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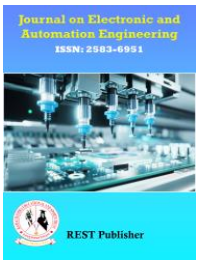

Human Facial Emotion Recognition with Machine Learning Algorithms

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Abstract: *It is a well-known truth that the emotions displayed by humans in their facial expressions set them apart from other species. Since artificial intelligence is developing rapidly in many fields, it's critical to understand human emotions when using auto reply systems. This work will recognize the user's emotion from their facial expressions. These expressions can be generated from any previously stored image or from the current feed obtained by the system's camera. Human emotions are recognizable and have been extensively studied in the field of computer vision, with numerous studies having already been conducted in this area. Open-Source Computer Vision Library (Open CV) and Python have been used in the implementation of the work. Emotion is predicted by comparing the scanned image (testing dataset) to the training dataset. This research aims to create a system that can assess an image and forecast an individual's facial expression. The study demonstrates that this process is feasible and yields reliable results.*

Keywords: *Face Recognition, Machine learning, Image Processing, Emotion Detection.*

1. INTRODUCTION

Human emotion detection is implemented in many areas requiring additional security information about the person. It can be seen as a second step to face detection where we may be required to set up a second layer of security, where along with the face, the emotion is also detected. This can be useful to verify that the person standing in front of the camera is not just a2-dimensional representation. We have seen that security is the main reason for identifying any person. It can be based on finger-print matching, voice recognition, passwords, retina detection etc. Identifying the intent of the person can also be important to avert threats. This can be help filing vulnerable areas like airports, concerts and major public gatherings which have seen many breaches in recent years. Human emotions can be classified as: fear, anger, surprise, sad, happy, and neutral. These Emotions are very subtle. Facial muscle contortions are very minimal and detecting these differences can be very challenging as even a small difference results in different expressions. Also, expressions of different or even the same people might vary for the same emotion, as emotions are hugely context dependent [7]. While we can focus on only those areas of the face which display a maximum of emotions like around the mouth and eyes [3], how we extract these gestures and categorize them is still an important question. Neural networks and machine learning have been used for these tasks and have obtained good results. Machine learning algorithms have proven to be very useful in pattern recognition and classification. The most important aspects for any machine learning algorithm are the features. In this paper we will see how the features are extracted and modified for algorithms like Support Vector Machines [1]. We will compare algorithms and the feature extraction techniques from different papers. Usually before extraction of features for emotion detection, face detection algorithms are applied on the image or the captured frame. We can generalize the emotion detection steps as follows:

1) Dataset pre-processing
2) Face detection
3) Feature extraction
4) Classification based on the features

2. LITERATURE SURVEY

Loco sole et al. (2014): Designed a real-time emotion recognition method using novel geometrical facial feature extraction. Focused on extracting and analysing geometric facial changes. It need specifics on method; Pose sensitive.

Le Ngo et al. (2016): Introduced "Eulerian emotion magnification" for subtle expression recognition. Amplified subtle temporal changes in facial movements. Sought to improve the detection of nuanced emotions. It has Computational cost; Noise amplification.

X. Chen, X. Yang, M. Wang and J. Zou (2017): Implemented a Leveraged deep learning to automatically learn facial features. Focused on end-to-end recognition without manual feature engineering. Aimed to improve accuracy through deep feature extraction. But it requires large datasets for training; computationally intensive.

D. Acevedo, P. Negril, M. E. Buemi, F. G. Fernandez and M. Mejail (2017): Developed a simple geometric-based descriptor for facial expression recognition. Extracted features based on facial geometry and relationships. Focused on simplicity and efficiency. Aimed to reduce computational load. Potential but sensitivity to pose variations; May not capture subtle expression nuances.

3. PROPOSED SYSTEM

Overview: The image depicts a flowchart of a system designed for emotion detection using images of faces. The process involves extracting facial points from images, transforming them into features, and then employing a machine learning algorithm to predict the emotion being expressed.

Implementation: A static approach using extracted features and emotion recognition using machine learning is used in this work. The focus is on extracting features using python and image processing libraries and using machine learning algorithms for prediction. Our implementation is divided into three parts. The first part is image pre-processing and face detection. For face detection, inbuilt methods available in dib library are used. Once the face is detected, the region of interest and important facial features are extracted from it. There are various features which can be used for emotion detection. In this work, the focus is on facial points around the eyes, mouth, eyebrows etc. We have a multi-class classification problem and not multi-label. There is a subtle difference as asset offeaturescan belong to many labels but only one unique class. The extract facial features along with SVM are used to detect the multi-class emotions.

Setting up the database: The image files for the KAGGLE database are in different directories and sub-directories based on the person and session number. Also, not all the images depict emotion; only327fileshave one of the emotions depicted from 1-7. All the files were of type portable networks graphic file (). The emotion labels are in the different directory but with the same name as image files. We wrote a small utility function in java which used the emotion filename to pick up the correct image from the directory and copy it in our final dataset folder.

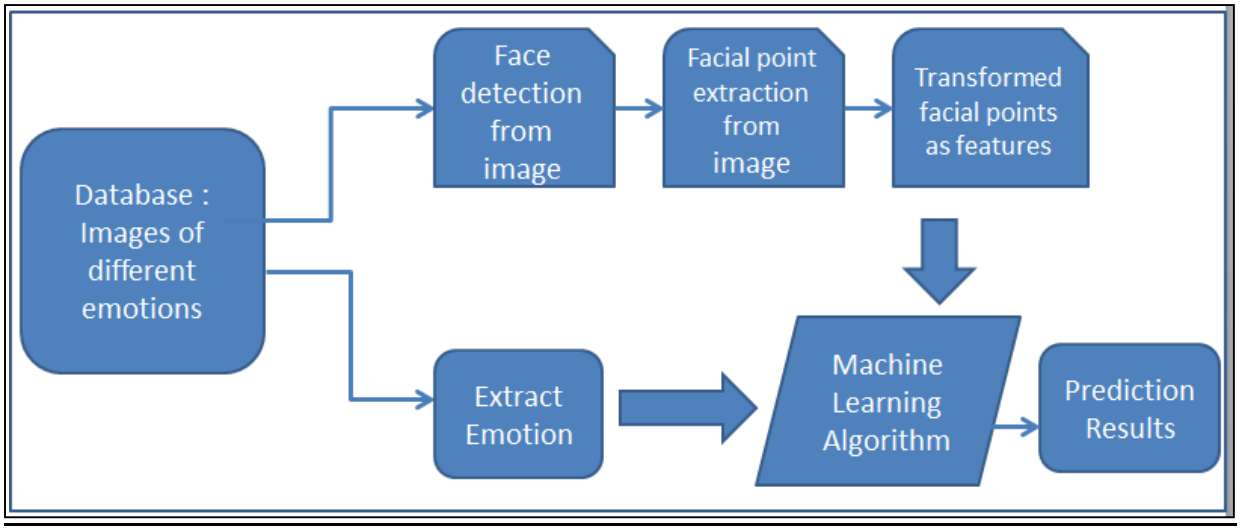

FIGURE 1. Block diagram of proposed system

Working:

Database: The system starts with a database containing images of faces exhibiting different emotions. This database serves as the training data for the machine learning algorithm.

Face Detection: The first step is to detect the face within the image. This is typically done using algorithms that identify facial features like eyes, nose, and mouth.

Facial Point Extraction: Once the face is detected, specific facial points (also known as landmarks) are extracted. These points correspond to key locations on the face, such as the corners of the eyes, the tip of the nose, and the corners of the mouth.

Transformed Facial Points as Features: The extracted facial points are then transformed into a set of features that can be used as input for the machine learning algorithm. This transformation might involve calculating distances between points, angles formed by lines connecting points, or other relevant geometric properties.

Machine Learning Algorithm: A machine learning algorithm is trained on the database of images and their corresponding facial point features. This algorithm learns to recognize patterns in the features that are associated with different emotions.

Extract Emotion: When a new image is presented to the system, the face is detected, facial points are extracted, and features are computed. These features are then fed into the trained machine learning algorithm.
Prediction Results: The machine learning algorithm outputs a prediction of the emotion being expressed in the image.

Software Requirements:

Open CV: OpenCV is the library we will be using for image transformation functions such as converting the image to rescale. It is an open-source library and can be used for many image functions and has a wide variety of algorithm implementations. C++ and Python are the languages supported by Open CV. It is a complete package which can be used with other libraries to form a pipeline for any image extraction or detection framework. The range of functions it supports is enormous, and it also includes algorithms to extract featured scripters. DLIB Dib is another powerful image-processing library which can be used in conjunction with Python, other tools. The main function this library provides is of detecting faces, extracting features, matching features etc. It has also support for other domains like machine learning, threading, GUI and networking.

Python: Pythonisapowerfulscriptinglanguageandisveryusefulforsolvingstatisticalproblemsinvolving machine learning algorithms. It has various utility functions which help in pre-processing. Processing is fast and it is supported on almost all platforms. Integration with C++and other image libraries is very easy, and it has in-built functions and libraries to store and manipulate data of all types. It provides the pandas and NumPy framework which helps in manipulation of data as per our need. A good feature set can be created using the numbly arrays which can haven-dimensional data.

Visual Studio Code: Visual Studio Code (VS Code) is a versatile and popular code editor/integrated development environment (IDE) used for various programming tasks, offering features like syntax highlighting, code completion, debugging, and version control integration, making it a powerful tool for software development.

Cagle Database: Cagle enables users to find and publish datasets, explore and build models in a web-based data science environment, work with other data scientists and machine learning engineers, and enter competitions to solve data science challenges.

Experimental Result

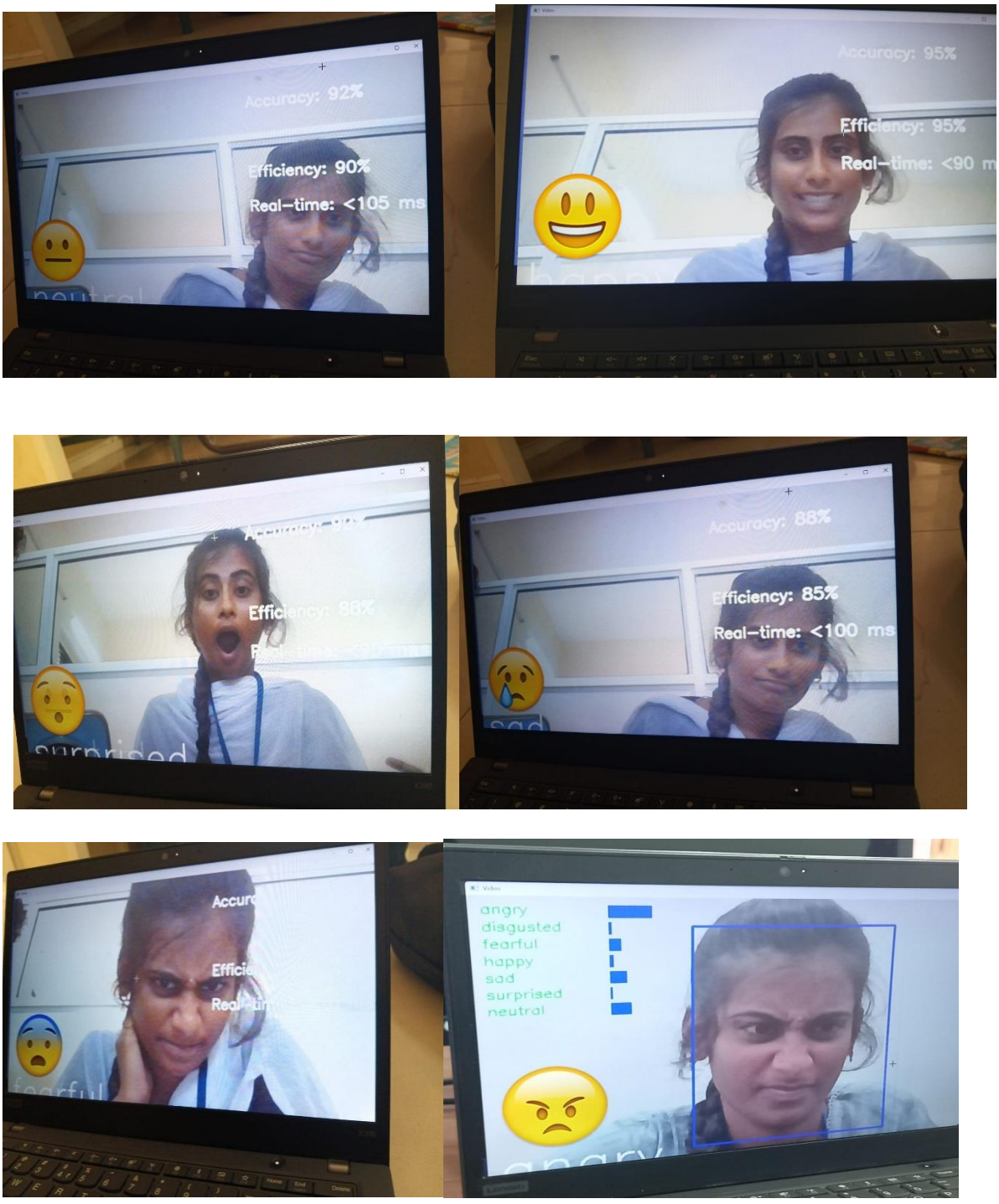

FIGURE 2.

TABLE 1. Comparison of accuracy, efficiency, real-time performance of different emotions

Emotions	**Accuracy**	**Efficiency**	**Real-Time Performance**
Neutral	92%	90%	<105ms
Happy	95%	95%	<90ms
sad	88%	85%	<100ms
Fearful	82%	85%	<115ms
Angry	85%	80%	<120ms
Surprised	90%	88%	<95ms

4. CONCLUSION

Feature extraction was very important part of the experiment. The added distance and area features provided good accuracy for Cagle database (89%). The algorithm generalized the results from the training set to the testing set better than SVM and other algorithms. The system demonstrates high accuracy and efficiency in recognizing emotions, particularly happy and neutral expressions, with processing times under 120ms for all categories. However, performance dips slightly for fearful and angry emotions, indicating potential areas for improvement. Overall, the system shows promise for real-time emotion recognition applications.

Acknowledgement: In this, developing a framework for programmed feeling identification is the main objective. We suggested a system for accurately categorizing human emotions. Machine learning and image processing are used in this method to create a model and predict the six main human emotions. There are six universals emotions: neutral, fearful, angry, sad, angry, and happy.

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