CO3554 - Data Management Project

- FINAL PRESENTATION -

SafeLABS

LABORATORY MANAGEMENT SYSTEM

20/ENG/094
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TABLE OF CONTENTS

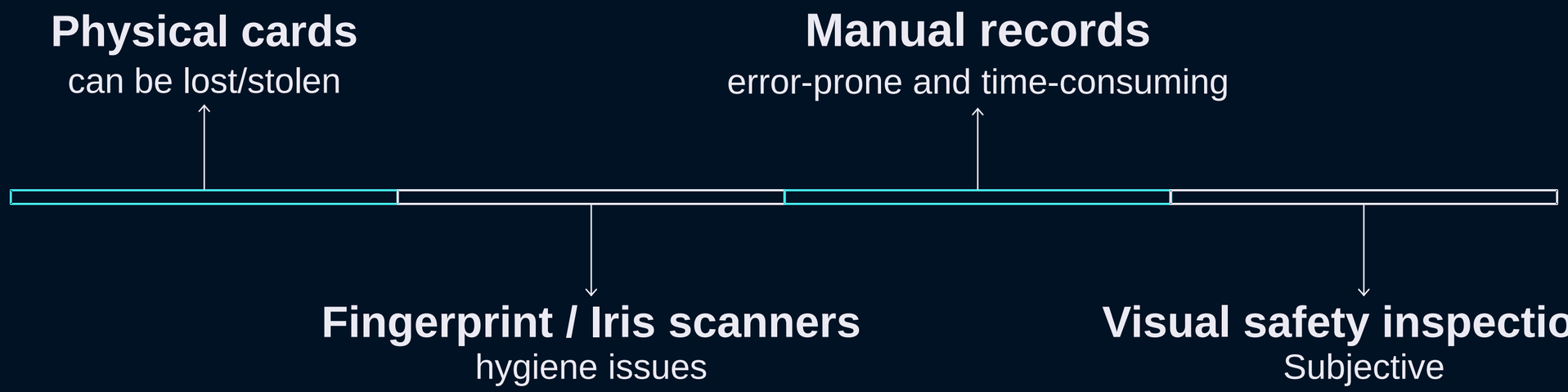
INTRODUCTION

Innovative laboratory management system with deep learning-based user authentication and safety compliance regulation

- Addresses critical challenges in laboratory access and safety
- Provides an automated authentication & attendance tracking system
- Integrates face recognition, safety compliance checks
- Scalable solution applicable to various institutional environments

BACKGROUND

Growing need for secure, intelligent authentication control, management & attendance tracking systems

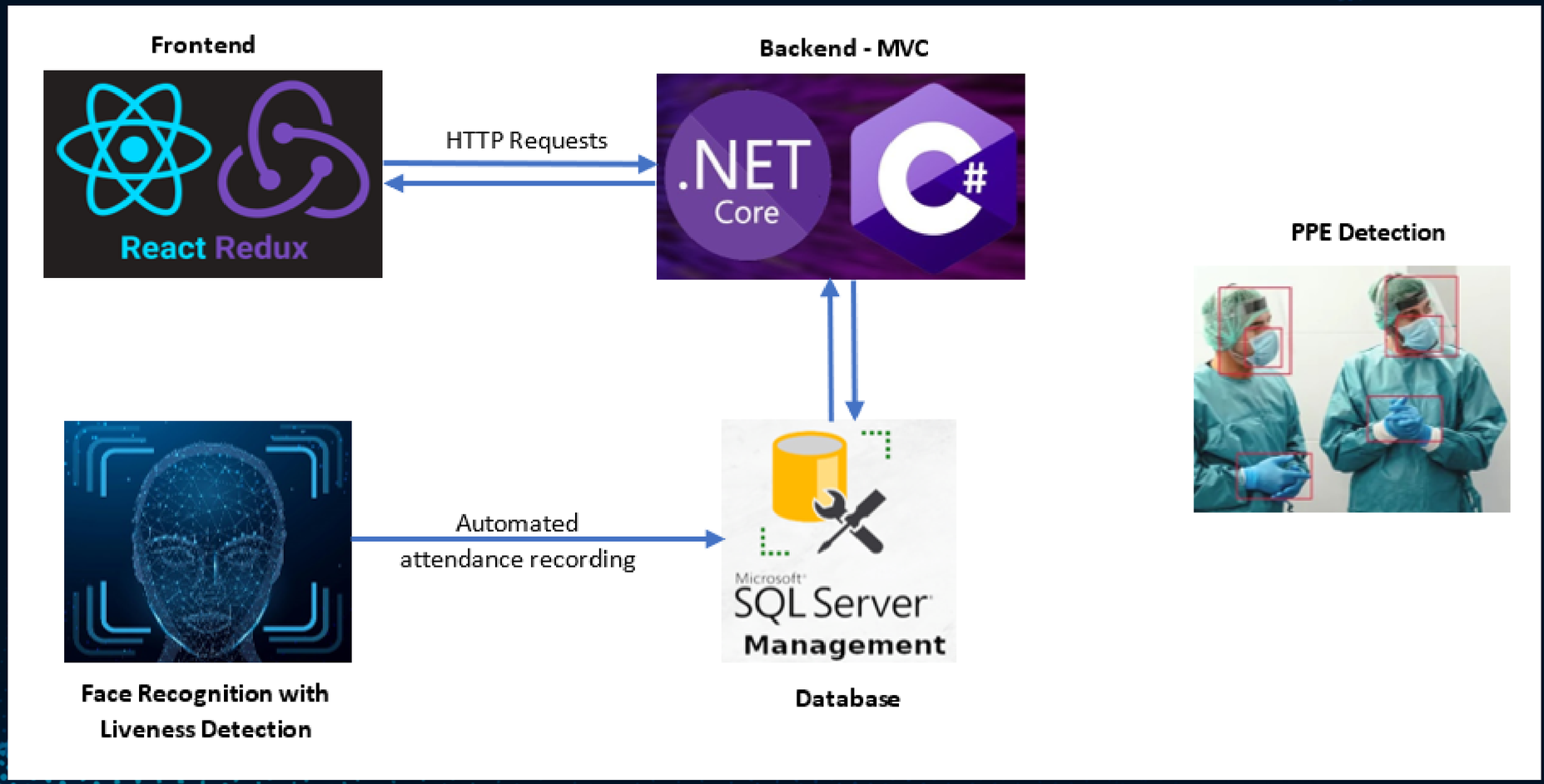


Need for automation and scalability

OBJECTIVES

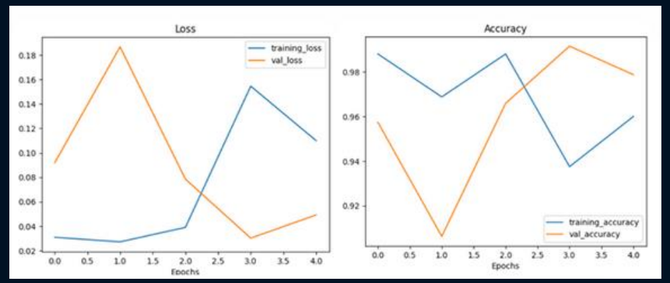
- Develop a comprehensive laboratory management system
- Implement robust user authentication mechanism using deep learning based face recognition
- Integrate safety compliance detection using object detection
- Provide automated attendance and real-time lab occupancy tracking
- Create a scalable web application for the convenience of users & management purposes

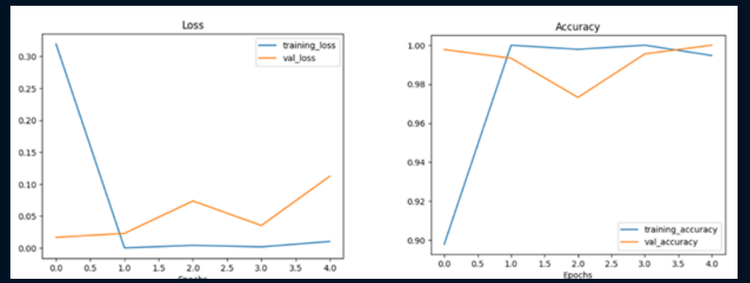
SYSTEM ARCHITECTURE

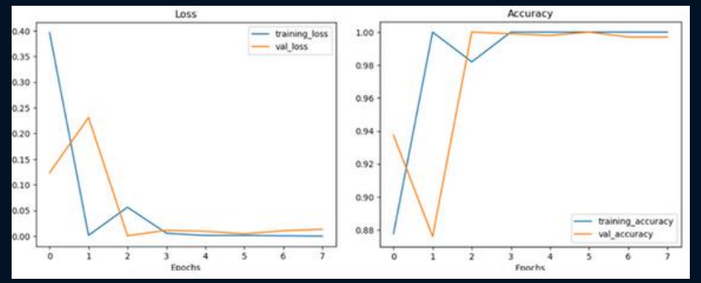


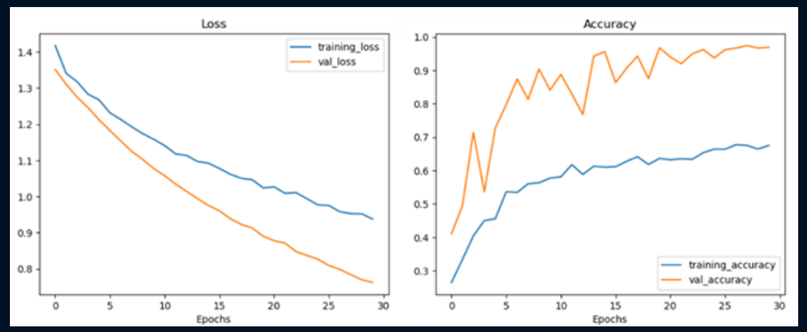
FACE RECOGNITION

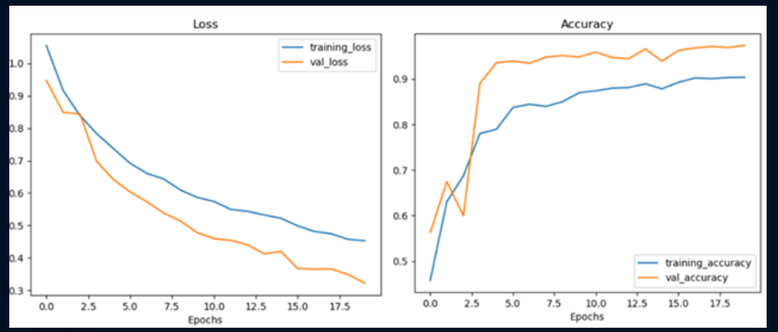
- Initial test was to build a face recognition model from scratch or using Transfer Learning
- Dataset Creation and Preprocessing was done before training











- Achieved better curves and accuracy by feature extraction of **InceptionV3** model

FACE RECOGNITION Contd.

Issues:

- Not accurate enough for custom images
- Need re-train the model when new user registers

Solution: Using a pre-trained face encoding generator model

Feature	face_recognition (dlib)	FaceNet	VGGFace	ArcFace
Accuracy (on LFW)	~97-99%	~99.63%	~97-98%	~99.83%
Speed	Fast with HOG Moderate with CNN	Moderate	Moderate	Slower
Architecture	ResNet-34	Inception - ResNet	VGG-16 / VGG-19	ResNet-50 / ResNet-100
Model Size	Small to Moderate	Moderate	Large	Large
Use Cases	Face recognition and verification, embedded applications	Face verification, clustering, embeddings generation	Face verification and classification	Face verification, high-accuracy face matching
Embedding Dimension	128	512	4096	512
Ease of Integration	High, easy with Python API	Moderate	Moderate to complex	Complex
Scalability	High, works with relational databases	Medium (best with specialized vector DBs)	Low	Low

FACE RECOGNITION Contd.

Used Technology: Dlib’s face_recognition library

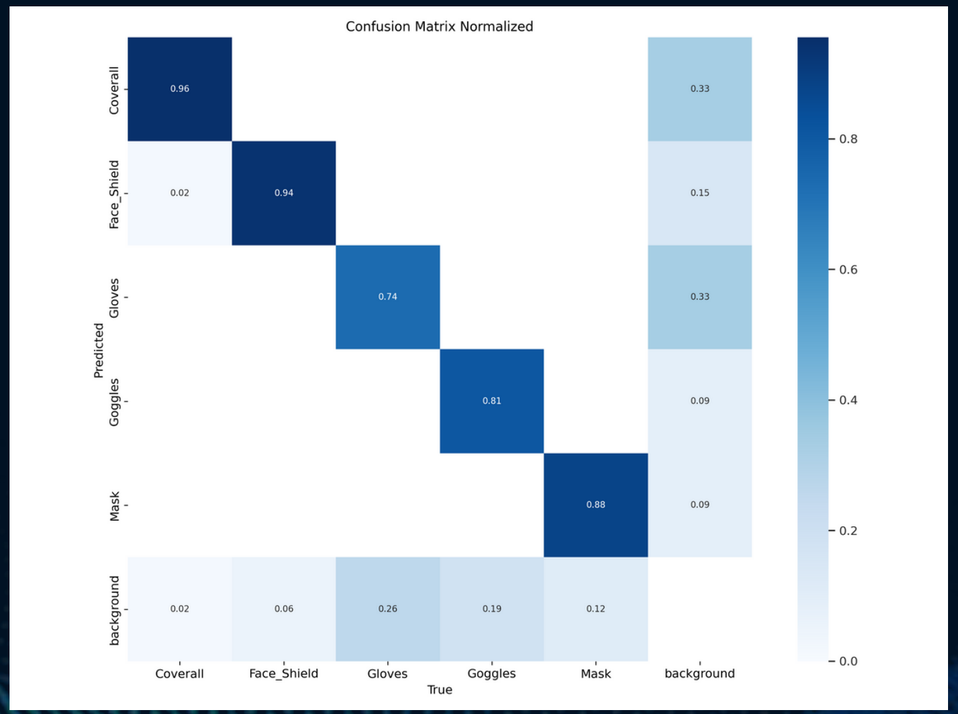
- HOG model for face detection
- ResNet-34 model for face recognition

Methodology

- Face encoding stored during registration
- Face verified against database
- Integration with **liveness detection** to ensures real presence
- Attendance recorded automatically

PPE Detection

- Suitable to implement at the entrance of a hazardous area in the laboratory
- CPPE-5 Dataset
  - ~1030 images of coverall, face shield, gloves, goggles and mask
  - Annotation files
- Preprocessed the dataset to train YOLOv8 model for 50 epochs



WEB APPLICATION FEATURES

- User Management
- Resource Management
- Real-time Lab Occupancy Tracking
- Announcements
- Role-based Access Control
- AES Encryption for Sensitive Data
- Password Changing & Proper Error Handling Capability

CHALLENGES

- Retraining deep learning models for new users
- Ensuring high accuracy in face recognition under different lighting conditions
- Balancing security and user experience
- Role-based access control implementation complexities
- Integrating multiple technologies seamlessly

FUTURE IMPROVEMENTS

- Integrate IoT and cloud services
- Mobile application development
- Use more robust anti-spoofing techniques
- Use advanced data encryption methods
- Scale the project idea to use in different scenarios

CONCLUSION

- SafeLABS automates lab authentication and safety compliance
- Integrates face recognition with liveness detection, and availability of PPE detection model
- Web application for laboratory management and occupancy tracking
- Scalable and adaptable to different environments and scenarios

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THANK YOU

ANY QUESTIONS ?