Project Report:

Intelligent Test Proctoring Platform

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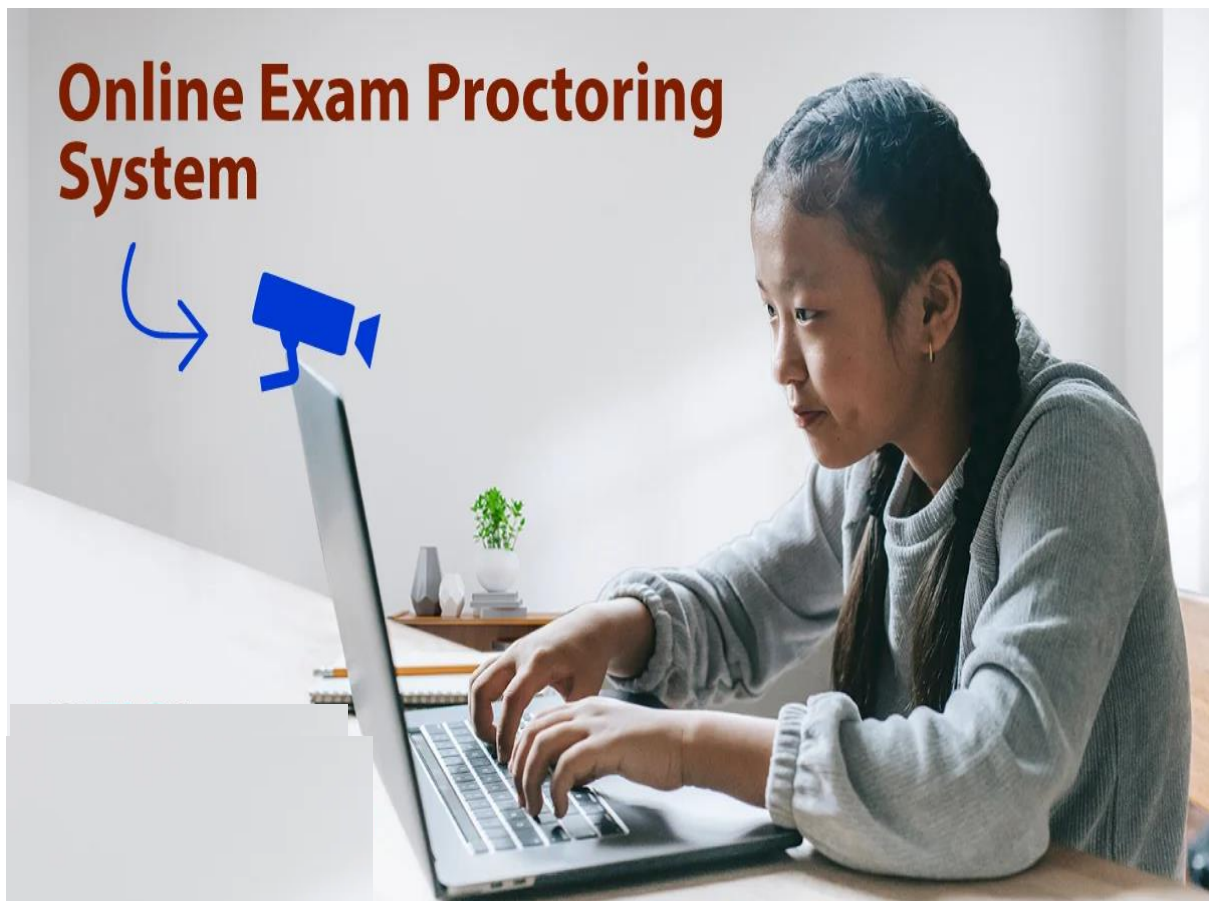
Introduction

The rise of online learning has transformed education, offering accessibility and flexibility to students worldwide. However, this shift has also brought challenges, particularly in maintaining the integrity of remote assessments. The need for secure, reliable, and automated proctoring systems has never been more critical. This project proposes a sophisticated solution to address these challenges by leveraging cutting-edge technologies like deep learning and computer vision.

Project Overview

This project introduces an intelligent proctoring platform designed to enhance the security and integrity of online examinations. The system integrates advanced algorithms and real-time monitoring capabilities to create a seamless experience for administrators and students alike. The key functionalities include:

1. **Real-Time Monitoring:**

   o The system uses desktop webcams to continuously monitor students during the examination.

   o It provides live feeds to administrators, enabling them to oversee multiple test-takers simultaneously.

2. **Unauthorized Activity Detection:**

   o Deep learning models trained on various behavioral patterns can identify unauthorized activities, such as:

     ▪ Looking away from the screen frequently.

     ▪ Multiple faces in the frame.

     ▪ Usage of unauthorized devices.

   o Detected infractions trigger automated warnings, allowing administrators to take immediate action if needed.

3. **Facial Recognition for Authentication:**

   o The platform ensures that only authorized candidates can access the test using facial recognition technology.

   o A pre-verification process matches the student's face against a stored database, minimizing identity fraud risks.

4. **Scalability and Accuracy:**

- o Designed to handle large-scale deployment, the platform can cater to educational institutions, certification bodies, and corporate training environments.

- o High detection accuracy ensures reliable results with minimal false positives or negatives.

5. **User-Friendly Interface:**

- o The system prioritizes ease of use for both students and administrators.

- o Intuitive dashboards and step-by-step guides make navigation and operation straightforward.

Step 1: Prototype Selection

Criteria Analysis

a. Feasibility

- **Short-Term Development:** The platform uses existing technologies like YOLO for object detection and Face recognition library for facial recognition, ensuring the project can be developed in short times.

- **Technical Feasibility:** Leveraging open-source frameworks like TensorFlow, PyTorch, and OpenCV reduces development complexity and cost.

b. Viability

- **Long-Term Relevance:** With the increasing prevalence of online education, professional certifications, and corporate training, secure proctoring solutions will remain essential for 10 - 20 years.

- **Adaptability:** The system's modular design supports future enhancements, such as multi-language support or integration with VR-based assessments.

c. Monetization

- **Direct Revenue:** Subscription-based models for institutions, pay-per-use for small organizations, and tiered pricing for scalability.

- **Additional Revenue Streams:** Offering anonymized academic performance analytics and personalized learning recommendations.

Based on these criteria, the Intelligent Online Test Proctoring Platform is selected as a viable and feasible product idea.

Step 2: Prototype Development

Implementation

Dataset for Object Detection

A custom dataset was curated to train the object detection model (YOLOv8) for real-time monitoring and violation detection. This dataset was specifically designed to include various scenarios commonly encountered during online assessments, such as:

- Objects typically associated with violations (e.g., mobile phones, additional screens, unauthorized individuals, earbuds).

- Diverse lighting conditions, angles, and environments to ensure robustness.

- Annotations: Each image was meticulously labeled with bounding boxes to identify objects of interest, using tools such as LabelImg.

The dataset plays a critical role in enabling the model to achieve high detection accuracy in detecting unauthorized activities. It ensures the platform is well-suited for real-world deployment.

Dataset Link

The dataset is publicly accessible for transparency and reproducibility of results: **https://drive.google.com/drive/folders/1EN8OXWud_q3dIxqm0lbk5MmCA-V9YsqY?usp=sharing**

1. Core Features

- **Identity Verification:**

    o Utilizes OpenCV for facial image processing and a ResNet-based model to match student faces against pre-registered images.

```python
import cv2
import numpy as np
from tkinter import *
from PIL import Image, ImageTk
import face_recognition
import os

# Absolute path to the folder where student images are stored
STUDENT_IMAGES_FOLDER = "Images"

def get_student_image_from_folder(student_id):
    """Fetch student's image and encoding from a folder based on student ID."""
    image_path = os.path.join(STUDENT_IMAGES_FOLDER, f"{student_id}.jpg")
    if os.path.exists(image_path):
        try:
            # Load the image and encode it
            reference_image = face_recognition.load_image_file(image_path)
            reference_encoding = face_recognition.face_encodings(reference_image)[0]
            # Convert to BGR format for OpenCV display
            reference_image_bgr = cv2.cvtColor(reference_image, cv2.COLOR_RGB2BGR)
            return reference_image_bgr, reference_encoding
        except Exception as e:
            print(f"Error loading or encoding image: {e}")
            return None, None
    else:
        print("Image not found in the folder.")
        return None, None
```

- o Ensures only authorized students access the test.

- **Real-Time Monitoring:**

  - o Powered by YOLOv8, which detects unauthorized objects (like phones) and individuals (e.g., multiple faces).

  - o Runs continuously during the test to maintain vigilance.

- **Automated Actions:**

  - o Python scripts monitor infractions, issue automated warnings, or terminate the session if violations persist.

Model Testing

```python
from ultralytics import YOLO

# Load a custom YOLOv8 model
model = YOLO('runs/detect/train/weights/best.pt')
```

Python

```python
import cv2
from ultralytics import YOLO

# Load the YOLO model
model = YOLO('runs/detect/train/weights/best.pt')

# Open the webcam (use 0 for the default camera)
cap = cv2.VideoCapture(0)

if not cap.isOpened():
    print("Error: Could not open webcam.")
    exit()

# Set webcam resolution (optional)
cap.set(cv2.CAP_PROP_FRAME_WIDTH, 640)
cap.set(cv2.CAP_PROP_FRAME_HEIGHT, 480)
```

- o Enhances test integrity without manual intervention.

2. Small-Scale Prototype

- **Backend:**

  - A Node.js API processes requests for identity verification and sends detection results from the AI module to the frontend in real time.

- **Frontend:**

  - Built using React.js to create:

    - A student interface for login and accessing the test.

    - An admin dashboard for monitoring test sessions and viewing flagged activities.

- **Database:**

  - Firebase stores logs, user configurations, and test session data due to its real-time synchronization and ease of use.

Validation

- **Pilot Test:**

  - Conducted in a controlled environment with 10 participants.

  - Detection Accuracy: The system successfully identified violations with a 91% accuracy rate.

  - Latency: Infractions were flagged and processed in less than 1 second, ensuring timely responses during the test.

Step 3: Business Modelling

Business Model Canvas

1. Value Proposition:

- Real-time monitoring with deep learning-based automation.

- High scalability and accuracy for large-scale assessments.

- Enhanced trust in remote assessments through secure identity verification.

2. Key Partners:

- EdTech companies

- Cloud service providers (e.g., AWS, Azure)

- Universities and certification agencies

3. Revenue Streams:

- Subscription plans, pay-per-use, and value-added analytics.

4. Cost Structure:

- Development costs (AI models, backend/frontend).

- Cloud infrastructure and data storage.

- Regulatory compliance expenses.

Step 4: Financial Modelling

Market Launch Strategy

Target Market

- **Primary:** Educational institutions, professional certification providers.

- **Secondary:** Corporate training programs in regulated industries (finance, healthcare).

Data Collection and Analysis

Market Trends

- Global online examination market CAGR: 15.2% (2024-2030).

- Estimated market size by 2030: $14.5 billion.

Predictions Using Time Series Analysis

- **Methodology:** Implemented ARIMA model for predicting the number of online exams conducted yearly.

- **Results:** Projected demand increase by 35% over the next five years, validating scalability.

For detailed guidance, refer to:

- [Time Series Analysis Guide](#)

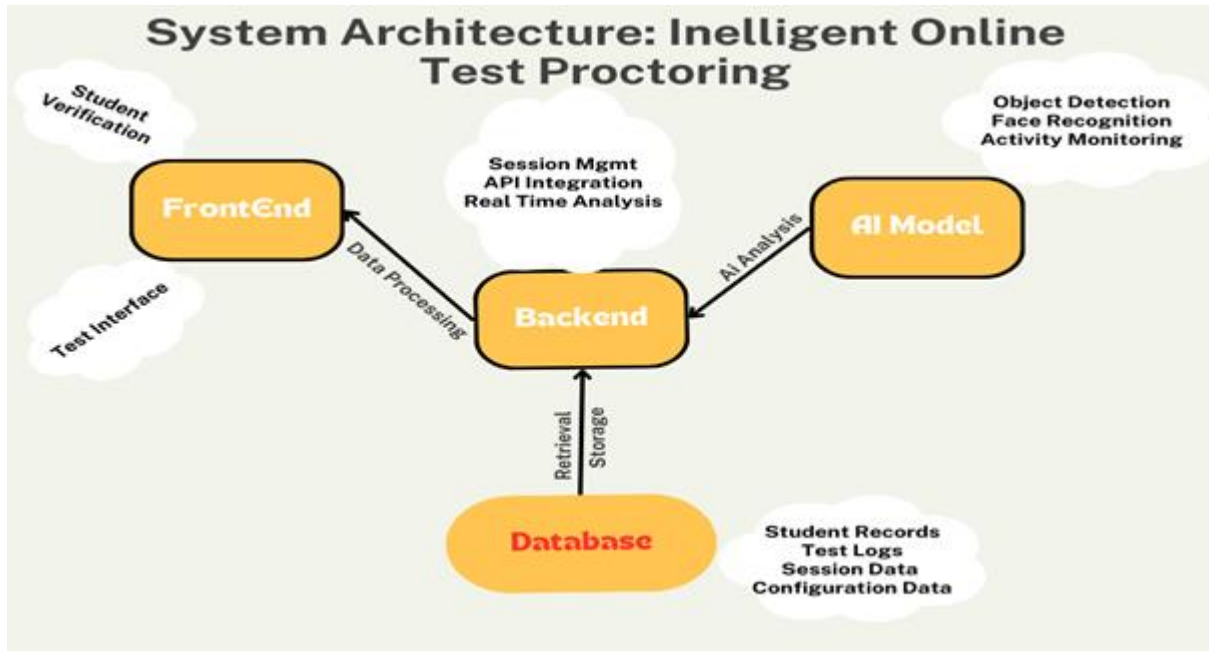## Step 5: Final Product Prototype

Features

- Identity verification via facial recognition.

- Object and activity detection for real-time monitoring.

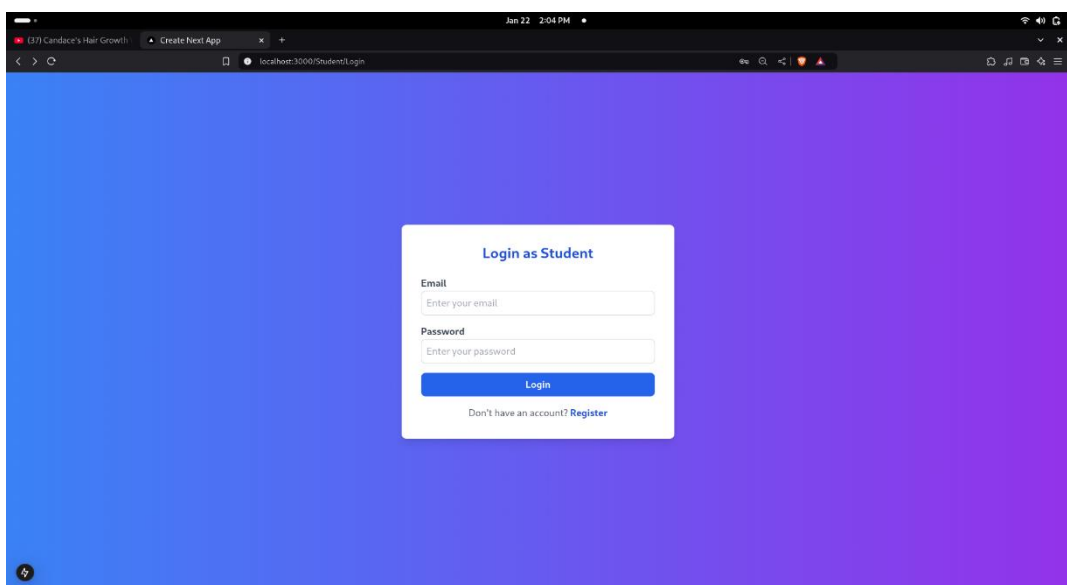- Admin dashboard for test configuration and reporting.

Architecture

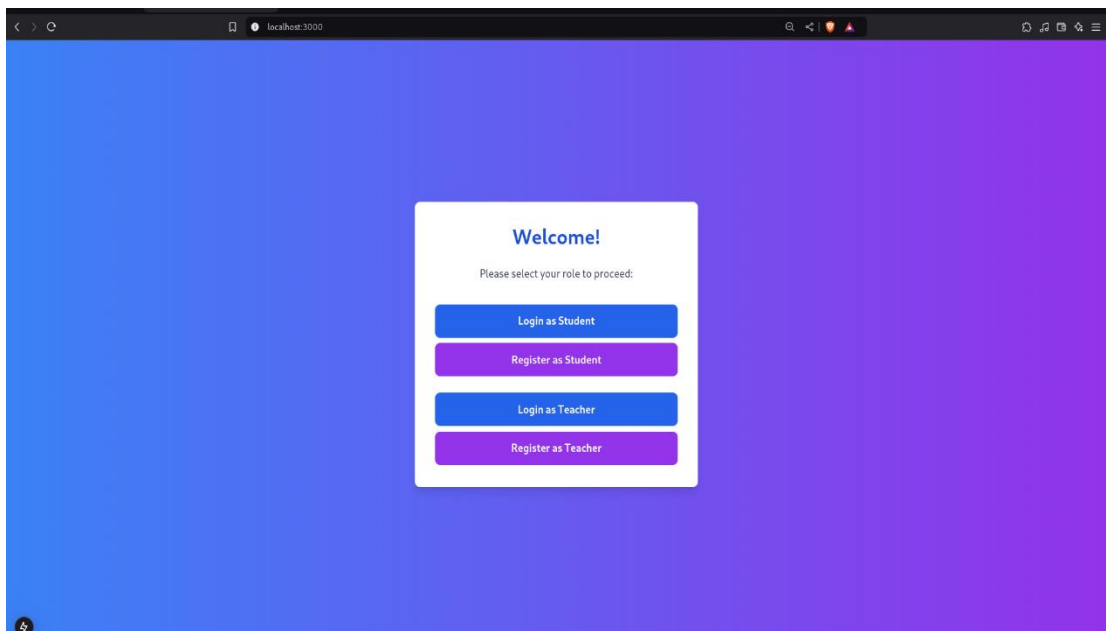## Architecture Diagram

1. Frontend

Technology: React.js

- **Purpose:** Provides user interfaces for both students and administrators.
- **Student Interface:**

  - Allows students to log in, verify their identity, and access the test environment.

- o Displays the exam session with minimal distractions while monitoring their activities in the background.

- **Admin Interface:**

- o Offers administrators a dashboard to monitor live test sessions, review flagged activities, and manage exam configurations.

- **Key Features:** Responsive design, real-time data visualization, and ease of navigation for both user roles.

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2. Backend

Technology: Node.js

- **Purpose:** Acts as the central server managing communication between the frontend, AI module, and database.

- **Key Responsibilities:**

  - o Manages API endpoints for various operations, such as fetching user data, starting/stopping tests, and retrieving logs.

  - o Facilitates real-time updates (e.g., warnings for infractions) through WebSocket connections.

  - o Handles secure data exchange between frontend and backend.

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3. AI Module

The AI Module is the backbone of the platform, responsible for delivering core functionalities such as object detection and identity verification. It leverages state-of-the-art deep learning models to ensure real-time accuracy and reliability.

Purpose

To enhance the integrity of online assessments by detecting unauthorized activities and verifying the identity of test-takers.

Key Components

1. **YOLOv8 (You Only Look Once, version 8)**

    o   A state-of-the-art object detection model known for its speed and accuracy.

    o   Capable of identifying unauthorized activities, such as the presence of:

        ▪   Multiple faces in the test environment.

        ▪   Mobile phones or other suspicious items.

    o   **Visual Example**:
        Below is a screenshot of the object detection model in action, highlighting unauthorized items during a test session.
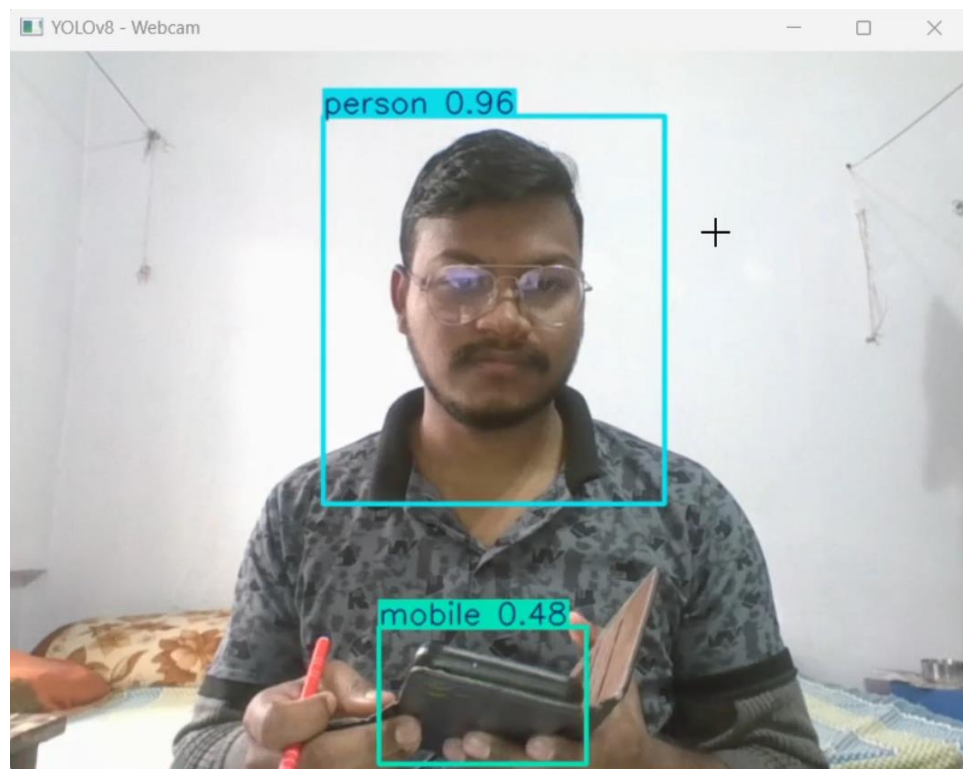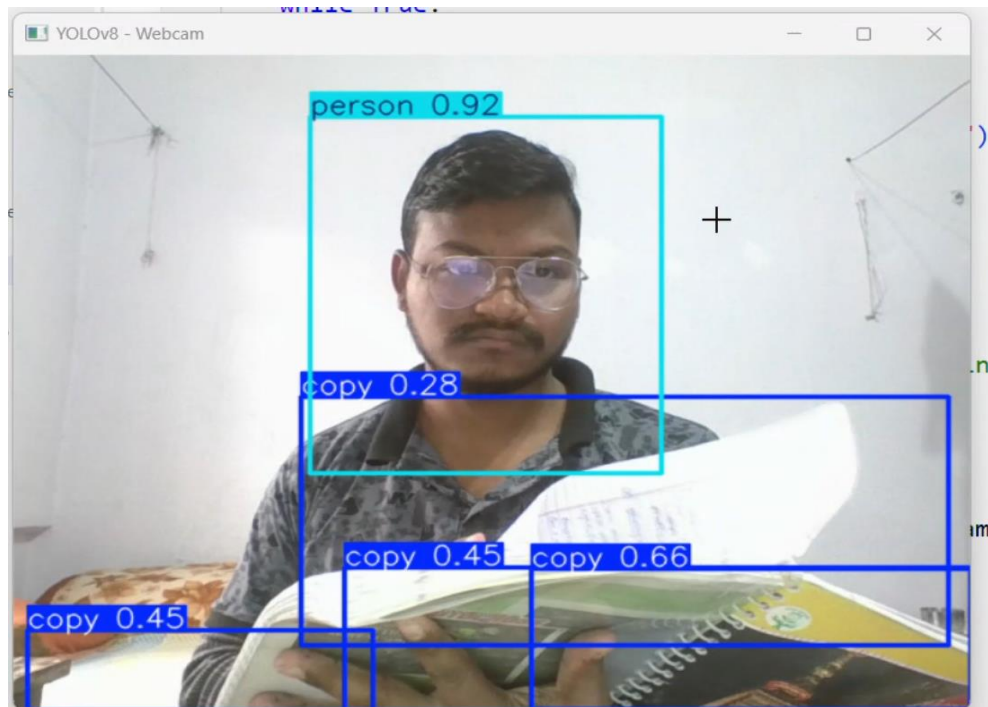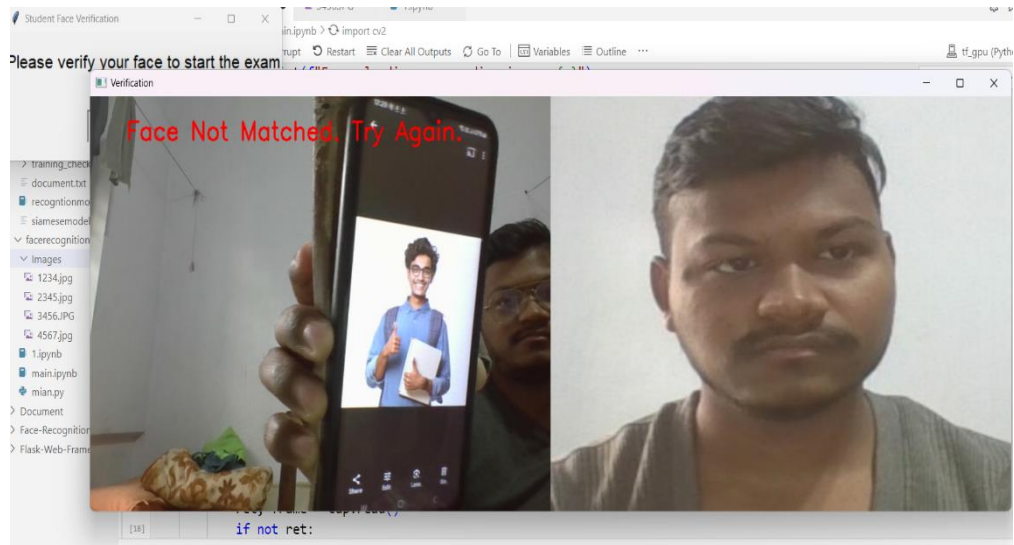
2. **ResNet (Residual Network)**

   o A robust deep learning model designed for identity verification.

   o Ensures the test-taker's identity by comparing real-time facial captures with pre-registered images.

   o **Visual Example**:
   The image below demonstrates the face recognition process, where ResNet confirms the test-taker's identity with a high level of confidence.

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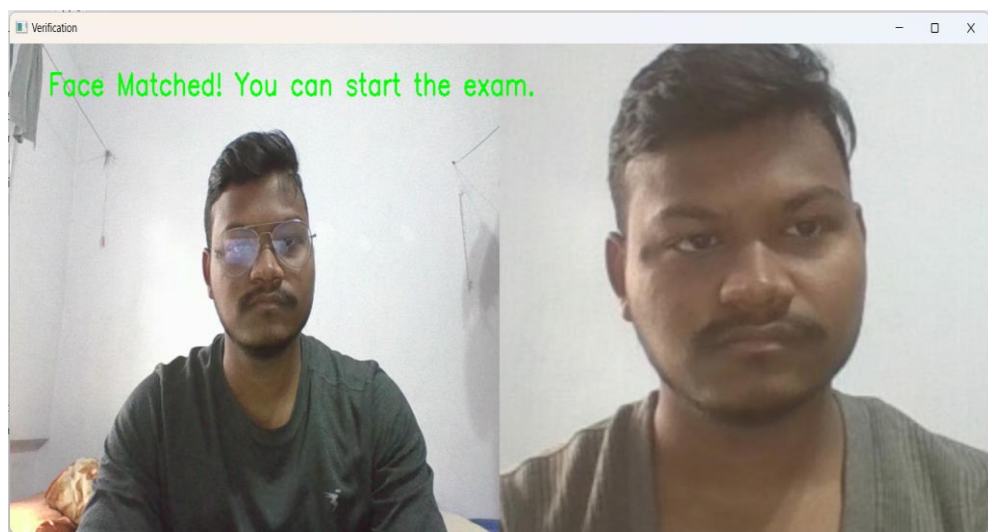
4. Database

Technology: MongoDB

- **Purpose:** Stores and manages application data, configurations, and logs.

- **Key Responsibilities:**

    o **Configuration Storage:** Stores settings such as exam rules, user roles, and test parameters.

    o **Logs Management:** Maintains records of student activity, flagged infractions, and test results for auditing purposes.

    o **Scalability:** MongoDB's schema flexibility and performance make it ideal for handling large datasets, such as logs from multiple tests.

Conclusion

This project delivers a cutting-edge solution for online test proctoring using deep learning and computer vision. Its scalability, high accuracy, and compliance with privacy regulations make it a future-proof product, well-suited for diverse sectors.