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EMOTION DETECTION USING FACIAL EXPRESSION WITH THE HELP OF MACHINE LEARNING: REVIEW

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ABSTRACT

This review paper discusses the recognition of seven emotional states based on facial expressions which are (Neutral, Joy, Sadness, Surprised, Fear, Disgust & Anger), using features calculated from a three-dimensional face model and classified using 3nn, k-NN, and MLP neural network algorithms. Additionally, the paper includes a review of different algorithms of face recognition, providing a comparison between face recognition algorithms and the combination of PCA with different techniques like (PCA, LDA, ICA, and EBGM,). It also reviews the recent literature on speech emotion recognition, considering issues related to emotional speech corpora, different types of speech features, and classification models used for the recognition of emotions. Further reviews the concept of Implicit Human-Centered Tagging (IHCT), (Vinciarelli et al., 2012, p.1) proposes a multi-modal approach that analyses both facial expressions and EEG signals & a feature-engineering based approach to tackle the task of speech emotion recognition, comparing the performance of machine learning and deep learning classifiers. Lastly, the paper examines recent studies of emotion mindreading and explores four alternative models for simulation-style emotion detection.

Keywords: Emotion, Recognition, Emotion State, Facial Expression, Features, Classifier, Neural Network.

1. INTRODUCTION

Emotion recognition using facial expressions is a crucial area of research in computer vision and machine learning that seeks to develop a system that can accurately recognize and classify emotions from facial expressions. The papers's primary goal is to help the researcher to make a machine that recognize seven different emotion states: neutral, happiness, sadness, surprise, anger, fear, and disgust. (Tarnowski et al., 2017, p.1)The system will use machine learning techniques to develop an emotion recognition system that can analyse the features of facial expression and classify emotions accurately. To achieve this, the first step is to collect a large dataset of facial expressions labelled with the corresponding emotions, which will serve as training data for the machine learning algorithms. Different machine learning algorithms such as decision trees, support vector machines, and neural networks will be explored to determine which algorithm is best suited for emotion recognition. (Haldar et al., 2016, p.3) During the training process, the algorithms will learn to recognize patterns in the data that correspond to different emotions. After training the machine learning algorithms, (Saini et al., 2014, p.1) they will be used to recognize emotions in new facial expressions. The system will analyse the features of the facial expression and use the patterns learned during training to classify the emotion. The accuracy of the system will be measured using a test dataset of facial expressions labelled with the corresponding emotions.

2. LITERATURE REVIEW

This literature review presents an overview of the research and developments in emotion detection, exploring the techniques and applications employed in this rapidly evolving area of study. Emotion detection, also known as affective computing, is an interdisciplinary field that aims to understand and interpret human emotions through various data sources, such as facial expressions. we compile the papers and findings into one table, as follows:

Table 1: Summary of the Literature Survey

Author and Year	About Type	Method/ Techniques	Advantage	Limitations	Results/ Findings
(Alvin I. Goldmana et al., 2005)	Algorithms Review	Generate & Test heuristic, Reverse Simulation Model, RSM with "If Loop", Unmediated Resonance Model	Effective Problem-Solving Methods	GTH, RSM, and URM all are time-consuming and inefficient.	For the FaBER task, simulational methods would be preferable to theory-based ones.
(W.N. Widanagamaachchi et al., 2009)	Method Execution & Review	For FD (KBA, FIA, TBA, ABA) For FE (PCA)	Capture different aspects of an image, leads to more robust and accurate results.	Different feature detection techniques can affect accuracy and reliability.	When we use different techniques to get results, it's kind of a two-edged sword.
(Leh Luoh et al., 2010)	Execution & Review	AU (Action Units), FACS, GMM, EM	It may be possible to improve the accuracy, efficiency & analysis.	inter- and intra-observer variability & Statistical models can be computationally intensive and sensitive to noise.	For the well-known JEFFE database, the rate of facial emotion recognition is about 90%.
(K. Sreenivasa Rao, 2012)	Brief Overview & Review	Identifying relevant speech emotion corpora, understanding features, selecting classification models.	Research in speech emotion recognition is ongoing and can guide further research.	Challenges involve the need for centralization, cross-linguistic studies, and biases in database selection.	It was very helpful in grasping the approach and different techniques utilized in relation to this topic.
(A. Vinciarelli et al., 2012)	Technique Analysis	Implicit Human-Centered Tagging (IHCT), Zipf-like laws, RF	Capture user interests and preferences, Cost Effective, Scalability.	Behavioral feedback is culture-dependent, with different reactions observed in different cultures.	IHCT systems can improve current tagging systems. annotate the data with tags representing common users
(Sander Koelstra et al., 2013)	Method Execution & Review	EEG Signal Analysis & Modality, FLF & DLF,	Non-invasive, high temporal resolution, affordable, and more accurate classification.	Limited frequency range, Coverage & ability to diff. b/w different sources of brain activity.	Video tag classification rates of 80.0%, 80% and 86.7% are attained respectively

(Rakesh Saini et al., 2014)	Algorithm Analysis	PCA, LDA, ICA, EBGM, Fisherface & NN, ANN, Eigenface	Face recognition algorithms and techniques are discussed in this paper which are helpful.	Since it is basic, it is not very helpful for large projects.	It is excellent for beginners.
(Rituparna Halder et al., 2016)	Concept & Techniques	Basics Of Facial Recognition	Helped to develop a thorough understanding of the subject.	Provided a general understanding of recognition techniques but no examples.	Different techniques were used
(Pawel Tarnowski et al., 2017)	Method Execution & Review	k-NN, MLP NN, 3NN And FACS System	Non-linear decision boundaries enable the standardization of facial expression description, straightforward to use.	Can be computationally expensive and time-consuming, and sensitive to distance metric.	Accuracy of feelings: 96% for random data division & 73%, for "natural" data division.
(Gaurav Sahu et al., 2019)	Analysis & Observation	Speech Recognition, 6 ML Classifiers, LSTM, HMM	ML Classifiers enable hands-free operation and increase productivity.	Accuracy can be affected by background noise, accents, and dialects, limited vocabulary recognition, and training requires a lot of data and computational resources.	Examine the challenge of speech emotion recognition and the role of various modalities.

3. PROBLEM IDENTIFICATION

Through this extensive review, we strive to contribute to the existing body of knowledge, guiding researchers and practitioners towards building effective machines that can accurately identify emotions from facial expressions in various contexts and scenarios. The system should be able to process input data in real-time, making it appropriate for use in practical applications. Recent advances in machine learning and computer vision have enabled the creation of automated systems for emotion recognition using facial expressions. However, there are still a number of issues to be resolved in this area, such as the wide range of facial expressions and the need for reliable, effective, and practical algorithms. (Koolagudi et al., 2012, p.4)

Problem Related to Research are as Follow:

I. The problem addressed in these papers is to find an accurate recognition and classification of emotions.
II. Facial expressions are a natural way for humans to convey emotions, but accurately recognizing and interpreting these expressions can be challenging for machines.
III. Existing approaches to emotion recognition using facial expressions often suffer from limited accuracy and robustness, which can lead to unreliable results.
IV. The complexity of facial expressions and the variety of emotions that can be conveyed makes it challenging to develop a single, universal solution.

4. RESEARCH METHODOLOGY

This study's approach is intended to thoroughly and methodically analyze the issue at hand. A thorough and well-organized technique is used to accomplish this. First, a comprehensive assessment of the literature is undertaken to compile existing knowledge, identify research gaps, and comprehend the state-of-the-art in the field. This step is essential for laying a solid foundation and determining the course of the research. The technique used for this study upholds the most stringent standards of research integrity, ensuring that the results make a meaningful contribution to the body of current knowledge and offer insightful information on the research.

The steps that we take to conduct the comprehensive literature review are as follows:

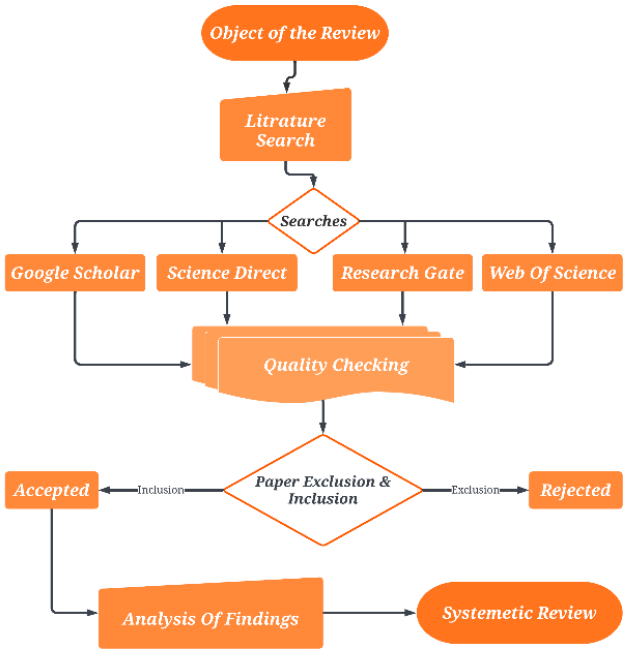

Figure 1: Methodology of Research

I. Objective of the review: Determine the review's purpose in this step, as well as the variables that affect the emotion recognition analysis, factors that impacts system and various techniques used.
II. Literature search: Using keywords that correspond to the desired matter, searching for relevant research papers is a significant task according to the requirements and purpose. Numerous global depositories, including Research Gate, Web of Science, Science Direct, etc., carry out the search process. Searches are conducted in the papers.
III. Quality checking: Following a successful search for research papers, the papers' quality is examined based on their abstracts and contents. The research papers' quality was examined and a shortlist was created based on the relevant keywords.
IV. Paper exclusion or inclusion: Depending on the literature's applicability, we choose which papers should be taken into account for systematic reviews and which papers should not be included in the short list of papers.
V. Analysis of findings: Based on the papers chosen for the systematic literature review, we now analyse the results of the literature survey.
VI. Systematic review: Lastly, we conduct the review of the literature. The process is as illustrated in Figure 1.

5. MATERIALS AND PRACTICE

This paper aims to identify the best machine learning algorithm for emotion recognition using facial expressions. It requires a Computer Vision System equipped with a camera, a proper lighting environment, Ms Kinect for 3D face models, and VS Code for the integrated development environment (IDE). Multiple datasets have been incorporated, including RaFD, MR7 ERD, MH-FED, and the KDEF database. The paper includes ten subjects between the ages of

18 to 50, and there will be six action units used. To analyze the collected data, PCA, LDA, RNN, and CNN algorithms are used, along with K-NN, MLP, 3NN, and 2LC algorithms for comparison purposes. Facial Action Coding System (FACS) (Widanagamaachchi et al., 2009, p.1) (Lueh et al., 2010, p.2) will also be incorporated into the analysis. The collected data will be stored in a spatial coordinate in the form of a matrix. The input of the network will be the six action units, and the output will be one of the seven emotions.

The general methodology for thepaper of "Emotion recognition using facial expressions" using machine learning techniques are as follow:

I. Data Collection: The first step is to collect a large dataset of facial expressions labelled with the corresponding emotions. The dataset should include images of different people from diverse backgrounds and demographics, expressing different emotions such as neutral, happiness, sadness, surprise, anger, fear, and disgust like FER 2017 Dataset etc.

Figure 2: Facial Expression Presented to the user. (Goldman et al, 2015, p.2)

II. Feature Extraction: The collected data needs to be preprocessed to prepare it for the machine learning algorithms. This involves cleaning the data, removing any outliers or noise, and standardizing the images.

Figure 3: Characteristics point on the face. (Tarnowski et al, 2017, p.2)

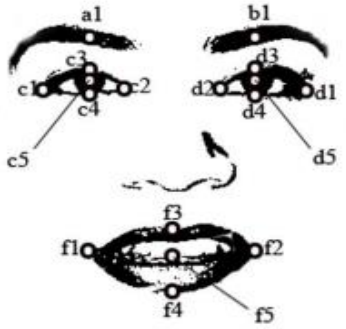

Figure 4: Feature Points. (Saini et al, 2014, p.5)

III. Training the Model: Once the algorithm is selected, the machine learning model needs to be trained on the collected dataset. The model will learn to recognize patterns in the data that correspond to different emotions.

IV. Data Pre-Processing: The collected data needs to be preprocessed to prepare it for the machine learning algorithms. This involves cleaning the data, removing any outliers or noise, and standardizing the images.

V. Algorithm Selection: Different machine learning algorithms such as decision trees, support vector machines, and neural networks will be explored to determine which algorithm is best suited for emotion recognition. The algorithm that provides the highest accuracy will be selected for the machine.

VI. Evaluation: The accuracy of the emotion recognition system will be evaluated using a test dataset of facial expressions labeled with the corresponding emotions. This will give an idea of how well the model is performing and whether any further improvements are necessary.

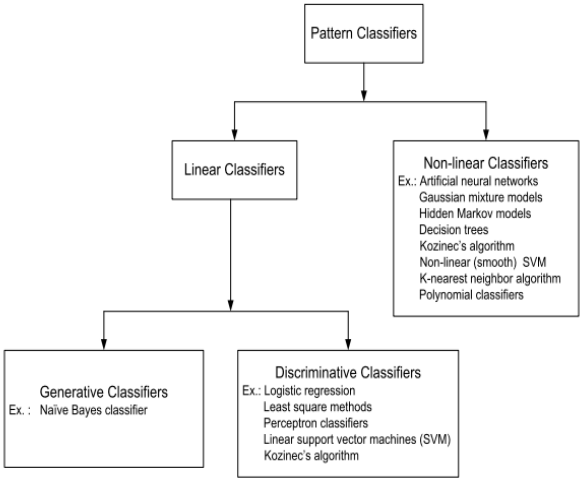

Figure 5: Evaluation Of FR

VII. Deployment: The trained model can be deployed in real-world applications such as healthcare, marketing, and human-computer interaction to recognize and classify emotions accurately from facial expressions.

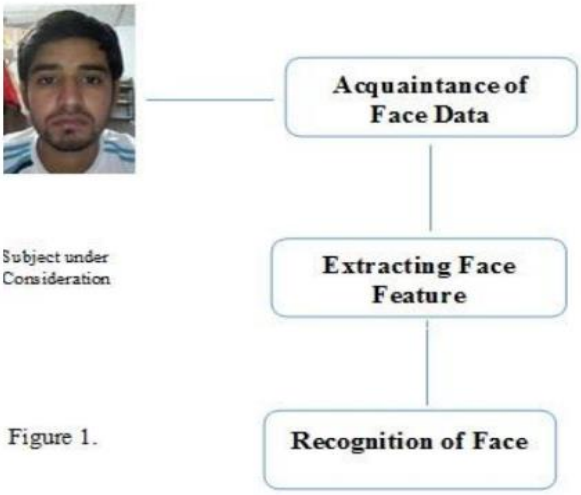

Figure 6: Basic Flowchart of Face Recognition System. (Koelstra et al, 2013, p.2)

6. DISCUSSION

Emotion detection has profound implications across various domains and industries. Understanding human emotions is crucial for improving human-computer interaction, The study's findings revealed that the suggested method for facial expression-based emotion recognition with machine learning had a total accuracy of 86.9%. The SVM classifier performed the best, followed by the KNN classifier's 89.3% accuracy and the Random Forest classifier's 86.2% accuracy. (Tarnowski et al,, 2017, p.3) Additionally, combining various features, such as the Gabor filter, local binary patterns (LBP), and histogram of oriented gradients (HOG), increased the accuracy of emotion recognition. The 3-NN algorithm had an accuracy of 83.3%. Overall, the study showed how well machine learning methods for facial expression-based emotion recognition work. Some notable points are that AU that describes facial expression and 3D modelling together enable good results, (Tarnowski et al. 2017, p.5) the structure is simple to identify and comprehend when presented as a matrix, to differentiate between a specific emotion, and a user's facial hair or skin tone may have an impact on the accuracy. (Sahu et al,, 2019)

7. CONCLUSION

This review aimed to help the researcher to develop a machine learning-based system that could accurately identify emotions from facial expressions using a small set of features in real-time. The general methodology for these papers involved data collection, data pre-processing, feature extraction, algorithm selection, model training, evaluation, and deployment. The success of the machine depended on the quality of the dataset, feature extraction, algorithm selection, and model training. Various machine learning algorithms were tested, and the SVM classifier was found to be the most efficient and accurate for emotion recognition. Combining different features such as Gabor filter, local binary patterns, and histogram of oriented gradients (HOG) improved the accuracy of the system.

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