Facial Recognition with Expression Detection System

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***Abstract*—This project aims to develop a machine learning-based system for facial recognition and expression detection. The system can classify expressions into five categories: Angry, Happy, Sad, Surprised, and Neutral. This report discusses the project's progress, challenges encountered, and future plans.**

***Index Terms*—Facial Recognition, Expression Detection, Machine Learning, ResNet50, OpenCV.**

I. Introduction

The "Facial Recognition with Expression Detection System" project focuses on building a machine learning-based model to detect human faces and recognize facial expressions. This system is designed for security, sentiment analysis, human-computer interaction, and behavioral studies. The integration of artificial intelligence into facial expression recognition has gained significant attention in various domains, including mental health monitoring, customer engagement analysis, and automated surveillance systems.

Our goal is to develop an efficient, real-time system that can classify human emotions into predefined categories such as Angry, Happy, Sad, Surprised, and Neutral. The project aims to overcome challenges in data collection, real-time processing, and accuracy enhancement to ensure practical usability in real-world applications.

This report provides an update on recent progress, challenges, and next works.

II. Progress

A. Model Selection

We read multiple research papers and analyzed different models such as VGG-Face and ResNet50. Based on our available resources, ResNet50 was selected due to its balance between efficiency and accuracy, making it ideal for real-time facial expression detection.

Further, hybrid models incorporating attention mechanisms and transformers are being explored for enhanced feature extraction and better classification performance.

B. Data Collection

Our group has four members. Each of us have been tasked with collecting photos of expressions of three different individuals, making a total of 12 individuals in the dataset. The dataset consists of five classes: Angry, Happy, Surprised and Neutral. We used OpenCV and the cvZone library to create a script that helps capture and preprocess the images efficiently.

To facilitate efficient image capturing and preprocessing, we developed a Python script utilizing OpenCV and the CvZone FaceDetector module. The script automates face detection, cropping, and dataset storage.

We also implemented data augmentation techniques such as:

- Rotation and flipping for different facial angles.
- Brightness adjustments to handle variations in lighting.
- Gaussian noise addition to improve model generalization.

By implementing these preprocessing techniques, the system ensures higher model robustness and better adaptability to real-world scenarios.

C. Dataset Collection Script

A Python script was created for real-time image collection and face detection using OpenCV.

Here's how the script works:

- The webcam is activated to capture live footage.
- Detects faces and extracts bounding boxes using the CvZone FaceDetector module.
- Saves cropped and resized images (224x224) into predefined folders based on expressions.
- Implements a manual image-saving feature with keyboard shortcuts (s to save, f to stop saving, ESC to exit).

III. Challenges

- **Dataset Imbalance:** Dataset Limitation: Without going through a trial and error process, it's difficult to estimate how much data we actually need to successfully train our model.
- **Hardware Constraints:** Training the models requires a lot of computer power, which slows down real-time performance.
- **Real-Time Processing Delays:** We also need to make it faster so that the system can detect faces and understand expressions without any delay.
- **Facial Expression Similarity:** Some facial expressions look very similar, making it hard for the system to correctly identify them. To solve this problem, we are testing advanced methods that can capture small details in facial features. These improvements will help the system recognize expressions more accurately.
- **Lighting Variations:** Changes in lighting can make it difficult for the system to detect and recognize faces properly. If the lighting is too bright or too dark, the system may not work correctly. To fix this issue, we are using

special methods to adjust the brightness automatically. These techniques will help the system recognize faces more accurately in different lighting conditions.

- **Occlusions:** Items like glasses, masks, and beards can block parts of the face, making recognition difficult. The system needs to be trained to handle such cases.
- **Pose Variability:** People may turn their heads or tilt their faces, which can reduce recognition accuracy. Solutions like pose normalization or multi-angle training are needed.
- **Scalability Issues:** When the system is deployed on a large scale, such as in crowded places, it must handle multiple faces at once without slowing down.
- **Ethical and Privacy Concerns:** Storing and analyzing facial data raises concerns about personal privacy and data security. The system should follow ethical AI guidelines.
- **Expression Ambiguity:** Some expressions are difficult to classify because they look similar, such as a neutral face versus a slightly happy or sad face.

IV. Future Work

- Making the System More Accurate: We will improve the model so it can better recognize facial expressions, even when emotions look similar.
- Usability for Real-World Use: Develop a user-friendly interface for real-world applications.
- Using the System on Mobile Phones: The system will be optimized to work on smartphones and small devices, making it useful for real-time applications like security and education.
- Training with More Diverse Faces: We will train the model with images of people from different backgrounds, ages, and lighting conditions to ensure fairness and better recognition.
- Adding Voice and Text Analysis: By combining facial expressions with voice tone and written text, the system will understand human emotions more accurately.
- Making the System Explainable: We will develop ways to show how the system makes decisions, so users can understand why a certain emotion was detected.
- Improving Dataset: Continue collecting expression images with equal balance across all classes.
- Reducing Bias in Recognition: The system will be improved to avoid unfair results based on race, gender, or age, making it accurate for everyone.
- Allowing Users to Give Feedback: A feedback option will be added so users can report mistakes, helping the system learn and improve over time.
- Making it Available Online: The system can be hosted on the internet, allowing different organizations to use it for various purposes like schools, hospitals, and businesses.
- Automatically Expanding the Dataset: New techniques will be used to collect more facial images and create synthetic data to improve accuracy.

V. Conclusion

We have successfully collected data, chosen a model, and processed the images. Even though we faced some challenges with hardware and resources, the project is moving forward as planned. Next, we will start training the model using the dataset we've gathered and work on getting the system ready for use.

References

[1] Anagha S. Dhavalikar, R. K. Kulkarni, "Face detection and facial expression recognition system", IEEE, DOI: 10.1109/ECS.2014.6892834, 2014.

[2] Kai-biao ge, jing wen, bin fang, "Adaboost Algorithm based on MB-LBP features with skin Color segmentation for face detection" Proceedings of the 2011 International Conference on wavelet analysis and pattern recognition, guilin, 10-13 july, 2011.

[3] Ewa Piatkowska "Facial Expression Recognition System", Master's Thesis Technical Report, 2009.

[4] Kamarul Hawari, Bin Ghazali, Jie Ma, Rui Xiao, "An Innovative Face Detection based on Skin Color Segmentation", International Journal of Computer Applications (0975-8887), Volume 34-No.2, November 2011.

[5] Aliaa A. A. Youssif and Wesam A. A. Asker, "Automatic Facial Expression Recognition System Based on Geometric and Appearance Features", Computer Information Journal, 2011, Volume 4, Issue 2, Page 115.

[6] V. Gomathi, Dr. K. Ramar, and A. Santhiyaku Jeevakumar, "A Neuro Fuzzy approach for Facial Expression Recognition using LBP Histograms", International Journal of Computer Theory and Engineering, Vol. 2, No. 2 April, 2010.

[7] Kamarul Hawari, Bin Ghazali, Jie Ma, Rui Xiao, "An Innovative Face Detection based on Skin Color Segmentation", International Journal of Computer Applications (0975-8887), Volume 34-No.2, November 2011.