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MULTIMODAL BIOMETRICS AUTHENTICATION SYSTEM FOR   MILITARY WEAPON ACCESS: FACE AND ECG AUTHENTICATION

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Introduction to Biometrics:

- Biometrics is the technology that analyzing the identification and authentication with people's unique physical and behavioral characteristics

- Examples : fingerprints, facial recognition, iris scans, voice recognition, and DNA.

- This technology is commonly used in security systems, access control, and identity verification.

- Biometrics can't be stolen like a password or key can.

Types of Biometrics:

- Fingerprint Recognition

- Face Recognition

- Iris Recognition

- DNA Matching

- ECG Recognition

- EEG Recognition

- Signature Recognition

- Hand Geometry

- Voice Identification

- Vein Recognition

ECG-based Authentication:

- ECG authentication, also known as electrocardiogram authentication, uses the unique electrical signals generated by a person's heart to verify their identity.

- Every person's heart has a unique size, shape, and electrical pattern. Therefore ECG captures these unique heart patterns.

- Just like fingerprints or iris patterns, each person's ECG is unique. The pattern of in an ECG graph varies slightly from person to person.

- More reliable and harder to fake than other biometric methods like fingerprints or face recognition.
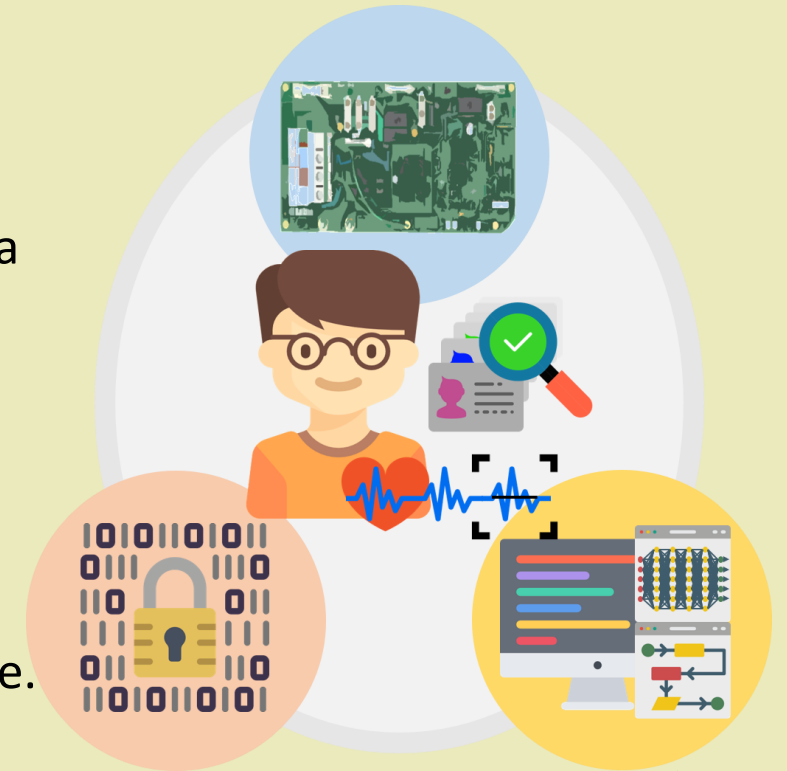
Facial based Authentication:

- Facial recognition, is a technology that identifies individuals by analyzing unique facial features.

- It is widely used for security and identity verification like unlocking smartphones, accessing secure facilities, to surveillance systems for public safety.

- It's often faster and more convenient than traditional methods like passwords or keys. Facial features are difficult to forge , enhancing security in authentication processes.

ECG Dataset Collection:

- Raw data collection: We have collected the ECG data from *physionet.org* website in .atr format. We have taken only 30 people data.

- Noise filtering and segmentation: We used few libraries in python like 'wfdb', 'biosppy' and 'matplot' to extract Noise-free and segmented images from .art file.

- Dataset organization and normalization: We organized data of those 30 different classes and normalized such that each folder contain 40 ECG image segmemts.

Facial Dataset Collection:

- Video collection: We have collected the facial videos from 30 different people with different face angles of video length 8-9sec.

- Picture extraction: From the collected videos we have extracted no of pictures according to the video length.

- Cropping and Grey scaling : By a python program which uses 'opencv' library, we extracted images that cropped only face and converts to greyscale then saves in a given directory.

About CNN Classification:

- CNN: A Convolutional Neural Network (CNN) is a type of deep neural network highly effective for analyzing visual image data.

- Convolutional layers apply filters to detect patterns like edges and textures and enabling the network to learn complex patterns.

- CNNs, trained on large datasets, excel in image related tasks, achieving state of the art performance in computer vision applications, including image classification, object detection, facial recognition and medical image analysis.

- The CNN model is efficient for quick training and generalization.

About VGG16 Architecture:

- VGG-16 is known for its simplicity, effectiveness, and strong performance in computer vision tasks like image classification and object recognition.

- VGG 16 was utilized to extract features from images, pre-trained on large-scale datasets like ImageNet, capturing general features like edges, textures, and patterns.
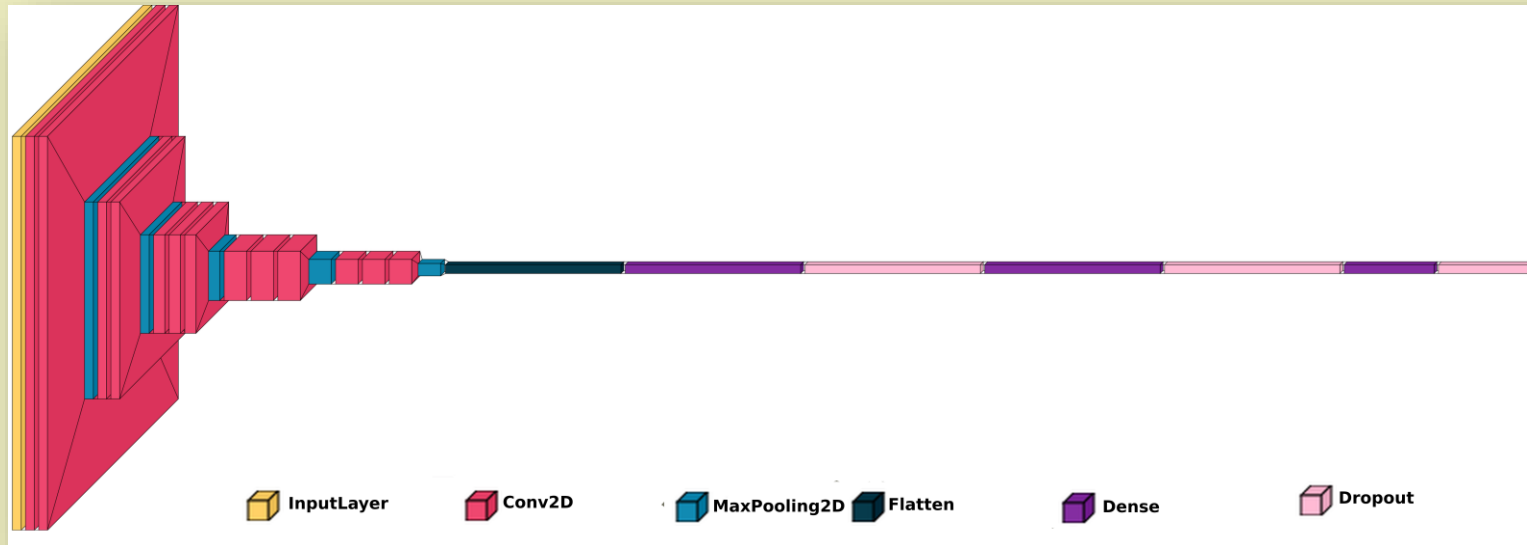
GUI with FLASK:

- The flask library is used to create a user-friendly frontend GUI.

- The system uses pre-trained model API for ECG authentication and face recognition to process inputs with help of frontend GUI interface.

- The application prompts users to upload their ECG data from local directory and face data via a camera interface

- The ECG and Facial authentication model class predicts the same then the system declares "Authentication successful" and logs the result, if not same it shows "No Authentication".
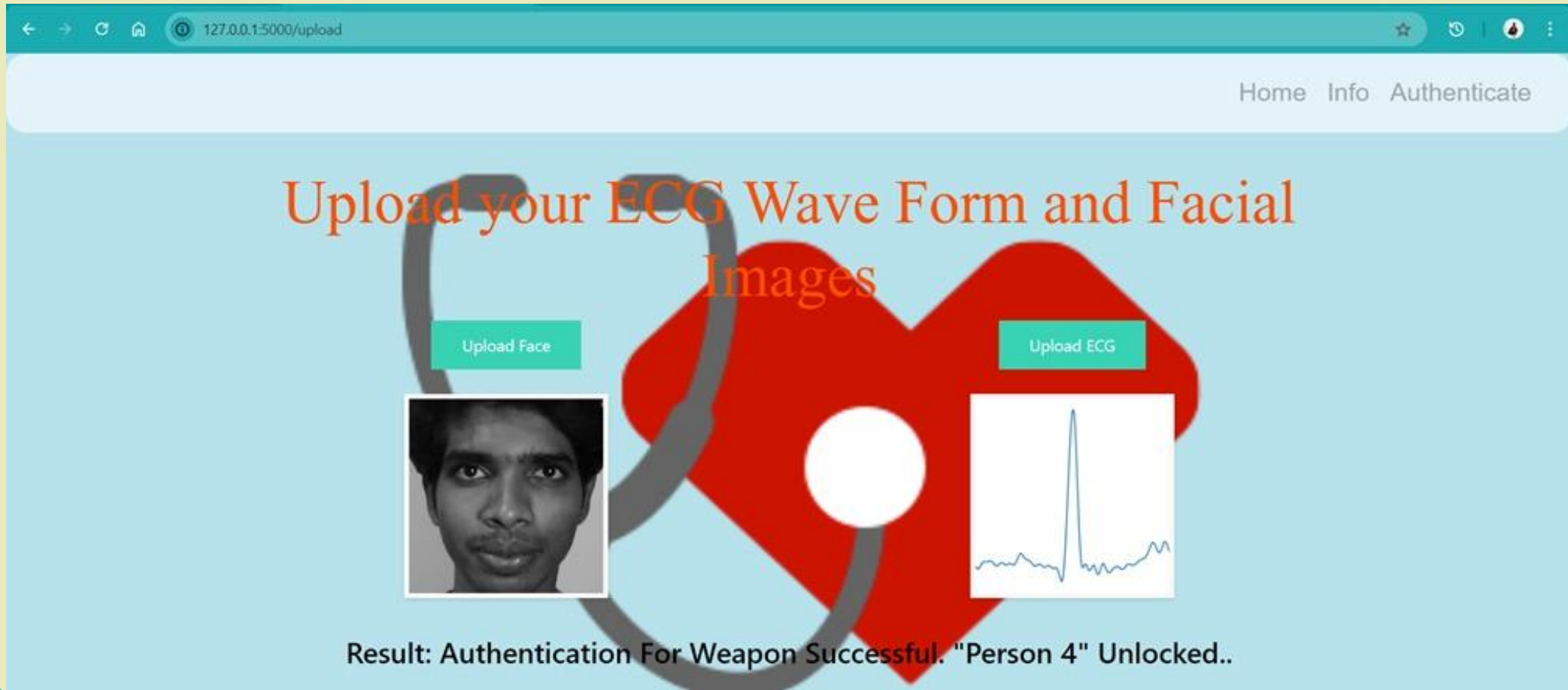
GUI

Flowchart :
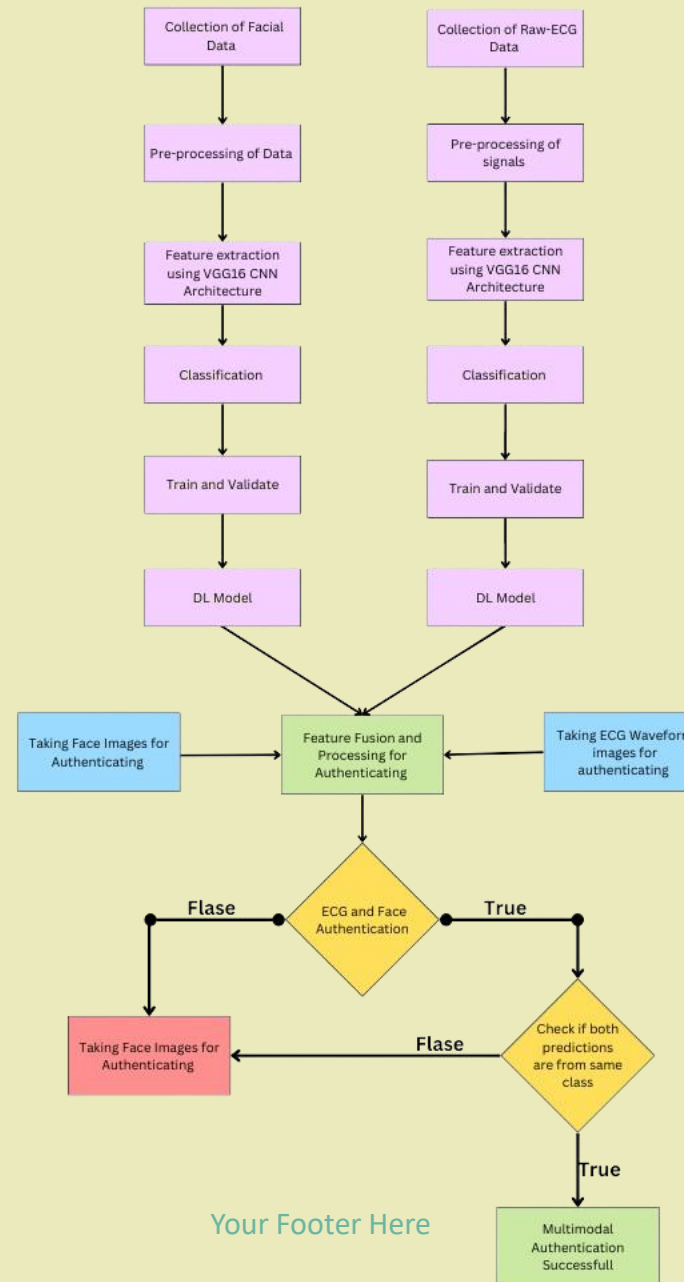
Hardware Part – ESP32 CAM (IoT)
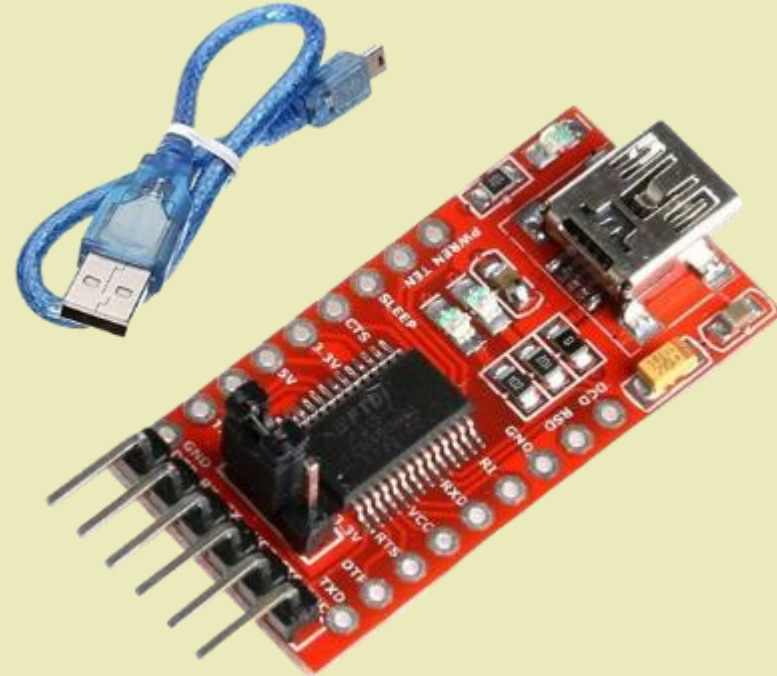
Model Analysis

VGG16 Model	Face Authentication	ECG Authentication	Fusion
Accuracy	95.6%	92.08%	98.33%
Recall	94.37%	90.83%	98.36%
Precision	95.35%	91.9%	98.33%
F1 score	94.3%	92.24%	98.33%

Results :
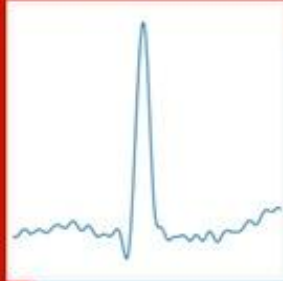
Applications:

- Examination Authentication: Ensure the identity of students during online or in person examinations.

- Voting systems: Enhance security in electronic voting system.

- Laboratory Entrance: Access secure entry to research labs and area with sensitive or hazardous materials.

- Server Access : Secure physical and digital access to servers and data storage centres.

Future Scope:

- Wearable devices can integrate with smart homes and Iot devices for secure access control, enabling continuous authentication, real-time security and ensuring authorizes access only.

- Advanced algorithms ensure secure storage and processing, benefiting sectors like banking, government and transportation.

Conclusion:

- The system uses facial and ECG data to preprocess and feed into a Convolutional Neural Network (CNN), which compares the data against a database. If matches, access is granted for military weapon access, while if not, access is denied.

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❑ A Review on ECG-Based Biometric Authentication Systems:
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❑ Deep Face Recognition for Biometric Authentication:Maheen Zulfiqar, Fatima Muhammad ,Jaleed Khurram& Khurshid

Thank You!

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