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# A SYSTEMATIC REVIEW OF FACIAL EXPRESSION DETECTION METHODS

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**ABSTRACT** - ***Facial expression analysis aims to understand human emotions by analyzing visual face information and is a popular topic in the computer vision community. In educational research, the analyzed students' affect states can be used by faculty members as feedback to improve their teaching style and strategy so that the learning rate of all the students present can be enhanced. Facial expression analysis has attracted much attention in educational research, and a few reviews on this topic have emerged. However, previous reviews on facial expression recognition methods in educational research focus mostly on summarizing the existing literature on emotion models from a theoretical perspective, neglecting technical summaries of facial expression recognition. In order to advance the development of facial expression analysis in educational research, this paper outlines the tasks, progress, challenges, and future trends related to facial expression analysis. First, facial expression recognition methods in educational research lack an overall framework.Second, studies based on the latest machine learning methods are not mentioned in previous reviews.Understanding emotions is one of the greatest capabilities of human beings, as it allows the understanding of facial expressions that facilitate the capture of important information about other individuals, which are used for the perception of mental or emotional states. Advances in Artificial Intelligence and Visual Computing, more specifically in Deep Learning with the advent of Artificial Neural Networks, have enhanced the ability of machines to infer human emotions through face expression.The convolutional neural network models analyzed in this review are based on deep learning with an emphasis on expression and microexpression recognition. The results suggest that database uses, with laboratory controlled images, combined with CNN's such as VGG and ResNet, have excellent performances in their tests. For better understanding, we will detail and compare all the methods obtained in the review.***

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## 1. INTRODUCTION

We currently live in a society that is constantly changing and technology has developed algorithms that allow facial emotion recognition, because facial expression transmits people's mood, feelings and state of soul. However, it is required that future research can improve the quality of emotion detection by improving the quality of the data set and the model used, for this reason, it is necessary to investigate other machine learning algorithms in the recognition of facial emotions, as they exist. identification deficiencies that limit the discrimination of extracted structural features. Emotions can be described as things we feel that are caused by neurons that shoot electrons around the tiny pathways inside the amygdala, the emotion centre of the brain. Emotion can also be described as a complex experience involving related feelings, which tends to move one out of a person's individuality come with physical and physiological changes, which regulate our behaviour, due to reactions to internal and external . Emotion is a salient characteristic of humans. It plays a useful role in human communication, as well as the growth and regulation of interpersonal relationships [7–9]. It also affects thoughts, actions, and the making of decisions.

## 2. DEVELOPMENT PROCESS

i)REQUIREMENT-ANALYSIS: It is a critical phase in the project's development process. It involves gathering, documenting, and understanding the specific needs and expectations of stakeholders for the weather prediction application. This phase focuses on identifying the functional and non-functional requirements, user expectations, system constraints, and desired features. By analyzing the requirements, the project team can define a clear scope and roadmap for the application's development, ensuring that it meets the users' needs and aligns with the project's objectives.
ii)PYTHON: Python is a dynamic, high level, free open source and interpreted programming language. It supports object-oriented programming as well as procedural oriented programming. In Python, we don't need to declare the type of variable because it is a dynamically typed language. For

example, x=10. Here, x can be anything such as String, int, etc. Python is an interpreted, object-oriented programming language similar to PERL, that has gained popularity because of its clear syntax and readability. Python is said to be relatively easy to learn and portable, meaning its statements can be interpreted in a number of operating systems, including UNIX-based systems, Mac OS, MS-DOS, OS/2, and various versions of Microsoft Windows 98. Python was created by Guido van Rossum, a former resident of the Netherlands, whose favourite comedy group at the time was Monty Python's Flying Circus. The source code is freely available and open for modification and reuse. Python has a significant number of users. 12 Features in Python - There are many features in Python, some of which are discussed below • Easy to code • Free and Open Source • Object-Oriented Language • GUI Programming Support • High-Level Language • Extensible feature • Python is Portable language • Python is Integrated language • Interpreted Language.

iii)PROPOSED SYSTEM: The evaluation method presented has selected few articles in relation to the initial base of 350 articles, the importance of the data obtained for future research is emphasized. In addition, it is suggested that new publications continue to contribute to the growing range of work on facial expression recognition, with new CNN models and databases, generating new performances and new ways of recognizing expressions and faces.

iv)RESOURCES REQUIREMENT:

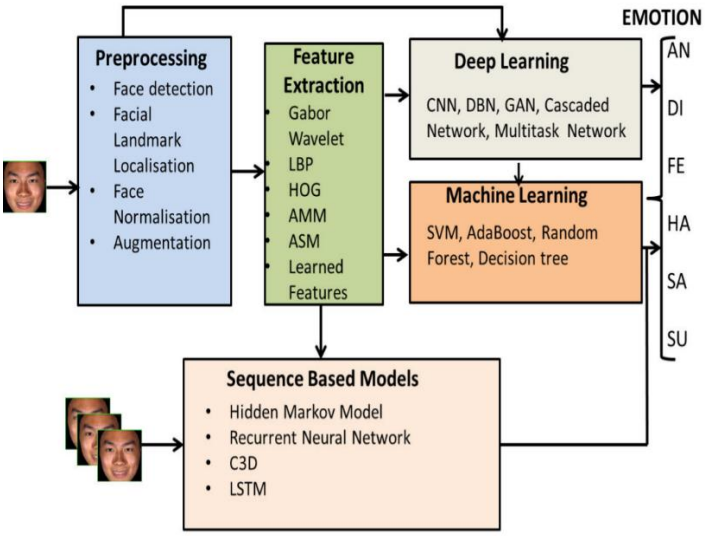
**SOFTWARE REQUIREMENTS:**

| | | |
|---|---|---|
| OPERATING SYSTEM | : | WINDOWS 10 (64 BIT) |
| SOFTWARE | : | PYTHON |
| TOOLS | : | ANACONDA (JUPYTER NOTEBOOK IDE) |

**HARDWARE REQUIREMENTS:**

| | | |
|---|---|---|
| HARD DISK | : | 500GB AND ABOVE |
| RAM | : | 8GB AND ABOVE |
| PROCESSOR | : | I5 AND ABOVE |

V)System Architecture:




## 3. TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub – assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

TYPES OF TESTS UNIT TESTING : Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.
INTEGRATION TESTING Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.
FUNCTIONAL TEST Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.
SYSTEM TEST System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration-oriented system

integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

## 4. LITERATURE REVIEW

Facial expression analysis is a field of study that focuses on interpreting and understanding human emotions and intentions through the observation and analysis of facial expressions. It involves the application of various techniques, including computer vision, machine learning, and psychology, to recognize and classify facial expressions into distinct emotional states. Facial expressions are a fundamental means of nonverbal communication, allowing individuals to convey their emotions, attitudes, and intentions. They provide valuable cues that can be used to infer a person's mental and emotional state, helping us understand their feelings, reactions, and intentions better. Facial expression analysis aims to capture, interpret, and quantify these expressions to gain insights into human behavior and improve various applications such as human-computer interaction, psychology research, market research, and more. Advancements in computer vision and machine learning techniques have revolutionized the field of facial expression analysis. Facial recognition algorithms can detect and track facial features, such as eyes, nose, mouth, and eyebrows, in real-time or from images and videos. Machine learning models can be trained on large datasets of labeled facial expressions to recognize and classify different emotions accurately. These models can detect subtle changes in facial muscle movements and patterns to infer emotional states like happiness, sadness, anger, surprise, fear, and disgust. We mainly focused on generating facial expression for seven emotions: happy, sad, fear, surprise, anger, disgust, and contempt.

## 5. PROBLEM STATEMENT

The great advances in the field of Artificial Intelligence have enabled a plethora of techniques proposed in the field of Computer Vision. Such an achievement has increased the amount of existing methods used in emotion detection. The large mass of authors, along with their productions, have popularized various Deep Learning techniques and methods in academia. This process resulted in the massification of techniques used to solve problems in the computational environment.

## 6. SYSTEM DESIGN AND DEVELOPMENT

**INPUT DESIGN:** Input design is the process of converting user-originated inputs to a computerbased format. Input design is one of the most expensive phases of the operation of computerized system and is often the major problem of a system. In the project, the input design is made in various web forms with various methods. For example, in the user creation form, the empty username and password is not allowed. The username if exists in the database, the input is considered to be invalid and is not accepted. Likewise, during the login process, the username is a must and must be available in the user list in the database. Then only login is allowed.

**OUTPUT DESIGN:** Output design generally refers to the results and information that are generated by the system for many end-users; output is the main reason for developing the system and the basis on which they evaluate the usefulness of the application. In the project, the booking details, the employee details, trip sheet details, are the web forms in which the output is available.

**CODE DESIGN:** Design Code means a code setting out the broad means parameters with reference to which the Developer will secure uniform standards of design quality, character of design, building materials, density of development and site layout within the Foresthill Site. 23

**DATABASE DESIGN:** The database design is a must for any application developed especially more for the data store projects. Since the Logistic automation method involves retrieving the information in the table and produced to the administrator, proper handling of the table is a must.

## 7. SOFTWARE DESCRIPTION & CODE

PYTHON : Python is commonly used for developing websites and software, task automation, data analysis, and data visualization. Since it’s relatively easy to learn, Python has been adopted by many non-programmers, such as accountants and scientists, for a variety of everyday tasks, like organizing finances. "Writing programs is a very creative and rewarding activity," says University of Michigan and Coursers instructor Charles R Severance in his book Python for Everybody. “You can write programs for many reasons, ranging from making living to solving a difficult data analysis problem to having fun to helping someone else solve a problem.

ANACONDA : Anaconda distribution comes with over 250 packages automatically installed, and over 7,500 additional open-source packages can be installed from PyPI as well as the conda package and virtual environment manager. It also includes a GUI, Anaconda Navigator, as a graphical alternative to the command line interface (CLI). The big difference between conda and the pip package manager is in how package dependencies are managed, which is a significant challenge for Python data science and the reason conda exists. When pip installs a package, it automatically installs any dependent Python packages without checking if these conflict with previously installed packages. It will install a package and any of its dependencies regardles of the state of the existing installation. Because of this, a user with a working installation of, for example, Google Tens or flow, can find that it stops working having used pip to install a different package that requires a different version of the dependent numpy library than the one used by Tensorflow. In some cases, the package may appear to work but produce different results in detail. In contrast, conda analyses the current environment including everything currently installed, and, together with any version limitations specified (e.g., the user may wish to have Tensorflow version 2,0 or higher), works out how to install a compatible set of dependencies, and shows a warning if this cannot be done. Open source packages can be individually installed from the Anaconda repository, Anaconda Cloud (anaconda.org), or the user's own private repository or mirror, using the conda install command.

ANACONDA NAVIGATOR : Anaconda Navigator is a desktop graphical user interface (GUI) included in Anaconda distribution that allows users to launch applications and

manage conda packages, environments and channels without using command-line commands. Navigator can search for packages on Anaconda Cloud or in a local Anaconda Repository, install them in an environment, run the packages and update them. It is available for Windows, macOS and Linux.

The following applications are available by default in Navigator:[16]

- JupyterLab
- Jupyter Notebook
- QtConsole
- Spyder
- Glue
- Orange
- RStudio
- Visual Studio Code

```
from keras.preprocessing import image as im

import cv2
import json
import numpy as np

def classify(frame, face_detector, model):

    # Emotions
    emotions = ('angry', 'disgust', 'fear', 'happy', 'sad', 'surprise', 'neutral')

    gray = frame

    # Detect faces
```

```
        face_properties = classifier.classify(img, face_detector, model)

        return json.dumps(face_properties)


if __name__ == '__main__':

    # Run the flask app
    app.run()
        * CMD - `myvirtualenv\Scripts\activate.bat`
    * Linux: `source myvirtualenv/bin/activate`
* Install required packages
    * Windows: `pip install -r requirements.txt`
    * Linux: `pip3 install -r requirements.txt`
* Make sure to have latest Chrome/Firefox Installed.
* To run,
    * Windows: `python server.py`
    * Linux: `python3 server.py`

## Deployment to heroku

* Create a new app.
* Connect your github repo to the app, select a branch and enable Automatic deployments.
* Install your OS Heroku CLI and login.
* Add a buildpack to the app to install required libraries for Open CV.
```bash
(env) kogam22@HOME-PC:~/code/FaceExpressionDetectionFlask$ heroku buildpacks:add --index 1
heroku-community/apt -a <your-app-name-here>
Buildpack added. Next release on <your-app-name-here> will use:
1. heroku-community/apt
2. heroku/python
Run git push heroku master to create a new release using these buildpacks.
```
* Update your branch to create new release.


## Issues
Any problems ? Feel free to open up a new issue.
```

```
    detected_faces = face_detector.detectMultiScale(gray, scaleFactor=1.2, minNeighbors=10,
minSize=(5, 5), flags=cv2.CASCADE_SCALE_IMAGE)

    # Face properties
    face_prop = []

    # Faces are detected more than 0 i.e not 0
    if len(detected_faces) > 0:
        # x,y = x,y coordinates
        # w,h = width, height
        for (x, y, w, h) in detected_faces:
            frame = cv2.rectangle(frame, (x, y), (x + w, y + h), (255, 0, 0), 2)
            img = cv2.rectangle(gray, (x, y), (x + w, y + h), (255, 0, 0), 2)

            adjust_img = img[y:y+h, x:x+w]  # Crop img to the face
            adjust_img = cv2.resize(adjust_img, (48, 48))  # Resize img to fit the ML model

            img_tensor = im.img_to_array(adjust_img)
            img_tensor = np.expand_dims(img_tensor, axis=0)

            img_tensor /= 255  # pixels are in scale of [0, 255]. normalize all pixels in
scale of [0, 1]

            predictions = model.predict(img_tensor)  # store probabilities of 2 facial
expressions
            label = emotions[np.argmax(predictions)]  # Get label with most probability

            confidence = np.max(predictions)  # Get the confidence of that label

            confidence *= 100 # Multiple probability by 100

            detect = dict()
            detect['label'] = label
            detect['score'] = str(confidence).split(".")[0]
            detect['x'] = str(x)
            detect['y'] = str(y)
            detect['width'] = str(w)
            detect['height'] = str(h)
```

## 8. CONCLUSION

It is concluded that the SVM and SoftMax algorithms are the most predominant, playing a crucial role in achieving optimal levels of precision in the training of the models. These algorithms, with their robustness and ability to deal with complex data, have proven to be fundamental pillars in the field of facial emotion recognition.

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