NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

School of Computer Science and Engineering
College of Engineering

Cross-Platform Facial Expression Recognition

Advancing FER Technology through Ensemble Deep Learning Techniques

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1. Abstract

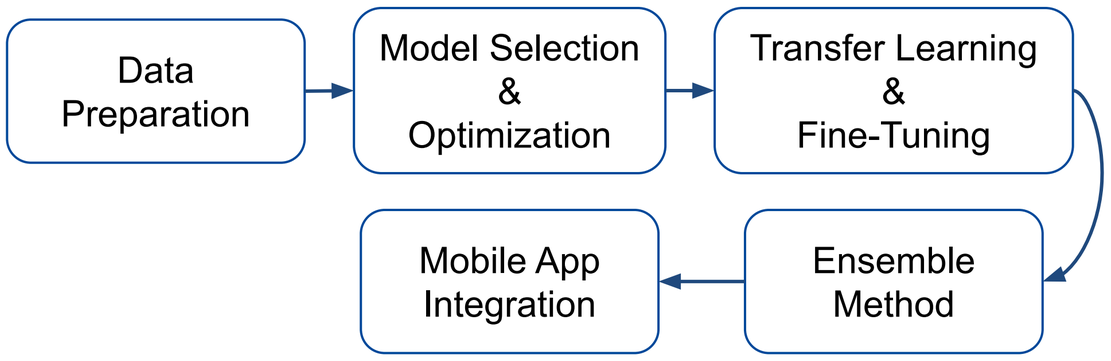
- This project enhances Facial Expression Recognition (FER) by developing a high-precision system using Convolutional Neural Networks (CNNs).
- It analyzes facial expressions from diverse datasets to improve macro expression analysis with an innovative ensemble method. This technique, optimized for server-side processing, overcomes mobile device limitations and integrates into a cross-platform application, making advanced FER technology accessible to the public.
- The project aims to contribute to advancements in emotional state detection, with wide-reaching implications for education, customer feedback, and mental health, paving the way for future technologies that empathetically interpret human emotions.

2. Objectives

- **Enhance Accuracy and Reliability:** Implement an ensemble of three distinct CNN models to boost the accuracy and reliability of macro facial expression analysis. This method combines the strengths of each model to optimize performance, utilizing server-side processing to handle complex tasks beyond the capability of mobile devices.
- **Accessibility through Mobile Integration:** Design and integrate the ensemble method into a cross-platform mobile application. This initiative aims to make advanced facial expression analysis accessible to a wider audience, democratizing sophisticated technology for everyday use.

3. Methodology

- **Data Preparation:** Enhanced FER-2013 dataset robustness through advanced augmentation techniques.
- **Model Selection & Optimization:** Selected ResNeXt, DenseNet, and MobileNetV2 for their unique strengths and optimized it for FER Task.
- **Transfer Learning & Fine-Tuning:** Adapted and fine-tuned pre-trained models for precise emotion recognition.
- **Ensemble Method:** Combined model strengths using weighted F1 score approach for enhanced accuracy and reliability.
- **Mobile App Integration:** Deployed in a cross-platform app for real-time, accessible emotion analysis



4. Tools

vertex.ai Firebase Flask Flutter PyTorch

5. App Flow

- **Login Page (Figure 1):** Displays the login interface where users can securely access their accounts.
- **Home Page (Figure 2):** Features three main functions accessible from the home screen, serving as the central hub for user interaction.
- **Emotion Result Page (Figure 3):** Shows the results of the emotion analysis; this page appears after a user uploads an image for analysis from the home page.
- **History Page (Figure 4):** Contains a list of previously analyzed images and their results, accessible via the 'History' button on the home page.

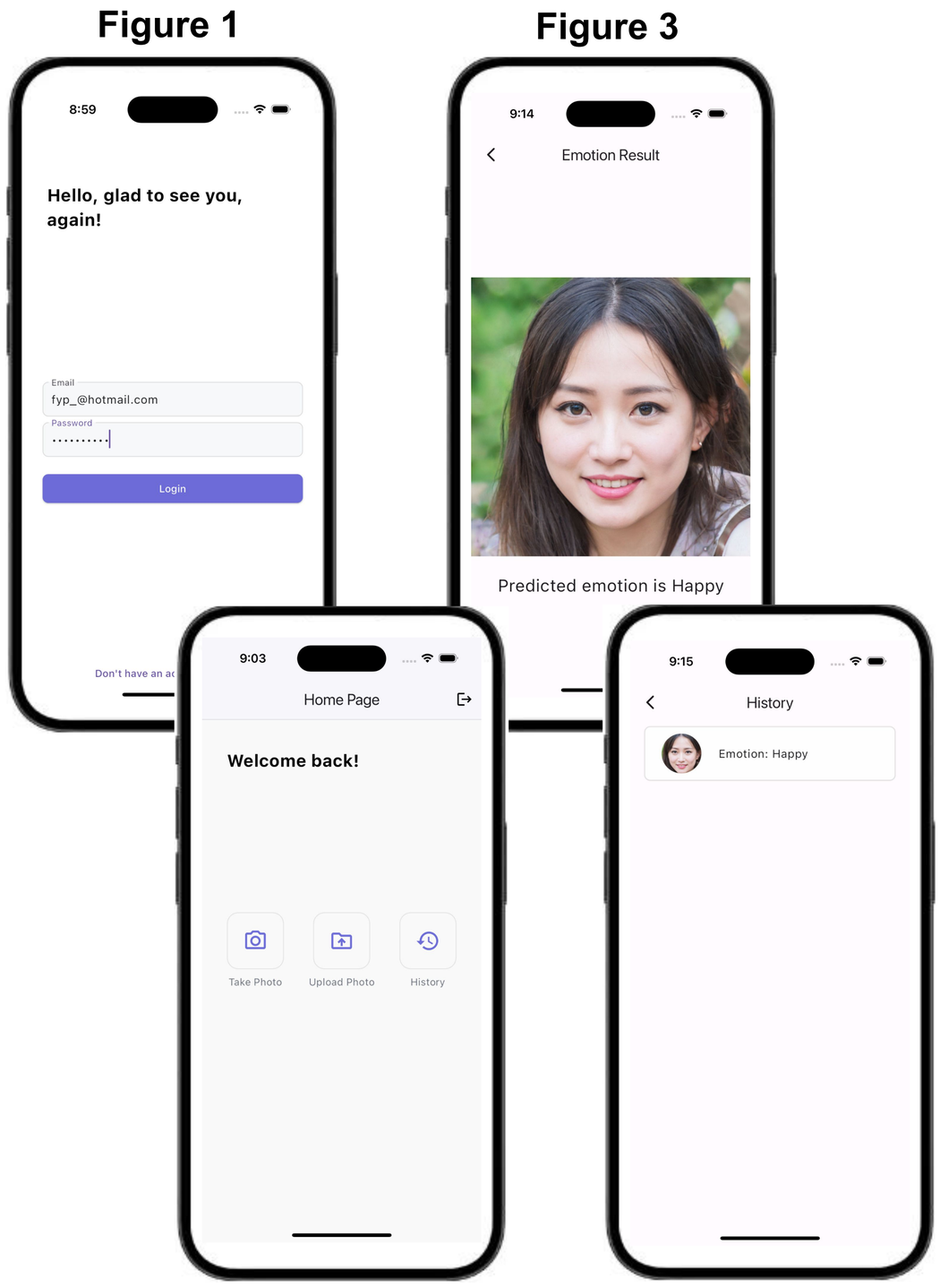


Figure 1 **Figure 3**

Figure 2 **Figure 4**

Conclusion & Future Work

- Developed an advanced FER system using CNNs, enhancing real-time emotion recognition by achieving a balanced F1-score across emotions, with a **macro average of 70%**. This ensures reliable detection across diverse expressions. Integrated into a mobile app, the system broadens access to sophisticated FER technology.
- Future work will refine deep learning models, expand detectable emotions, optimize real-time performance, and enhance system reliability across diverse demographic and cultural backgrounds.