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A Survey on Gender Classification and Age Prediction Hybrid Models Based on Deep Learning Techniques

[*1]Vinit Pannalal Balbhadre, [2]Nitesh Gupta and [3]Anurag Srivastava

[*1]Mtech Scholar CSE, Department of Computer Science & Engineering, NRI Institute of Information Science and Technology (NIIST), Rajiv Gandhi Proudyogiki Vishwavidyalaya (R.G.P.V), Bhopal, Madhya Pradesh, India.

[2, 3]Assistant Professor, Department of Computer Science & Engineering, NRI Institute of Information Science and Technology (NIIST), Rajiv Gandhi Proudyogiki Vishwavidyalaya (R.G.P.V), Bhopal, Madhya Pradesh, India.

Abstract

Age and gender prediction from visual data have gained significant attention in computer vision research due to their wide-ranging applications in various domains such as marketing, healthcare, and security. This survey investigates the landscape of gender classification and age prediction hybrid models, focusing on their foundation in deep learning techniques. With the proliferation of deep learning methodologies, these models have garnered considerable attention for their applications in diverse domains, ranging from security systems to targeted advertising. Through an extensive examination of existing literature, this survey elucidates the advancements, challenges, and future prospects of such models. Key findings reveal the strides made in developing robust hybrid models, alongside persistent challenges related to data bias, interpretability, and generalization. Moreover, the survey underscores the importance of considering social and ethical implications in the deployment of these models, advocating for interdisciplinary collaboration and ethical guidelines. By synthesizing current research, this survey offers insights into the evolving landscape of gender classification and age prediction, serving as a foundation for future advancements and responsible deployment of deep learning-based hybrid models.

Keywords: CNN, Age Prediction, Gender Classification, Deep Learning, Recurrent neural network (RNN), Pre-processing, Feature Selection.

Introduction

Gender classification and age prediction are fundamental tasks in computer vision and machine learning with wide-ranging applications, including security systems, personalized marketing, and human-computer interaction. With the rapid advancement of deep learning techniques, hybrid models that integrate multiple data modalities have emerged as powerful tools for tackling these tasks. This survey provides a comprehensive overview of the landscape of gender classification and age prediction hybrid models based on deep learning techniques, aiming to elucidate the current state, challenges, and future directions in this field [1].

Deep learning methods, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have revolutionized the field of computer vision, enabling remarkable progress in tasks such as image classification, object detection, and facial recognition. Leveraging the expressive power of deep neural networks, researchers have developed hybrid models that fuse information from diverse sources, including images, audio, and text, to enhance the accuracy and robustness of gender classification and age prediction systems.

Throughout this survey, we explore the various approaches and architectures employed in gender classification and age prediction hybrid models. We analyze the effectiveness of different deep learning techniques, such as feature extraction, transfer learning, and ensemble methods, in addressing the challenges posed by these tasks. Additionally, we examine the impact of dataset biases, model interpretability, and ethical considerations on the development and deployment of hybrid models. By synthesizing insights from existing literature, this survey aims to provide researchers, practitioners, and policymakers with a comprehensive understanding of the current advancements and challenges in gender classification and age prediction hybrid models. Ultimately, we hope to inspire further research and foster responsible innovation in this critical area of deep learning and artificial intelligence [2].

Real Age Estimation

Real age estimation, a subset of age prediction tasks, aims to accurately determine a person's chronological age from visual data, such as images or videos. Unlike perceived age, which is subjective and influenced by factors like grooming and lifestyle, real age refers to the actual number of years a person has lived. This task has garnered significant interest due to its

***Corresponding Author:** Vinit Pannalal Balbhadre

potential applications in various domains, including healthcare, biometrics, entertainment, and market research [3]. Accurate real age estimation poses several challenges stemming from the complex nature of human aging and the variability in facial appearance across individuals. Deep learning techniques have emerged as effective tools for addressing these challenges by leveraging large-scale datasets and sophisticated architectures to extract discriminative features from facial images [4].

Gender Prediction

Gender prediction, a task in computer vision, involves determining the gender of individuals from visual data like images or videos. Deep learning techniques, particularly convolutional neural networks (CNNs), are commonly employed for this purpose. By training on labeled datasets containing images paired with gender labels, CNNs learn to extract gender-related features from facial attributes and patterns. Pre-processing steps such as face detection and alignment ensure accurate input to the model [3]. Evaluation metrics like accuracy or F1 score measure the performance of gender prediction models. Applications of gender prediction include demographic analysis, targeted advertising, and security systems. Continued research in deep learning methods and the availability of diverse datasets contribute to advancing the accuracy and reliability of gender prediction systems in real-world scenarios [4].

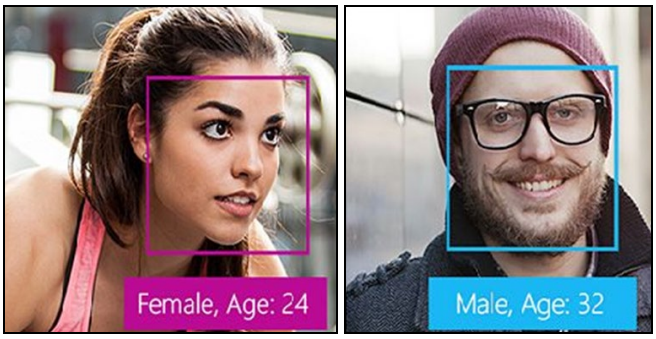

Fig 1: Facial Analyses

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.

The aim of the authors [1] research is to devise and analyze an expression-invariant gender classification algorithm. This algorithm is founded on the fusion of image intensity variation, shape, and texture features, extracted from various scales of facial images using a block processing technique. Looking ahead, our proposed system could potentially be extended for medical analyses, offering personalized medication and nutritional recommendations based on individual gender and age factors. Such an expansion could herald a new era in personalized healthcare, underscoring the importance of our research.

Authors [2] research presents a new idea based on modifying the deep network structure and using learning methods of the two other researchers. We made some modification on the structure of the convolutional neural network (CNN) that was used by the first researcher, then, authors used two learning methods, which were adopted by the second researcher, Single-Task Learning (STL) and Deep Multi-Task Learning (DMTL) approach, and we present new structure of CNN according to the above two modifications, implemented and evaluated, and the results show the effective performance of authors proposed structure.

Authors [3] 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 [5] 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 [6] 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.

Finding of the Review

The survey findings reveal significant progress in the development of gender classification and age prediction hybrid models based on deep learning techniques. Researchers have achieved notable accuracy rates in classifying gender and predicting age from various data sources, including facial images, voice recordings, and textual data. Moreover, the integration of multiple modalities, such as combining facial features with voice characteristics, has demonstrated improved performance compared to single-modal approaches.

However, challenges persist, particularly regarding data bias and the generalization of models across diverse populations. Issues related to interpretability and transparency also emerge as significant hurdles, raising concerns about the ethical implications and societal impact of these models. Furthermore, the survey highlights the importance of interdisciplinary collaboration and the need for ethical guidelines to address these challenges and ensure the responsible deployment of gender classification and age prediction hybrid models.

Overall, while the survey showcases promising advancements, it also underscores the necessity of continued research to overcome existing limitations and foster the ethical development and deployment of deep learning-based hybrid models.

Conclusion

This survey delves into the landscape of gender classification and age prediction hybrid models, primarily based on deep learning techniques. The exploration underscores the significance of these models in various applications, spanning from security systems to personalized marketing strategies. Throughout this survey, it becomes evident that while significant progress has been made in developing robust hybrid models, several challenges persist, particularly concerning data bias, interpretability, and generalization to diverse populations. Despite these challenges, the advancements in deep learning methodologies offer promising avenues for further refinement and innovation. As research continues to evolve, addressing these challenges will be imperative to ensure the ethical deployment and efficacy of gender classification and age prediction models in real-world scenarios. Additionally, there is a growing recognition of the importance of considering social and ethical implications in the development and deployment of these models, emphasizing the need for interdisciplinary collaboration and ethical guidelines. In essence, this survey serves as a comprehensive overview of the current state, challenges, and future directions of gender classification and age prediction hybrid models based on deep learning techniques, highlighting both their potential and the responsibility associated with their use in society.

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