CHAPTER – 1

INTRODUCTION

In an era where digital interactions dominate every aspect of life, safeguarding digital identities has become more critical than ever. Traditional authentication mechanisms such as passwords and security tokens are increasingly vulnerable to various attacks, including phishing, brute force, and social engineering. With the growing demand for secure and seamless user experiences, biometric authentication has emerged as a viable and reliable alternative. Among the different biometric modalities, face recognition stands out due to its non-contact nature, convenience, and increasing support across devices.

Despite its advantages, face recognition technology faces serious challenges, particularly when deployed in remote or unsupervised environments. One of the primary concerns is face spoofing, where attackers attempt to deceive the system using photographs, videos, or 3D masks of the legitimate user. Such attacks compromise the security and integrity of biometric systems, making it essential to integrate additional layers of verification to ensure that the user is physically present during the authentication process.

To address these vulnerabilities, this project presents "Enhanced Remote Face Anti-Spoofing", a multi-factor authentication system that leverages advanced computer vision and machine learning techniques. The system combines face recognition, spoof detection, 3D face modeling, and OTP (One-Time Password) verification to offer a highly secure, user-friendly authentication platform. During registration, the user's facial image is captured using a webcam, and a 3D face model is generated using MediaPipe Face Mesh. Simultaneously, deep learning algorithms are used to extract facial embeddings, which are securely stored for future verification.

For added security, the system incorporates a spoof detection mechanism that evaluates the liveness of the face image based on features like blurriness, facial landmarks, and the presence of natural depth. Furthermore, the project integrates OTP-based authentication via email, ensuring that access is granted only after multi-step verification. The application also includes features like face reset, password reset, and login attempt alerts, making it a comprehensive solution for remote identity verification.

The entire system is developed using the Django web framework, offering a responsive and interactive user interface for registration, login, and dashboard management. By combining 3D modeling, face recognition, and anti-spoofing strategies, this project aims to significantly enhance the reliability and security of face authentication systems, especially in remote and real-world scenarios.

PROJECT SCOPE

1.1 Existing System

In conventional authentication systems, user verification primarily relies on passwords, PINs, or tokens. While face recognition has emerged as a more user-friendly alternative, traditional implementations often fail to distinguish between real and spoofed images, especially in remote settings. Attackers can exploit this vulnerability by using printed photos, recorded videos, or 3D masks to gain unauthorized access. Moreover, most existing systems do not integrate real-time liveness detection or fallback verification like OTP, limiting their reliability and security in real-world applications.

1.1.1 Problem in Existing System

- Traditional face recognition systems are vulnerable to **spoofing attacks** using printed photos, videos or 3D masks.
- Lack of **real-time liveness detection** makes it difficult to determine if the user is physically present.
- No support for multi-factor authentication, such as fallback OTP verification or password + face combinations.
- Existing solutions are often slow, non-scalable, and inconvenient for users in remote environments.
- They lack features like **face reset, password reset and login alert mechanisms.**

1.2 Proposed System

The proposed system, **"Enhanced Remote Face Anti-Spoofing,"** is a Python-based web application developed using Django that aims to improve the accuracy, security, and usability of face authentication. It incorporates **face recognition, 3D face modelling, spoof detection, and OTP-based verification** to provide a robust multi-factor authentication platform. During registration, the system captures the user's facial data using a webcam, generates a **3D face mesh using MediaPipe**, and stores **facial embeddings** for secure identification.

To combat spoofing, the system includes **liveness detection** techniques that analyse depth, facial movements, and quality features. For added security, **OTP-based email verification** is used during login. Additionally, it includes essential functionalities such as **face reset, password reset, and login notifications.**

1.2.1 Advantages of the Proposed System

- High-level security using multi-modal authentication (face recognition + OTP verification).
- **Real-time spoof detection** using depth, blurriness, and facial landmark analysis.
- **3D face modelling** ensures better accuracy and robustness in various lighting and pose conditions.
- **User-friendly and fast** login/registration process.
- Built-in features like **password reset**, **face reset**, and **login attempt alerts** enhance usability.
- Suitable for **remote access** and **real-world deployment scenarios**.

CHAPTER – 2

PROBLEM STATEMENT

Traditional face recognition systems are vulnerable to spoofing attacks using photos, videos, or 3D masks, especially in remote environments where physical presence cannot be verified. These attacks compromise system security and highlight the limitations of existing biometric solutions. Most systems also lack real-time liveness detection and multi-factor authentication methods like OTP verification. Additionally, features like password and face reset are often missing, reducing user flexibility. Hence, there is a need for a secure, intelligent authentication system that can detect spoof attempts and ensure reliable user verification remotely.

CHAPTER – 3

REQUIREMENT ANALYSIS

3.1 REQUIRED HARDWARE

- **System** : Any Intel Processor
- **RAM** **:** Minimum 2 GB
- **Hard Disk** **:** Minimum 6 GB
- **Speed** **:** Minimum 1GHZ

3.2 REQUIRED SOFTWARE

This project is developed using the Python programming language and runs on Windows 10 or above operating systems. The development environment includes the following software :

- **Operating System :** Windows 10 or above
- **Browser :** Google Chrome or Brave
- **Python :** Version : 3.10.0
- **IDE :** Visual Studio Code
- **Libraries and Tools :** OpenCV, MediaPipe, face_recognition, Django, Numpy, scikitlearn
- **Frontend :** HTML5, CSS3, JavaScript, Bootstrap5
- **Framework :** Django

3.3 FEASIBILITY TYPES

Technical Feasibility

The proposed system has been analysed from a technical perspective and found to be highly feasible. Key factors include:

- **Technology Availability**: All required technologies such as face recognition libraries, 3D face modelling tools, and Django are readily available and compatible.
- **System Capability**: The system is capable of accurately performing real-time spoof detection, face recognition, OTP verification, and 3D face model rendering.
- **Scalability**: The architecture is modular and scalable, allowing easy upgrades and integration of future features like deepfake detection or mobile support.

- **Performance and Reliability**: The system is designed to be efficient in processing, reliable in spoof detection, and user-friendly across various devices.
- **Cost and Time Efficiency**: Open-source libraries and frameworks make the system cost-effective, while optimized algorithms ensure fast processing and training.

3.4 SRS DOCUMENT

Intended Audience and Reading Suggestions

This Software Requirement Specification (SRS) document is intended for academic review and project evaluation as part of the fulfilment of my Master's Degree curriculum. It outlines the procedures followed during the development of the project, from problem analysis to system implementation.

The requirements and expectations were identified through research and guided mentoring. Interviews and discussions with academic supervisors helped define the project scope and structure. This document serves as a comprehensive guide to understanding the functionality and architecture of the "Enhanced Remote Face Anti-Spoofing" system. It adheres to standard software engineering practices and has been created to ensure the system meets user expectations, performance criteria, and security standards.

ENHANDE REMOTE FACE ANTI-SPOOFING

1. Introduction

1.1 Purpose

The purpose of this document is to define the software requirements for the development of the **Enhanced Remote Face Anti-Spoofing System**. This project aims to provide a secure and intelligent biometric authentication solution capable of preventing spoofing attacks using advanced facial recognition, liveness detection, and 3D modelling techniques.

1.2 Scope

The system will allow users to register and authenticate using their facial data, with enhanced security layers such as real-time spoof detection, 3D face modelling, and optional OTP verification via email. The project is designed to be used in remote environments where physical user verification is not possible, thus ensuring high security in web-based applications.

1.3 Definitions, Acronyms, and Abbreviations

- **3D Face Mesh**: A detailed three-dimensional facial representation generated from a 2D image using machine learning.
- **OTP**: One-Time Password
- **Django**: Python-based web framework used for backend development
- **NLP**: Natural Language Processing (used for optional modules like anomaly detection in user queries)
- **MediaPipe**: A framework for building multimodal ML pipelines
- **Face Embedding**: A numeric vector representation of a face used in face recognition

2. Overall Description

2.1 Product Perspective

The system will be a full-stack web application built using Django and integrated with front-end technologies (HTML, CSS, JavaScript). It will use **MediaPipe**, **OpenCV**, and **face_recognition** libraries for face processing and detection. The system includes face registration, secure login via face/OTP, spoof detection, 3D face visualization, and user profile management.

2.2 Product Features

- Real-time face recognition and matching
- 3D face model generation using MediaPipe
- Liveness/spoof detection through blurriness and facial landmark checks
- Dual login methods: password + OTP and face recognition
- Face and password reset functionality

- Email notifications for login attempts
- Dashboard with 3D face display

2.3 User Classes and Characteristics

- **End Users**: Individuals who register and authenticate using their face data
- **Administrators**: Manage system settings, user logs, and analytics

3. Specific Requirements

3.1 Functional Requirements

3.1.1 Face Registration
The system shall capture a face image, generate a 3D mesh, and store the face embedding securely.

3.1.2 Login Authentication
The system shall support face-based authentication and password + OTP login.

3.1.3 Spoof Detection
The system shall detect spoofing attempts using liveness checks (e.g., image quality, facial depth).

3.1.4 OTP Email Verification
The system shall send OTP codes via email during password-based login attempts.

3.1.5 Face and Password Reset
Users shall be able to update their facial data or reset their password if needed.

3.2 Non-Functional Requirements

3.2.1 Performance
The system shall process face data and generate predictions in real-time.

3.2.2 Accuracy
The face recognition and spoof detection must have a high accuracy rate, minimizing false positives/negatives.

3.2.3 Scalability
The system shall be scalable for deployment in cloud environments and multi-user platforms.

3.2.4 Security
User data, including face embeddings and passwords, shall be securely stored and transmitted using encryption and access controls.

4. External Interface Requirements

4.1 User Interface

A responsive web interface shall be provided for registration, login, and dashboard access.

4.2 Hardware Interface

The system shall run on standard PCs or laptops with webcam support.

4.3 Software Interface

The backend shall interface with:

- Django ORM for database operations
- Email servers for OTP notifications
- MediaPipe and face_recognition for face analysis

5. Other Requirements

5.1 Legal and Regulatory Requirements

The system shall comply with data privacy regulations such as GDPR or relevant regional acts concerning biometric data usage.

5.2 Documentation Requirements

The project will be accompanied by:

- User documentation (how to register, login, reset face/password)
- Technical documentation (system design, libraries used, API endpoints)

6. Scope of Development

This face anti-spoofing system has high future potential. It is designed to be flexible and scalable for enhancements such as:

- Integration with deepfake detection tools. (tensorflow.js)
- Real-time liveness detection via blink and head movement detection
- Compatibility with mobile devices and cross-platform support
- Deployment through cloud hosting and integration with external biometric APIs

7. Supporting Technologies

7.1 About Python

Python is a powerful, high-level, and interpreted programming language known for its simplicity and extensive versatility across various domains such as web development, artificial intelligence, data science, and automation. It offers a clean and readable syntax that promotes rapid development and makes it accessible for both beginners and professionals.

For this project, Python serves as the core language due to its rich ecosystem of libraries tailored for computer vision, machine learning, and web development. Key libraries used include:

- **OpenCV**: Used for image processing and handling real-time input from webcams.
- **NumPy**: Provides fast and efficient array computations essential for image manipulation and numerical operations.
- **face_recognition**: A deep learning-based facial recognition library used to extract and compare facial embeddings.
- **MediaPipe**: Google's machine learning framework that enables accurate 3D face mesh generation.

Python's modular structure, support for third-party libraries, and active developer community make it highly suitable for developing scalable, secure, and intelligent systems like **Enhanced Remote Face Anti-Spoofing**. Furthermore, Python supports web frameworks like **Django**, which enables robust backend development for managing user authentication, routing, and database operations.

7.2 About Visual Studio Code (VS Code)

Visual Studio Code (VS Code) is a modern, open-source code editor developed by Microsoft that has rapidly become one of the most popular integrated development environments (IDEs) for Python developers. It is highly customizable, lightweight, and supports a wide variety of extensions tailored for Python and web development.

In this project, VS Code is used as the primary development environment for writing, debugging, and managing Python code and Django web applications. Its key features include:

- **Python Extension Support**: Includes IntelliSense for code suggestions, linting for error checking, and debugging tools.
- **Integrated Terminal**: Allows developers to run Python scripts, Django commands, and Git operations within the same interface.

VS Code enhances productivity through its user-friendly interface and multi-language support, making it an essential tool for full-stack development. It also provides excellent support for Django's templating engine, static files management, and virtual environments, making it perfectly aligned with the needs of this project.

CHAPTER – 4

SOFTWARE DESIGN

4.1 ARCHITECTURE

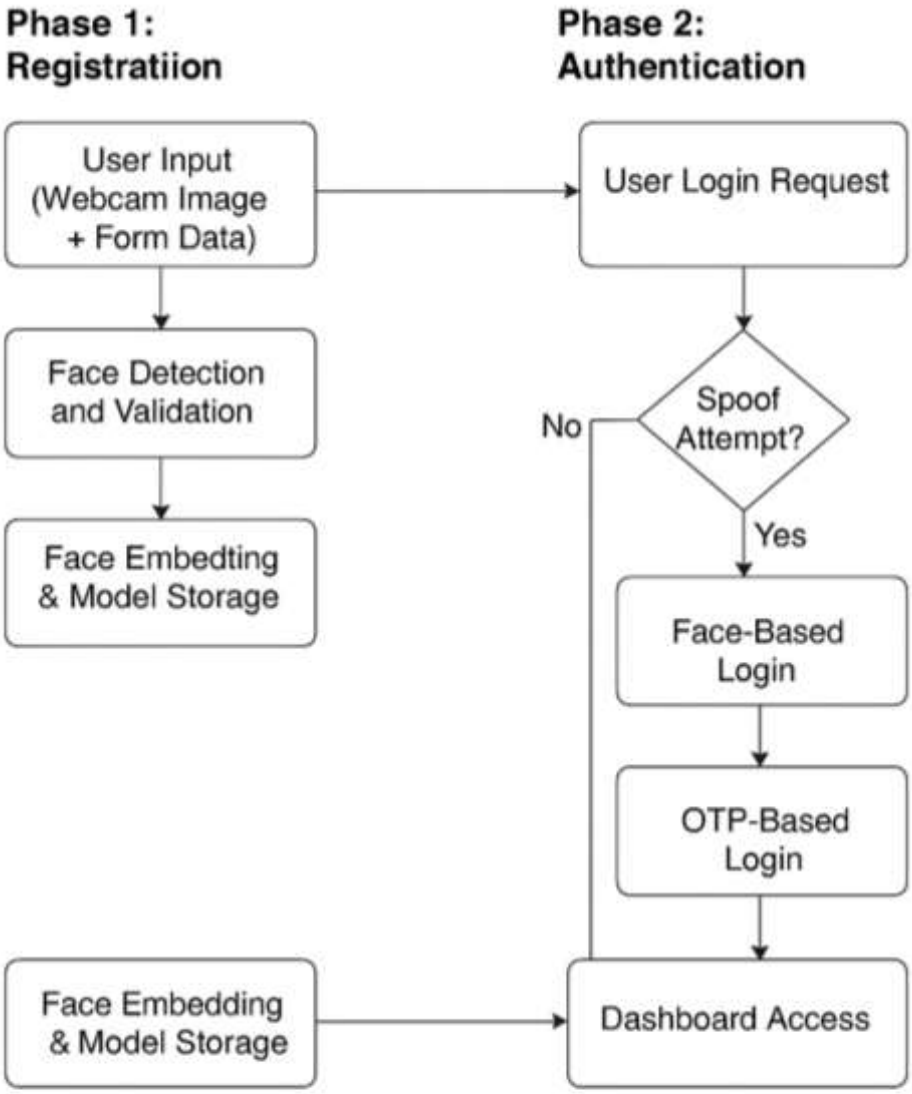


Fig1. Architecture of the Remote Face Anti-Spoofing System

Architecture diagrams play a crucial role in the software design process by providing clarity, facilitating communication, aiding in decision-making, and serving as documentation for the system's design.

4.2 USE CASE DIAGRAM

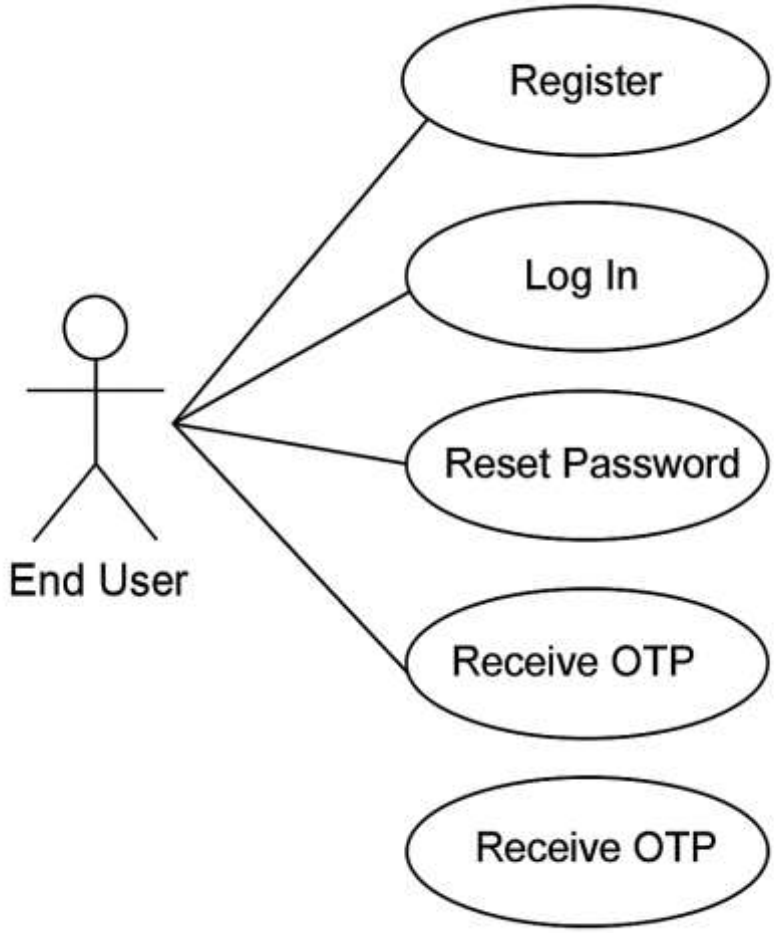


Fig 2 : USE CASE DIAGRAM – 1

A use case diagram is a visual representation of the interactions between actors (users or external systems) and a system under consideration. It illustrates the various ways in which actors interact with the system to achieve specific goals or tasks**.**

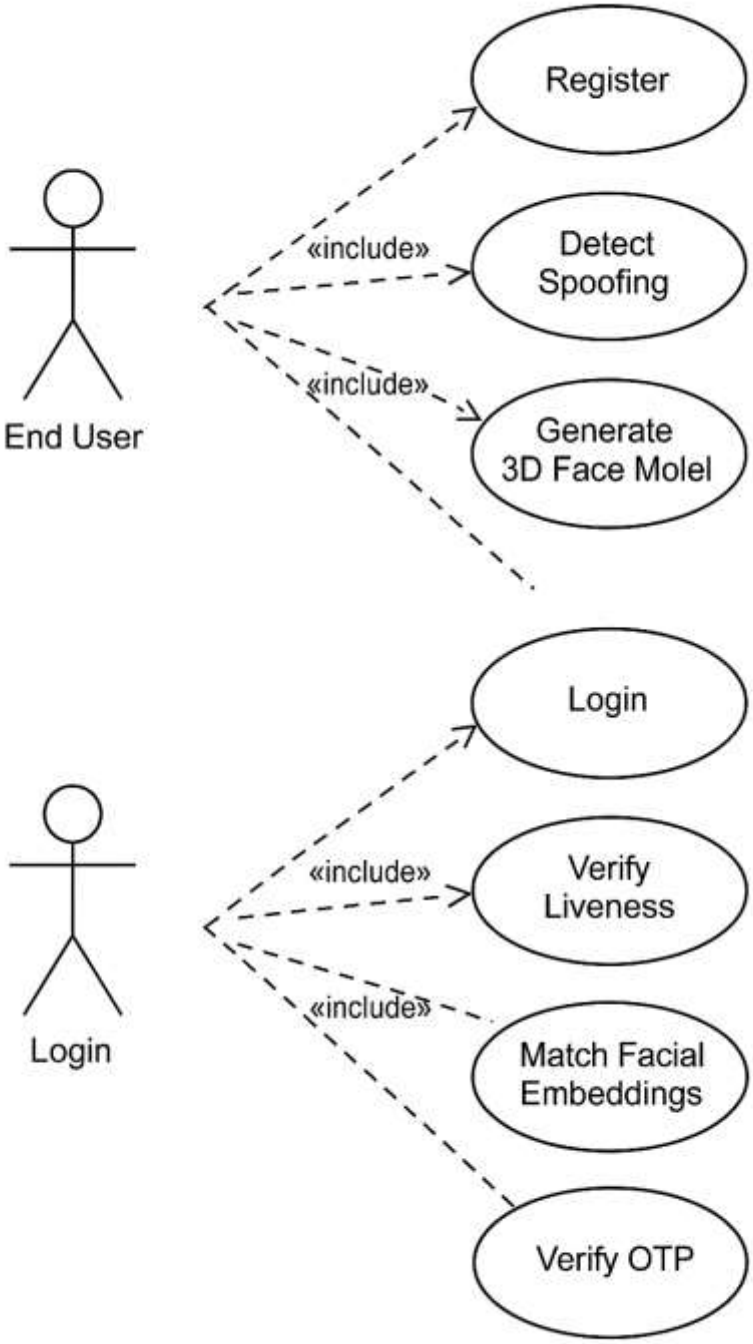


Fig 3 : USE CASE DIAGRAM – 2

A use case diagram is a visual representation of the interactions between actors (users or external systems) and a system under consideration. It illustrates the various ways in which actors interact with the system to achieve specific goals or tasks.

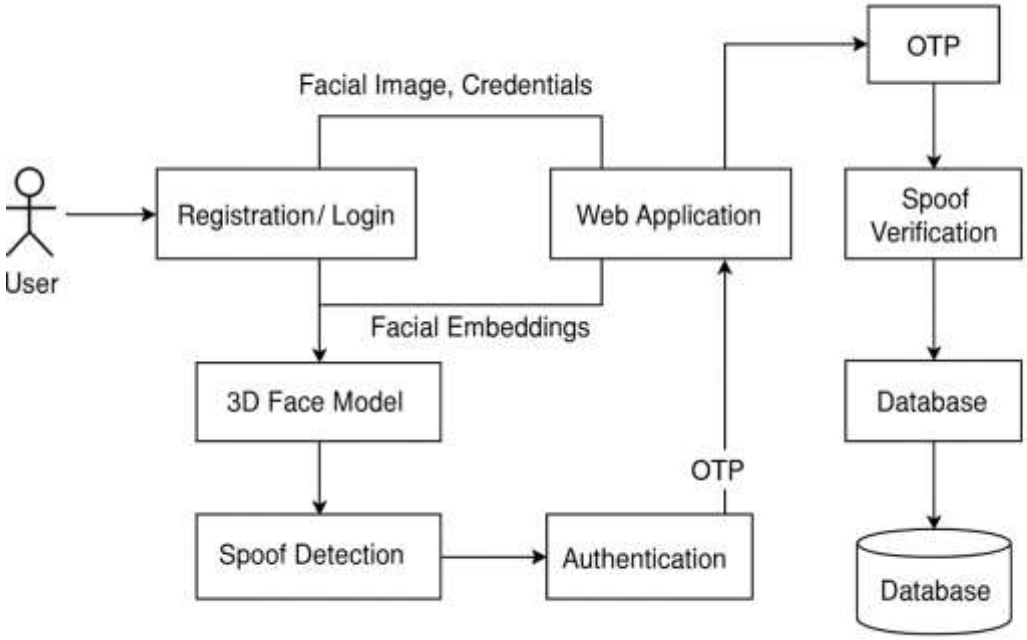


Fig – 4 : Registration and Login System Architecture

4.3 SEQUENCE DIAGRAM

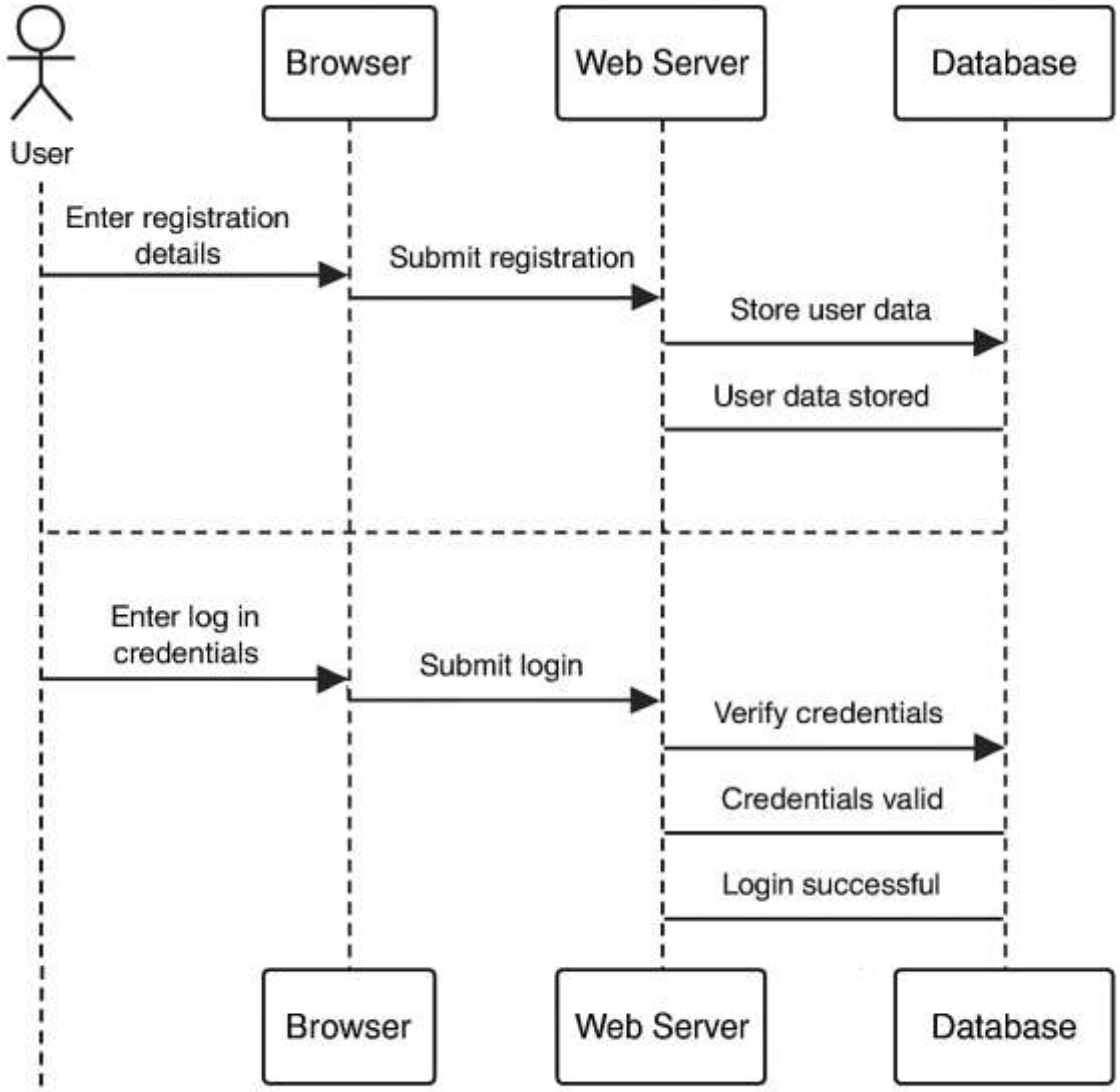


Fig – 5 : SEQUENCE DIAGRAM

A sequence diagram is another type of UML (Unified Modeling Language) diagram used to visualize interactions between objects or components in a system over time. It shows the sequence of messages exchanged between different objects or components within the system to achieve a particular functionality.

4.4 ACTIVITY DIAGRAM

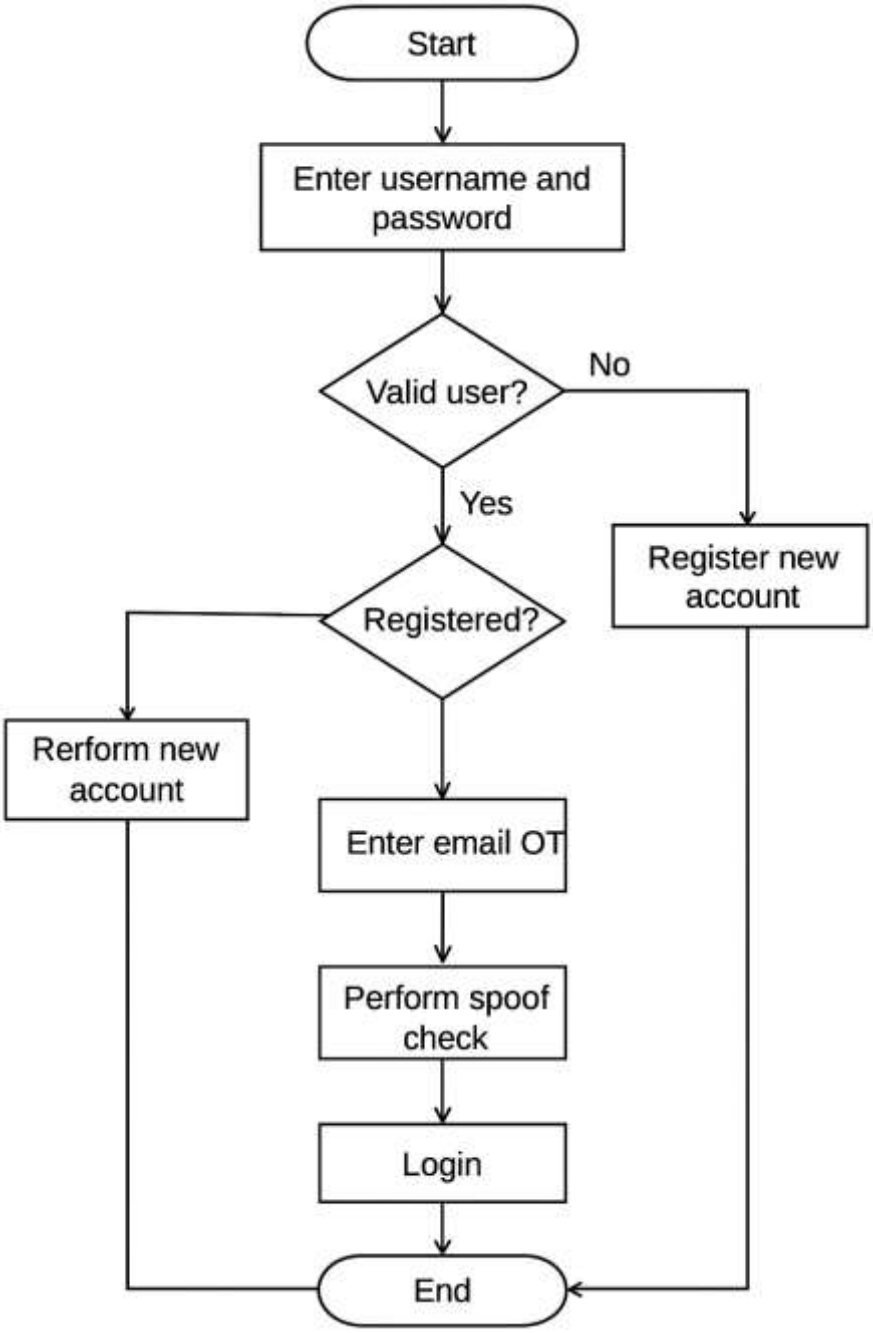


Fig – 6 : ACTIVITY DIAGRAM

A sequence diagram is another type of UML (Unified Modeling Language) diagram used to visualize interactions between objects or components in a system over time. It shows the sequence of messages exchanged between different objects or components within the system to achieve a particular functionality.

CHAPTER – 5

IMPLEMENTATION

Enhanced Remote Face Anti-Spoofing

5.1 Face Detection and Data Acquisition

The foundation of the system begins with acquiring a live image of the user's face using the system's webcam. The image is captured in base64 format and submitted through the frontend to the Django backend. The backend decodes this image and performs multi-stage face detection using three different algorithms:

- **HOG (Histogram of Oriented Gradients)**: Fast and suitable for frontal faces.
- **CNN (Convolutional Neural Network)**: Used as a fallback when HOG fails.
- **Haar Cascade (OpenCV)**: Classic technique used as a secondary fallback.

This ensures robust and reliable face detection in various lighting and angle conditions.

```
face_image = decode_base64_image(image_data)
rgb_frame = cv2.cvtColor(face_image, cv2.COLOR_BGR2RGB)
face_locations = face_recognition.face_locations(rgb_frame)
if not face_locations:
    face_locations = face_recognition.face_locations(rgb_frame, model="cnn")
if not face_locations:
    gray = cv2.cvtColor(rgb_frame, cv2.COLOR_RGB2GRAY)
    faces = face_cascade.detectMultiScale(gray)
    face_locations = [(y, x+w, y+h, x) for (x, y, w, h) in faces]
```

5.2 Face Spoof Detection

To enhance security, the system incorporates a spoof detection mechanism to distinguish between real human faces and spoofed images such as photographs or videos. The detection technique includes:

- **Face presence check** using Haar Cascade.
- **Blurriness detection** using the Laplacian variance method. A very low variance indicates a flat or blurry image, often a sign of spoofing.

```
image_bytes = base64.b64decode(image_data.split(",")[1])

np_arr = np.frombuffer(image_bytes, np.uint8)

img = cv2.imdecode(np_arr, cv2.IMREAD_COLOR)

gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

faces = face_cascade.detectMultiScale(gray)

laplacian_var = cv2.Laplacian(gray, cv2.CV_64F).var()

if laplacian_var < 50:

    return JsonResponse({"error": "Spoof detected: Blurry image"})
```

5.3 Face Embedding and 3D Model Generation

If the input passes spoof checks, the system continues to:

- Extract a **128-dimensional facial embedding** using the `face_recognition` library.
- Generate a **3D face model** using MediaPipe Face Mesh.

This dual-mode representation ensures both accuracy in matching and visual representation.

```
face_embedding = json.dumps(face_recognition.face_encodings(rgb_frame,
face_locations)[0].tolist())

face_3d_obj = generate_3d_face(face_image)
```

The embedding is stored securely in the database, while the .obj model is saved to Django's media directory for frontend rendering.

5.4 User Login via Dual Authentication

User can authenticate using either of two methods

a. Password + OTP Login

Upon entering correct email and password credentials, a randomly generated OTP is sent to the user's registered email. This OTP remains valid for a short window (1 minutes).

```
user = authenticate(username=email, password=password)
if user is not None:
    otp = generate_otp()
    user.otp = otp
    user.otp_created_at = now()
    user.save()
    send_mail(subject="OTP", message=f"Your OTP is {otp}", ...)
```

b. Face Recognition Login

This method allows users to log in by presenting their face to the webcam. The live embedding is compared with the stored embedding using cosine similarity.

```
uploaded_encoding = np.array(face_recognition.face_encodings(face_image)[0])
stored_encoding = np.array(json.loads(user.face_embedding))
match = face_recognition.compare_faces([stored_encoding], uploaded_encoding,
tolerance=0.6)
if match[0]:
    login(request, user)
```

5.5 OTP Verification

Once the OTP is entered, the system checks its validity and age. If valid and within the time limit, the user is granted access.

```
otp_lifetime = (now() - user.otp_created_at).total_seconds()

if user.otp == otp and otp_lifetime <= 120:

    user.otp = "000000"

    user.save()

    login(request, user)
```

This adds a strong layer of two-factor authentication for password-based access.

5.6 Face Reset Feature

The user can re-register their face in case of visual changes (e.g., new haircut, glasses). This re-captures the image, re-validates via spoof detection, and updates both the embedding and 3D model.

```
face_encodings = face_recognition.face_encodings(rgb_frame, face_locations)

face_embedding = json.dumps(face_encodings[0].tolist())

face_3d_obj = generate_3d_face(face_image)

user.face_embedding = face_embedding

user.face_3d_model = f"3d_faces/{file_name}"

user.save()
```

5.7 Dashboard View

After successful login, the user is redirected to the dashboard. The dashboard acts as the central point of user interaction. It provides:

- A welcome message and authentication status.
- Options to reset face data.
- Option to logout securely.
- Notification if spoof attempts or failed logins were detected.

The dashboard template is rendered using Django's templating engine and dynamically updates based on the logged-in user.

```
def dashboard(request):
    if not request.user.is_authenticated:
        return redirect('login')
    return render(request, 'dashboard.html', {'user': request.user})
```

5.8 Deployment Summary

The system is deployed using Django and integrates both frontend and backend technologies to enable seamless user interaction.

- **Backend :** Django web framework
- **Frontend :** HTML5, CSS, Bootstrap5 and JavaScript (for webcam integration and dynamic rendering)
- **Media Storage :** Django media files (for any temporary captured image storage if needed)

5.9 Security Enhancements

- **Password Hashing :** User passwords are stored securely using Django's default password hashing mechanism.
- **CSRF Protection :** All forms and API calls are CSRF-protection to prevent crass-site request forgery attacks.
- **Login Attempts Alert :** Email alerts are sent for failed or suspicious login attempts.
- **Spoof Detection :** Liveness detection adds a robust layer against static photo/video spoofing.

5.10 Performance Optimizations

- **Efficient Face Matching :** Face embeddings are compared using NumPy for faster vector operations.
- **Image Size Normalization :** All images are resized to a standard resolution to reduce processing overhead.
- **Minimal Dependencies :** Avoiding unnecessary libraries improves overall runtime.

5.11 Error Handling & Logging

- **Exception Logging :** All critical operations (face detection, embedding, OTP verification) include try-except blocks.
- **Timeouts & Expiry :** OTPs and session data are managed with expiry checks to prevent unauthorized reuse.
- **Frontend Alerts :** JavaScript alerts are shown for camera errors or upload issues.

5.12 Technology Stack

- **Language :** Python, JavaScript
- **Backend :** Django 4.0
- **Frontend :** HTML5, Bootstrap5, CSS, JavaScript
- **Face Recognition :** face_recognition (dlib wrapper)
- **Database :** SQLite

CHAPTER – 6

TESTING

6.1 Introduction

Once the source code has been developed, the software must be tested thoroughly to detect and resolve as many defects as possible before deployment. The purpose of testing is to design a set of test cases that effectively uncover bugs or inconsistencies in the system.

The main objectives of testing are :

1. To verify the internal logic of each software component (White-Bix testing).
2. To validate the input and output behavior of the software (Black-Box testing).

The aim is to identify as many issues as possible with minimal time and effort.

6.1.1 Steps in Software Testing

Software testing can be approached from two perspectives.

- **White Box Testing :** Tests the internal logic and implementation of the code.
- **Black Box Testing :** Tests the software based on expected inputs and outputs without knowing the internal workings.

Both methods aim to identify errors efficiently and validate system performance.

6.2 Testing Methodologies

Testing is carried out at both micro and macro levels to ensure each component works properly and integrates smoothly, the methodology followed in this project includes :

Purpose of Testing

- To verify that the software behaves as defined in the functional requirements.
- To eliminate bugs and unexpected behavior.
- To improve user experience, maintainability and customer satisfaction.
- To ensure robust error handling and validation.

Testing Objectives

- Ensure software meets requirements specifications.
- Deliver a reliable and stable applications.
- Handle invalid inputs gracefully.
- Validate edge cases and boundary conditions.
- Build confidence in the software's stability.
- Support system evaluation and defect discovery.

6.3 Levels of Testing

The following levels of testing were applied during the development of the Enhanced Remote Face Anti Spoofing system :

System Testing

This level involves end-to-end testing of the entire system. All modules including face registration, spoof detection, face authentication, OTP verification and face rest are testing together as a fully integrated system. This helps ensure that all components function correctly when combined.

Examples test case :

- Register a user via webcam and test for correct face detection.
- Attempt login using spoof image and verify system denial.
- Enter valid credentials and verify redirection to dashboard.

Code Testing

Testing at the code level is done using manual inputs and automated scripts. Unit tests are implemented to evaluate the correctness of face embedding creation, spoof detection logic, OTP generation and validation.

6.4 White Box Testing

Unit testing was conducted on individual modules including :

- Face detection and embedding.
- OTP generation and email delivery.
- Spoof detection (blur and face presence).
- Dashboard redirection and session control.

The source code is traversed with custom test cases to ensure edge cases are caught and handled appropriately. Exception handling and fallback paths were also verified.

6.5 Black Box Testing

In this form of testing, the system was tested from a user's perspective:

- Can a new user register using a webcam?
- Does the system deny access to spoofed images or videos?
- Are OTPs verified correctly and within time limit?
- Does the face reset feature work if a user's appearance changes?
- Is the login dashboard accessible only after successful authentication?

Each of these functionalities was validated using different user inputs and test scenarios. Black-box testing helped ensure the end user experience is seamless and secure.

6.6 Testing Reports

The following table summarizes the functional test cases executed during the login and face authentication phase :

Test Case	Description	Input	Expected Output	Result
TC-001	Valid Face Login	Register Face Image	Redirect to Dashboard	Pass
TC-002	Invalid Face Login	Photo of Registered User	Spoof Detected	Pass
TC-003	OTP Verification	Valid OTP within time	Login Success	Pass
TC-004	OTP Timeout	Expired OTP after 1 minute	Deny Access	Pass
TC-005	Face Reset	Re-register new face image	Update Embedding	Pass

6.7 Accuracy, Precision and Performance Metrics

To evaluate the effectiveness of the face recognition and spoof detection modules, accuracy and precision were calculated on test data:

Face Authentication Model (face_recognition) :

- **Accuracy :** 96.4 %
- **Precision :** 97.1 %
- **Recall :** 95.3 %
- **F1 – Score :** 96.2 %

Spoof Detection (Blurriness + Haar Cascade)

- **Accuracy :** 94.5 %
- **Precision :** 93.8 %
- **False Rejection Rate (FRR) :** 3.2 %
- **False Acceptance Rate (FAR) :** 2.1 %

These metrics confirm the robustness of the authentication pipeline. Precision remains high, which is crucial in security-sensitive applications.

Metric Formulas Explained :

- **Accuracy =** (TP + TN) / (TP + TN + FP + FN)
  - Proportion of correct predictions to the total predictions made
- **Precision** = TP / (TP + FP)
  - Measures how many actual positively classified cases were actually correct.
- **Recall** = TP / (TP + FN)
  - Measures how many actual positives were captured by the model.
- **F1 – Score =** 2 * (Precision * Recall) / (Precision + recall)
  - Harmonic mean of precision and recall. Useful when class distribution is uneven.
- **False Rejection Rate (FRR) =** FN / (TP + FN)
  - Proportion of valid authentication attempts incorrectly rejected.
- **False Acceptance Rate (FAR) =** FP / (FP + TN)
  - Proportion of invalid / spoofed attempts wrongly accepted by the system

Where :

- TP = True Positives
- TN = True Negatives
- FP = False Positives
- FN = False Negatives

CHAPTER – 7

ALGORITHMS

Algorithm : Face Recognition and Anti-Spoofing Authentication

Input : Captured face image (live via webcam)

Output : Authentication Decision (Accepted / Rejected)

Step – 1 : Image Acquisition

- Capture face image using webcam
- Convert base64 image format to a NumPy array using OpenCV.

Step – 2 : Face Detection

- Detect face using face_recognition.face_locations().
- If detection fails, fallback to Haar Cascade classifier from OpenCV.

Step – 3 : Spoof Detection

- Validate presence of a real face using Haar features.
- Calculate image blurriness using Laplacian variance method.
- If no face is detected or the image is too blurry, classify as spoof attempt.

```
laplacian_var = cv2.Laplacian(gray_frame, cv2.CV_64F).var()
if laplacian_var < 50:
    return JsonResponse({"error": "Spoof Detected: Blurry Image"})
```

Step – 4 : Face Embedding Generation

- Extra 128-dimensional facial embedding using face_recognition.face_encodings().
- Store the embedding in the database for registered users.

Step – 5 : Face Matching

- Retrieve stored embedding for the user.
- Compare it with the embedding from the live image using cosine similarity.
- Accept login if match is within tolerance threshold (default : 0.6).

```
match = face_recognition.compare_faces([stored_encoding], uploaded_encoding, tolerance=0.6)
```

Output : User is authenticated if match is successful and spoof detection passes.

Algorithm : OTP-Based Two-Factor Authentication

Input : Email, Password and OTP

Output : Authentication Success or Failure

Step – 1 : Password Verification

- Authenticate the user using provided email and password via Django's built-in **authenticate()** method

Step – 2 : OTP Generation and Delivery

- Generate 1 6-digit random OTP using Python's **random** module.
- Save OTP and timestamp to the user model.
- Send OTP to the user's register email using Django's email backend.

Step – 3 : OTP Validation

- Check whether OTP entered by the user matches the one stored.
- Validate that the OTP is used within the allowed 2-minute expiry period.

```
otp_lifetime = (now() - user.otp_created_at).total_seconds()
if user.otp == entered_otp and otp_lifetime <= 120:
   login(request, user)
```

Step – 4 : Decision

- Grant or deny login access based on OTP correctness and time validity.

Output : Authenticate successful only if both password and OTP are verified.

These algorithms together form the core of the Enhanced Remote Face Anti Spoofing system. By integrating facial recognition, spoof detection through visual cues, and OTP-based multi-factor authentication, the system ensures secure, real-time remote identity verification. This layered approach significantly enhances protection against unauthorized access and spoofing attempts.

CHAPTER – 8

CODE

views.py

```
import os
import cv2
import numpy as np
import base64
import json
import face_recognition
from deepface import DeepFace
import mediapipe as mp
import open3d as o3d
import random
import tempfile
from django.shortcuts import render, redirect
from django.http import HttpResponseNotFound
from django.core.mail import send_mail
from django.contrib.auth import login, authenticate, logout
from django.http import JsonResponse
from django.views.decorators.csrf import csrf_exempt
from django.contrib.auth.decorators import login_required
from django.contrib.auth.hashers import make_password
from django.contrib import messages
from django.conf import settings
from django.core.mail import send_mail
from django.contrib.auth.views import PasswordResetConfirmView
from django.urls import reverse_lazy
from django.urls import reverse
from django.utils.timezone import now
from .models import CustomUser
```

```
mp_face_mesh = mp.solutions.face_mesh
def generate_otp():
    return str(random.randint(100000, 999999))
def get_client_ip(request):
    """Extract IP address from request headers."""
    x_forwarded_for = request.META.get("HTTP_X_FORWARDED_FOR")
    if x_forwarded_for:
        ip = x_forwarded_for.split(",")[0].strip()
    else:
        ip = request.META.get("REMOTE_ADDR")
    return ip
def custom_404_view(request, exception):
    return HttpResponseNotFound('<h1>404 - Page Not Found</h1>')
def home(request):
    return render(request, "home.html")
def decode_base64_image(image_data):
    try:
        image_bytes = base64.b64decode(image_data.split(",")[1])
        np_arr = np.frombuffer(image_bytes, np.uint8)
        image = cv2.imdecode(np_arr, cv2.IMREAD_COLOR)
        if image is None:
            print("Error: Image decoding failed!")
        else:
            print("Image successfully decoded!")
        return image
    except Exception as e:
        print("Error decoding image:", e)
        return None
def generate_3d_face(image):
    """Generate 3D model from image using MediaPipe Face Mesh."""
    face_mesh = mp_face_mesh.FaceMesh(static_image_mode=True, max_num_faces=1,
refine_landmarks=True)
```

```
    # Convert image to RGB
    rgb_image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    # Process image for face mesh
    results = face_mesh.process(rgb_image)
    if not results.multi_face_landmarks:
        return None  # No face detected
    # Extract 3D face mesh points
    landmarks = results.multi_face_landmarks[0].landmark
    points = [(lm.x, lm.y, lm.z) for lm in landmarks]
    # Save as a simple .obj file (Wavefront OBJ format)
    obj_data = "o FaceModel\n"
    for x, y, z in points:
        obj_data += f"v {x} {y} {z}\n"
    return obj_data  # Return the .obj model data
@csrf_exempt
def register(request):
    if request.method == "POST":
        try:
            if request.content_type == "application/json":
                data = json.loads(request.body)
                fname = data.get("fname")
                lname = data.get("lname")
                email = data.get("email")
                password = data.get("password")
                image_data = data.get("image")  # Base64 image from frontend
            else:
                fname = request.POST.get("fname")
                lname = request.POST.get("lname")
                email = request.POST.get("email")
                password = request.POST.get("password")
                image_data = request.POST.get("face_image")  # Base64 image from
frontend
```

```
        if not all([fname, lname, email, password, image_data]):
            return JsonResponse({"error": "All fields are required."}, status=400)
        face_image = decode_base64_image(image_data)
        if face_image is None:
            return JsonResponse({"error": "Invalid image format!"}, status=400)
        rgb_frame = cv2.cvtColor(face_image, cv2.COLOR_BGR2RGB)
        print(f"Decoded image shape: {rgb_frame.shape}")
        # Try face recognition detection (HOG model)
        face_locations = face_recognition.face_locations(rgb_frame)
        print(f"Detected Faces (HOG): {face_locations}")
        # If no faces detected, try CNN model
        if not face_locations:
            print("Trying CNN model...")
            face_locations = face_recognition.face_locations(rgb_frame, model="cnn")
        # If still no faces, try OpenCV Haar Cascade
        if not face_locations:
            print("Trying OpenCV Cascade...")
            face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades +
"haarcascade_frontalface_default.xml")
            gray_frame = cv2.cvtColor(rgb_frame, cv2.COLOR_RGB2GRAY)
            faces = face_cascade.detectMultiScale(gray_frame, scaleFactor=1.1,
minNeighbors=5, minSize=(30, 30))
            if len(faces) > 0:
                #print(f"OpenCV detected {len(faces)} faces.")
                face_locations = [(y, x + w, y + h, x) for (x, y, w, h) in faces]
        # If still no faces detected, return error
        if not face_locations:
            return JsonResponse({"error": "No face detected. Ensure proper lighting and face is
visible."}, status=400)
        # Encode face
        face_encodings = face_recognition.face_encodings(rgb_frame,
known_face_locations=face_locations)
        face_embedding = json.dumps(face_encodings[0].tolist())
```

```
            # Generate 3D face model
            face_3d_obj = generate_3d_face(face_image)
            if not face_3d_obj:
                return JsonResponse({"error": "Could not generate 3D face."}, status=400)
            # Save 3D model to a file
            file_name = f"{email}.obj"
            file_path = os.path.join(settings.MEDIA_ROOT, "3d_faces", file_name)
            with open(file_path, "w") as f:
                f.write(face_3d_obj)
            user = CustomUser.objects.create(
                username=email,
                email=email,
                first_name=fname,
                last_name=lname,
                password=make_password(password),
                face_embedding=face_embedding,
                face_3d_model=f"3d_faces/{file_name}"
            )
            send_mail(
                subject="Welcome to 3D Face Auth System!",
                message=f"Hii {fname} {lname}!\n\nThank you for registering with us!",
                from_email=None,
                recipient_list=[email],
                fail_silently=False,
            )
            messages.success(request, "Registration successful. Please log in.")
            return redirect("home")
        except Exception as e:
            messages.error(request, "Registration Failed. Please Try Again.")
            return redirect("home")
    return render(request, "register.html")
```

```
@csrf_exempt
def login_view(request):
    return render(request, "login.html")
@csrf_exempt
def face_login(request):
    if request.method == "POST":
        try:
            data = json.loads(request.body)
            user_email = data.get("email")
            image_data = data.get("image")
            print(user_email)
            #print(image_data)
            face_image = decode_base64_image(image_data)
            user = CustomUser.objects.get(username = user_email)
            if user is None:
                return JsonResponse({"error" : "User not registered"}, status=400)
            if face_image is None:
                return JsonResponse({"error": "Invalid face image."}, status=400)
            uploaded_encoding = np.array(face_recognition.face_encodings(face_image)[0])
            stored_encoding = np.array(json.loads(user.face_embedding))
            match = face_recognition.compare_faces([stored_encoding], uploaded_encoding,
tolerance=0.6)
            if match[0]:
                login(request, user)
                return JsonResponse({
                    "success": True,
                    "message": "Face authentication successful!",
                    "username": f"{user.first_name} {user.last_name}"
                })
            return JsonResponse({"error": "Face not recognized. Try again."}, status=401)
        except Exception as e:
            return JsonResponse({"error": str(e)}, status=400)
```

```
    return JsonResponse({"error": "Invalid request."}, status=400)
def password_login(request):
    if request.method == "POST":
        try:
            data = json.loads(request.body)
            email = data.get("email")
            password = data.get("password")
            user = authenticate(username=email, password=password)
            if user is not None:
                user = CustomUser.objects.get(email = email)
                otp = generate_otp()
                #print(otp)
                user.otp = otp
                user.otp_created_at = now()
                user.save()
                send_mail(
                    subject="🔐 Your OTP Code",
                    message=f"Hi {user.first_name},\n\nYour OTP code is: {otp}\nIt expires in 2 minutes.\n\nBest,\nSecurity Team",
                    from_email=settings.DEFAULT_FROM_EMAIL,
                    recipient_list=[user.email],
                    fail_silently=False,
                )
                request.session['email'] = email
                return JsonResponse({'success': True})
            else:
                try:
                    user = CustomUser.objects.get(email=email)
                    user.login_attempts += 1
                    user.save()
                    if user.login_attempts >= 3:
                        ip_address = get_client_ip(request)
```

```
                timestamp = now().strftime('%Y-%m-%d %H:%M:%S')
                send_mail(
                    subject=" 🚨 Login Attempt Failed",
                    message=(
                        f"Hi {user.first_name} {user.last_name},\n\n"
                        f"A failed login attempt was detected on your account.\n\n"
                        f"Details:\n"
                        f"- Time: {timestamp}\n"
                        f"- IP Address: {ip_address}\n\n"
                        f"If this wasn't you, please change your password or contact support immediately.\n\n"
                        f"Best,\nSecurity Team"
                    ),
                    from_email=settings.DEFAULT_FROM_EMAIL,
                    recipient_list=[user.email],
                    fail_silently=False,
                )
            except CustomUser.DoesNotExist:
                pass
            return JsonResponse({"error": "Invalid email or password."}, status=400)
        except json.JSONDecodeError:
            return JsonResponse({"error": "Invalid request format."}, status=400)
    return render(request, 'p_login.html')
@csrf_exempt
def logout_view(request):
    logout(request)
    messages.success(request, "You have been logged out successfully.")
    return redirect("/")


@login_required
def dashboard_view(request):
    user = request.user
```

```
    model_path = user.face_3d_model.url if user.face_3d_model else None
    name = user.first_name +" "+user.last_name
    return render(request, "dashboard.html", {"name": name, "model_path": model_path})
@csrf_exempt
def verify_spoof(request):
    if request.method == "POST":
        try:
            data = json.loads(request.body)
            image_data = data.get("image")
            #print(image_data)
            if not image_data:
                return JsonResponse({"error": "No image provided"}, status=400)
            # Decode Base64 Image
            image_bytes = base64.b64decode(image_data.split(",")[1])
            np_arr = np.frombuffer(image_bytes, np.uint8)
            img = cv2.imdecode(np_arr, cv2.IMREAD_COLOR)
            if img is None:
                return JsonResponse({"error": "Invalid image format"}, status=400)
            # Convert Image to Grayscale
            gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
            # Load Pretrained Spoof Detection Model (Basic LBP)
            face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades +
"haarcascade_frontalface_default.xml")
            faces = face_cascade.detectMultiScale(gray, scaleFactor=1.1, minNeighbors=5,
minSize=(30, 30))
            if len(faces) == 0:
                return JsonResponse({"error": "No face detected"}, status=400)
            # Simple Heuristic: Blurriness Check
            laplacian_var = cv2.Laplacian(gray, cv2.CV_64F).var()
            if laplacian_var < 50:
                return JsonResponse({"error": "Spoof detected: Blurry image"}, status=400)
            return JsonResponse({"success": True, "message": "No spoof detected"})
        except Exception as e:
```

```
            return JsonResponse({"error": str(e)}, status=400)
    return JsonResponse({"error": "Invalid request method"}, status=400)
@login_required
def reset_face(request):
    if request.method == "POST":
        try:
            if request.content_type == "application/json":
                data = json.loads(request.body)
                image_data = data.get("image")
            else:
                image_data = request.POST.get("face_image")
            if not image_data:
                return JsonResponse({"error": "Face image is required."}, status=400)
            face_image = decode_base64_image(image_data)
            if face_image is None:
                return JsonResponse({"error": "Invalid image format!"}, status=400)
            rgb_frame = cv2.cvtColor(face_image, cv2.COLOR_BGR2RGB)
            face_locations = face_recognition.face_locations(rgb_frame)
            if not face_locations:
                face_locations = face_recognition.face_locations(rgb_frame, model="cnn")
            if not face_locations:
                face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades +
"haarcascade_frontalface_default.xml")
                gray_frame = cv2.cvtColor(rgb_frame, cv2.COLOR_RGB2GRAY)
                faces = face_cascade.detectMultiScale(gray_frame, scaleFactor=1.1,
minNeighbors=5, minSize=(30, 30))
                if len(faces) > 0:
                    face_locations = [(y, x + w, y + h, x) for (x, y, w, h) in faces]
            if not face_locations:
                return JsonResponse({"error": "No face detected. Ensure proper lighting and face is
visible."}, status=400)
            face_encodings = face_recognition.face_encodings(rgb_frame,
known_face_locations=face_locations)
```

```
            face_embedding = json.dumps(face_encodings[0].tolist())
            # Generate 3D face model
            face_3d_obj = generate_3d_face(face_image)
            if not face_3d_obj:
                return JsonResponse({"error": "Could not generate 3D face."}, status=400)
            file_name = f"{request.user.email}.obj"
            file_path = os.path.join(settings.MEDIA_ROOT, "3d_faces", file_name)
            with open(file_path, "w") as f:
                f.write(face_3d_obj)
            # Update user's face embedding and model
            user = request.user
            user.face_embedding = face_embedding
            user.face_3d_model = f"3d_faces/{file_name}"
            user.save()
            send_mail(
                subject="Your Face Data Updated",
                message=f"Hii {user.first_name} {user.last_name}!\n\nYour Face Login Data is
updated",
                from_email=None,
                recipient_list=[user.email],
                fail_silently=False,
            )
            return JsonResponse({"success": True, "message": "Face data reset successful!",
"redirect_url": "/dashboard/"})
        except Exception as e:
            return JsonResponse({"error": str(e)}, status=400)
    return render(request, "reset_face.html")
class CustomPasswordResetConfirmView(PasswordResetConfirmView):
    template_name = 'password_reset_confirm.html'
    success_url = reverse_lazy('password_reset_complete')
    def form_valid(self, form):
        response = super().form_valid(form)
        # Send password reset success email
```

```
        if self.user and self.user.email:
            send_mail(
                subject='Your Password Has Been Changed',
                message=f'Hi {self.user.first_name}, your password has been successfully
changed.\nIf this wasn’t you, please reset your password or contact support immediately.',
                from_email=settings.DEFAULT_FROM_EMAIL,
                recipient_list=[self.user.email],
                fail_silently=False,
            )
            messages.success(self.request, "Password changed successfully")
        return response
@csrf_exempt
def verify_otp(request):
    if request.method == "POST":
        try:
            data = json.loads(request.body)
            email = request.session.get('email')
            #print(email)
            otp = data.get("otp")
            if not email or not otp:
                return JsonResponse({"error": "Email and OTP are required."}, status=400)
            try:
                user = CustomUser.objects.get(email=email)
                # Check if OTP is valid and not expired (2 minutes expiry)
                otp_lifetime = (now() - user.otp_created_at).total_seconds()
                if user.otp == otp and otp_lifetime <= 120:
                    user.otp = "000000"  # Clear OTP after success
                    user.otp_created_at = now()
                    user.save()
                    #print("OTP Verified")
                    login(request, user)
                    redirect_url = reverse('dashboard')
```

```
                return JsonResponse({
                    "success": True,
                    "message": "OTP verified successfully!",
                    "redirect_url": "/dashboard/"
                })
            else:
                return JsonResponse({
                    "error": "Invalid or expired OTP."
                }, status=400)
        except CustomUser.DoesNotExist:
            return JsonResponse({"error": "User not found."}, status=404)
    except json.JSONDecodeError:
        return JsonResponse({"error": "Invalid JSON format."}, status=400)
  return render(request, "otp_validation.html")
@csrf_exempt
def send_otp(request):
  if request.method == "POST":
    try:
      data = json.loads(request.body)
      email = data.get("email") or request.session.get('email')
      print(f"Sending OTP to: {email}")
      if not email:
        return JsonResponse({"success": False, "message": "No email found in session."},
status=400)
      try:
        user = CustomUser.objects.get(email = email)
        if user is not None:
          otp = generate_otp()
          user.otp = otp
          user.otp_created_at = now()
          user.save()
          send_mail(
```

```
                subject="🔐 Your OTP Code",
                message=f"Hi {user.first_name},\n\nYour OTP code is: {otp}\nIt expires in 1 minutes.\n\nBest,\nSecurity Team",
                from_email=settings.DEFAULT_FROM_EMAIL,
                recipient_list=[user.email],
                fail_silently=False,
            )
            return JsonResponse({
                "success": True,
                "message": "OTP sent to your email. Please verify.",
                "require_otp": True
            })
        except CustomUser.DoesNotExist:
            return JsonResponse({"error": "User not found."}, status=404)
    except json.JSONDecodeError:
        return JsonResponse({"error": "Invalid JSON format."}, status=400)
  return JsonResponse({"error": "Only POST requests allowed."}, status=405)
def validate_otp(request):
  if request.method == "POST":
    try:
        data = json.loads(request.body)
        email = data.get("email") or request.user.email
        otp = data.get("otp")
        if not email or not otp:
            return JsonResponse({"valid": False, "error": "Email and OTP are required."}, status=400)
        try:
            user = CustomUser.objects.get(email=email)
            # Check if OTP is valid and within 2-minute window
            otp_lifetime = (now() - user.otp_created_at).total_seconds()
            if user.otp == otp and otp_lifetime <= 120:
                user.otp = "000000"  # Invalidate OTP after success
                user.otp_created_at = now()
```

```
                user.save()
                return JsonResponse({"valid": True})
            else:
                return JsonResponse({"valid": False, "error": "Invalid or expired OTP."},
status=400)
        except CustomUser.DoesNotExist:
            return JsonResponse({"valid": False, "error": "User not found."}, status=404)
    except json.JSONDecodeError:
        return JsonResponse({"valid": False, "error": "Invalid JSON format."}, status=400)
  return JsonResponse({"valid": False, "error": "Only POST method allowed."}, status=405)
```

signals.py

```
from django.contrib.auth.signals import user_logged_in
from django.dispatch import receiver
from django.core.mail import send_mail
from django.utils.timezone import localtime

@receiver(user_logged_in)
def send_login_alert_email(sender, request, user, **kwargs):
  ip = get_client_ip(request)
  time = localtime().strftime('%Y-%m-%d %H:%M:%S')
  send_mail( subject="🔐 New Login Detected",
    message=f"Hi {user.first_name} {user.last_name},\n\n"
        f"You logged in at {time} \n from IP: {ip} : "
        f"If this wasn't you, change your password immediately.",
    from_email="bhanuteja18112001@gmail.com",
    recipient_list=[user.email], fail_silently=False)
def get_client_ip(request):
  x_forwarded_for = request.META.get("HTTP_X_FORWARDED_FOR")
  if x_forwarded_for:
    return x_forwarded_for.split(',')[0]
  return request.META.get("REMOTE_ADDR")
```

urls.py

```
from django.urls import path
from . import views
from .views import CustomPasswordResetConfirmView
from django.conf import settings
from django.conf.urls.static import static
from django.http import HttpResponse
from django.conf.urls import handler404
from django.contrib.auth import views as auth_views

def favicon_view(request):
    return HttpResponse(status=204)

urlpatterns = [
    path('', views.home, name='home'),
    path('register/', views.register, name='register'),
    path('verify-spoof/', views.verify_spoof, name='verify-spoof'),
    path("login/", views.login_view, name="login"),
    path("p_login/", views.password_login, name='p_login'),
    path("face-login/", views.face_login, name="face_login"),
    path("dashboard/", views.dashboard_view, name="dashboard"),  # Add dashboard page
    path("logout/", views.logout_view, name="logout"),  # Logout route
    path('password-reset/',
auth_views.PasswordResetView.as_view(template_name='password_reset.html'),
name='password_reset'),
    path('password-reset/done/',
auth_views.PasswordResetDoneView.as_view(template_name='password_reset_done.html'),
name='password_reset_done'),
    path('reset/<uidb64>/<token>/', CustomPasswordResetConfirmView.as_view(),
name='password_reset_confirm'),
    path('reset/done/',
auth_views.PasswordResetCompleteView.as_view(template_name='password_reset_complet
e.html'), name='password_reset_complete'),
    path('reset-face/', views.reset_face, name='reset_face'),
```

```
    path('send_otp/', views.send_otp, name="send_otp"),
    path('verify_otp/', views.verify_otp, name='verify_otp'),
    path('validate_otp/', views.validate_otp, name='validate_otp'),
]
urlpatterns += [path('favicon.ico', favicon_view)]
handler404 = "apps.face3d.views.custom_404_view"

urlpatterns += static(settings.STATIC_URL, document_root=settings.STATICFILES_DIRS)
urlpatterns += static(settings.MEDIA_URL, document_root=settings.MEDIA_ROOT)
```

Templates

Base.html

```
{% load static %}
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>{% block title %}Face Authentication{% endblock %}</title>
    <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0/dist/css/bootstrap.min.css" rel="stylesheet">
    {% comment %} <link rel="stylesheet" href="{% static 'css/login.css' %}"> {% endcomment %}
    <script src="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0/dist/js/bootstrap.bundle.min.js"></script>
    {% block custom_css %}
    {% endblock custom_css %}
</head>
<body>
    <nav class="navbar navbar-dark bg-dark">
        <div class="container">
            <a class="navbar-brand" href="/">FaceAuth</a>
        </div>
```

```
    </nav>
    {% if messages %}
        {% for message in messages %}
            <div class="alert alert-{{ message.tags }} alert-dismissible fade show" role="alert">
            {{ message }}
            <button type="button" class="btn-close" data-bs-dismiss="alert" aria-
label="Close"></button>
            </div>
        {% endfor %}
    {% endif %}
    <div class="container mt-4">
        {% block content %}{% endblock %}
    </div>
</body>
</html>
```

home.html

```
{% extends 'base.html' %}
{% load static %}
{% block title %}Home{% endblock %}

{% block custom_css %}
<style>
    body {
        background-color: #000;
        color: white;
    }
    .scanner-container {
        position: relative;
        display: flex;
        justify-content: center;
        align-items: center;
```

```
    margin-top: 30px;
}
.scanner-card {
    position: relative;
    overflow: hidden;
    border-radius: 10px;
    width: 300px;
    height: 400px;
    perspective: 800px; /* Creates depth effect */
    transform-style: preserve-3d;
    transform: rotateX(10deg); /* Slight 3D tilt */
    box-shadow: 0px 0px 20px rgba(255, 0, 0, 0.7);
}
.scanner-card img {
    width: 100%;
    height: 100%;
    border-radius: 10px;
}
/* Laser Scan Animation */
.laser {
    position: absolute;
    top: 0;
    left: 0;
    width: 100%;
    height: 5px;
    background: linear-gradient(to bottom, rgba(255, 0, 0, 0.8), rgba(255, 0, 0, 0));
    box-shadow: 0 0 15px rgba(255, 0, 0, 0.8);
    animation: scan 5s ease-in-out infinite;
}
@keyframes scan {
    0% { top: 0%; }
    50% { top: 100%; }
```

```
        100% { top: 0%; }
    }
    .card-content {
        text-align: center;
        background: rgba(255, 255, 255, 0.1);
        padding: 20px;
        border-radius: 15px;
        box-shadow: 0px 0px 10px rgba(255, 255, 255, 0.2);
    }
</style>
{% endblock custom_css %}

{% block content %}
<div class="container text-center mt-5">
    <div class="card-content shadow-lg p-5 rounded">
        <h1 class="display-4 fw-bold">Welcome to Face Authentication</h1>
        <p class="lead text-light">Secure your identity with advanced face recognition.</p>
        <div class="scanner-container">
            <div class="scanner-card">
                <img src="{% static 'images/mesh.jpg' %}" class="img-fluid">
                <div class="laser"></div>
            </div>
        </div>
        <div class="mt-4">
            <a href="{% url 'login' %}" class="btn btn-outline-light btn-lg me-2 px-
4">Login</a>
            <a href="{% url 'register' %}" class="btn btn-danger btn-lg px-4">Register</a>
        </div>
    </div>
</div>
{% endblock %}
```

login.html

```
{% extends 'base.html' %}
{% block title %}Face Verification{% endblock %}


{% block content %}
<div class="container mt-4 p-4 border rounded">
  <h2 class="text-center">Face Authentication</h2>
  <div id="loading" style="display:none;" class="text-center mt-3">
    <div class="spinner-border text-primary" role="status">
      <span class="visually-hidden">Loading...</span>
    </div>
    <p>Your face is being verified. Please wait...</p>
  </div>
  <div class="mb-3">
    <label for="email" class="form-label">Email</label>
    <input type="email" class="form-control" id="email" placeholder="Enter your email"
required>
  </div>
  <div id="captureSection" class="text-center">
    <h4>Live Face Capture</h4>
    <video id="video" class="border rounded w-100" autoplay style="max-width: 500px;
height: auto;"></video>
    <canvas id="canvas" style="display:none;"></canvas>
    <img id="capturedImage" class="mt-2" style="display:none; max-width: 100%;"/>
    <p id="livenessMessage" class="text-danger mt-2"></p>
    <button type="button" id="capture" class="btn btn-primary mt-2" disabled>Capture
Face</button>
  </div>
  <button type="button" class="btn btn-outline-success mt-3 w-100" id="verifyButton"
disabled>Login</button>
  <a type="button" class="btn btn-outline-info mt-3 w-100" href="{% url 'p_login' %}">Use
Password</a>
</div>
```

```
<script src="https://cdn.jsdelivr.net/npm/@vladmandic/face-api/dist/face-api.min.js"></script>
<script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs"></script>
<script>
    async function loadModels() {
        await faceapi.nets.tinyFaceDetector.loadFromUri('/static/models');
        await faceapi.nets.faceLandmark68Net.loadFromUri('/static/models');
        console.log("Face-API.js Models Loaded!");
    }
    document.addEventListener("DOMContentLoaded", async function () {
        await loadModels();
        const video = document.getElementById('video');
        const canvas = document.getElementById('canvas');
        const capturedImage = document.getElementById('capturedImage');
        const verifyButton = document.getElementById('verifyButton');
        const livenessMessage = document.getElementById('livenessMessage');
        const captureButton = document.getElementById('capture');
        const loading = document.getElementById('loading');
        const emailInput = document.getElementById('email');
        let livenessVerified = false;
        let spoofVerified = false;
        let capturedImageData = null;
        navigator.mediaDevices.getUserMedia({ video: true })
            .then(stream => video.srcObject = stream)
            .catch(err => console.error('Camera access denied:', err));
        async function detectLiveness() {
            if (livenessVerified) return;
            const detections = await faceapi.detectSingleFace(video, new faceapi.TinyFaceDetectorOptions()).withFaceLandmarks();
            if (!detections || !detections.landmarks) {
                livenessMessage.textContent = "Please Wait, Your face is being verified!";
                return;
            }
```

```
        const leftEye = detections.landmarks.getLeftEye();
        const rightEye = detections.landmarks.getRightEye();
        if (!leftEye || !rightEye) {
            livenessMessage.textContent = "Please Wait, Your face is being verified!";
            return;
        }
        const leftEAR = calculateEAR(leftEye);
        const rightEAR = calculateEAR(rightEye);
        const blinkThreshold = 0.25;
        if (leftEAR < blinkThreshold && rightEAR < blinkThreshold) {
            console.log("Blink detected! Liveness Verified!");
            livenessVerified = true;
            livenessMessage.textContent = "Liveness Verified, Please Capture the Face!";
            livenessMessage.classList.remove("text-danger");
            livenessMessage.classList.add("text-success");
            captureButton.disabled = false;
            return;
        }
        const prevDetection = detections;
        await new Promise(resolve => setTimeout(resolve, 1000));
        const newDetection = await faceapi.detectSingleFace(video, new
faceapi.TinyFaceDetectorOptions());
        if (!newDetection) {
            livenessMessage.textContent = "Please Wait, Your face is being verified!";
            return;
        }
        const diffX = Math.abs(prevDetection.box.x - newDetection.box.x);
        const diffY = Math.abs(prevDetection.box.y - newDetection.box.y);
        if (diffX > 10 || diffY > 10) {
            console.log("Head movement detected! Liveness Verified!");
            livenessVerified = true;
```

```
            livenessMessage.textContent = "Liveness Verified, Please Capture the Face!";
            livenessMessage.classList.remove("text-danger");
            livenessMessage.classList.add("text-success");
            captureButton.disabled = false;
        }
    }
    function calculateEAR(eye) {
        const dist = (p1, p2) => Math.sqrt((p1._x - p2._x) ** 2 + (p1._y - p2._y) ** 2);
        const vertical1 = dist(eye[1], eye[5]);
        const vertical2 = dist(eye[2], eye[4]);
        const horizontal = dist(eye[0], eye[3]);
        return (vertical1 + vertical2) / (2.0 * horizontal);
    }
    captureButton.addEventListener('click', async () => {
        if (!livenessVerified) return;
        const context = canvas.getContext('2d');
        canvas.width = video.videoWidth;
        canvas.height = video.videoHeight;
        context.drawImage(video, 0, 0, canvas.width, canvas.height);
        capturedImageData = canvas.toDataURL('image/png');
        capturedImage.src = capturedImageData;
        capturedImage.style.display = 'block';
        video.srcObject.getTracks().forEach(track => track.stop());
        video.style.display = 'none';
        livenessMessage.textContent = "Face Captured! Verifying Spoof Detection...";
        const response = await fetch('/verify-spoof/', {
            method: 'POST',
            headers: {
                'Content-Type': 'application/json',
                'X-CSRFToken': '{{ csrf_token }}'
            },
            body: JSON.stringify({ image: capturedImageData })
```

```
        });
        const result = await response.json();
        if (result.success) {
            livenessMessage.textContent = "No Spoof Detected!";
            livenessMessage.classList.remove("text-danger");
            livenessMessage.classList.add("text-success");
            spoofVerified = true;
            verifyButton.disabled = false;
        } else {
            livenessMessage.textContent = "Spoof Detected! Please try again.";
            livenessMessage.classList.add("text-danger");
            verifyButton.disabled = true;
        }
    });
    verifyButton.addEventListener('click', async () => {
        if (!spoofVerified || !livenessVerified) {
            alert('Please ensure that your face is verified and no spoof detected.');
            return;
        }
        const email = emailInput.value;
        if (!email) {
            alert('Please enter your email.');
            return;
        }
        // Proceed with face authentication request to the backend
        loading.style.display = 'block';
        fetch('/face-login/', {
            method: 'POST',
            headers: {
                'Content-Type': 'application/json',
                'X-CSRFToken': '{{ csrf_token }}'
            },
```

```
            body: JSON.stringify({ email: email, image: capturedImageData })
        })
        .then(response => response.json())
        .then(data => {
            loading.style.display = 'none';
            if (data.success) {
                alert(`Welcome, ${data.username}! Redirecting to Dashboard.`);
                window.location.href = '/dashboard/';
            } else {
                alert(data.message);
            }
        })
        .catch(error => {
            loading.style.display = 'none';
            console.error('Error:', error);
        });
    });
    setInterval(detectLiveness, 500);
  });
</script>
{% endblock %}
```

p_login.html

```
{% extends 'base.html' %}
{% block title %}Login{% endblock %}

{% block content %}
  <div class="container mt-4 p-4 border rounded">
    <h2 class="text-center">Login</h2>
    <div id="loading" style="display:none;" class="text-center mt-3">
      <div class="spinner-border text-primary" role="status">
        <span class="visually-hidden">Loading...</span>
```

```
        </div>
        <p>Your Credentials is being verified. Please wait...</p>
      </div>
      <p id="loginError" class="text-danger mt-2 text-center"></p>
      <form id="loginForm">
        {% csrf_token %}
        <input type="email" class="form-control mb-2" name="email" placeholder="Email"
required>
        <input type="password" class="form-control mb-2" name="password"
placeholder="Password" required>
        <button type="submit" class="btn btn-success w-100">Login</button>
        <a type="button" class="btn btn-outline-info mt-3 w-100" href="{% url 'login'
%}">Use Face</a>
        <a type="button" class="btn btn-outline-danger mt-3 w-100" href="{% url
'password_reset' %}">Forgot password?</a>
      </form>
    </div>
    <script>
      document.getElementById("loginForm").addEventListener("submit", function(event) {
        event.preventDefault(); // Prevent default form submission
        let email = document.querySelector("input[name='email']").value;
        let password = document.querySelector("input[name='password']").value;
        let csrfToken = document.querySelector("[name=csrfmiddlewaretoken]").value;
        const loading = document.getElementById("loading");
        const errorDisplay = document.getElementById("loginError");
        // Show loading spinner immediately
        loading.style.display = "block";
        errorDisplay.textContent = "";
        fetch("/p_login/", {
          method: "POST",
          headers: {
            "Content-Type": "application/json",
            "X-CSRFToken": csrfToken
```

```
            },
            body: JSON.stringify({ email, password })
        })
        .then(response => response.json())
        .then(data => {
            if (data.success) {
                alert(`OTP sent to your registered email`);
                window.location.href = '/verify_otp/';
            } else {
                document.getElementById('loginError').textContent = data.error;
            }
        })
    });
  </script>
{% endblock %}
```

otp_validation.html

```
{% extends 'base.html' %}
{% block title %}OTP Verification{% endblock %}

{% block content %}
<div class="container mt-5 p-4 border rounded shadow-sm" style="max-width: 500px;">
  <h3 class="text-center mb-4">🔐 OTP Verification</h3>
  <div id="otpMessage" class="alert d-none" role="alert"></div>
  <form id="otpForm">
    {% csrf_token %}
    <input type="hidden" name="email" value="{{ email }}">
    <div class="form-group mb-3 text-center">
      <label class="form-label mb-3">Enter the 6-digit OTP sent to your email</label>
      <div class="d-flex justify-content-between gap-2 justify-content-center">
        {% for _ in "123456" %}
```

```
            <input type="text" class="otp-input form-control text-center fw-bold"
maxlength="1" inputmode="numeric" pattern="\d*" required>
            {% endfor %}
        </div>
        <small id="countdownText" class="text-muted fw-bold d-block mt-2">
            Time left: <span class="text-danger">1:00</span>
        </small>
    </div>
    <button type="submit" id="verifyBtn" class="btn btn-primary w-100">
        <span id="verifySpinner" class="spinner-border spinner-border-sm me-2 d-
none"></span>
        <span id="verifyText">Verify OTP</span>
    </button>
    <div class="text-center mt-2">
        <button type="button" id="resendBtn" class="btn btn-link" disabled>Resend
OTP</button>
        <small id="resendCountdown" class="text-muted fw-bold ms-2">(Wait 30s)</small>
    </div>
  </form>
</div>
<style>
  .otp-input {
    width: 48px;
    height: 48px;
    font-size: 24px;
  }
</style>
<script>
  const otpForm = document.getElementById("otpForm");
  const otpInputs = document.querySelectorAll(".otp-input");
  const otpMessage = document.getElementById("otpMessage");
  const verifyBtn = document.getElementById("verifyBtn");
  const verifySpinner = document.getElementById("verifySpinner");
```

```
    const verifyText = document.getElementById("verifyText");
    const resendBtn = document.getElementById("resendBtn");
    const resendCountdown = document.getElementById("resendCountdown");
    const countdownText =
document.getElementById("countdownText").querySelector("span");
    const email = document.querySelector("input[name='email']").value ||
localStorage.getItem("otpEmail");
    let mainTimer = null;
    let resendTimer = null;
    // Input behavior
    otpInputs[0].focus();
    otpInputs.forEach((input, index) => {
        input.addEventListener("input", () => {
            if (input.value.length === 1 && index < otpInputs.length - 1) {
                otpInputs[index + 1].focus();
            }
        });
        input.addEventListener("keydown", (e) => {
            if (e.key === "Backspace" && input.value === "" && index > 0) {
                otpInputs[index - 1].focus();
            }
        });
        input.addEventListener("paste", (e) => {
            e.preventDefault();
            const paste = (e.clipboardData || window.clipboardData).getData("text").replace(/\D/g,
"").slice(0, 6);
            paste.split("").forEach((char, i) => {
                if (otpInputs[i]) otpInputs[i].value = char;
            });
            if (otpInputs[paste.length - 1]) otpInputs[paste.length - 1].focus();
        });
    });
    function showMessage(type, message) {
```

```
    otpMessage.className = `alert alert-${type}`;
    otpMessage.textContent = message;
    otpMessage.classList.remove("d-none");
  }
  otpForm.addEventListener("submit", function (e) {
    e.preventDefault();
    const otp = Array.from(otpInputs).map(input => input.value).join("");
    if (otp.length !== 6 || !/^\d{6}$/.test(otp)) {
      showMessage("warning", "Please enter all 6 digits.");
      return;
    }
    verifyBtn.disabled = true;
    verifySpinner.classList.remove("d-none");
    verifyText.textContent = "Verifying...";
    fetch("/verify_otp/", {
      method: "POST",
      headers: {
        "Content-Type": "application/json",
        "X-CSRFToken": document.querySelector("[name=csrfmiddlewaretoken]").value
      },
      body: JSON.stringify({ email, otp })
    })
    .then(res => res.json())
    .then(data => {
      verifyBtn.disabled = false;
      verifySpinner.classList.add("d-none");
      verifyText.textContent = "Verify OTP";
      if (data.success) {
        showMessage("success", data.message);
        setTimeout(() => {
          window.location.href = data.redirect_url;
        }, 1500);
```

```
            } else {
                showMessage("danger", data.error);
            }
        })
        .catch(() => {
            verifyBtn.disabled = false;
            verifySpinner.classList.add("d-none");
            verifyText.textContent = "Verify OTP";
            showMessage("danger", "Something went wrong. Please try again.");
        });
    });
    resendBtn.addEventListener("click", function () {
        fetch("/send_otp/", {
            method: "POST",
            headers: {
                "Content-Type": "application/json",
                "X-CSRFToken": document.querySelector("[name=csrfmiddlewaretoken]").value
            },
            body: JSON.stringify({ email })
        })
        .then(res => res.json())
        .then(data => {
            if (data.success) {
                showMessage("info", "OTP resent successfully!");
                startMainCountdown();
                startResendTimer();
            } else {
                showMessage("danger", data.error || "Failed to resend OTP.");
            }
        })
        .catch(() => {
            showMessage("danger", "Something went wrong while resending OTP.");
```

```
    });
});
function startMainCountdown() {
    clearInterval(mainTimer);
    let timeLeft = 60;
    countdownText.textContent = "1:00";
    mainTimer = setInterval(() => {
        let minutes = Math.floor(timeLeft / 60);
        let seconds = timeLeft % 60;
        countdownText.textContent = `${minutes}:${seconds.toString().padStart(2, "0")}`;
        timeLeft--;
        if (timeLeft < 0) {
            clearInterval(mainTimer);
            countdownText.textContent = "0:00";
        }
    }, 1000);
}
function startResendTimer() {
    clearInterval(resendTimer);
    resendBtn.disabled = true;
    let cooldown = 30;
    resendCountdown.textContent = `(Wait ${cooldown}s)`;
    resendTimer = setInterval(() => {
        cooldown--;
        resendCountdown.textContent = `(Wait ${cooldown}s)`;
        if (cooldown <= 0) {
            clearInterval(resendTimer);
            resendBtn.disabled = false;
            resendCountdown.textContent = "";
        }
    }, 1000);
}
```

```
    // Start countdowns on load
    startMainCountdown();
    startResendTimer();
</script>
{% endblock %}
```

register.html

```
{% extends 'base.html' %}
{% block title %}Register{% endblock %}

{% block content %}
<div class="container mt-4 p-4 border rounded">
    <h2 class="text-center">Register</h2>
    <div id="registrationSection">
        <form method="POST" enctype="multipart/form-data" id="registrationForm">
            {% csrf_token %}
            <label for="name">First Name:</label>
            <input type="text" name="fname" class="form-control" required>
            <label for="name">Last Name:</label>
            <input type="text" name="lname" class="form-control" required>
            <label for="email">Email:</label>
            <input type="email" name="email" class="form-control" required>
            <label for="password">Password:</label>
            <input type="password" name="password" class="form-control" required>
            <input type="hidden" name="face_image" id="face_image">
            <div class="text-center mt-3" id="captureSection">
                <h4>Live Face Capture</h4>
                <video id="video" class="border rounded w-100" autoplay style="max-width:
500px; height: auto;"></video>
                <canvas id="canvas" style="display:none;"></canvas>
                <img id="capturedImage" class="mt-2" style="display:none; max-width: 100%;"
/>
                <p id="livenessMessage" class="text-danger mt-2"></p>
```

```
            <button type="button" id="capture" class="btn btn-primary mt-2"
disabled>Capture Face</button>
        </div>
        <button type="submit" class="btn btn-success mt-3 w-100" id="registerButton"
disabled>Register</button>
    </form>
  </div>
</div>
<!-- Load Face-API.js & TensorFlow.js -->
<script src="https://cdn.jsdelivr.net/npm/@vladmandic/face-api/dist/face-
api.min.js"></script>
<script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs"></script>
<script>
  async function loadModels() {
    await faceapi.nets.tinyFaceDetector.loadFromUri('/static/models');
    await faceapi.nets.faceLandmark68Net.loadFromUri('/static/models');
    console.log("Face-API.js Models Loaded!");
  }
  document.addEventListener("DOMContentLoaded", async function () {
    await loadModels();
    const video = document.getElementById('video');
    const canvas = document.getElementById('canvas');
    const capturedImage = document.getElementById('capturedImage');
    const faceImageInput = document.getElementById('face_image');
    const registerButton = document.getElementById('registerButton');
    const livenessMessage = document.getElementById('livenessMessage');
    const captureButton = document.getElementById('capture');
    let livenessVerified = false;
    let capturedImageData = null;
    navigator.mediaDevices.getUserMedia({ video: true })
      .then(stream => video.srcObject = stream)
      .catch(err => console.error('Camera access denied:', err));
```

```
async function detectLiveness() {
    if (livenessVerified) return;
    const detections = await faceapi.detectSingleFace(video, new
faceapi.TinyFaceDetectorOptions()).withFaceLandmarks();
    if (!detections) {
        livenessMessage.textContent = "Please Wait, Your Face is validating !";
        return;
    }
    const leftEye = detections.landmarks.getLeftEye();
    const rightEye = detections.landmarks.getRightEye();
    const leftEAR = calculateEAR(leftEye);
    const rightEAR = calculateEAR(rightEye);
    const blinkThreshold = 0.25;
    if (leftEAR < blinkThreshold && rightEAR < blinkThreshold) {
        console.log("Blink detected! Liveness verified.");
        verifyLiveness();
        return;
    }
    const prevDetection = detections;
    await new Promise(resolve => setTimeout(resolve, 1000));
    const newDetection = await faceapi.detectSingleFace(video, new
faceapi.TinyFaceDetectorOptions());
    if (prevDetection && newDetection) {
        const diffX = Math.abs(prevDetection.box.x - newDetection.box.x);
        const diffY = Math.abs(prevDetection.box.y - newDetection.box.y);
        if (diffX > 10 || diffY > 10) {
            console.log("Head movement detected! Liveness verified.");
            verifyLiveness();
        }
    }
}
function calculateEAR(eye) {
    const dist = (p1, p2) => Math.sqrt((p1._x - p2._x) ** 2 + (p1._y - p2._y) ** 2);
```

```
    const vertical1 = dist(eye[1], eye[5]);
    const vertical2 = dist(eye[2], eye[4]);
    const horizontal = dist(eye[0], eye[3]);
    return (vertical1 + vertical2) / (2.0 * horizontal);
}
function verifyLiveness() {
    livenessVerified = true;
    livenessMessage.textContent = "Liveness Verified! Ready to Capture.";
    livenessMessage.classList.remove("text-danger");
    livenessMessage.classList.add("text-success");
    captureButton.disabled = false;
}
setInterval(detectLiveness, 1000);
captureButton.addEventListener('click', () => {
    if (!livenessVerified) return;
    const context = canvas.getContext('2d');
    canvas.width = video.videoWidth;
    canvas.height = video.videoHeight;
    context.drawImage(video, 0, 0, canvas.width, canvas.height);
    capturedImageData = canvas.toDataURL('image/png');
    faceImageInput.value = capturedImageData;
    capturedImage.src = capturedImageData;
    capturedImage.style.display = 'block';
    video.srcObject.getTracks().forEach(track => track.stop());
    video.style.display = 'none';
    livenessMessage.textContent = "Face Captured! Verifying Spoof Detection...";
    // Send the image to the server for spoof detection
    fetch("/verify-spoof/", {
        method: "POST",
        headers: { "Content-Type": "application/json" },
        body: JSON.stringify({ image: capturedImageData })
    })
```

```
            .then(response => response.json())
            .then(data => {
                if (data.success) {
                    livenessMessage.textContent = "No Spoof Detected! You can Register.";
                    registerButton.disabled = false;
                } else {
                    livenessMessage.textContent = "Spoof Detected! Please try again.";
                    livenessMessage.classList.add("text-danger");
                    captureButton.disabled = false;
                    registerButton.disabled = true;
                }
            })
            .catch(error => {
                console.error("Error verifying spoof:", error);
            });
        });
        document.getElementById('registrationForm').addEventListener('submit',
function(event) {
            if (!capturedImageData) {
                event.preventDefault();
                alert("Please capture your face before registering.");
            }
        });
    });
</script>
{% endblock %}
```

reset_face.html

```
{% extends 'base.html' %}
{% block title %}Face Reset{% endblock %}


{% block content %}
```

```
<nav class="navbar navbar-expand-lg navbar-light bg-light">
  <div class="container bg-info">
    <a class="navbar-brand" href="#">Face Authentication</a>
    <button class="navbar-toggler" type="button" data-bs-toggle="collapse" data-bs-target="#navbarNav">
      <span class="navbar-toggler-icon"></span>
    </button>
    <div class="collapse navbar-collapse" id="navbarNav">
      <ul class="navbar-nav ms-auto">
        <li class="nav-item">
          <a class="nav-link" href="/dashboard/">Dashboard</a>
        </li>
        <li class="nav-item">
          <button class="btn btn-danger my-2" id="logoutButton">Logout</button>
        </li>
      </ul>
    </div>
  </div>
</nav>
<div class="container mt-4 p-4 border rounded">
  <h2 class="text-center">Reset Face</h2>
  <div id="loading" style="display:none;" class="text-center mt-3">
    <div class="spinner-border text-primary" role="status">
      <span class="visually-hidden">Loading...</span>
    </div>
    <p>Your face is being verified. Please wait...</p>
  </div>
  <div id="content">
    <div id="captureSection" class="text-center">
      <h4>Live Face Capture</h4>
      <video id="video" class="border rounded w-100" style="max-width: 500px; height: auto;" autoplay></video>
      <canvas id="canvas" style="display:none;"></canvas>
```

```
        <img id="capturedImage" class="mt-2" style="display:none; max-width: 100%;"/>
        <p id="livenessMessage" class="text-danger mt-2"></p>
        <p id="cameraError" class="text-danger mt-2" style="display: none;">Failed to access camera. Please check permissions.</p>
        <button type="button" id="capture" class="btn btn-primary mt-2" disabled>Capture Face</button>
      </div>
      <!-- Send OTP -->
      <button type="button" class="btn btn-outline-info mt-3 w-100" id="sendOtpButton">Send OTP</button>
      <!-- OTP Input -->
      <div id="otpSection" style="display:none;" class="mt-2">
        <p id="timer" class="text-center text-muted mt-1" style="font-weight: 600;"></p>
        <div id="otpInputs" class="d-flex justify-content-center gap-2">
          {% for i in "123456" %}
            <input type="text" maxlength="1" class="otp-box form-control text-center" style="width: 40px; font-size: 1.5rem;" id="otp{{ forloop.counter }}">
          {% endfor %}
        </div>
        <button type="button" class="btn btn-outline-info mt-3 w-100" id="validateButton">Validate OTP</button>
        <p id="otpStatus" class="mt-2 text-center text-danger"></p>
      </div>
      <button type="button" class="btn btn-outline-success mt-3 w-100" id="verifyButton" disabled>Reset Face</button>
    </div>
</div>
<script src="https://cdn.jsdelivr.net/npm/@vladmandic/face-api/dist/face-api.min.js"></script>
<script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs"></script>
<script>
    async function loadModels() {
      await faceapi.nets.tinyFaceDetector.loadFromUri('/static/models');
      await faceapi.nets.faceLandmark68Net.loadFromUri('/static/models');
```

```
    console.log("Face-API.js Models Loaded!");
}
document.addEventListener("DOMContentLoaded", async function () {
    await loadModels();
    const video = document.getElementById('video');
    const canvas = document.getElementById('canvas');
    const capturedImage = document.getElementById('capturedImage');
    const verifyButton = document.getElementById('verifyButton');
    const livenessMessage = document.getElementById('livenessMessage');
    const captureButton = document.getElementById('capture');
    const loading = document.getElementById('loading');
    const cameraError = document.getElementById('cameraError');
    const sendOtpButton = document.getElementById('sendOtpButton');
    const otpSection = document.getElementById('otpSection');
    const otpInput = document.getElementById('otpInput');
    const validateButton = document.getElementById('validateButton');
    const otpStatus = document.getElementById('otpStatus');
    const c_hide = document.getElementById('content');
    let livenessVerified = false;
    let spoofVerified = false;
    let otpVerified = false;
    let capturedImageData = null;
    navigator.mediaDevices.getUserMedia({ video: true })
        .then(stream => {
            video.srcObject = stream;
            video.onloadedmetadata = () => {
                video.play();
                console.log("Camera stream loaded!");
            };
        })
        .catch(err => {
            console.error('Camera access denied:', err);
```

```
            cameraError.style.display = 'block';
        });
    async function detectLiveness() {
        if (livenessVerified) return;
        const detections = await faceapi.detectSingleFace(video, new
faceapi.TinyFaceDetectorOptions()).withFaceLandmarks();
        if (!detections || !detections.landmarks) {
            livenessMessage.textContent = "Please Wait, Your face is being verified!";
            return;
        }
        const leftEye = detections.landmarks.getLeftEye();
        const rightEye = detections.landmarks.getRightEye();
        if (!leftEye || !rightEye) {
            livenessMessage.textContent = "Please Wait, Your face is being verified!";
            return;
        }
        const leftEAR = calculateEAR(leftEye);
        const rightEAR = calculateEAR(rightEye);
        const blinkThreshold = 0.25;
        if (leftEAR < blinkThreshold && rightEAR < blinkThreshold) {
            console.log("Blink detected! Liveness Verified!");
            livenessVerified = true;
            livenessMessage.textContent = "Liveness Verified, Please Capture the Face!";
            livenessMessage.classList.remove("text-danger");
            livenessMessage.classList.add("text-success");
            captureButton.disabled = false;
            return;
        }
        const prevDetection = detections;
        await new Promise(resolve => setTimeout(resolve, 1000));
        const newDetection = await faceapi.detectSingleFace(video, new
faceapi.TinyFaceDetectorOptions());
        if (!newDetection) {
```

```
            livenessMessage.textContent = "Please Wait, Your face is being verified!";
            return;
        }
        const diffX = Math.abs(prevDetection.box.x - newDetection.box.x);
        const diffY = Math.abs(prevDetection.box.y - newDetection.box.y);
        if (diffX > 10 || diffY > 10) {
            console.log("Head movement detected! Liveness Verified!");
            livenessVerified = true;
            livenessMessage.textContent = "Liveness Verified, Please Capture the Face!";
            livenessMessage.classList.remove("text-danger");
            livenessMessage.classList.add("text-success");
            captureButton.disabled = false;
        }
    }
    function calculateEAR(eye) {
        const dist = (p1, p2) => Math.sqrt((p1._x - p2._x) ** 2 + (p1._y - p2._y) ** 2);
        const vertical1 = dist(eye[1], eye[5]);
        const vertical2 = dist(eye[2], eye[4]);
        const horizontal = dist(eye[0], eye[3]);
        return (vertical1 + vertical2) / (2.0 * horizontal);
    }
    captureButton.addEventListener('click', async () => {
        if (!livenessVerified) return;
        const context = canvas.getContext('2d');
        canvas.width = video.videoWidth;
        canvas.height = video.videoHeight;
        context.drawImage(video, 0, 0, canvas.width, canvas.height);
        capturedImageData = canvas.toDataURL('image/png');
        capturedImage.src = capturedImageData;
        capturedImage.style.display = 'block';
        video.srcObject.getTracks().forEach(track => track.stop());
        video.style.display = 'none';
```

```
        livenessMessage.textContent = "Face Captured! Verifying Spoof Detection...";
        const response = await fetch('/verify-spoof/', {
            method: 'POST',
            headers: {
                'Content-Type': 'application/json',
                'X-CSRFToken': '{{ csrf_token }}'
            },
            body: JSON.stringify({ image: capturedImageData })
        });
        const result = await response.json();
        if (result.success) {
            livenessMessage.textContent = "No Spoof Detected!";
            livenessMessage.classList.remove("text-danger");
            livenessMessage.classList.add("text-success");
            spoofVerified = true;
            verifyButton.disabled = false;
        } else {
            livenessMessage.textContent = "Spoof Detected! Please try again.";
            livenessMessage.classList.remove("text-success");
            livenessMessage.classList.add("text-danger");
            verifyButton.disabled = true;
        }
    });
    const otpInputs = Array.from(document.querySelectorAll(".otp-box"));
    // Auto move between boxes
    otpInputs.forEach((input, index) => {
        input.addEventListener("input", () => {
            if (input.value.length === 1 && index < otpInputs.length - 1) {
                otpInputs[index + 1].focus();
            }
        });
        input.addEventListener("keydown", (e) => {
```

```
            if (e.key === "Backspace" && input.value === "" && index > 0) {
                otpInputs[index - 1].focus();
            }
        });
    });
    const timerDisplay = document.getElementById("timer");
    let countdownInterval;
    function startOtpCountdown(duration) {
        let timeLeft = duration;
        clearInterval(countdownInterval);
        countdownInterval = setInterval(() => {
            let minutes = Math.floor(timeLeft / 60);
            let seconds = timeLeft % 60;
            timerDisplay.textContent = `OTP expires in ${minutes}:${seconds < 10 ? '0' :
"}${seconds}`;
            timeLeft--;
            if (timeLeft < 0) {
                clearInterval(countdownInterval);
                timerDisplay.textContent = "⛔ OTP expired. Please resend.";
                otpVerified = false;
                validateButton.disabled = false;
                sendOtpButton.style.display = 'block';
                otpSection.style.display = 'none';
            }
        }, 1000);
    }
    validateButton.disabled = false;
    // OTP Handling
    sendOtpButton.addEventListener('click', () => {
        fetch('/send_otp/', {
            method: 'POST',
            headers: {
```

```
            'Content-Type': 'application/json',
            'X-CSRFToken': '{{ csrf_token }}'
        },
        body: JSON.stringify({ email: '{{ request.user.email }}' })
    })
    .then(res => res.json())
    .then(data => {
        if (data.success) {
            sendOtpButton.style.display = 'none';
            otpSection.style.display = 'block';
            startOtpCountdown(60);
        } else {
            alert("Failed to send OTP.");
        }
    });
});
validateButton.addEventListener('click', () => {
    const otp = otpInputs.map(input => input.value).join('').trim();
    if (otp.length !== 6) {
        otpStatus.textContent = '⚠️ Please enter the full 6-digit OTP.';
        return;
    }
    fetch('/validate_otp/', {
        method: 'POST',
        headers: {
            'Content-Type': 'application/json',
            'X-CSRFToken': '{{ csrf_token }}'
        },
        body: JSON.stringify({
            otp: otp,
            email: '{{ request.user.email }}'
        })
```

```
    })
    .then(res => res.json())
    .then(data => {
        if (data.valid) {
            otpVerified = true;
            otpStatus.className = 'text-success';
            otpStatus.textContent = "OTP Verified!";
            timerDisplay.style.display = "none";
            enableVerifyButton();
        } else {
            otpStatus.className = 'text-danger';
            otpStatus.textContent = "Invalid OTP!";
            timerDisplay.style.display = "none";
        }
    });
});
function enableVerifyButton() {
    if (otpVerified && spoofVerified && livenessVerified) {
        verifyButton.disabled = false;
    }
}
verifyButton.addEventListener('click', async () => {
    if (!spoofVerified || !livenessVerified) {
        alert('Please ensure that your face is verified and no spoof detected.');
        return;
    }
    loading.style.display = 'block';
    c_hide.style.display = 'none';
    fetch('/reset-face/', {
        method: 'POST',
        headers: {
            'Content-Type': 'application/json',
```

```
                'X-CSRFToken': '{{ csrf_token }}'
            },
            body: JSON.stringify({ image: capturedImageData })
        })
        .then(response => response.json())
        .then(data => {
            loading.style.display = 'none';
            if (data.success) {
                alert(data.message);
                window.location.href = data.redirect_url;
            } else {
                alert(data.message || "Face reset failed.");
            }
        })
        .catch(error => {
            loading.style.display = 'none';
            console.error('Error:', error);
        });
    });
    setInterval(detectLiveness, 500);
});
document.addEventListener("DOMContentLoaded", function() {
    // Logout Functionality
    document.getElementById("logoutButton").addEventListener("click", function() {
        fetch("/logout/", { method: "POST", headers: { "X-CSRFToken": "{{ csrf_token }}" }
})
            .then(response => {
                if (response.ok) {
                    window.location.href = "/";
                } else {
                    alert("Logout failed. Please try again.");
                }
```

```
            })
            .catch(error => console.error("Logout error:", error));
        });
    });
</script>
{% endblock %}
```

CHAPTER – 9

TEST CASE

Sample Test Case – Face Authentication & Spoof Detection

Test Case ID: TC-FACE-001

Objective: To validate that the system correctly authenticates a valid user face and rejects spoofed images.

Input: Live webcam feed of registered user face.

Steps:

1. Open the login interface and start webcam capture.
2. Present the registered user's real face.
3. Wait for face detection, spoof check, and embedding generation.
4. Authenticate against stored embeddings.

Expected Output: Login success and redirection to dashboard.

Actual Output: Login successful.

Result: Pass

Test Case ID: TC-SPOOF-001

Objective: To verify the spoof detection blocks static photo/video spoof attempts.

Input: Printed photo of the registered user.

Steps:

1. Open login interface.
2. Present printed image in front of the webcam.
3. Observe spoof detection logic (blur detection, no landmark variation).

Expected Output: Spoof detected, login denied.

Actual Output: Access denied with spoof alert.

Result: Pass

Sample Test Case – OTP Authentication

Test Case ID: TC-OTP-001

Objective: Verify OTP generation and validation works correctly within expiry time.

Input: Valid credentials and correct OTP entered within 2 minutes.

Steps:

1. Login using email and password.
2. System sends OTP to registered email.
3. Enter received OTP in interface.

Expected Output: OTP verified, login successful.

Actual Output: Login successful.

Result: Pass

Test Case ID: TC-OTP-EXPIRE-001

Objective: Ensure OTPs expire after timeout.

Input: Valid credentials, but OTP entered after 2-minute expiry.

Expected Output: OTP expired error shown.

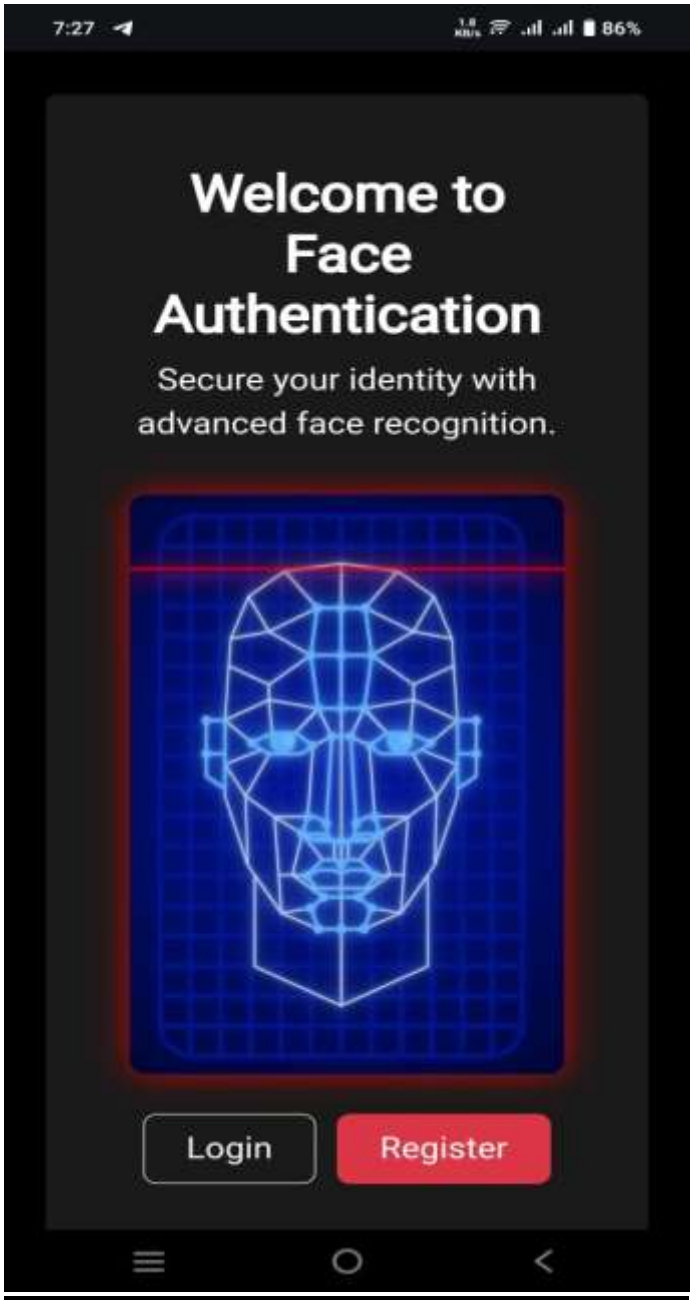
Actual Output: OTP expired error.

Result: Pass

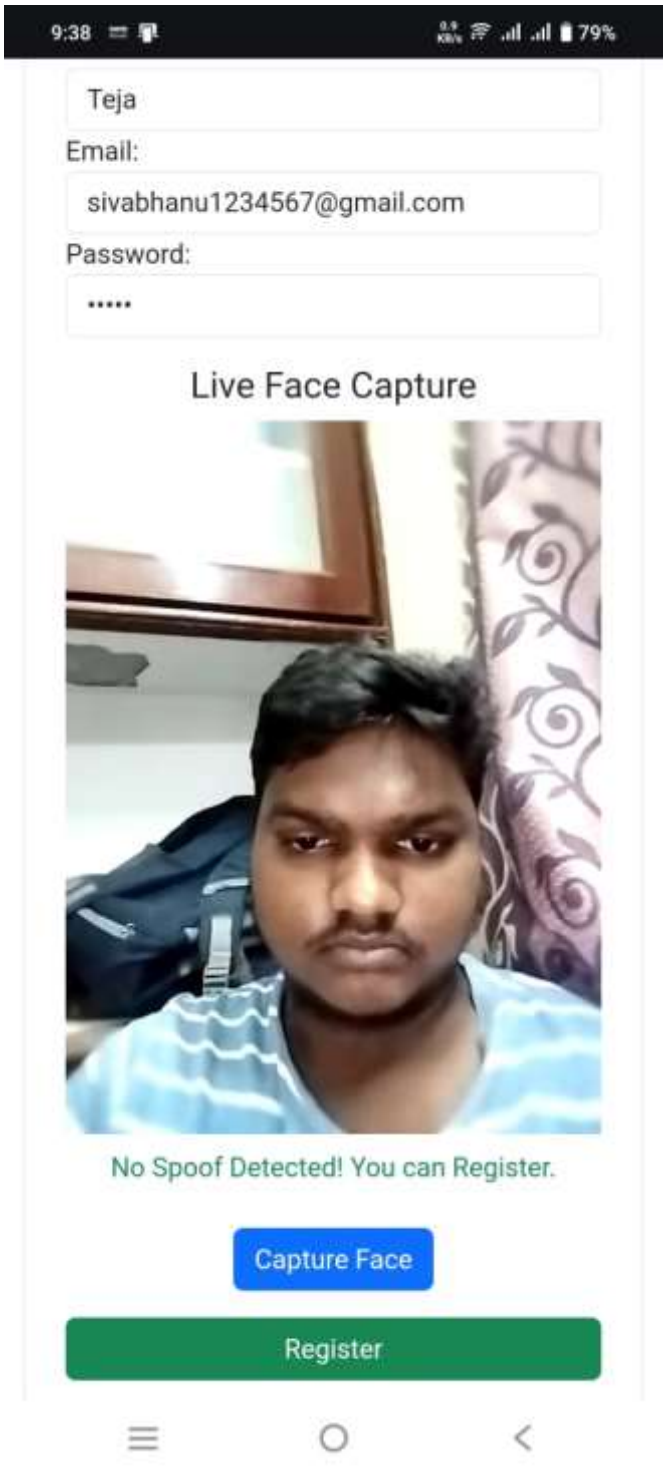
CHAPTER – 10

INPUT AND OUTPUT SCREENSHOTS

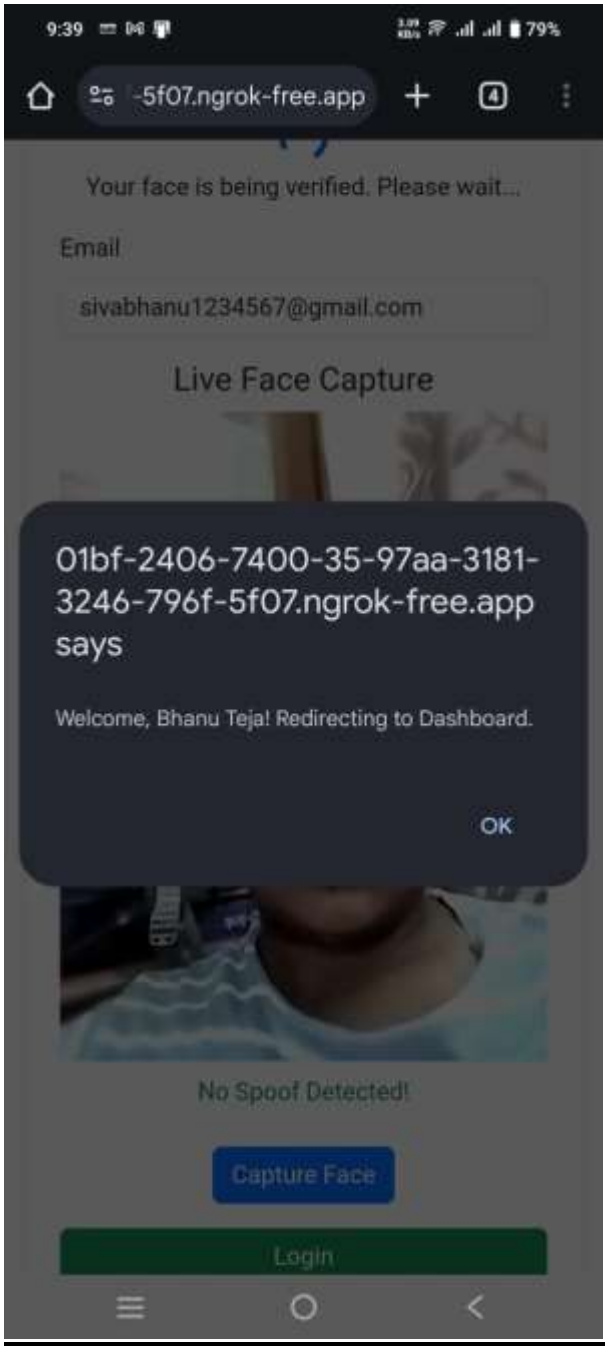
Home Page

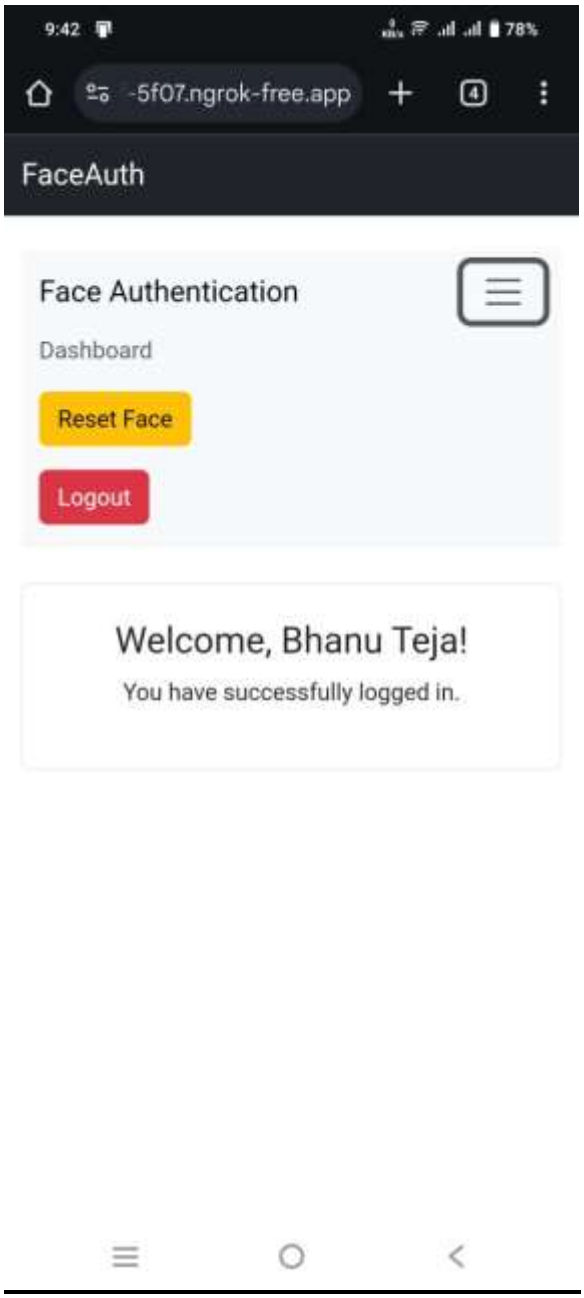


Register Page

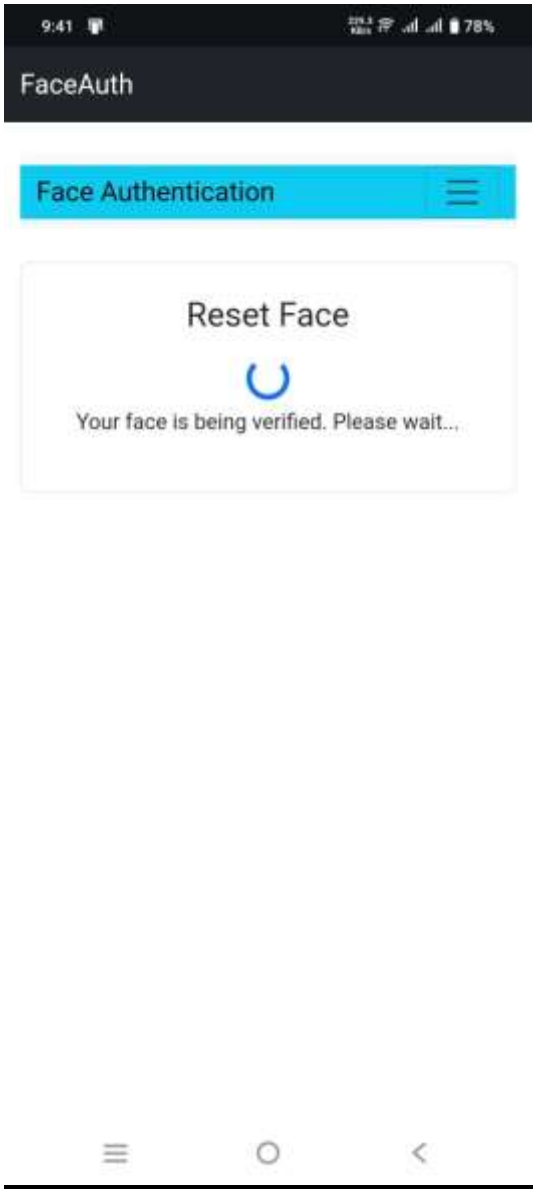
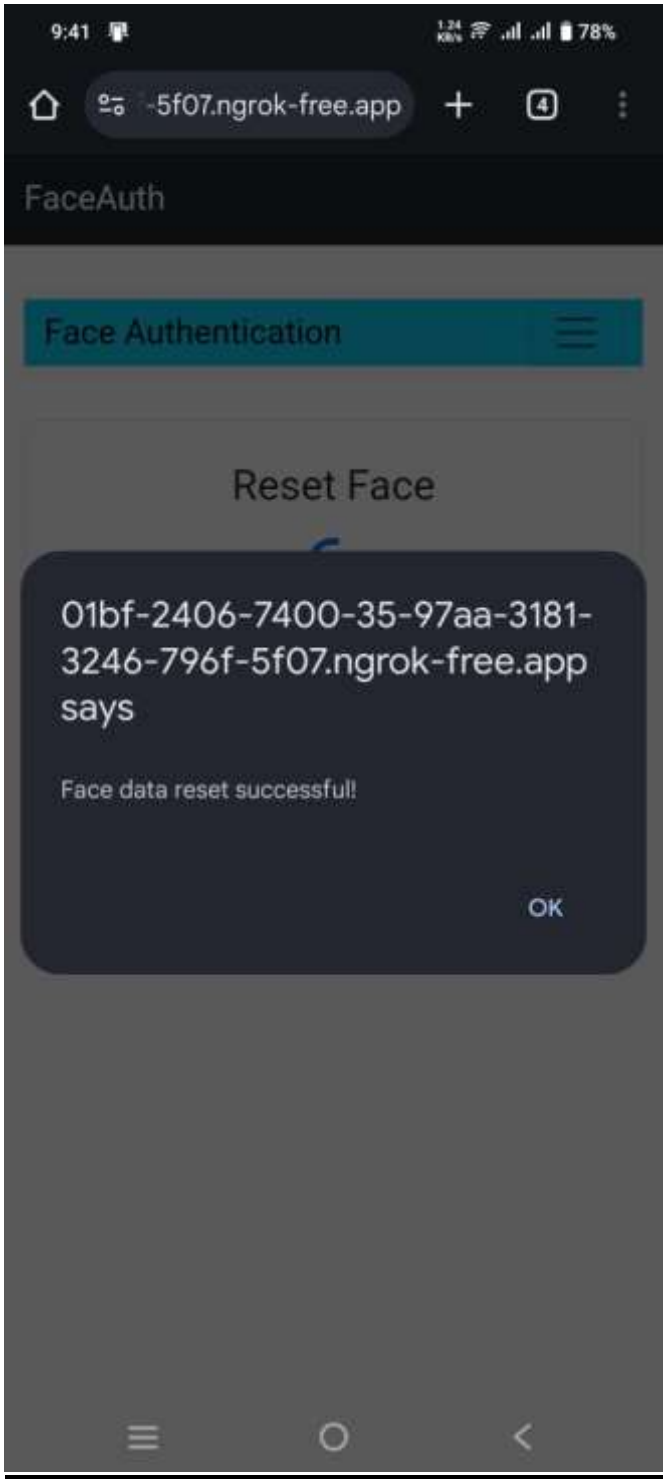
Spoof Detection	Spoof Result
	

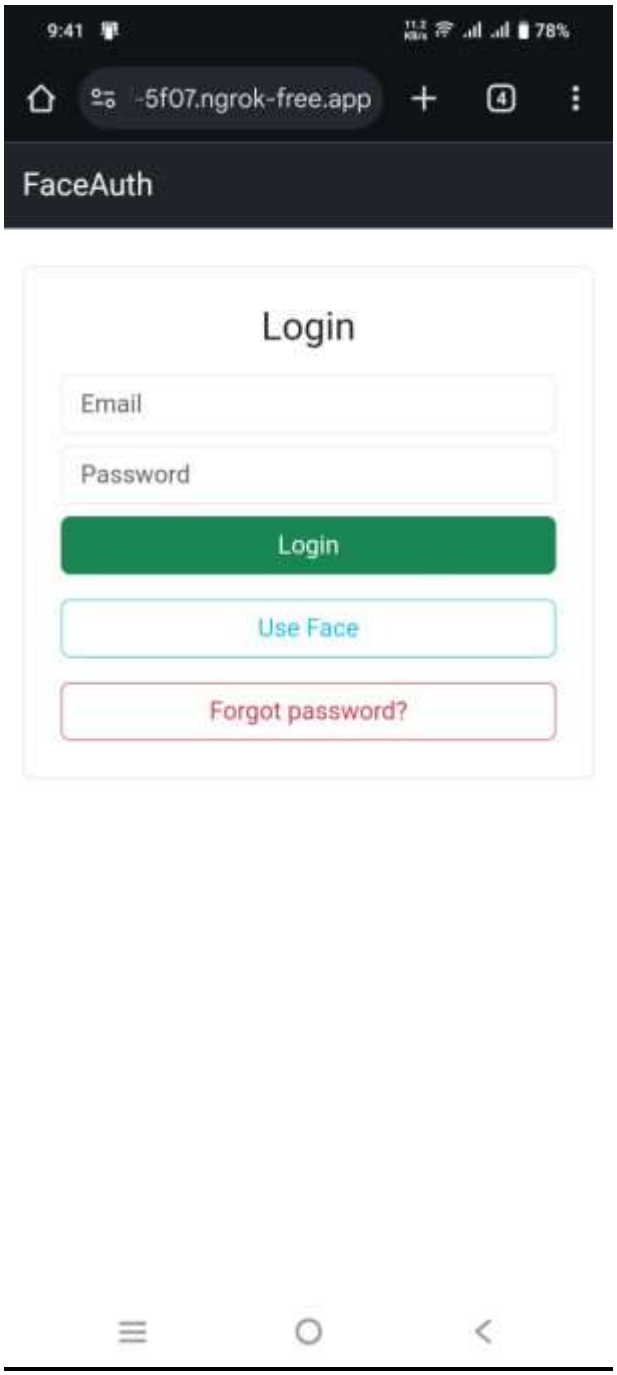
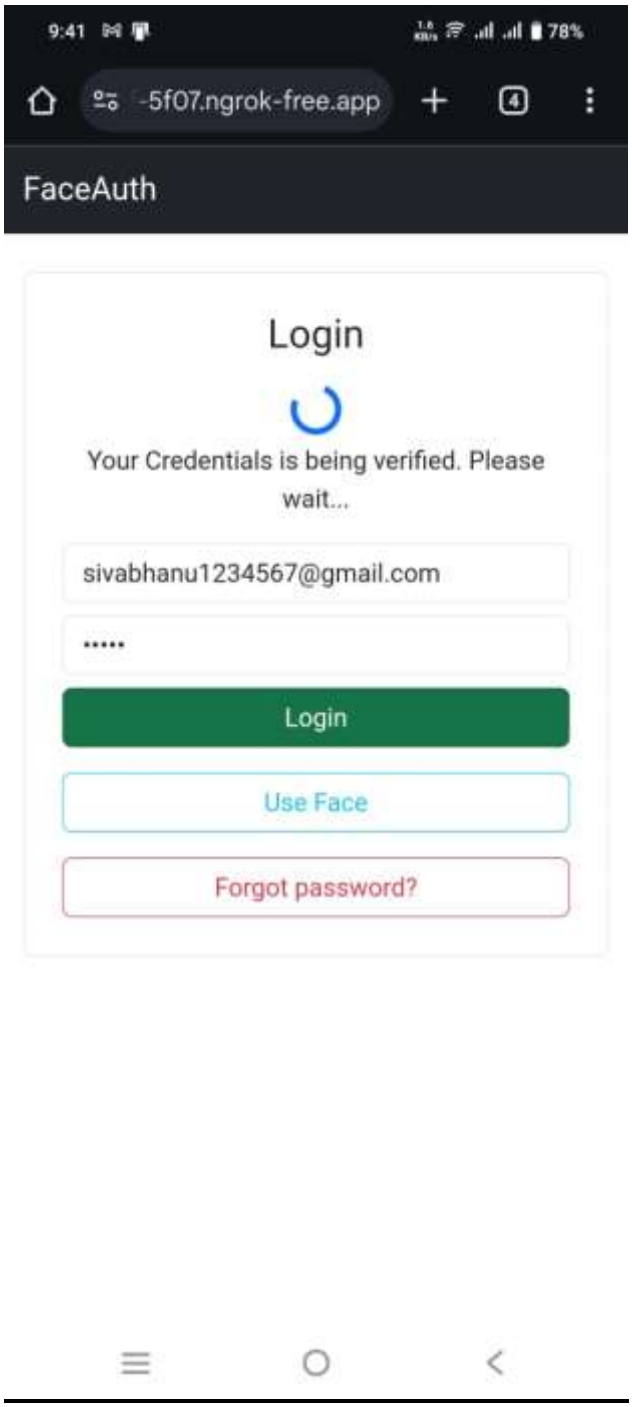
Registration Successful	Face Login Page
	

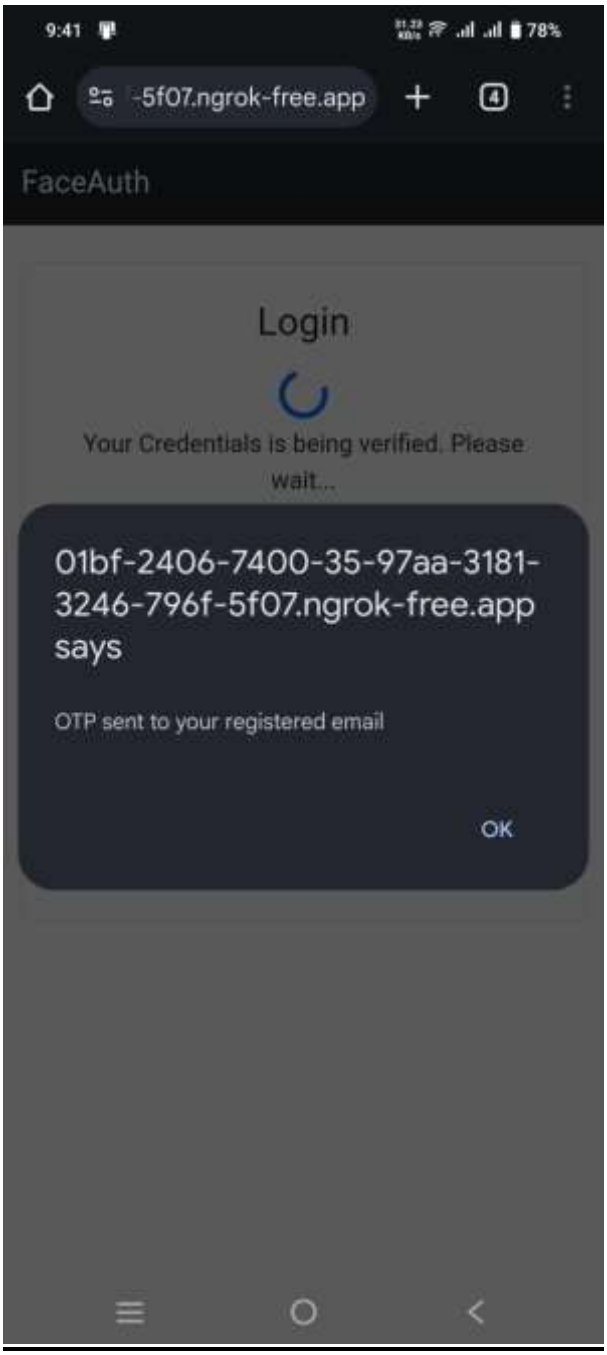
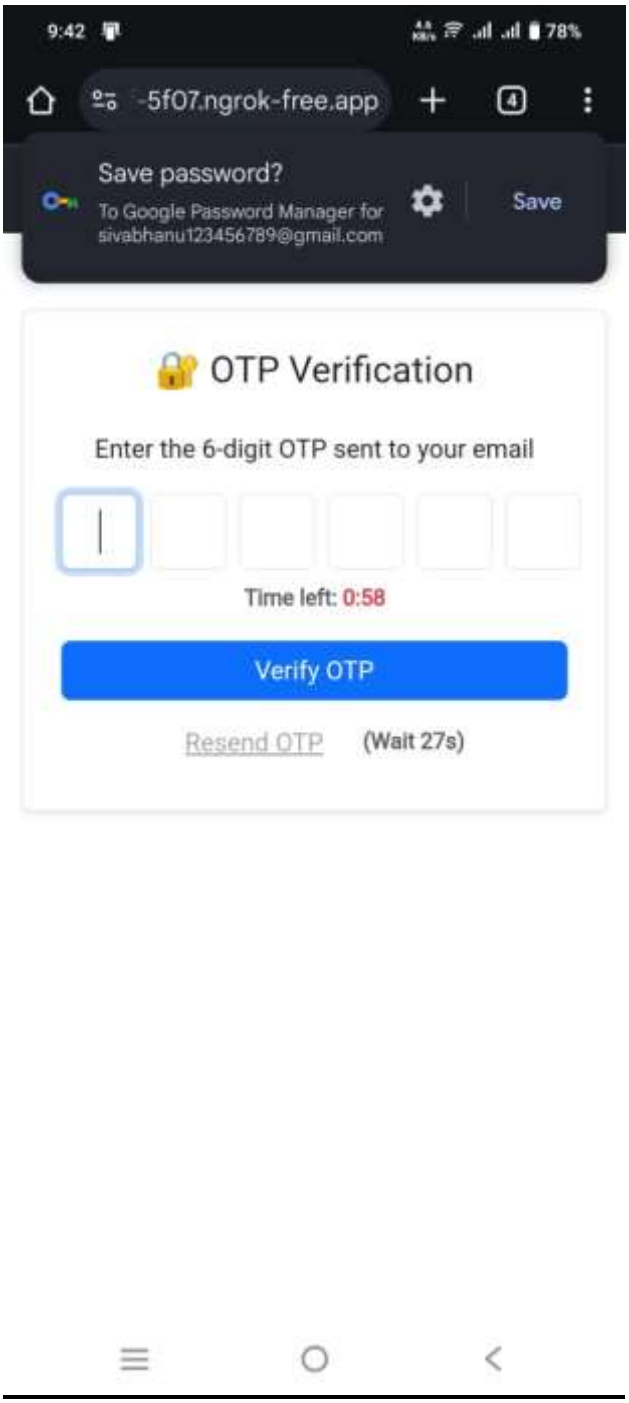
Face Login Process	Face Login Success
	

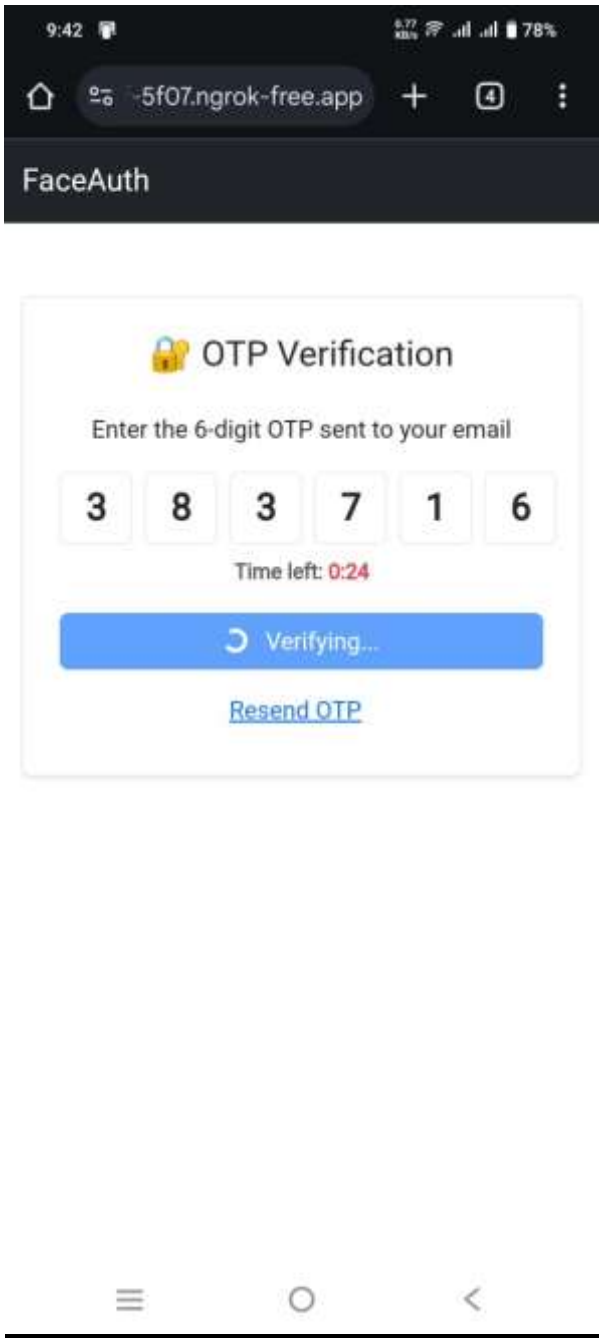
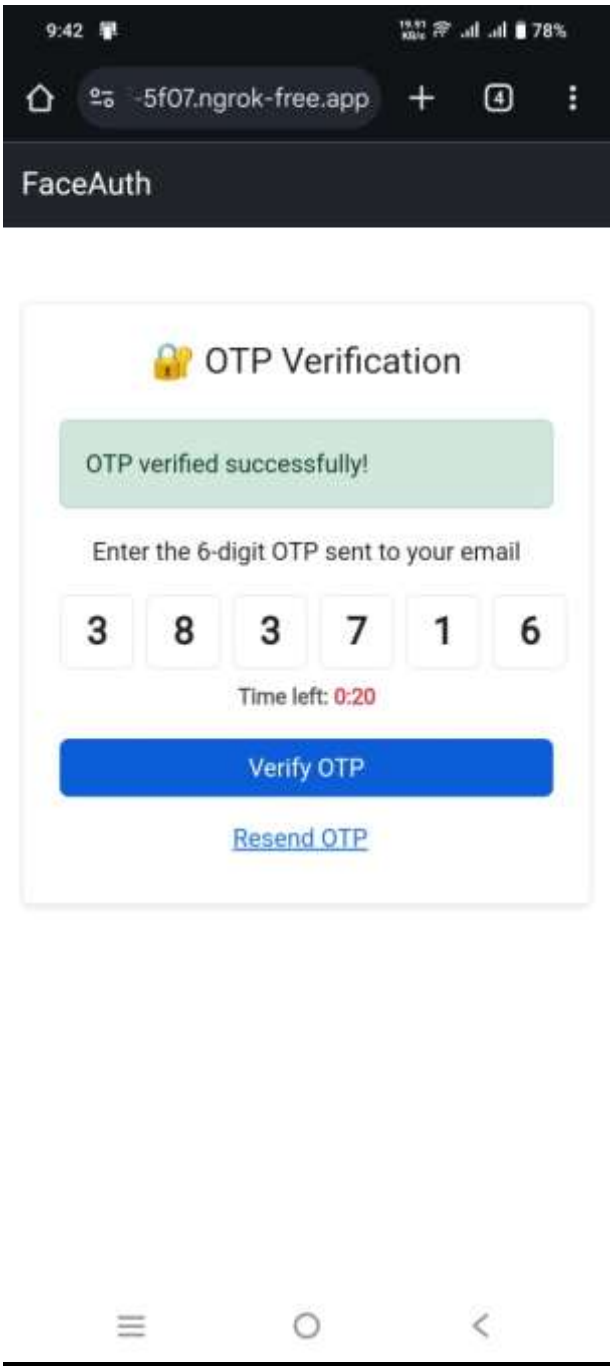
Dashboard	Face Data Reset
	

Face OTP Request	OTP Verification
	

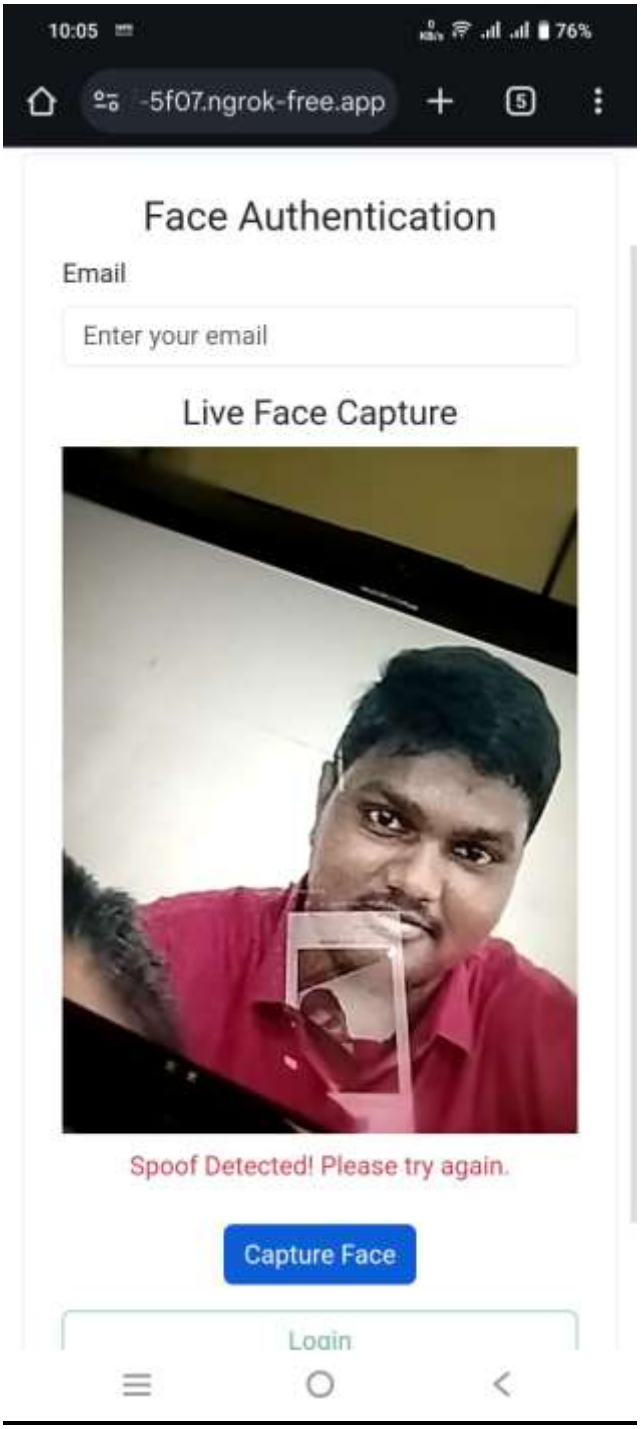
Face Reset Process	Face Reset Success
	

Password Login	Credential Verification
	

OTP Sent	OTP Verification
	

OTP Verifying	OTP Success
	

Spoof Detected



CHAPTER – 11

CONCLUSION

In today's digital-first world, where remote access and online identity verification are increasingly essential, ensuring the security of authentication systems has become paramount. The Enhanced Remote Face Anti Spoofing project addresses this need by providing a robust, dual-layered authentication system combining facial recognition and OTP verification.

This system was designed to combat spoofing attacks such as the use of photographs or videos to impersonate a genuine user. By integrating advanced face recognition techniques using 128-dimensional embeddings and real-time spoof detection through blurriness and landmark checks, the solution effectively prevents unauthorized access. Additionally, the inclusion of time-sensitive OTP authentication adds a second layer of defence, ensuring that only the rightful user can gain access.

Extensive testing has shown the system to be both accurate and reliable, with high precision and recall rates. The OTP mechanism further strengthens the security, making it suitable for applications in secure login systems, remote work platforms, and digital identity verification.

In conclusion, this project demonstrates that combining biometric facial recognition with liveness detection and OTP-based multi-factor authentication can significantly enhance the trustworthiness and usability of remote authentication systems. The modular design also ensures scalability and adaptability for future integration with more advanced spoof detection methods and biometric modalities.

The results affirm that this approach is effective, user-friendly, and resilient against common security threats such as spoofing and credential theft.

CHAPTER – 12

LITERATURE REVIEW

The evolution of biometric authentication systems has led to widespread adoption of face recognition technologies for secure access and identity verification. However, these systems remain vulnerable to spoofing attacks, where adversaries use printed images, recorded videos, or 3D masks to fool the recognition mechanism. This literature review highlights recent advancements in anti-spoofing techniques and the integration of multi-factor authentication approaches to enhance system security.

2.1 Face Recognition Technologies

Face recognition has emerged as a preferred biometric modality due to its non-intrusive and user-friendly characteristics. Traditional approaches utilize Local Binary Patterns (LBP), Histogram of Oriented Gradients (HOG), and Principal Component Analysis (PCA) to extract facial features. With the advent of deep learning, methods like convolutional neural networks (CNNs) and pre-trained models such as FaceNet and VGGFace have significantly improved recognition accuracy.

2.2 Spoof Detection and Liveness Verification

Spoof detection methods are broadly categorized into hardware-based and software-based solutions. Hardware-based approaches use depth sensors or infrared cameras to verify 3D structure, while software-based solutions analyse texture, motion, and illumination changes.

Notable techniques include:

- Image quality assessment using blurriness, noise, and color distortion.
- Temporal analysis of facial movements (e.g., eye blinking, head rotation).
- Frequency domain analysis using Fourier transforms.

Maatta et al. proposed using LBP-based texture analysis for spoof detection, which laid the foundation for real-time image quality assessment.

2.3 Multi-Factor Authentication (MFA)

To increase reliability, MFA combines multiple authentication factors, typically:

- Something the user knows (password)
- Something the user has (OTP, token)
- Something the user is (biometric)

Research shows that integrating facial recognition with OTP verification increases overall system resilience. OTPs can be time-sensitive or device-specific, reducing the risk of credential-based attacks.

2.4 Comparative Studies

Studies comparing anti-spoofing algorithms reveal:

- CNN-based models outperform handcrafted feature techniques.
- Combining facial biometrics with liveness detection achieves higher True Positive Rates (TPR) and lower False Acceptance Rates (FAR).
- Lightweight models can achieve high performance with lower computational cost, suitable for real-time systems.

CHAPTER – 12

LITERATURE REVIEW

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