estimation as either a classification or regression problem. In the case of age classification, age is coupled with a specific range or age group. On the other hand, age regression is a single value estimated for a person. However, it is very challenging to estimate an exact age due to diversity in the aging process across different ages [1]. Furthermore, for accurate age estimation, the model needs a huge amount of correctly labelled face data.

### Gender Estimation

A lot of progress has been achieved in the gender estimation topic, but it is still a challenging problem in the real-world environment. The literature about gender estimation comes under the umbrella of the authors of [1]. Here, we will discuss some of those methods where the well-known classifiers are used for the gender estimation. As one of the very early methods, the authors of [1] used a fully connected two-layer neural network that learned from a limited number of near-frontal face images for gender classification. In [1], SVM classifiers were directly applied to image intensities. Similarly, AdaBoost was introduced instead of SVM classifier by keeping the same working pipeline.

## 3. LITERATURE SURVEY

There are several works related to age and gender recognition using facial expression recognition, deep neural network and convolution neural network, recurrent neural network. Detailed review of the work is discussed in this chapter.

Authors [1] propose a deep learning-founded enterprise solution for smart store customer relationship management (CRM), which allows us to predict the age and gender from a customer’s face image taken in an unconstrained environment to facilitate the smart store’s extended services, as it is expected for a modern venture. Authors handle our classification tasks utilizing an empirically leading pre-trained convolutional neural network (CNN), the VGG-16 network, and incorporate batch normalization. Especially, the age estimation task is posed as a deep classification problem followed by a multinomial logistic regression first-moment refinement. Authors validate our system for two standard benchmarks, one for each task, and demonstrate state-of-the-art performance for both real age and gender estimation.

Authors [2] propose a much simpler convolutional net architecture that can be employed even if no learning data is available. In a recent study presenting a potential benchmark for age and gender estimation, we show that our strategy greatly outperforms existing state-of-the-art methods.

Authors [3] propose a novel end-to-end CNN approach, to achieve robust age group and gender classification of natural real world faces. Two-level CNN architecture includes feature extraction and classification itself. The feature extraction process extracts a feature corresponding to age and gender, and the classification process classifies the face images according to age and gender. Particularly, we address the large variations in unfiltered real-world faces with a robust image pre-processing algorithm that prepares and processes those facial images before being given into the CNN model.
Authors [4] authors review various models and algorithms for recognition of age and gender and rsults of this study indicated that the SVM (99.80%) and the LBP (98.7%) had the highest detection accuracy rates, along with GAP (99.85 %). In general, different age estimation and face recognition techniques and algorithms can be effectively applied to particular scenarios or applications. In addition, new issues were found regarding the techniques of age estimation and face recognition. Therefore, the study has provided new trends and prospects for future researchers.

## 4. FACE RECOGNITION

Face recognition for age and gender recognition represents a pivotal application within the broader scope of computer vision, leveraging advanced technologies to extract meaningful insights from facial images. In recent years, the fusion of deep learning and face recognition has significantly elevated the accuracy and efficiency of age and gender prediction models.

The key challenge in age and gender recognition lies in the inherent complexity of facial features, which evolve with age and exhibit considerable diversity across different demographic groups. Deep learning, particularly convolutional neural networks (CNNs), has emerged as a powerful tool for overcoming these challenges. CNNs excel at learning hierarchical representations of facial features, enabling the model to discern subtle variations and patterns that are indicative of age and gender.

Face recognition technology have led to the development of attention mechanisms within deep learning architectures. These mechanisms enable the model to focus selectively on critical regions of the face, enhancing its ability to capture fine-grained details relevant to age and gender classification. This attention-driven approach not only improves accuracy but also provides interpretability, shedding light on the specific facial features influencing predictions. The practical applications of face recognition for age and gender recognition are diverse, spanning industries such as marketing, healthcare, and security. For instance, in retail, understanding the demographic composition of customers allows for targeted advertising and personalized shopping experiences. In healthcare, age and gender prediction can contribute to patient profiling and assist in tailoring medical interventions.

### 4.1 Deep Learning

Deep learning is a subset of artificial intelligence and machine learning that employs neural networks to enable computers to learn and make decisions without explicit programming. The term "deep" refers to the multiple layers in these networks, facilitating the learning of complex representations from data. Neural networks, inspired by the human brain, consist of interconnected layers of artificial neurons. They autonomously extract features from raw data, eliminating the need for manual feature engineering. Deep learning models require substantial labelled data for training and iteratively adjust their parameters through back propagation. Widely used in computer vision, speech recognition, and natural language processing, deep learning has achieved remarkable success in diverse applications such as image classification, language translation, and medical diagnosis. Its versatility and automated feature extraction make it a powerful tool in the evolving landscape of artificial intelligence.

## 5. PROPOSED MODEL

This section presents the proposed deeply learned CCN based classification model for age group and gender classification of unfiltered real-life face images. The proposed approach requires an image pre-processing (face detection, landmark detection, and face alignment) stage that pre-processes and prepares the face images before they are input into the proposed CNN architecture. Therefore, our solution is divided into three major steps: image pre-processing, feature learning, and classification itself. Figure 5.1 show the work flow of proposed model.

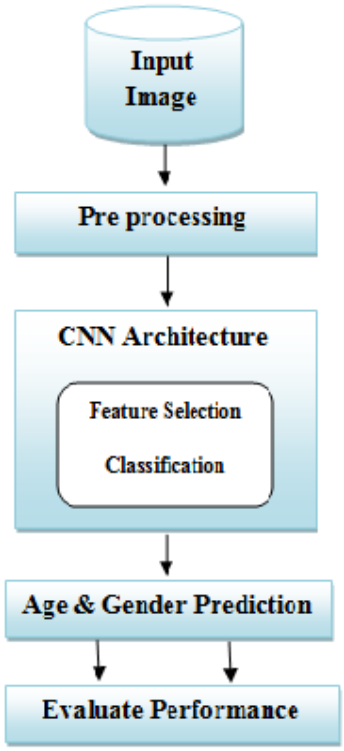


Figure 5.1: Proposed CNN Based Model

**Image Processing:** The age and gender classification task is dealt with by intelligent algorithms in unprocessed real world settings. Most of those face images are not aligned and are not frontal, with distinct degrees of disparity in pose, appearance, lighting, and background conditions. Therefore, those face images need first to be sensed, then aligned, and, by and by, used as input for classifiers.

**Face Detection:** The first stage of image pre-processing is face detection. The face detection state locates the face in an input image. In this work, we employ an open-source face detector: Head Hunter described in [14]. In order to detect a face, all the input pictures square measure revolved within the range of −90° to 90° angles and with a step of 5°. After that, the detector confirms the input image with the most accurate output of the face detector and in an exceedingly case wherever the face is not the modifications of the input image, the original input image is heightened and the face detection algorithm is replicated until a face is conceded. An up scaling technique helps in discovering faces in all the input images.

**Image Landmark & Face Alignment:** A subset of face detection is the facial landmark detection and face alignment stage, where we utilize the state-of-the-art solution in, is image pre-processing solution is an open-source Multi view facial landmark detection algorithm that uses five landmark detection models, including a frontal model, two half-profile models, and two full profile models. All these five models are trained to work in one of the correlated portrait poses. Face alignment, on the other hand, requires running all five facial landmark models on the detected faces. An affine transformation is then performed on the model, with the highest confidence score, to the predefined optimal settings of those landmarks.

**CNN Architecture:** Our CNN architecture is a novel six-layer network, comprising four convolutional and two fully connected layers. The CNN design is an end-to-end sequential deep learning architecture, including feature extraction and classification phases. The feature extraction phase has four convolution layers, with the corresponding parameters, including the number of each filter's kernel size, as well as the number of filters, and the stride. It consists of a convolution layer, activation layer, batch normalization, max-pooling layer, and drop out. On another hand, the classification layer contains two well-connected layers that deal with the classification stage of the model. We arranged the Gender and Age grouping task as an end-to-end deep classification problem; hence, Soft Max with a cross-entropy function is embraced to acquire a probability for each age group and gender class.

6. Result Analysis

1) Age Prediction

The MAEs attained by the proposed model for age identification over benchmark datasets are shown in Table 6.1. The graphs representing the change in the MAE with the increase in the number of epochs for UTKFace, the MAE value decreases for each of the training and validation processes. This shows that the model has been properly trained and validated. However, there are no signs of saturation or steadiness in the MAE values for any of the training process graphs, which indicate that there is no case of overfitting. Also, the fact that the training MAE never gets lower than the validation MAE for every epoch further validates the absence of overfitting.

**TABLE 6.1: MAEs achieved by the proposed model for age classification over standard benchmark datasets**

| Dataset | MAE |
|---|---|
| Wikipedia Age | 5.45 |
| UTKFace | 1.07 |
| Adience DB | 10.57 |
| Proposed model | 3.10 |

**2) Gender Classification**

Here, gender prediction for the UTKFace and AdienceDB datasets. The accuracies attained by the proposed GRA_Net model for gender classification over two benchmark datasets are shown in Table 6.2.

| Dataset | Accuracy (%) |
|---|---|
| **UTKFace** | 99.2 |
| **AdienceDB** | 81.4 |

TABLE 6. 2: Comparison of both age and gender classification results measured in terms of accuracy for UTKFace dataset

| Model | Gender (%) | Age (%) |
|---|---|---|
| **MTCNN** | 98.23 | 70.1 |
| **RAN** | 97.5 | 88.4 |
| **Proposed model** | 99.2 | 93.7 |

## 6. CONCLUSION

The development of an improved model for age and gender recognition using deep learning techniques represents a significant stride in the field of computer vision and image processing. Through meticulous training and optimization, this model showcases enhanced accuracy and robustness in accurately predicting age and gender from diverse datasets. The integration of advanced neural network architectures and innovative feature extraction methods has contributed to the model's superior performance, making it a valuable asset in real-world applications such as facial recognition systems, personalized user experiences, and targeted marketing. As technology continues to evolve, the continuous refinement of such models holds promise for addressing nuanced challenges and further advancing the capabilities of age and gender recognition in various domains.

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