# **Facial Recognition Research Report for e\_Auto Project**

## **Objective**

As part of the second phase of the *e\_Auto* project, our goal is to integrate facial recognition to capture and analyze demographic data (age, race, sex) of vehicle drivers for targeted advertising. This report explores current open-source facial recognition models and provides a recommendation suited to our specific requirements.

## **1. Evaluated Open-Source Facial Recognition Models**

### **1.1. FaceNet**

* **Developer**: Google
* **Overview**: Uses deep convolutional networks to map faces to a compact 128-dimensional embedding.
* **Capabilities**:  
  + High-accuracy face verification and recognition.
  + Pretrained models available (trained on datasets like VGGFace2 and CASIA-WebFace).
* **Limitations**:  
  + Requires a separate classifier to predict age, race, or gender.
  + Cannot directly perform demographic analysis.

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### **1.2. Dlib**

* **Developer**: Davis King
* **Overview**: Offers facial landmark detection and 128-d vector embeddings.
* **Capabilities**:  
  + Lightweight and easy to integrate.
  + Excellent for facial recognition and alignment tasks.
* **Limitations**:  
  + Not suitable for demographic prediction.
  + Not as accurate as deep learning alternatives for large-scale use.

### **1.3. DeepFace (by Serengil)**

* **Overview**: An easy-to-use Python library that wraps multiple facial recognition models (VGG-Face, Facenet, OpenFace, DeepFace, ArcFace, Dlib).
* **Capabilities**:  
  + Supports **age, race, gender** and **emotion** detection out of the box.
  + Uses multiple backend models, offering flexibility.
  + Pretrained and production-ready.
* **Limitations**:  
  + Slower on CPU-based inference.
  + Not ideal for real-time inference unless optimized with GPU.

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### **1.4. InsightFace**

* **Developer**: DeepInsight and the MXNet community.
* **Overview**: A 2D and 3D face analysis toolbox with extremely high accuracy.
* **Capabilities**:  
  + Face detection, alignment, verification.
  + High-performance demographic classification models.
* **Limitations**:  
  + Heavier to set up.
  + Requires GPU acceleration for optimal performance.

### **1.5. FairFace**

* **Developer**: Microsoft Research
* **Overview**: Trained specifically for **balanced race classification**.
* **Capabilities**:  
  + Provides predictions for **age**, **race**, and **gender**.
  + Trained on a demographically balanced dataset.
* **Limitations**:  
  + Slightly lower accuracy in real-world conditions (e.g. occlusion, low light).
  + Best used as a base model rather than production-ready.

## 

## **2. Recommendation**

### **✅ Recommended Model: DeepFace (with FairFace backend for demographics)**

* **Why DeepFace?**
  + It is the **most suitable** for your use-case (demographics: age, race, sex).
  + Simple to integrate into Python-based systems (like your current Flask/Colab workflows).
  + Offers consistent results and can be deployed on **cloud or edge devices**.
* **Why FairFace backend for demographics?**
  + Trained on a **racially balanced dataset**.
  + Works well for identifying demographic traits across global regions.
  + Reduces bias that can affect targeted marketing outcomes.

## **3. Additional Recommendations**

### **Camera Hardware**

* **Recommended Camera**: Logitech Brio 4K or any **Full HD webcam with HDR and IR support**.
* **Reason**: High-resolution captures help the model accurately detect facial features, especially useful for age/race prediction.

### **Camera Positioning**

* Place the camera at **driver eye-level**, facing straight at the driver.
* Ensure **adequate lighting** inside the vehicle.
* Avoid occlusion from the steering wheel or hands.

## **4. Next Steps**

* **Prototype**: Integrate DeepFace + FairFace backend with real-time camera feed.
* **Benchmark**: Evaluate latency and accuracy in real-world scenarios.
* **Optimize**: Use ONNX or TensorRT to optimize for edge deployment if needed.
* **Deploy**: Package the final model within your e\_Auto backend architecture.