Report On

Age and Gender Detection using CNN

Submitted in partial fulfillment of the requirements of the Mini project
in Semester VII of Fourth Year Artificial Intelligence & Data Science Engineering

by

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CERTIFICATE

This is to certify that the Mini Project entitled **"Age and Gender Detection using CNN"** is a bonafide work of **Shubham Waghmare (57), Mokshad Ketan Sankhe(67), Sudeep Shetty (70)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **"Bachelor of Engineering"** in Semester VII of Fourth Year **"Artificial Intelligence and Data Science".**

Dr. Tatwadarshi P N
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Mini Project Approval

This Mini Project entitled **"Age and Gender Detection using CNN"** by **Shubham Waghmare (57), Mokshad Ketan Sankhe(67), Sudeep Shetty (70)** is approved for the degree of **Bachelor of Engineering** in in Semester VII of Fourth Year **Artificial Intelligence and Data Science.**

Examiners

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(Internal Examiner Name & Sign)

2……
(External Examiner Name & Sign)

Date:

Place:

Abstract

Age and gender detection have become crucial components in various computer vision applications, including security, personalized advertising, and demographic analysis. Traditional methods that rely on manual feature extraction often struggle with accuracy, particularly in real-world scenarios where image quality and facial variations present significant challenges.

In this work, we propose an Age and Gender Detection System using Convolutional Neural Networks (CNN) to overcome these limitations. Our system leverages the deep learning capabilities of CNNs to automatically learn and extract meaningful features from facial images, allowing for precise and efficient classification. By utilizing CNN's ability to capture spatial hierarchies in images, the model identifies subtle patterns that distinguish age groups and gender with high accuracy.

The architecture is optimized to generalize well across diverse facial images, lighting conditions, and resolutions, making it highly scalable and adaptable for real-world use. This system offers a robust, automated solution for age and gender detection, marking a significant advancement in facial recognition technology with broad potential applications across industries.

Acknowledgement:

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Contents

List of Abbreviations

1. **CNN** - Convolutional Neural Network
2. **GUI** - Graphical User Interface
3. **AI** - Artificial Intelligence
4. **EDA** - Exploratory Data Analysis
5. **RAM** - Random Access Memory
6. **GPU** - Graphics Processing Unit (implied in context related to deep learning tasks)
7. **GDPR** - General Data Protection Regulation
8. **PIL** - Python Imaging Library
9. **UTKFace** - University of Tennessee Knoxville Face Dataset (though not explicitly an abbreviation, it's commonly recognized as one)
10. **VGGFace** - Visual Geometry Group Face dataset or model (derived from Visual Geometry Group)
11. **OpenCV** - Open Source Computer Vision Library
12. **Keras** - (though technically not an abbreviation, it's frequently used in this context as such)
13. **Tkinter** - (again, not technically an abbreviation, but a commonly recognized name for a Python GUI toolkit)
14. **ML** - Machine Learning (implied within the discussion of TensorFlow and Keras)
15. **IoT** - Internet of Things

List of Figures

1. INTRODUCTION

1.1 INTRODUCTION

In the field of computer vision, age and gender detection have gained significant attention due to their wide range of applications, including security, personalized advertising, human-computer interaction, and demographic analysis. Traditional methods of age and gender classification rely on manual feature extraction and handcrafted models, which often fail to achieve high accuracy, especially in real-world scenarios where image quality, lighting, and facial variations pose challenges.

In response to these limitations, we present an Age and Gender Detection System using Convolutional Neural Networks (CNN). This system leverages the power of deep learning to automatically learn and extract meaningful features from facial images, enabling precise and efficient age and gender classification. By utilizing CNN's ability to capture spatial hierarchies in images, our model is capable of identifying subtle patterns that distinguish age groups and gender with high accuracy.

The proposed system takes an input image, processes it through multiple layers of the CNN, and outputs predictions for both age and gender. The architecture of the CNN is designed to optimize the learning of facial features relevant to these tasks, ensuring that the model can generalize well across different faces, lighting conditions, and image quality.

This solution addresses the challenges of traditional methods by offering an automated, scalable, and reliable approach to age and gender detection, with potential applications in numerous industries. As the demand for intelligent systems continues to grow, this CNN-based model represents a significant advancement in the domain of facial recognition technologies, contributing to the development of smarter, more responsive systems.

1.2 PROBLEM STATEMENT & OBJECTIVE

Problem Statement:

In the domain of computer vision, the accurate detection of age and gender from facial images is essential for a variety of applications, including security, customer analytics, and personalized services. The challenge lies in designing a model that can accurately analyze facial features across diverse age groups, ethnicities, and lighting conditions, while maintaining efficiency in real-time scenarios. Despite advancements in machine learning, there is still a pressing need for adaptable and scalable systems that can reliably perform age and gender detection in a wide range of environments and use cases.

Objectives:

a. To develop a highly accurate age and gender detection system using Convolutional Neural Networks (CNNs) that can process facial images and provide real-time results.
b. To provide an easy-to-use platform that allows users to seamlessly access demographic data through facial analysis, ensuring efficient and quick detection of age and gender.
c. To improve awareness and understanding of the importance of demographic recognition systems in various fields such as security, marketing, and personalized services.
d. To address the challenges of accurate age and gender classification across diverse populations by creating a model that accounts for variations in facial features, ethnicity, and environmental factors.
e. To minimize detection errors and enhance the reliability of systems that require age and gender information by providing an adaptable and scalable solution.
f. To empower organizations and individuals to utilize demographic data for improved decision-making, personalization, and user engagement through accurate predictions.
g. To contribute to the advancement of facial recognition technology by generating a robust and validated dataset, which can be used for further optimization of detection algorithms and research.

1.3 SCOPE

1. **Target Users:**

- Individuals aged 13 and above, globally, particularly those interested in demographic analysis, fashion, marketing, or social media applications.
- Developers and researchers looking to integrate age and gender detection into their applications.

2. **Features:**

- Age and gender prediction using a trained deep learning model.
- User interface for image upload and real-time camera access.
- Display of predicted age and gender on detected faces, along with confidence scores.

3. **Platforms:**

- Primary platform: Windows,Linux & MacOS using a Tkinter-based GUI for user interaction.

1.4 TECHNOLOGIES:

- **Python**: Python is a high-level, interpreted programming language known for its simplicity and versatility. It is widely used for various applications, including web development, data analysis, artificial intelligence, and machine learning.
- **OpenCV**: OpenCV (Open Source Computer Vision Library) is a library of programming functions aimed at real-time computer vision. It provides tools for image and video processing, enabling face detection, object tracking, and image manipulation.
- **MediaPipe**: MediaPipe is a cross-platform framework for building multimodal applied machine learning pipelines. It includes pre-trained models and libraries for tasks like face detection, pose estimation, and object tracking.
- **Keras**: Keras is an open-source neural network library written in Python. It acts as an interface for the TensorFlow library, allowing users to build and train deep learning models with ease.
- **TensorFlow**: TensorFlow is an open-source machine learning framework developed by Google. It is widely used for building and training deep learning models, particularly for tasks like image classification and natural language processing.
- **Tkinter**: Tkinter is the standard GUI toolkit for Python. It provides tools to create graphical user interfaces (GUIs) for applications, enabling users to interact with the program through windows, buttons, and other interface elements.
- **NumPy**: NumPy is a fundamental package for scientific computing in Python. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays.
- **Pandas**: Pandas is a Python library for data manipulation and analysis. It provides data structures and tools for working with structured data, making it easier to perform operations like filtering, aggregating, and transforming data.
- **Matplotlib**: Matplotlib is a plotting library for Python that provides a flexible way to create static, animated, and interactive visualizations. It is widely used for data visualization in scientific computing and machine learning.
- **Seaborn**: Seaborn is a Python data visualization library based on Matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics.
- **Pillow**: Pillow is a Python Imaging Library (PIL) that adds image processing capabilities to Python. It allows users to open, manipulate, and save different image file formats.

2. LITERATURE SURVEY

The literature survey for implementing deep learning techniques highlights a growing research focus on utilizing neural networks to analyze medical data and detect thyroid disorders. Existing studies demonstrate the potential of this approach for improving early diagnosis, optimizing treatment plans, and providing real-time insights into patient health indicators, underscoring the significance of leveraging deep learning for thyroid disease detection in the healthcare industry.

2.1 SURVEY OF EXISTING SYSTEM

- Puja Deya, Tanjim Mahmud, Mohammad Sanaullah Chowdhury, Mohammad Shahadat Hossain, & Karl Andersson (2024). Human Age and Gender Prediction from Facial Images Using Deep Learning Methods. This paper presents a Convolutional Neural Network (CNN) model for accurate age and gender prediction from facial images, addressing challenges in real-world variability. Tested on Adience and UTKFace datasets, the model outperforms traditional methods with high accuracy.
- Rajiv Kumar, Kuldeep Singh, , Dharmendra Prasad Mahato, & Umesh Gupta (2023). Facebased age and gender classification using deep learning model. This paper proposes a CNN-based method for age and gender classification from real-world facial images, achieving high accuracy and outperforming previous approaches.
- Mohammed Kamel Benkaddour, Sara Lahlali, & Maroua Trabelsi (2020). Human Age and Gender Classification using Convolutional Neural Network. The paper addresses the challenge of classifying age and gender from facial images, especially in real-world, uncontrolled scenarios where images might have varied lighting, poses, and resolutions.

2.2 LIMITATION OF EXISTING SYSTEM:

Sr No	Paper Title	Published Year	Limitations	Research Gap
1	Human Age and Gender Classification using Convolutional Neural Network	2021	High computational complexity due to deep CNN models.	Explore ways to reduce computational complexity without sacrificing accuracy.
2	Face based age and gender classification using deep learning model	2023	Complex CNN architecture, but optimization relies heavily on hyper-parameters and pre-training, making it time-consuming.	Investigate faster, more efficient architectures or hyper-parameter optimization techniques to reduce the training time.
3	Human Age and Gender Prediction from Facial Images Using Deep Learning Methods	2024	Complex CNN architecture with significant data requirements and interpretability challenges.	Improve model interpretability, reduce data requirements, and test robustness in more uncontrolled, real-world environments.

2.3 MINI PROJECT CONTRIBUTION:

The Age and Gender Detection System using CNN significantly advances the field of computer vision by providing an efficient and accurate solution for age and gender classification. This project leverages deep learning techniques, specifically Convolutional Neural Networks (CNN), to automatically extract meaningful facial features, ensuring robust performance across diverse real-world scenarios.

The system's core contribution lies in its ability to process facial images and classify both age and gender with high precision, addressing challenges such as variations in lighting, pose, and facial expressions. By utilizing multiple CNN layers, the model is able to capture intricate patterns, enabling accurate classification even in complex conditions.

The project offers a user-friendly interface for seamless integration into applications across industries such as security, personalized advertising, and demographic analysis. Its real-time processing capabilities enhance efficiency, making it suitable for large-scale deployment. The use of advanced pre-processing techniques like face detection and alignment ensures that the system remains robust and adaptable to different environments, further improving accuracy.

Additionally, the system supports the visual representation of classification results, aiding in decision-making processes for businesses and organizations. By automating the classification of age and gender, this project streamlines processes that previously required manual input, paving the way for more intelligent, responsive systems in modern applications.

3. PROPOSED SYSTEM

3.1 DATASETS

The UTKFace dataset contains over 20,000 facial images, each annotated with key attributes such as age, gender, and ethnicity. The dataset spans a wide range of age groups, from 0 to 116 years old, and includes diverse gender and ethnic categories. The images are collected in various real-world settings, resulting in variations in lighting, facial expressions, and resolution. Key details include age, gender, and ethnicity, which can be used for tasks like age and gender prediction.

To conduct the analysis, the dataset underwent preprocessing steps such as resizing images and normalizing pixel values to standardize the data for model training. Exploratory Data Analysis (EDA) revealed the distribution of attributes, helping understand the relationships between features. The primary purpose of this dataset is to aid in developing robust machine learning models for accurate age and gender classification using facial images in diverse, real-world conditions.

3.2 DETAILS OF HARDWARE & SOFTWARE

Hardware:

1. Processor: Intel Core i3 or AMD Ryzen 3 processor
2. Memory (RAM): 4 GB to 8 GB of RAM, allowing for smooth Processing applications.
3. Operating System: A pre-installed operating system such as Windows 10, macOS, or a Linux distribution, depending on user preference and requirements.

Software:

1. Python 3.11
2. Google Colab
3. Visual Studio Code

4. IMPLEMENTATION

4.1 FLOW DIAGRAM

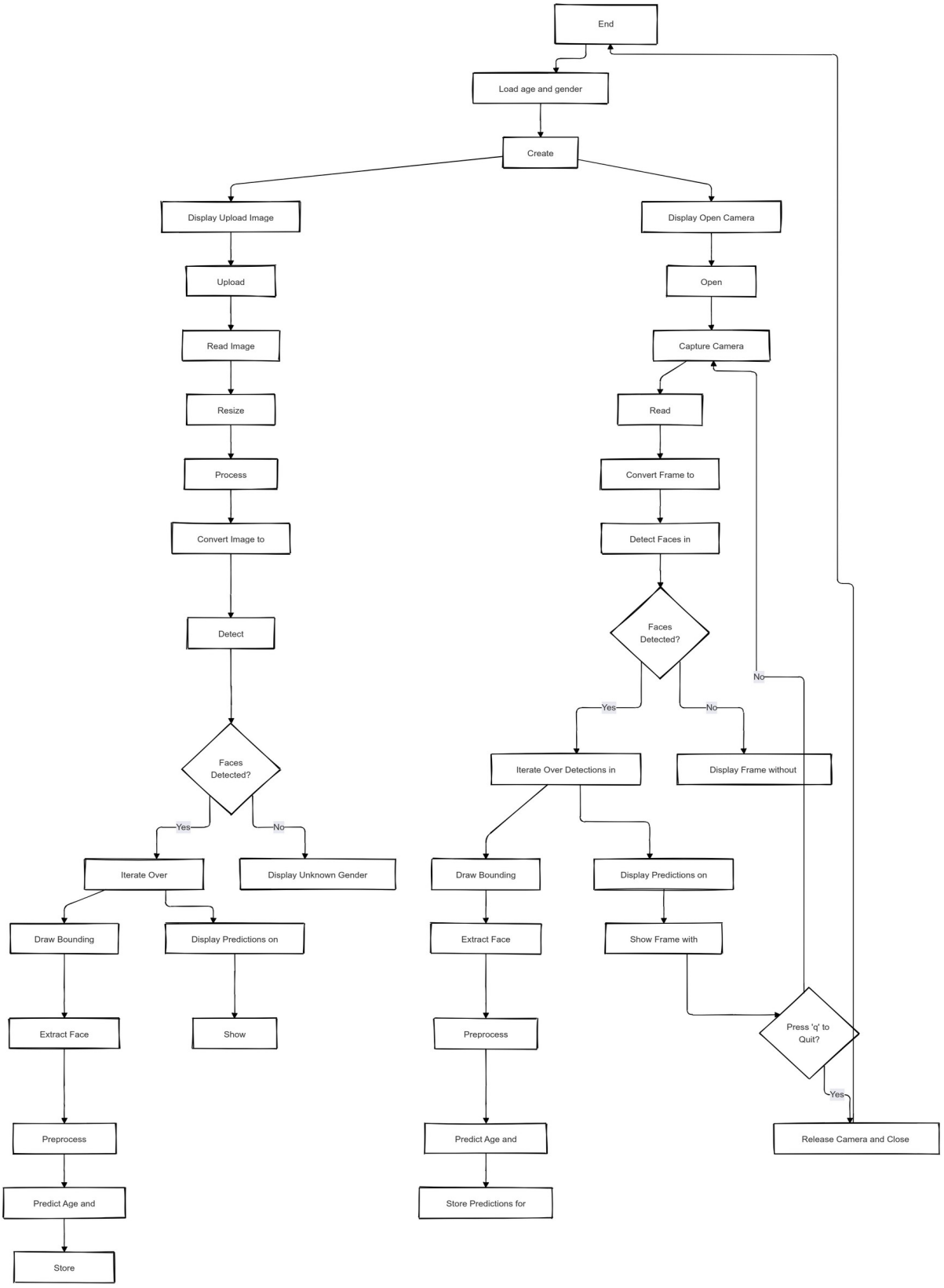
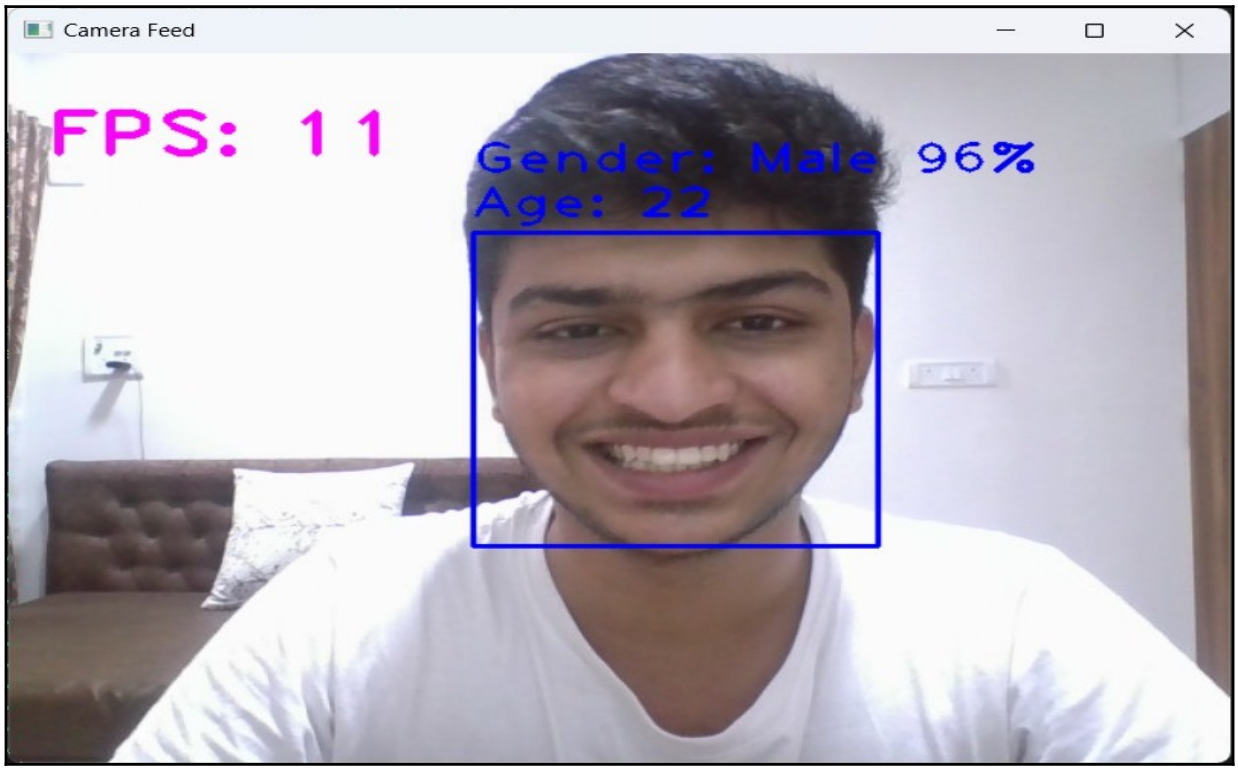


Fig. 4.1.1: Working

4.2 RESULTS:

4.2.1 Menu Screen

4.2.2 Upload Image Result



4.2.3 Camera Image Result

4.2.1 - This is the first screen user interact with, it let's you select if you want to predict age and gender using image or camera

4.2.2 – This screen show us the prediction result using upload image option, the predicted gender is female and age is 24

4.2.3 - This screen show us the prediction result using open camera option, the predicted gender is male and age is 22

4.3 ANALYSIS OF MINI PROJECT

1. **Technology Stack and Libraries**: The choice of Convolutional Neural Networks (CNNs) for this project is commendable, as CNNs are particularly effective for image-related tasks such as age and gender detection. Keras provide the framework for building and training these deep learning models, offering the flexibility and scalability needed for complex image processing tasks. Additionally, image processing libraries like OpenCV enhance the project by enabling efficient facial detection and manipulation, ensuring high accuracy and performance. This technology stack is well-suited for building an accurate, scalable, and responsive detection system.

2. **Machine Learning Integration**: The integration of CNN models for age and gender detection addresses a critical need in various domains, including marketing, security, and healthcare. CNN's layered architecture enables the model to learn complex features from facial images, delivering accurate predictions. By utilizing pretrained models such as **VGGFace** or **ResNet**, or training the CNN from scratch with a diverse dataset, the project ensures that the detection system is robust and capable of high accuracy. This integration showcases the power of machine learning to provide actionable insights from visual data, driving better decision-making in real-time applications.

3. **Efficient Reporting**: The system streamlines the reporting process by automatically generating structured outputs based on the predicted age and gender. This feature is especially useful in areas such as security, where timely and organized reporting of demographic data is crucial.

4. **Adaptability and Scalability**: The project demonstrates adaptability and scalability, allowing for future enhancements based on additional requirements or expanding datasets. The model can be fine-tuned with more diverse data to accommodate varying demographics, ensuring that it continues to provide accurate results across different populations. The modular design of the CNN architecture also allows the system to be scaled, making it possible to integrate additional features, such as emotion recognition or face verification, as needs evolve. This adaptability ensures the project's long-term relevance and flexibility in various applications.

5. **Practical Applications**: Age and gender detection systems have practical applications in areas such as public safety, marketing, and healthcare. In security, the system can assist in identifying and monitoring individuals in public spaces. In marketing, demographic data can be used to tailor advertisements or services to specific age groups or genders, optimizing user engagement. In healthcare, such a system could be used for patient profile management or even as an aid in demographic studies. These diverse applications demonstrate the wide-ranging impact that age and gender detection can have in improving operational efficiency and decision-making across industries.

6. **Room for Future Development**: While the project offers a strong foundation for age and gender detection, future development could focus on improving accuracy through larger, more diverse datasets, integrating with wearables for real-time monitoring, enabling real-time video processing for dynamic detection, addressing ethical considerations like privacy and GDPR compliance, and expanding cross-platform deployment for broader accessibility and scalability.

4.4 CONCLUSION

The Age and Gender Detection system marks a significant step forward in leveraging artificial intelligence to solve real-world challenges in fields such as security, marketing, and healthcare. Through the integration of Convolutional Neural Networks (CNNs), the system demonstrates its ability to accurately predict age and gender from facial images, showcasing the power of deep learning in visual data analysis.

Utilizing cutting-edge machine learning libraries and technologies, the project offers a user-friendly solution that is both scalable and adaptable to various applications. Its simple interface ensures accessibility for users across different domains, while the model's efficiency and accuracy set a strong foundation for further development.

Reflecting on the progress of the Age and Gender Detection system, the future holds endless possibilities for enhancement, including improved accuracy with diverse datasets, real-time video processing, and cross-platform deployment. These developments, coupled with ethical considerations such as privacy and data security, will shape the project into a versatile tool for a wide range of industries.

4.5 FUTURE SCOPE

1. Improvement in Accuracy: Training the model on larger, more diverse datasets can help reduce bias and improve detection accuracy across different ethnicities and age ranges.
2. Real-Time Video Processing: Expanding the system to process continuous video streams would allow for dynamic age and gender detection in surveillance or entertainment industries.
3. Ethical Considerations: Addressing privacy concerns and ensuring compliance with data protection regulations like GDPR could be incorporated into the system, improving trust and user acceptance.
4. Cross-Platform Deployment: The system could be extended to various platforms, including mobile devices, cloud-based solutions, or IoT devices, increasing its accessibility and scalability.

5. REFERENCE

[1] Puja Deya, Tanjim Mahmud, Mohammad Sanaullah Chowdhury, Mohammad Shahadat Hossain, & Karl Andersson (2024). Human Age and Gender Prediction from Facial Images Using Deep Learning Methods. In Proceedings of the 15th International Conference on Ambient Systems, Networks and Technologies (ANT). Hasselt, Belgium.

[2] Rajiv Kumar, Kuldeep Singh, , Dharmendra Prasad Mahato, & Umesh Gupta (2023). Facebased age and gender classification using deep learning model. In Proceedings of the International Conference on Machine Learning and Data Engineering (ICMLDE 2023).

[3] Mohammed Kamel Benkaddour, Sara Lahlali, & Maroua Trabelsi (2020). Human Age and Gender Classification using Convolutional Neural Network. In Proceedings of the 2nd International Workshop on Human-Centric Smart Environments for Health and Well-being (IHSH).