Real-Time Facial Emotion Recognition Using AI

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Introduction

- **Facial emotion recognition** (FER) is a technology that analyzes facial expressions from images or videos. [1]
- It has diverse **applications** in healthcare, gaming, and marketing. [2]
- Our project aims to build a **real-time emotion analysis app**.
- Focuses on **Middle Eastern faces**, and women wearing **hijab**.
- Improves **usability** in the Arab world.

Project Impact

- FER systems are important due to their **impact** on many field.
- In **healthcare**, used to monitor the facial expressions of patients. [3]
- In **social life**, it can help in communicate with others. [4]
- In **education**, used to monitoring students' attention. [5]

Related Work

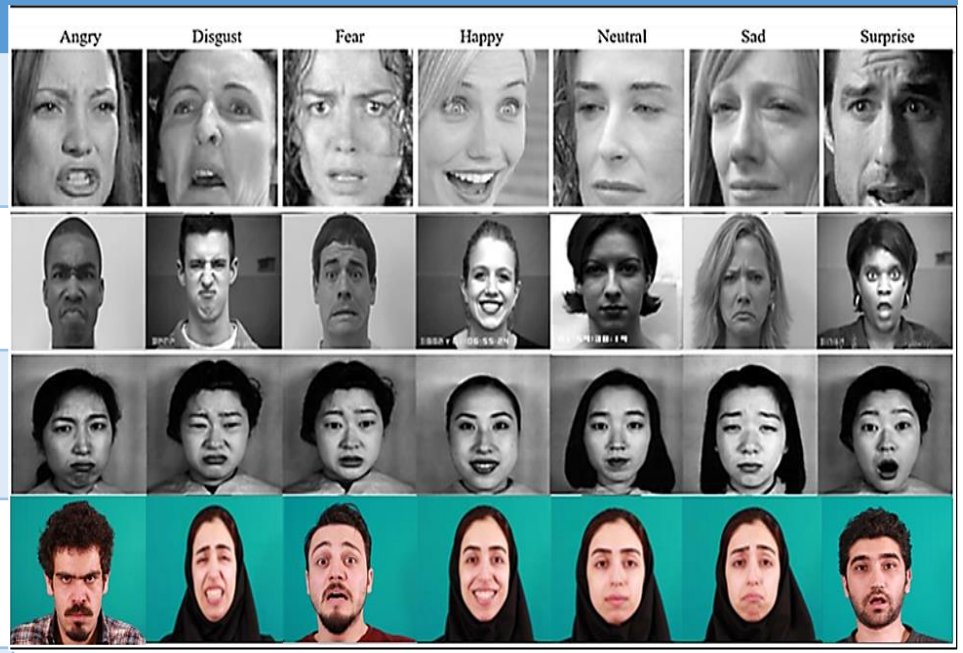
- **Face Analyzer** is Android app that detect faces and provides facial attributes. [6]
  - The **disadvantage** is that results are not always accurate, and it does not work in real-time.
- Where our app stands out is the **lack of bias**.
  - Provide **advice** and helpful **video**.
  - Detect emotions in **real-time**.
  - Sends a **notification** about the user's feeling.

Face Analyzer App [7]

Datasets

Dataset	Includes	Total Number of Images	Number of Classes	Resolution	Emotion Classes	Source
FER2013	_	35,887	7	48x48	Angry, Disgust, Fear, Happy, Sad, Surprise, Neutral	Kaggle
Extended Cohn-Kanade (CK+)	_	902	7	640x490 or 640x480	Angry, Disgust, Fear, Happy, Sad, Surprise, Neutral	University of California, Berkeley
Japanese Female Facial Expression (JAFFE)	_	213	7	256x256	Angry, Disgust, Fear, Happy, Sad, Surprise, Neutral	Kyushu University, Japan
Iranian Emotional Faces Database (IEFDB)	_	248	7	5184x3456	Angry, Disgust, Fear, Happy, Sad, Surprise, Neutral	Tehran University of Medical Sciences, Iran
Hybrid	CK+, JAFFE, and IEFDB Datasets	1363	7	48x48	Angry, Disgust, Fear, Happy, Sad, Surprise, Neutral	We Created It

Sample Images



Datasets Preprocessing

- Preprocessed the datasets images into the **FER2013** dataset images format.
  - **Resized** the images to a size of **48x48** pixels.
  - Converted the **color space** of the images to **grayscale**.
  - **Normalized** the pixel values to a range between 0 and 1.
  - **Split** them as show in the table below.

Dataset	Split Value	Number of Images for IEFDB Dataset	Number of Images for Hybrid Dataset
Train	60%	158	872
Test	20%	50	273
Validation	20%	40	218

Retraining and Testing the CNN Model

- We used a **CNN** algorithm that can learn to extract facial features.
- It provides high accuracy to changes in facial expression and lighting. [8]
- Using **Python**, we have retrained and tested the ML model.
- Using the **Scikit-learn** library to train-test split.
- Using the **TensorFlow** library to load a pre-trained kaggle_model file.

The First Results

- We first **retrained** the model on the training set of the **IEFDB**.
- Using specific **hyperparameters** values.

Model Hyperparameters Retrained on the IEFDB Train Set

Model Hyperparameters	Values
Learning Rate	0.01
Number of Epochs	400
Batch Size	40
Optimizer	Adam
Loss Function	Categorical Cross-entropy

Accuracies of the Model Retrained on the IEFDB Train Set

Dataset	IEFDB Dataset Accuracy	Hybrid Dataset Accuracy
Train	92%	–
Test Before Retraining the Model	28%	16%
Test After Retraining the Model	74%	33%
Validation	58%	–

The Final Results

- To obtain good accuracy, and improve the performance of the ML model.
- We tried to increase the size of the training dataset using the hybrid dataset.
- We **retrained** the model on the training set of the **hybrid dataset**.

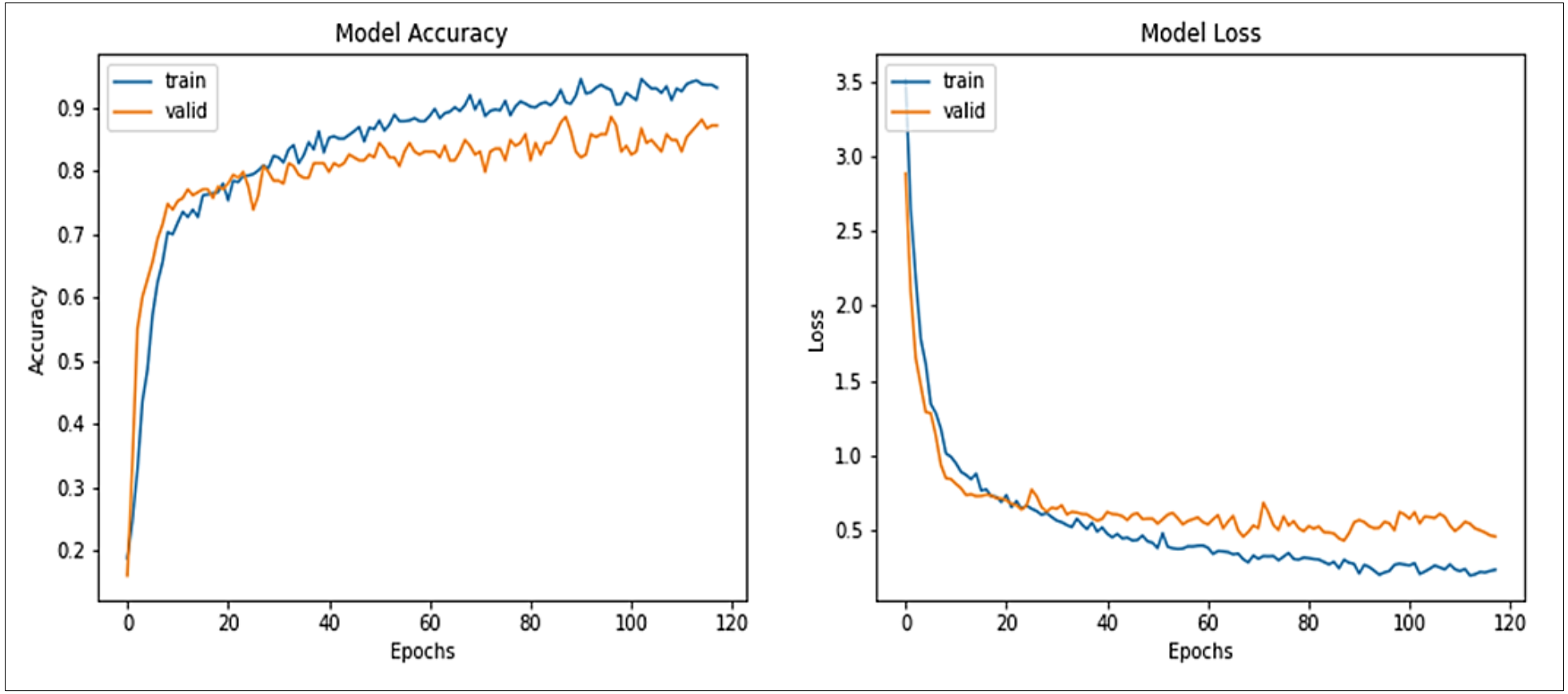
Model Hyperparameters Retrained on the Hybrid Train Set

Model Hyperparameters	Values
Learning Rate	0.001
Number of Epochs	300
Batch Size	70
Optimizer	Adam
Loss Function	Categorical Cross-entropy

Accuracies of the Model Retrained on the Hybrid Train Set

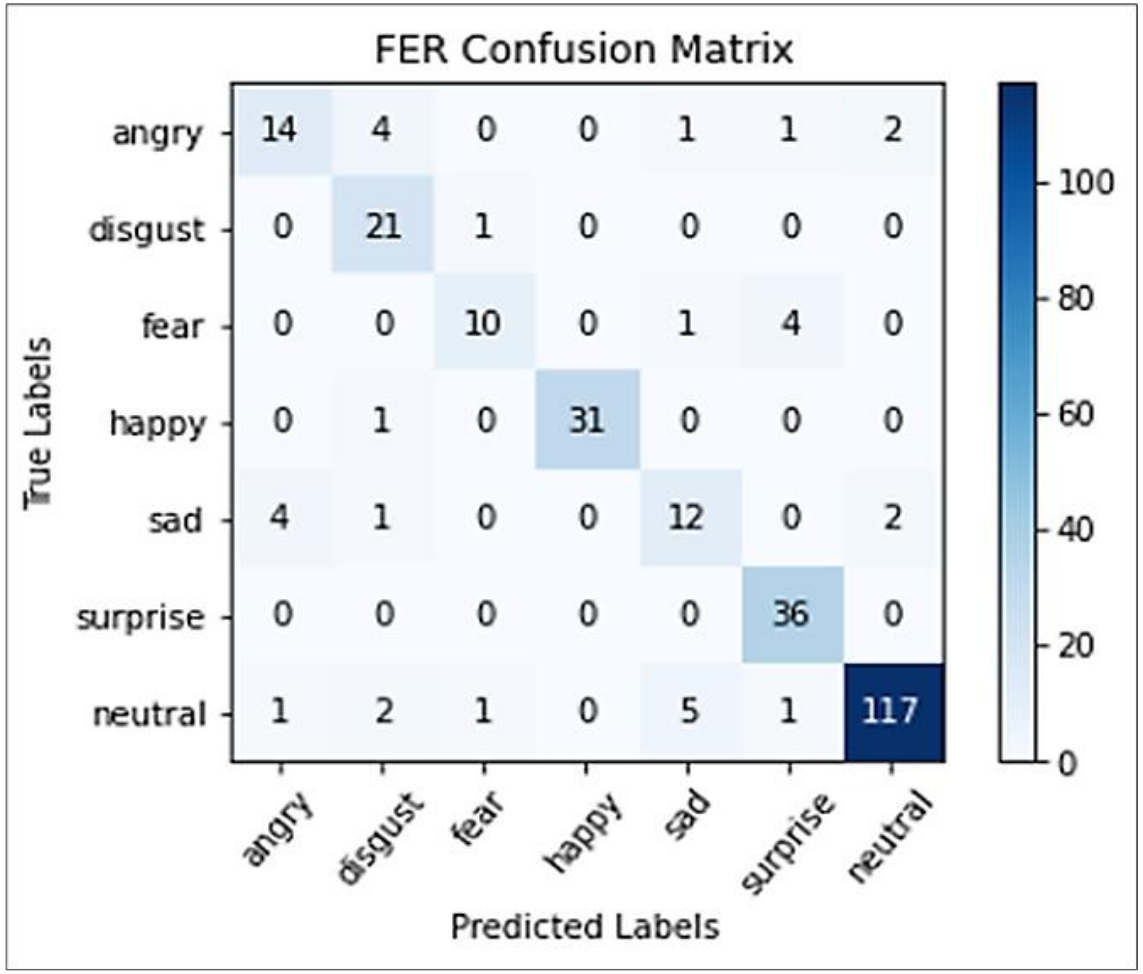
Dataset	IEFDB Dataset Accuracy	Hybrid Dataset Accuracy
Train	–	99%
Test Before Retraining the Model	34%	19%
Test After Retraining the Model	90%	88%
Validation	–	87%

Accuracy and Loss Model Graphs for Training and Validation Sets in the Hybrid Dataset



Confusion Matrix for Hybrid Test Set

- The most of the false predictions are in **neutral** emotion.



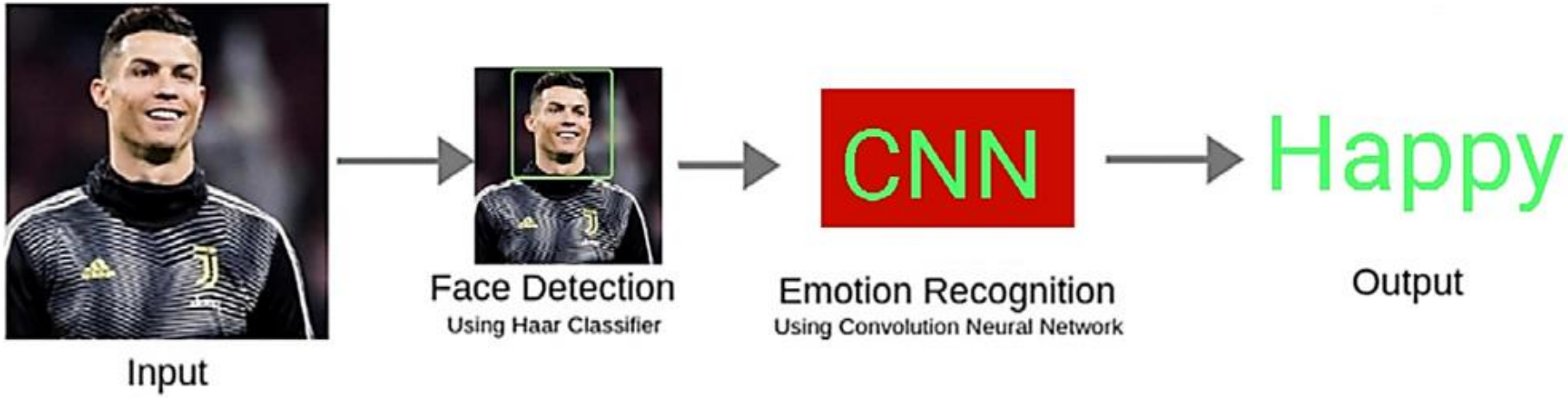
Convert Keras Model to TensorFlow Lite

We converted our Keras model to **TFLite** format for use in our Android app based on several steps:

1. Import the TensorFlow Lite converter.
2. Used the **TFLiteConverter** module to convert our Keras model into TFLite format.
3. We add it to our Android app as a model file.
4. In our app, we used the **TensorFlow Lite interpreter** to load the model.

Face Detection

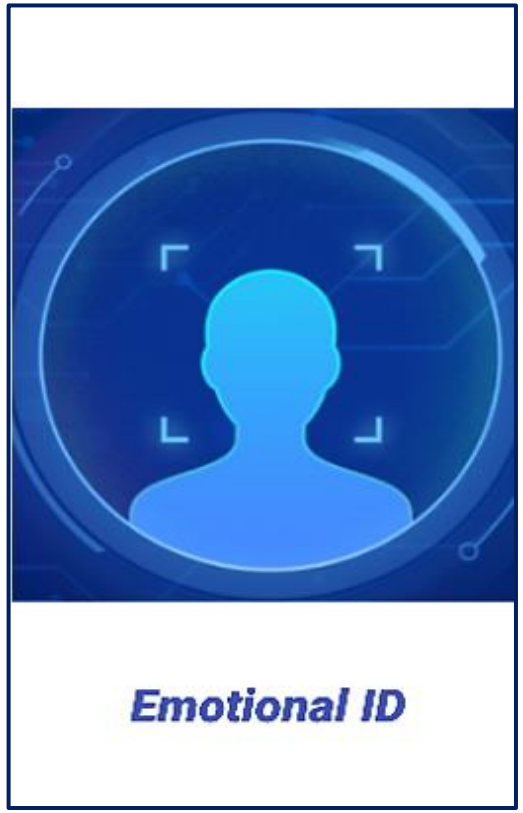
- We used the **haarcascade_frontalface_alt.xml** file in our app for face detection.
  - Which is a pre-trained model classifier trained on a large dataset of face images.
  - It is part of the **OpenCV** library.
- This classifier can be used in various computer vision **applications**, such as security systems, and facial recognition. [9]



Face Detection and Emotion Recognition

App Design and How it Works

- We developed our app using **Android Studio**, **Java** language, and **XML** code to design the UI.



Screen 1

Screen 2

Screen 3

Take a Photo from the Camera

Steps:

- Press the button TAKE PHOTO.
- Press CAPTURE IMAGE button to take a photo.
- To view the results press PROCESS IMAGE button.
- Then, the app displays the captured image, emotion, and advice.
- Press WATCH VIDEO button to opens a video.

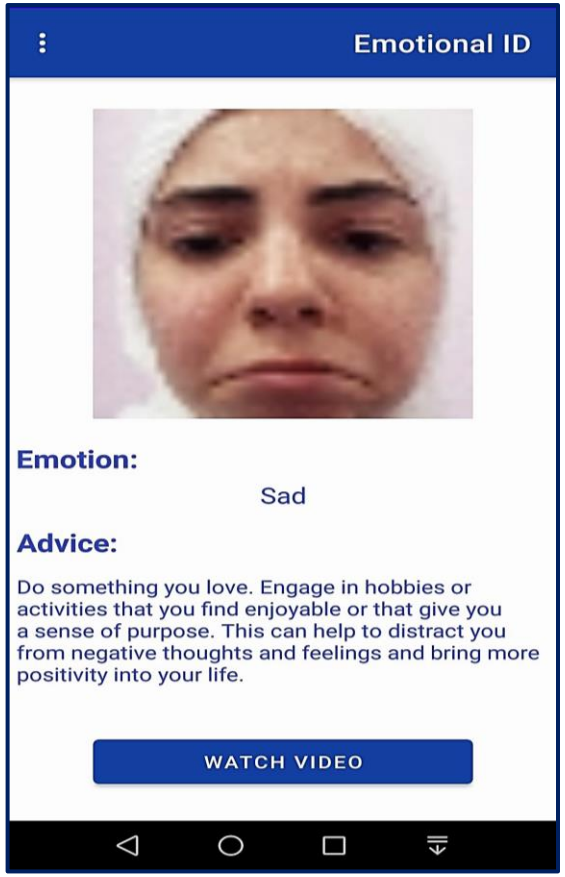


Image That Take by Camera

Choose Photo from Gallery

Steps:

- Press the button TAKE PHOTO.
- Press CHOOSE IMAGE FROM GALLERY button to choose a photo.
- To view the results press PROCESS IMAGE button.
- Then, the app displays the chosen image, emotion, and advice.
- Press WATCH VIDEO button to opens a video.

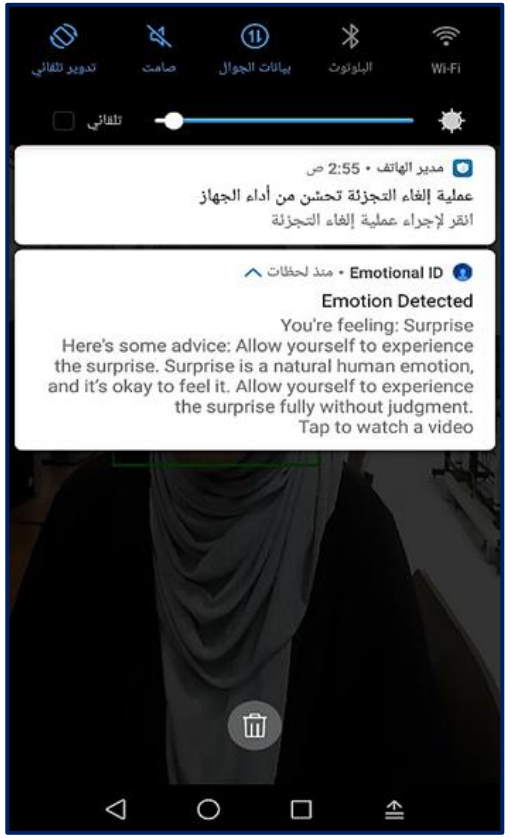
Image That Choose from Gallery

Detects Emotions in Real-Time

Steps:

- Press the button REAL-TIME.
- The camera screen will open.
- Press  at the top to flip the camera.
- Press  at the top to set the delay time to send notification.
- You will receive a notification containing your emotions and tips.
- Clicking on the notification will open a video for you to watch.

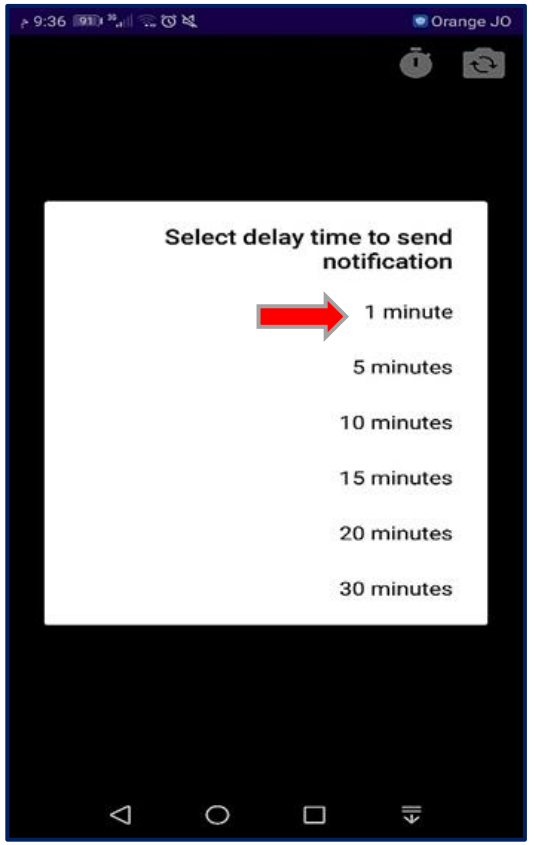
Surprise Emotion in Real-Time



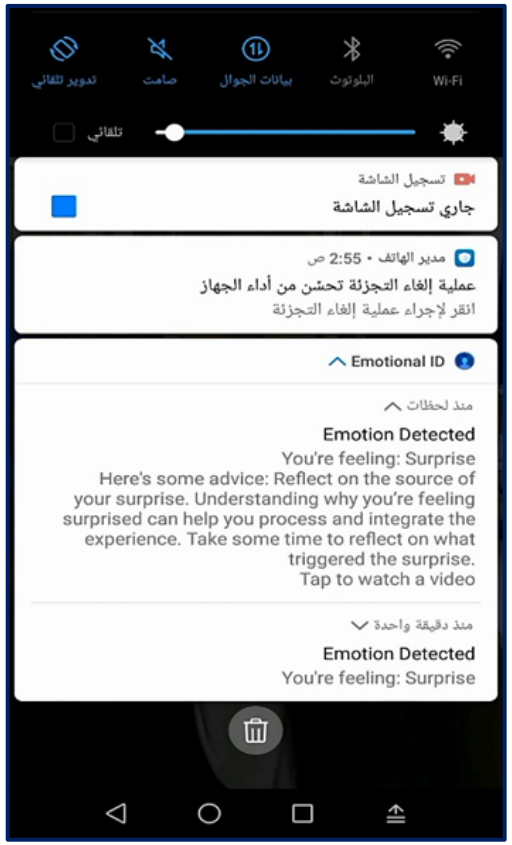
Surprise Notification

Select Delay Time to Send Notification

- You can choose one of these times.
- If we choose **one minute** for example, the notification will be sent after one minute.



Choose a Delay of One Minute



The Notification Appears After One Minute

Conclusions

- Our project addressed the challenge of identifying facial expressions by developing a **real-time facial emotion recognition app**.
- Focused on **Middle Eastern faces**, especially for women wearing **hijab**.
- To overcome the **bias** and **inaccuracy**.
- Used the efficient **CNN** algorithm to analyze facial expressions.
- It turned out that the retrained model on a **hybrid dataset** is the most accurate.
- Test accuracy of **88%** was achieved on the **hybrid test set** and test accuracy of **90%** on the **IEFDB test set**.
- We hope that our work will be beneficial for both academic and industrial purposes.

Future Work

- Expand the dataset.
- Link to cloud services.
- Integration with wearable devices, such as smartwatches.
- Detect emotions using voice or body language.

References

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[8] L. Bejjagam, and R. Chakradhara, "Facial Emotion Recognition using Convolutional Neural Network with Multiclass Classification and Bayesian Optimization for Hyper Parameter Tuning," 2022.

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Thank you!