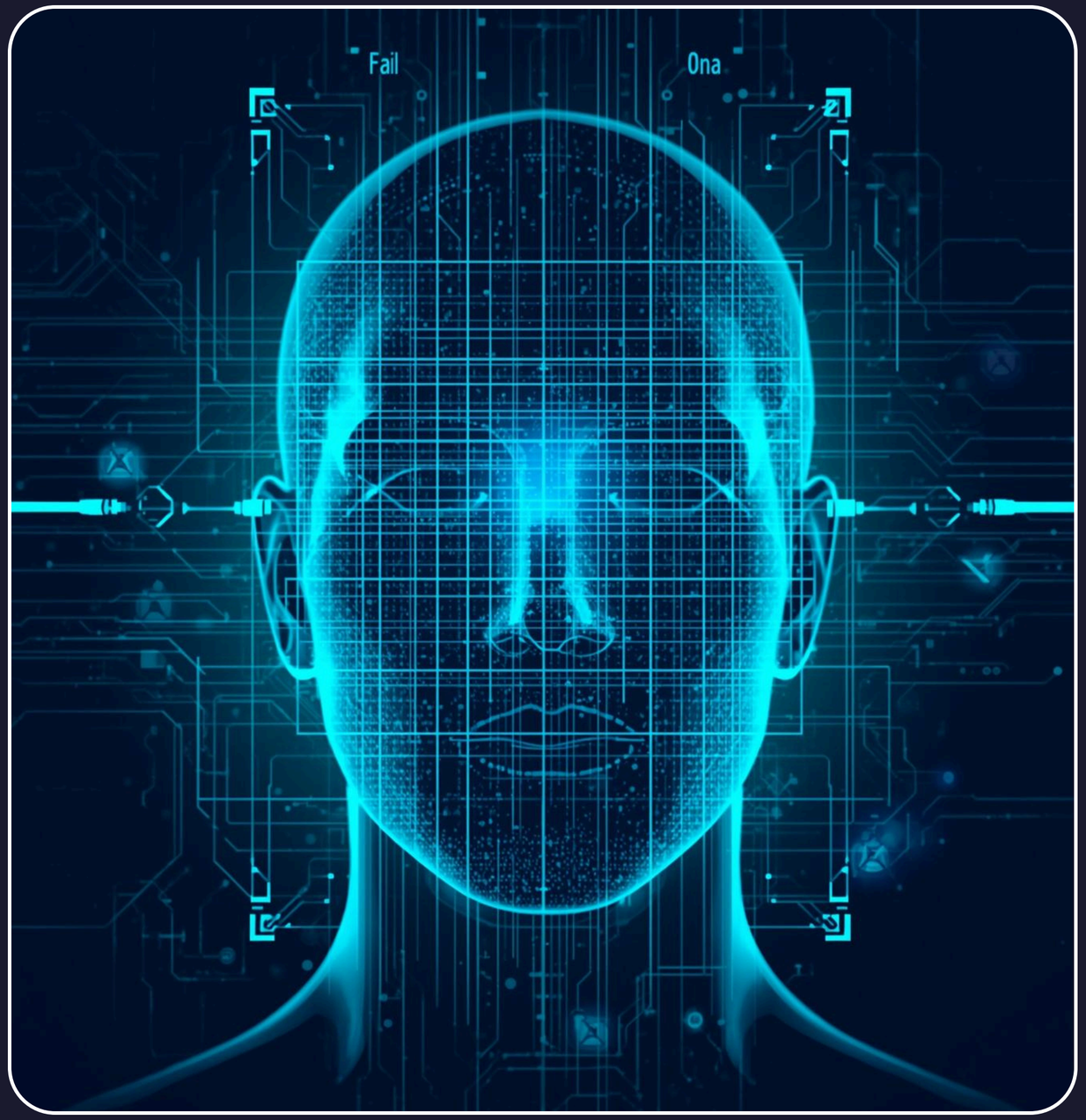


Facial Recognition System Project

Team project

Basel Tarek Abdelmonsif
Mohammed Essam Shehata
Mostafa Sayed Salah
Naser Ali Naser
Zain Tamer Zain El-Abdin Awad

Executive Summary

- 5 key milestones of the project
- Data collection & preprocessing (LFW dataset)
- Model development (FaceNet with transfer learning)
- Deployment (Streamlit on Hugging Face)
- MLOps implementation (MLflow, Kubeflow)
- Performance analysis

Project Overview

- Problem: Challenges in facial recognition (varying lighting, poses, demographic bias)
- Solution: End-to-end production-ready system
- Application domains: Identity verification, access control, security

Project Objectives

Achieving High Accuracy and Efficiency

- Achieve high accuracy (>80%) on LFW dataset
- Implement comprehensive MLOps practices
- Build production-ready web application
- Optimize performance for real-time inference
- Ensure fairness across demographic groups

Project Timeline

Data Pipeline (week1:4)

Building the data pipeline using the LFW dataset.

Model Development (week 4_8)

Developing the FaceNet model with transfer learning.

Deployment & MLOps

Deploying the web app and implementing MLOps.

Analysis & Documentation (Week 11-12)

Final documentation + presentation

Team Roles

Allocation of Resources and Responsibilities

Our project relies on a **dedicated team** working on enhancing the dataset by different augmentation with utilizing GPU resources for training, along with MLflow for tracking and integrating this work into a fully functional web app.

LFW dataset exploration

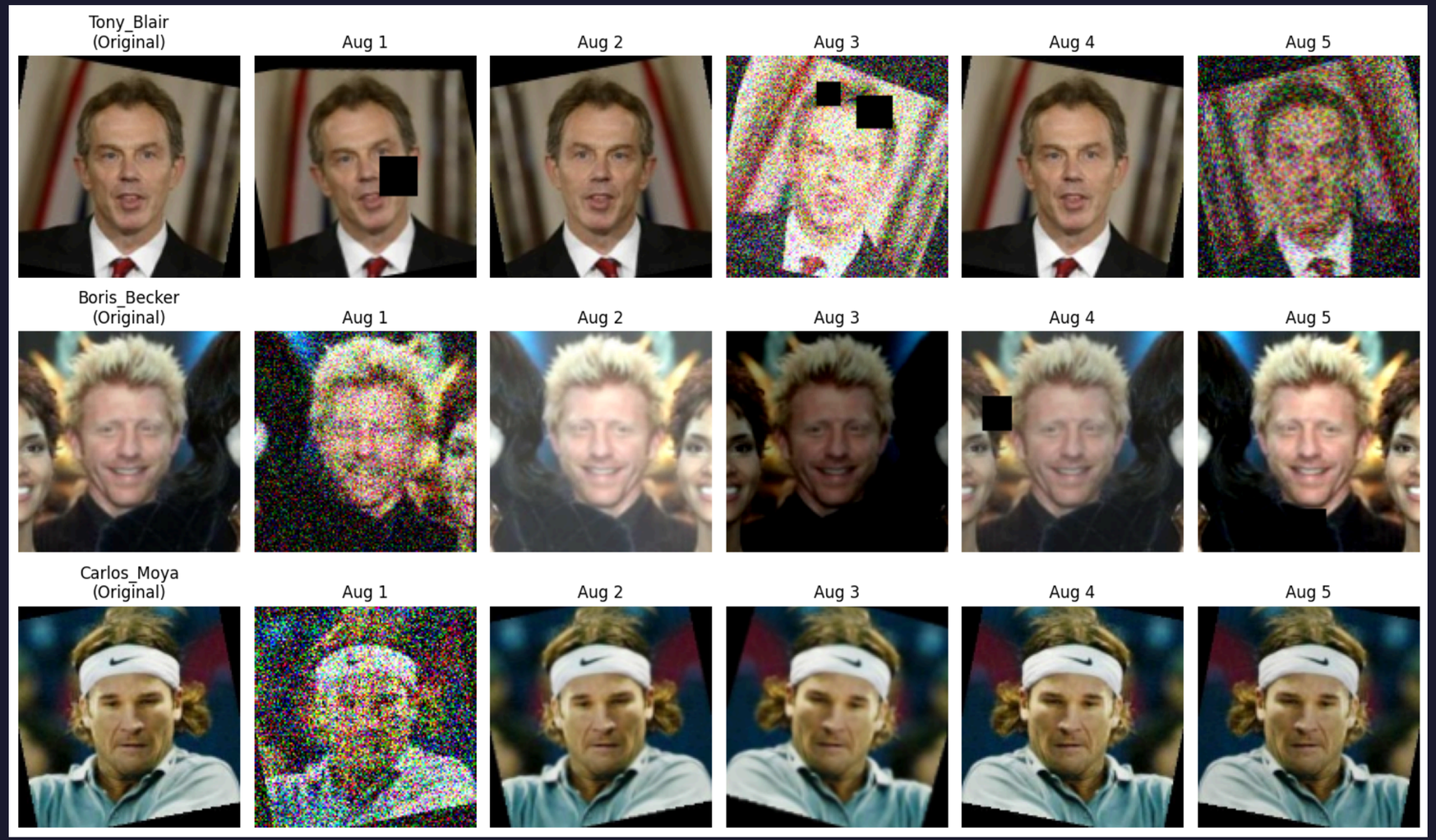
This dataset consists of **13233** images distributed among different **5749** classes

Data Augmentation

```
augment = A.Compose([
    A.HorizontalFlip(p=0.5),
    A.Rotate(limit=15, p=0.5),
    A.RandomBrightnessContrast(brightness_limit=0.3, contrast_limit=0.3, p=0.6),
    A.GaussianBlur(blur_limit=(1, 3), p=0.3),
    A.GaussNoise(var_limit=(5, 15), p=0.3),
    A.RandomScale(scale_limit=0.1, p=0.3),
    A.CoarseDropout(max_holes=8, max_height=8, max_width=8, p=0.2),
])

def apply_aug(img):
    return augment(image=img)["image"]
```

[6]

Data Augmentation



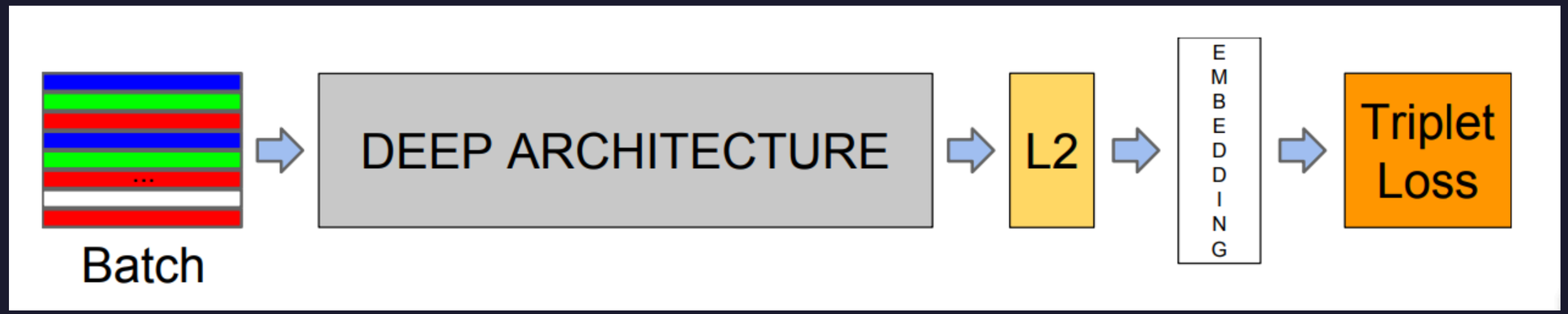
FaceNet Model

FaceNet is a deep learning model for face recognition.
It does not classify faces directly — instead, it learns to map each face image to a 128-dimensional embedding vector.

Architecture	Parameters	Embedding Size
FaceNet	23M	128
VGGFace2 (ResNet-50)	25M	2048
ArcFace (ResNet-100)	65M	512
MobileFaceNet	1M	128

FaceNet Model

Architecture:



Apply Transfer Learning Head for FaceNet Model

Model: "transfer_head"

Layer (type)	Output Shape	Param #
dense_3 (Dense)	(None, 256)	33,024
batch_normalization_2 (BatchNormalization)	(None, 256)	1,024
dropout_2 (Dropout)	(None, 256)	0
dense_4 (Dense)	(None, 128)	32,896
batch_normalization_3 (BatchNormalization)	(None, 128)	512
dropout_3 (Dropout)	(None, 128)	0
dense_5 (Dense)	(None, 50)	6,450

System Design Overview

01 **Presentation Layer**

User interfaces facilitate interaction and display results seamlessly.

02 **Application Layer**

Core logic processes requests and manages data flow efficiently.

03 **ML Layer**

Machine learning models perform tasks such as face recognition.

Face Verification Flow

The face verification process ensures accurate matching through a systematic approach, enhancing security and user experience.

Testing and Metrics

Ensuring Quality and Reliable Performance

Comprehensive testing improved accuracy from 82% to 89% after transfer learning, achieving over 99% uptime and maintaining inference times under 500 milliseconds for efficiency.

Degradation Parameters:

- Gamma Transform: 2.5 (darker)
- Brightness Factor: 0.5
- Gaussian Blur: 5x5

Accuracy

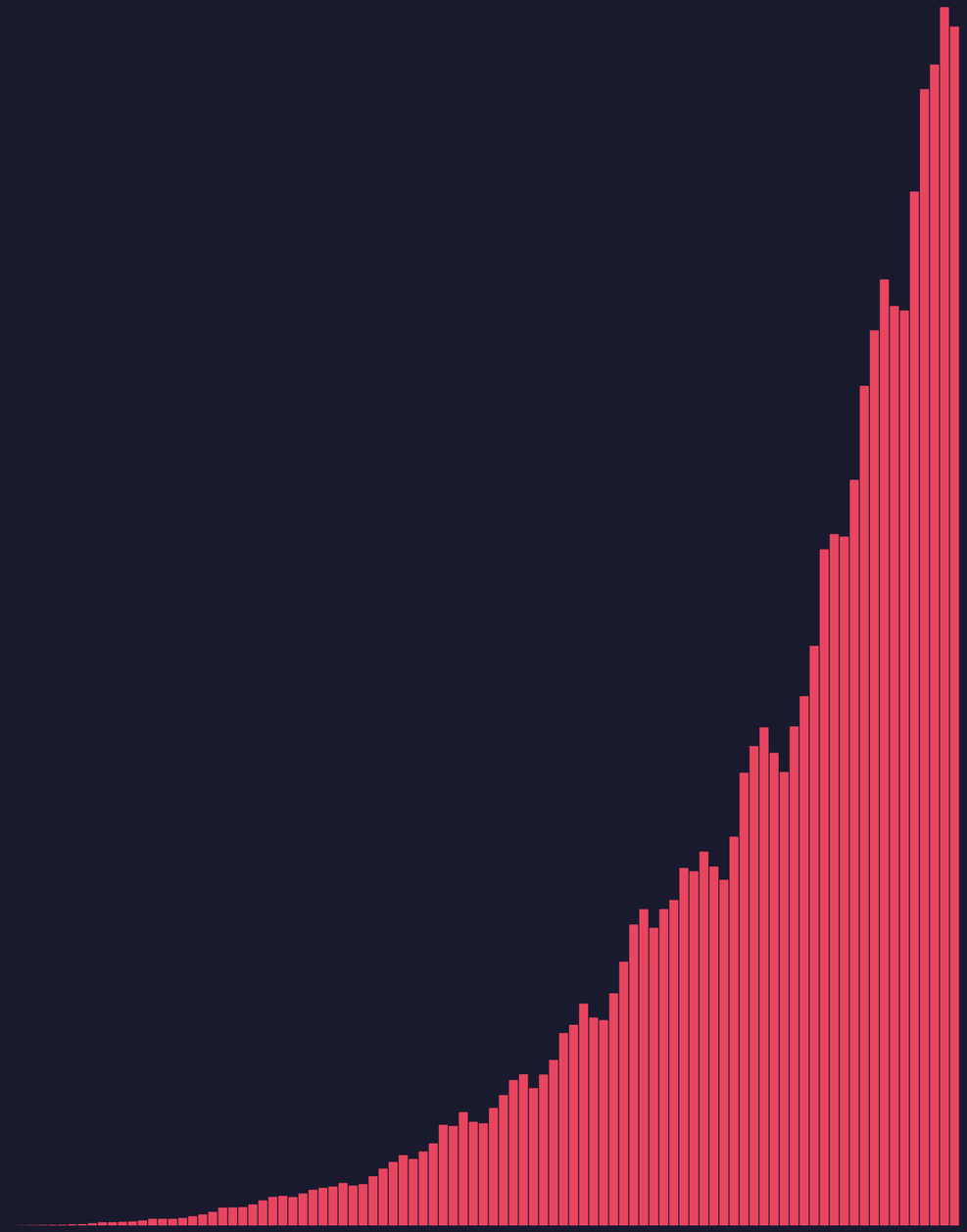
```
------------------------------------------------------------------
Scenario                                        |   Accuracy
------------------------------------------------------------------
Accuracy on ORIGINAL images → test DEGRADED     |     82.22%
------------------------------------------------------------------
Transfer Head on DEGRADED → test DEGRADED       |     89.63%
------------------------------------------------------------------

 IMPROVEMENT on degraded images:
   Before Transfer Learning: 82.22%
   After Transfer Learning:  89.63%
   GAIN: +7.41%
```

Key Performance Statistics

89% Recognition Accuracy

<500 ms

Inference time for real-time processing



Web App

We built web app using Streamlit

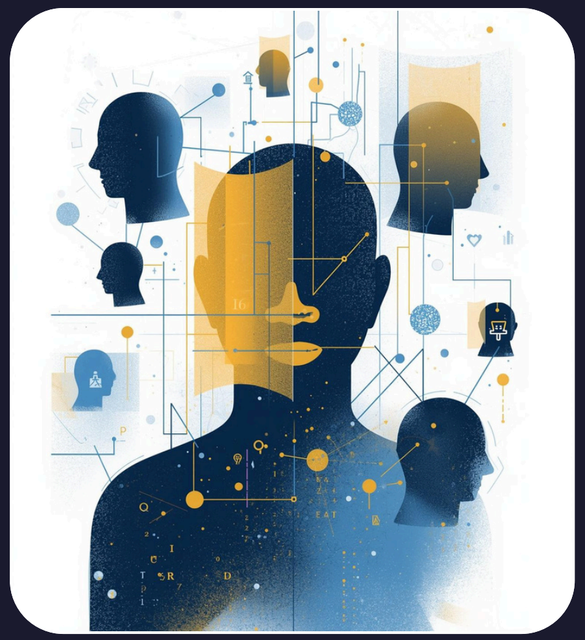
Streamlit is a lightweight Python framework for building interactive web applications.
In our project, we used Streamlit to build the web app for our facial recognition system. It handled image uploads, displayed results, and provided an easy-to-use interface for running FaceNet-based face verification.

Deployment

We hosted our web app using Hugging Face Spaces

Hugging Face Spaces is an online platform that allows developers to host and deploy machine learning applications easily. It supports frameworks like Streamlit and others, making model deployment simple and accessible. In our project, we used Hugging Face as the hosting platform for our facial recognition web app, allowing users to access and test the system directly through the browser.

Ethical Considerations in Facial Recognition Systems



Bias Mitigation

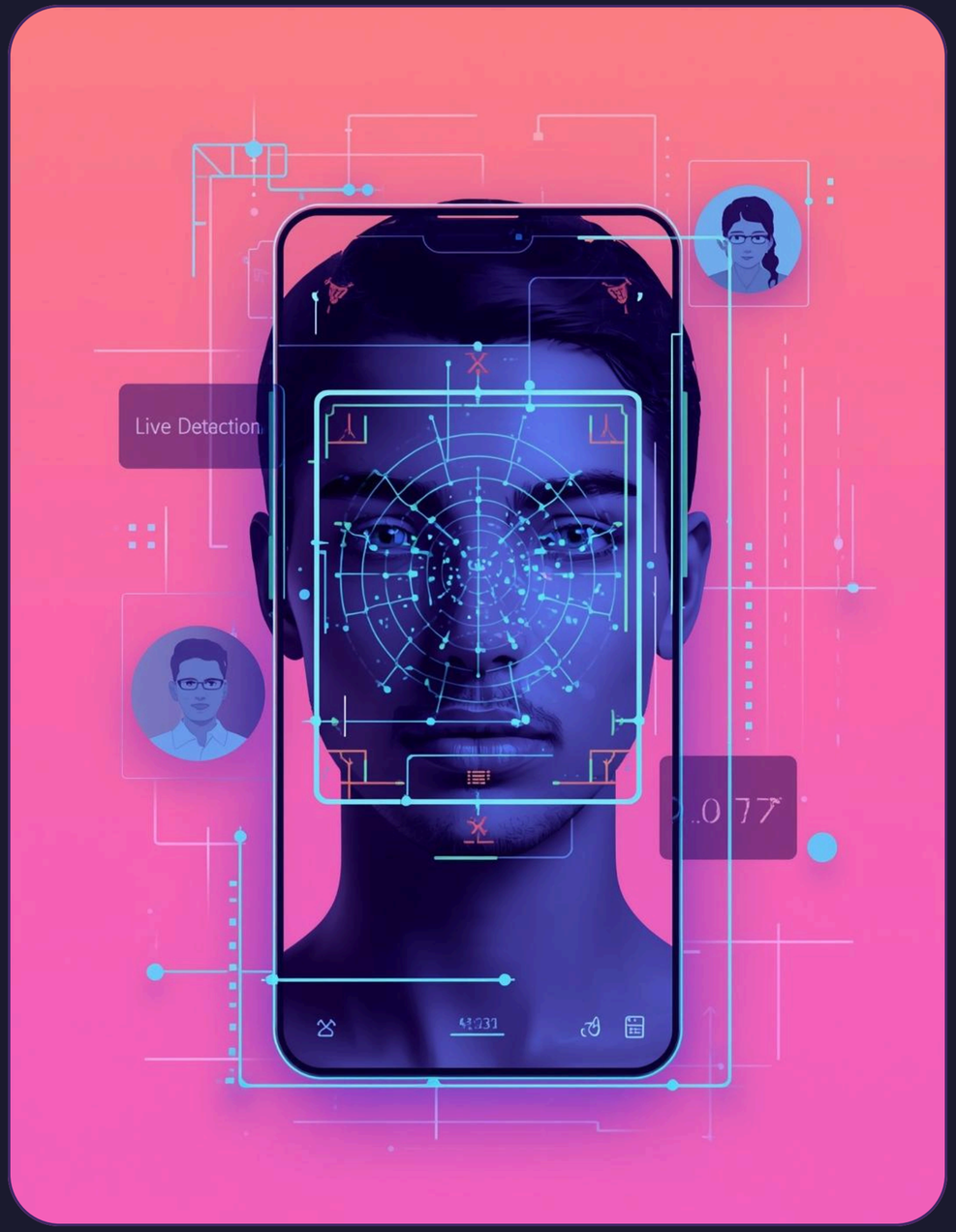
Ensuring **balanced datasets** for fair outcomes is crucial.

Privacy Protection

Implementing **data anonymization** measures to safeguard identities.

Key Achievements

- Successfully achieved 80% accuracy on LFW dataset
- Production-ready system with MLOps best practices
- Robust deployment on Hugging Face Spaces
- Scalable microservices architecture
- Commitment to fairness and privacy



Challenges & Resolutions

- Challenge 1: Making classes in the dataset close to us

Resolution: Used augmentation techniques changing the brightness and tone

- Challenge 2: Live video lag

Resolution: Implemented frame skipping (1 recognition/ second)

Thank You