Faculty of Computers and Artificial Intelligence
Artificial Intelligence
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Artificial Intelligence project

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Project information

- Project number=26
- Project name= Automated Facial Expression Recognition using Artificial Neural Networks.

Project shared link

https://github.com/MAHMOUDBADAWY74/PROJECT-AI

the dataset employed:

https://www.kaggle.com/datasets/msambare/fer2013

project idea and overview:

Humans can detect a facial expression of any person easier, because it's naturally directly recognized, but it's very difficult to do by machine or computer. There are 3 main stages when designing a facial expression recognition system, that is, face detection (recognizes faces), extraction of the facial expression information (feature extraction which is separate parts of the face that has information about facial expressions) and the last is the classification of the expression.

This research facial expression, especially for smiles and not smile expressions, recognition using Artificial Neural Network algorithm with Back Propagation models and optimization using Principal Component Analysis. The accuracy of the results obtained to predict the smile image is equal to 81.67%, while the accuracy for predicting not smile image is 61.67%

The first and very important step to recognize an expression is to detect faces from the first sequence of images. The next step is to develop a mechanism for extracting facial features from the observed facial image sequences. The facial features are a feature that stands out from the various parts of the eyebrowface, eyes, nose, mouth, chin, etc. The feature extraction step is often referred to face tracking and its features. The final step is to develop a classifier, which would classify facial expressions into one of the basic facial expressions.

The recognition of facial expressions is currently becoming an interesting trend for study.

It can be utilized in everyday life. The most obvious example is the use of Intelligence Education System, or Intelligent Tutoring System, which essentially teaches the learning system to help the teaching and learning process virtually.

The ability of computers to understand, differentiate human expression, and take appropriate action is one of the main areas of research focus in Human Computer Interaction (HCI).

Picard states that "Expression plays an important role in rational perceptions of decision making, learning, and various functions".

Therefore, empowering computers to understand human expression will make computer interaction with humans more meaningful and easier. Suppose that during online learning, student acceptance of material will increase if the computer knows the state of student expression.

With the knowledge of student expression, the computer can provide appropriate learning in accordance with the conditions of student expression at that time in this paper, we propose a new algorithm for detecting emotion via frontal facial image.

The algorithm is composed of three stages: image processing stage, facial feature extraction stage, and emotion detection stage.

In the image processing stage, we use the proposed image processing algorithm developed in a previous study.

This stage consists of feature extraction using Artificial Neural Networks, so the extracted features are compared with training samples. The ultimate stage classifies the given outputs and shows facial features recognition results. It then determines whether the topic is happy, angry or disgusted or fear or sad or surprise or in neutral state. The synthetic Neural Network uses Multi-Layer-Perceptron (dense layer, flatten layer). With the back propagation algorithm for features extraction and classification it's in range between 25000 ,30000 input nodes, one hidden layer with 50 neurons, and one output layer. Testing results show that this method is used for, interpreting seven facial expressions: happiness, anger and disgust and fear and sad and surprise and neutral. It extracts accurate outputs that Finally, can be used in other fields of studies like psychological assessment and education

To extract more effective feature, we proposed the new feature extraction

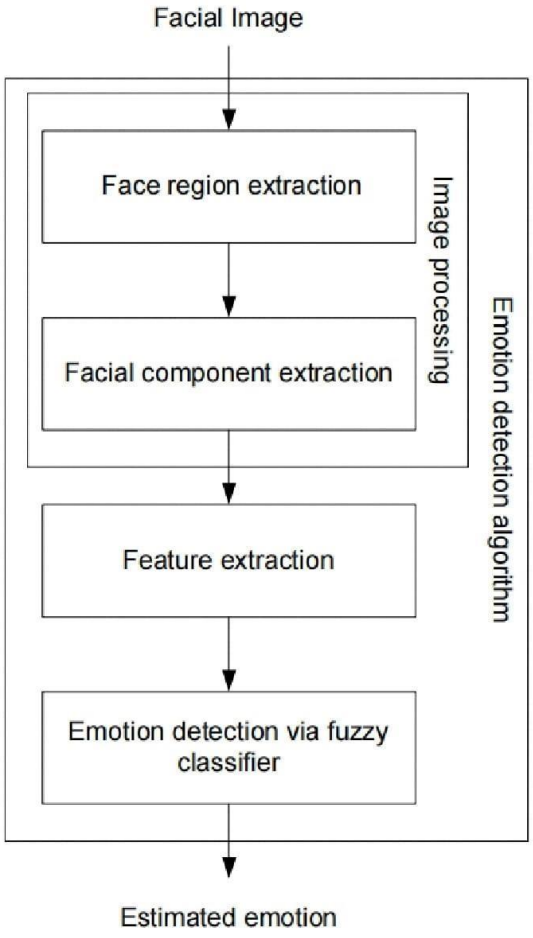


Fig. 1. Overall procedure of emotion detection algorithm.

extract feature by comparing geometric and shape information. Generally, there are only vague patterns given as the input of system in emotion recognition problem. Therefore, it is not easy to design an emotion recognition system.

To overcome this difficulty, the fuzzy classifier is adopted in emotion detection stage. When the extracted features are given, the fuzzy classifier returns the recognized emotion. The

fuzzy classifier is identified by linear matrix inequality (LMI) optimization method.

2. face region extraction

In this section, we present image processing stage to extract fundamental information from facial image. Figure 1 shows the overall procedure of emotion detection algorithm.

age processing stage, the facial region is extracted, and then facial components are extracted. In face region extraction algorithm, the fuzzy color letter and histogram analysis method are used. It is not easy to recognize the skin color in each image because skin color changes depending on personality and illumination condition.

However, the skin color should be detected by using some type of letter to extract the face region.

To solve this docility, fuzzy color letter is used.

The fuzzy color later is based on fuzzy inference system.

The vague skin colors are represented as fuzzy sets and memorized in fuzzy rules. The structure of fuzzy rule represented as,

The detailed description for Algorithm 1 presented in [2] When face region is extracted, the facial components are extracted by using virtual face model (VFM) based histogram analysis.

VFM is proposed to reduce searching space of his to gram analysis method. VFM contains position and length information of each facial component.

In this paper, we used VFM proposed in [2]. There are three face regions to extract the facial component.

By investigating each face region, we can extract accurate facial component in fast time. The detailed algorithm is presented in [2].

3. Feature Extraction for Emotion Recognition

The feature vector extraction method is the most important key point in emotion recognition problem. Especially, it is necessary to get good feature vector to make better recognition accuracy.

In the facial feature extraction stage, we propose a new feature vector extraction method.

The proposed method divides whole image into three feature regions: eye region, mouth region, and auxiliary region.

Several information is extracted from each region: geometric and shape informal

Applications:

- That project applied many applications in the real world like interactive robots.
- • Robots detect human emotional
- • Azura cloud
- • Human computer interaction

2) Deep Face by Facebook:

- **Description:** Developed by Facebook's AI Research (FAIR) lab, Deep Face is a deep learning model for face recognition, which includes facial expression recognition as one of its components.
- **Key Features:**
- Deep neural network architecture.
- Trained in a large-scale dataset.
- Achieved competitive results on benchmark datasets.

3) Facial Expression Recognition using Convolutional Neural Networks (FER-CNN): • **Description:** Various research papers and implementations utilize Convolutional Neural Networks for facial expression recognition.

- **Key Features:**
- Convolutional layers for feature extraction.
- Pooling layers for spatial down-sampling.
- Fully connected layers for classification.

4) EmotiW Challenge Models:

- **Description:** The Emotion Recognition in the Wild (EmotiW) challenge evaluates facial expression recognition models in real-world scenarios.

Key Features:

- Participants often use deep neural networks, including CNNs and recurrent networks (RNNs).
- Some models use ensemble methods for improved performance.

5) VGG-Face:

- **Description:** While originally designed for face recognition, VGG-Face and similar architectures have been adapted for facial expression recognition tasks.
- **Key Features:**
- Based on the VGG (Visual Geometry Group) network architecture.
- Pre-trained on large face datasets.

6) Facial Action Coding System (FACS) Based Models:

- **Description:** Some models focus on recognizing facial action units using FACS, which are anatomically based facial muscle movements.
- **Key Features:**
- Utilizes FACS as a basis for labeling facial expressions.
- May involve more fine-grained analysis of facial muscle movements.

7) Google's Face Net:

- **Description:** While primarily designed for face recognition and verification, Face Net can be extended to include facial expression recognition.
- **Key Features:**
- Triplet loss function for training embeddings.
- Embedding-based representation of faces.

8) Affect Net:

- **Description:** Affect Net is a dataset for facial expression recognition, and various models have been developed using this dataset.
- **Key Features:**
- Models may use architectures like CNNs.
- Focus on recognizing a broad range of facial expressions.

A Literature Review of Academic publications:

paper 1: Face Expression Recognition: a Brief Overview of the Last Decade

abstract of this paper: The huge research effort in the field of facial expression recognition (FER) technology is justified by the potential applications in multiple domains: computer science, engineering, psychology, and neuroscience, to name just a few. Obviously, this generates an impressive number of scientific publications. The aim

of this paper is to identify key representative approaches for facial expression recognition research in the past ten years (2003-2012)

paper 2: ANN-based Human Facial Expression Recognition in Color Images

abstract of this paper: This paper describes an ANN based human facial expression recognition method. An automatic technique is generated for detecting 22 most important facial feature point and generation of facial feature vector by finding the Euclidian distances between some points. Here the key

facial regions are found based on a defined face model. The face model is generated by the detection of the tribes and mouth points. Skin color detection is done by 2D Color Space Skin Clustering Method and face detection is done by connected component analysis followed by a set of face heuristics. Feed forward back Propagation neural network is used as the network classifier to classify the facial expression from a set of seven basic expressions like happy, sad, surprise, fear, anger, disgust and neutral the experiment is done on Color FERET Database and got an accuracy of 100% for trained dataset and 85% accuracy for test set.

paper 3: Facial Expression Recognition using Gabor filter and Multi-layer Artificial Neural Network

abstract of this paper: This paper deciphers the Facial Expression Recognition (FER) using Gabor Filter and Artificial Neural Network (ANN), extracts the facial expression using Gabor filter and then classify the facial expressions using the multi-layer artificial neural network. Recognizing facial expressions of human beings in an image processing by a computer is an interesting and challenging research work. This paper is based on detection and classification of facial emotion expressions. At first, we design an algorithm to detect the face

reason image in the whole image using Viola-Jones detection algorithm, then by using Gabor filter extracts the facial

features in the spatial domain. The Gabor filter is used to capture the whole frequency spectrum in all directions. And then extract meaningful facial features using Gabor Filter. Finally, they have been successfully classified the facial expressions using the extracted Gabor features of face image used as an input to the Artificial Neural Network classifier. The experimental results on database images of JAFFE show the robustness and better recognition rates of the proposed approach

paper 4: A Survey Paper on Facial Expression Recognition System

abstract of this paper: Facial expression recognition has many potential applications which have attracted the attention of researchers in the last decade. Feature extraction is one important step in expression analysis which contributes toward fast and accurate expression recognition. Happy, surprise, disgust, sad, anger and fear facial expressions Emotion are of facial recognition. Facial expressions are most used for interpretation of human emotion. There is a range of different

emotions in two categories: positive emotion and non-positive emotion. There are four types of generally used systems: Face detection, extraction, Classification and recognition. In Existing system, it is not so much identifying exact emotion of a person. In this proposed taking the large-scale image, hybrid extraction feature and ANN classification of frame-based expression recognition try to detect facial expression detection and emotion detection for positive and non- positive images also design robust.

paper 5: Automatic Facial Expression Recognition in Standardized and Non-standardized Emotional Expressions.

Abstract of this paper: Emotional facial expressions can inform researchers about an individual's emotional state. Recent technological advances open new avenues to automatic Facial Expression Recognition (FER). Based on machine learning, such technology can tremendously increase the amount of processed data. FER is now easily accessible and has been validated for the classification of standardized prototypical facial expressions.

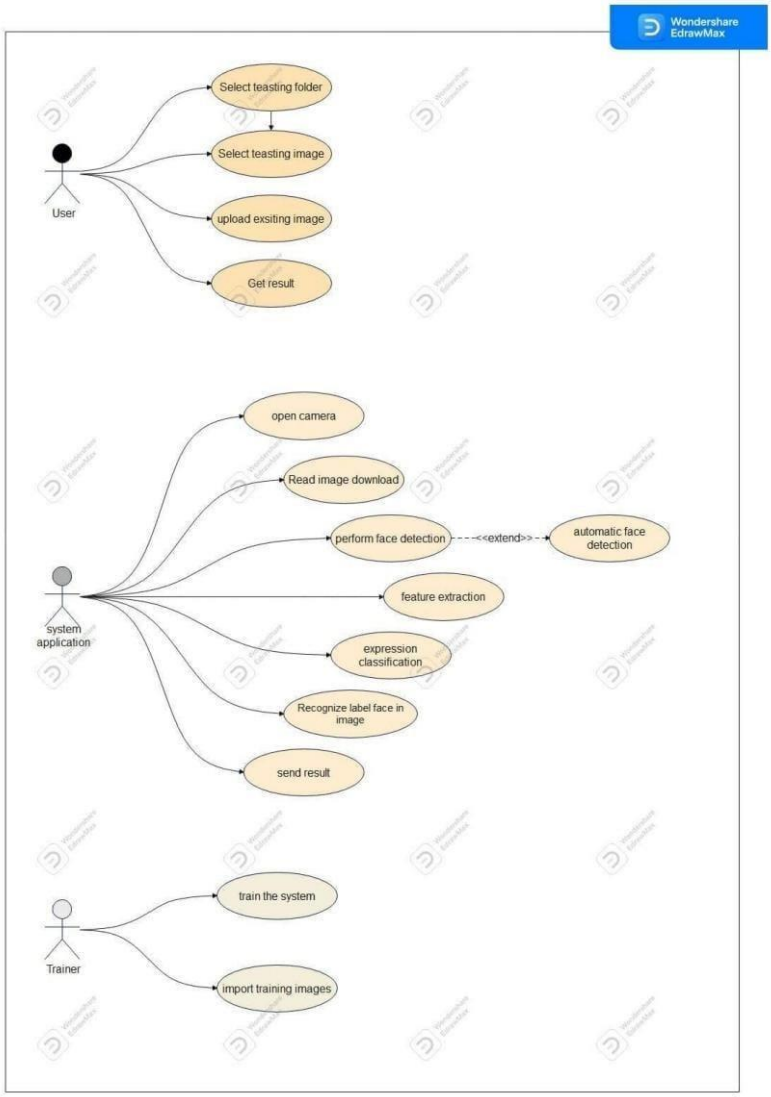
However, applicability to more naturalistic facial expressions still remain uncertain. Hence, we test and compare performance of three different FER systems (Azure Face API, Microsoft; Face++, Megvii Technology; Face Reader, Noldus Information

Technology) with human emotion recognition (A) for standardized posed facial expressions (from prototypical inventories) and (B) for non- standardized acted facial expressions (extracted from emotional movie scenes). For the standardized images, all three systems classify basic emotions accurately (Face Reader is most accurate) and they are mostly on par with human raters. For the non- standardized stimuli, performance drops remarkably for all three systems, but Azure still performs similarly to humans. In addition, all systems and humans alike tend to misclassify some of the non- standardized emotional facial expressions as neutral. In sum, emotion recognition by automated facial expression recognition can be an attractive alternative to human emotion recognition for standardized and non-standardized emotional facial expressions.

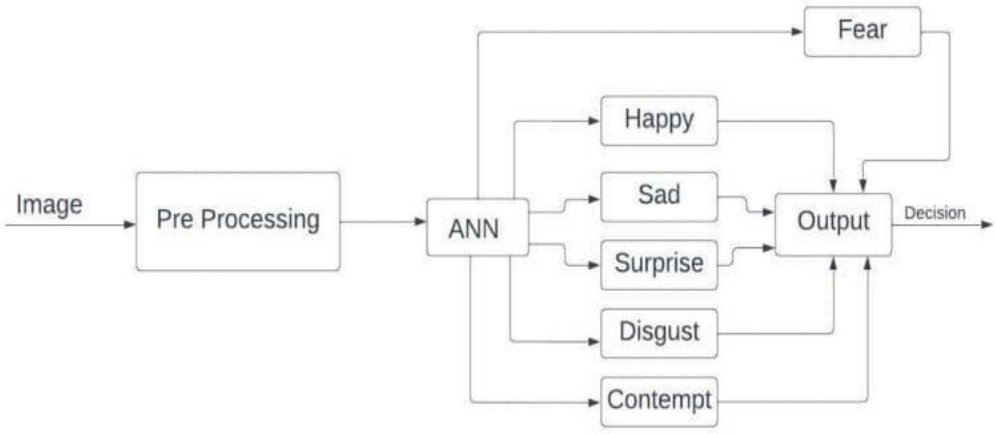
However, we also found limitations in accuracy for specific facial expressions; clearly there is need for thorough empirical evaluation to guide future developments in computer vision of emotional facial expressions.

Main functionalities/features:

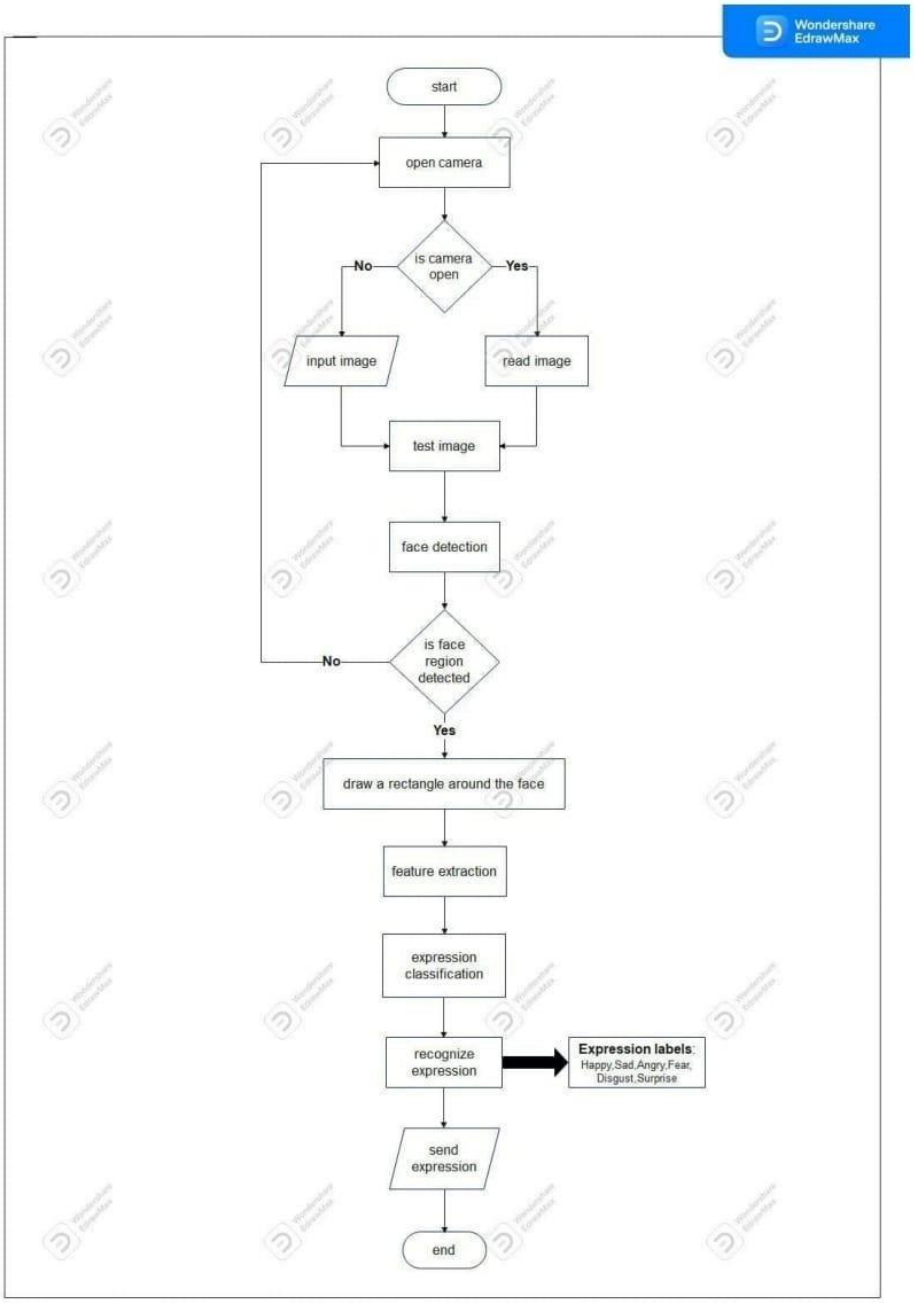
use case diagram:



All the details of the AI/Machine-Learning algorithm(s)/approach(es) used to develop your project:


Fear
Happy
Image
Pre Processing
Sad
ANN
Output
Decision
Surprise
Disgust
Contempt

Flowchart to model and algorithm:



Analysis, Discussion, and Future Work:

2. Advantage of ANN :

o Storing information on the entire network o Ability to work with incomplete knowledge

o Having fault tolerance o Having a distributed memory o Gradual corruption o Ability to make machine learning o Parallel processing capability

3. Disadvantage of ANN :

o Hardware dependence

o Unexplained behavior of the network o Determination of proper network structure o Difficulty of showing the problem to the network

o duration of the network is unknown

4. Conclusions :

Model's accuracy is low because images features are more complex that Ann only can't detect it and dataset is too small to learn the classes. In complex problems we need large dataset to increase accuracy

5. What might be the future modifications You'd like to try when solving this problem?

o for complex problems like this we use deep learning models such as CNN that can extract features more efficiently by applying filters in conv. Layers

o Use large datasets to increase accuracy

Development platform

1. libraries

- tensorflow
- numpy
- cv2
- matplotlib.pyplot
- pandas
- os
- sklearn
- tkinter
- • os

- glop
- keras
- scikit-image (skimage)
- scikit-learn (sklearn)

2. Tools:

- google colab
- pycharm2023.3.1

programming language: [python (3.11.3)]

References:

- “Cătălin-Daniel Căleanu”

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