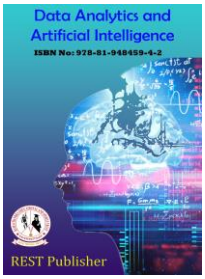
Data Analytics and Artificial Intelligence
Vol: 3(3), 2023
REST Publisher; ISBN: 978-81-948459-4-2
Website: http://restpublisher.com/book-series/daai/



Prediction of People's Abnormal Behaviors Based on Machine Learning Algorithm

Vijaya Lakshmi D M, *Jothiprasath M, Ganesh Kumar M, Harshavardhan S
Adhiyamaan College of Engineering (Autonomous), Hosur, India.
*Corresponding Author Email: jothiprasathmuthukumar@gmail.com

Abstract: *Nonverbal cues that are conveyed by facial expressions are crucial to interpersonal relationships. A common component of human-machine interfaces is the automatic recognition of facial expressions; it could also be utilized in clinical practice and behavioral science. Solid expression recognition by machines remains a challenge despite the fact that people perceive facial expressions practically immediately. A facial expression can be thought of as disfigurements of the facial parts and their spatial relationships or changes in the pigmentation of the face from the perspective of automatic recognition. The issues surrounding the representation and arrangement of static or dynamic qualities of these distortions or face pigmentation are the focus of research into automatic facial expression recognition.*

Key Words: *Emotion recognition, facial expression, facial muscles, neuronal pathways, face detection*

1. INTRODUCTION

The most effective form of nonverbal communication is facial expression, which conveys emotional state, mindset, and intention. Not only can facial expressions alter the flow of a conversation, but they also give listeners a way to convey a lot of information to the speaker without saying a word. When spoken words and facial expressions do not coincide, facial expressions have a greater influence on how information is interpreted. A facial expression can be thought of as either changes in the pigmentation of the face or deformations of facial components and their spatial relationships from the perspective of automatic recognition. The changes in a person's facial appearance in response to their inner emotional states, social communications, or intentions are represented by facial expressions. The most effective, natural, nonverbal, and immediate way for humans to communicate their feelings and intentions is through facial expression. Emotions can be conveyed more quickly through facial expressions than through words. As machines and people begin to share a variety of responsibilities, the need for effective communication channels between humans and machines grows. Human machine interaction (HMI) systems are the components of these communication channels. The development of more useful HMI systems that no longer rely on conventional devices like keyboards, mice, and displays but instead take commands directly from the user's voice and mimics is made possible by technological advancements. By only utilizing human-to-human communication channels and not requiring artificial equipment, these systems aim to replicate human interaction.

2. EMOTION RECOGNITION

The process of recognizing human emotion is called emotion recognition. The degree to which individuals are able to accurately identify the feelings of others varies widely. A relatively new area of research is the application of technology to assist individuals in emotion recognition. In general, the technology performs best when used in context with multiple modalities. Automating the recognition of facial expressions from video, spoken expressions from audio, written expressions from text, and physiology as measured by wearables has received the most attention to date. The extent to which humans are able to recognize emotion varies greatly. When learning about automated emotion recognition, it's important to remember that there are multiple sources of "ground truth," or the truth about what the actual emotion is.

3. FACIAL EXPRESSION

One or more motions or positions of the muscles beneath the skin of the face constitute an expression. These movements, according to one set of controversial theories, convey an individual's emotional state to observers. Nonverbal communication includes facial expressions. They are present in the majority of other mammals and some other animal species, and they are a primary means of communicating social information between humans. It is possible for humans to adopt a facial expression either voluntarily or involuntarily, and the neural mechanisms that control the expression differ depending on the situation. The cortical pathway in the brain is where voluntary facial expressions originate and are frequently socially conditioned. In contrast, involuntary facial expressions are thought to be innate and originate in the sub cortex of the brain. The amygdala plays a significant role in the process of facial recognition, which can be an emotional experience for the brain. The integrative center for emotions, emotional behavior, and motivation is the Amygdala. The eyes are frequently regarded as significant facial expression features. It is possible to use aspects like blinking rate to determine whether a person is lying or anxious. Additionally, eye contact is regarded as an essential component of interpersonal communication. However, there are cultural differences regarding whether or not it is socially acceptable to keep eye contact.

4. FACIAL MUSCLES

Social communication relies heavily on facial expressions. The movement of the muscles in the face that connect to the skin and fascia is what causes them. These muscles move the skin, making wrinkles, folds, and facial features like the mouth and eyebrows move. In the embryo, these muscles grow from the second pharyngeal arch. Expression is also slightly influenced by the internal and external pterygoid muscles, the temporalis, the masseter, and the muscles used for chewing. Beginning with the first pharyngeal arch, these muscles develop.

5. NEURONAL PATHWAYS

Facial expression is correlated with two brain pathways: the first is intentional articulation. The corticobulbar projections, specifically, are the pathway by which voluntary expression travels from the primary motor cortex through the pyramidal tract. Display rules in emotion, which are social precepts that influence and modify expressions, are associated with the cortex. Consciously, cortically related expressions are made.

6. FACE DETECTION

Face detection is a computer technology that can identify human faces in digital images. It is used in many different applications. The psychological process by which people locate and pay attention to faces in a visual scene is also referred to as face detection. Face detection is an example of object-class detection in its own right. The goal of object-class detection is to locate the locations and dimensions of all objects in an image that fall into a particular class. Algorithms for face detection concentrate on identifying frontal human faces. It is comparable to image detection, which involves matching a person's image bit by bit. The image matches the database-stored images. The matching process will be invalidated by any database modifications to facial features.

7. OBJECTIVES

To use a machine learning model for facial emotional recognition, to use the webcam in real-time, and to achieve high accuracy in determining the subject's emotional state.

8. I.LITERATURE SURVEY

Multimodal system for continuous monitoring of elderly people's living conditions. The system makes use of both environment-specific premise-embedded sensors and a wearable sensor network for each individual. The paper demonstrates the advantages of utilizing complementary mobility sensor data: an accelerometer-based wearable network and visual flow-based image analysis. The paper provides results for indoor and outdoor recognition of complex movements and several basic poses. A polar histogram-based method of visual pose recognition, complementary use and synchronization of data from wearable and premise-embedded networks, and an automatic danger detection algorithm driven by two premise- and subject-related databases received more attention than a comprehensive system description. The use

of the dynamic time-warping algorithm to measure the distance between actions represented as elementary poses in behavioral records and the feeding of the databases with real-life recordings from the subject are also novel features of our method. The main outcomes of our method testing are as follows: a framework (FILTWAM, or "Framework for Improving Learning through Webcams and Microphones") for real-time emotion recognition in e-learning by using webcams. This framework achieves 95.5% accuracy for elementary pose recognition using the video system, 96.7% accuracy for elementary pose recognition using the accelerometer-based system, 98.9% accuracy for elementary pose recognition using the combined accelerometer and video-based system, and 80% accuracy for complex outdoor activity recognition using the accelerometer- Based on the learner's verbalizations and facial expressions, FILTWAM provides timely feedback. In a proof-of-concept study, the facial expression software module for FILTWAM has been developed and tested. The primary objective of this study was to demonstrate that webcam data can accurately and in real time translate facial expressions into extracted emotional states. Ten test subjects were used to calibrate the software. They were given the same computer-based tasks, each of which required them to imitate a specific facial expression 100 times. Video recordings were made of all sessions. Two experts annotated and rated the recorded behaviors of participants for the purpose of validating the face emotion recognition software. The software results and the expert findings were compared, and the overall kappa value was 0.77. Based on the emotions that were requested and the emotions that were recognized, our software is 72% accurate overall. Our software is able to continuously and unobtrusively monitor the behaviors of learners and converts these behaviors directly into emotional states, whereas the software that is currently in use only permits discontinuous, obtrusive, and non-real-time facial detection. Emotion recognition, which is an intuitive reflection of a person's mental state that contains rich emotional information and is one of the most important forms of interpersonal communication, paves the way for enhancing the quality and efficacy of e-learning[2]. It is applicable to a variety of fields, including psychology. Zeng Guofan, a well-known figure in ancient China, taught people how to recognize facial expressions. In his book Bing Jian, he provides a summary of eight methods for identifying people, particularly for selecting the appropriate method, which translates to "look at the eyes and nose for evil and righteousness, the lips for truth and falsehood; the disposition for fame and success, the spirit for wealth, and the hamstrings for failure, the fingers and claws for inspiration; You can concentrate on what he has said if you want to learn about his execution. It is said that a person's face can reveal their personality, mind, goodness, and bad side. However, traditional facial expression emotion recognition technology suffers from insufficient feature extraction and susceptibility to external environmental influences due to the complexity and variability of human emotion features. A novel feature fusion dual-channel expression recognition algorithm is therefore proposed in this article, and it is based on philosophical and machine learning theory. More specifically, the issue of subtle changes in facial expressions is ignored by the feature extracted using a convolutional neural network (CNN). The Gabor feature of the ROI area is used as input in the first path of the proposed algorithm. First, segment the active facial expression emotion area from the original face image and extract the emotion features of the area using the Gabor transform in order to make full use of the area's detailed features. Concentrate on the in-depth description of the surrounding area. By designing an effective attention module that combines the depth of the feature map with spatial information, the second path suggests a channel attention network based on depth separable convolution to improve linear bottleneck structure, reduce network complexity, and prevent overfitting. It outperforms the competition on the FER2013 dataset, is more focused on extracting important features, and improves emotion recognition accuracy [3]. In an e-learning environment, there are more opportunities to encourage online communication and sharing thanks to the emergence of Web 2.0 technology. MyNote, a Web 2.0 annotation system developed on the basis of Web 2.0 core concepts that emphasize active sharing and easy access, was the focus of this study, which also sought to understand people's perceptions of MyNote from a usability perspective. In this study, multimedia learning objects within a Learning Management System (LMS) and outside of the LMS both made use of MyNote. The evaluation showed that, using factor analysis, the perceptions of MyNote were categorized according to interactivity, usefulness, helpfulness, and willingness to use in the future. Interactivity and helpfulness were also found to be statistically significant in predicting MyNote's future usage. The Expression of the Emotions in Man and Animals is Charles Darwin's third major work of evolutionary theory, following On the Origin of Species (1859) and The Descent of Man (1871). Lastly, the habit of taking notes affected learners' perceptions of using MyNote. [4] The Expression was originally intended to be a chapter in The Descent of Man, but it grew in length and was published on its own in 1872. Darwin examines the animal origins of human traits like raising one's eyebrows when surprised and raising one's upper lip when sneering aggressively in this book about the biological aspects of emotional life. In 1872, The Expression was translated into German; in 1873 and 1874, French and Dutch versions were released. In 1890, a book with only minor revisions was published in a second edition. The Expression has never been out of print, but it has also

been called Darwin's "forgotten masterpiece"[5]. Facial expression recognition is done with static images. For identifying faces in images, they suggested using the Hue Saturation Value (HSV) color model. Principal Component Analysis (PCA) was used to lower the Eigenspace's dimensionality. The Euclidean distance between the mean Eigenfaces in the training dataset and the input test image can be used to identify emotions. A Census Transformation (CT)-based feature histogram has been used to depict the facial region. This system needs a collection of images to train and create a classification model. The level of precision is not particularly high. In order to alter the outcome, certain sample test images must be calculated and trained. It was only possible to predict image samples.

9. EXISTING METHOD

Images used for facial expression recognition are static images. To detect the face in an image they proposed the Hue Saturation Value (HSV) color model. For reducing the high dimensionality of the Eigenspace Principal Component Analysis (PCA) has been used. By calculating the Euclidean distance between the input test image and the mean of the Eigenfaces of the training dataset the various emotions are recognized. The Census Transformation (CT) based feature histogram has been used to represent facial regions. This system needs a set of images for training and building a classification model. Thus, images in the Cohn-Kanade database are used for training. For the detection and identification of face, computer vision libraries are mandatory. OpenCV library provides functions for the same. Using OpenCV, face detection and feature point location is executed. Dlib is used for training and building the classification model. The problem of predicting the state of human behavior based on user profile in a ubiquitous home network using the multilevel statistical structure known as HHMM. In a home network system, algorithms that use user-provided information to examine a user's behavior patterns. The algorithm we propose for detecting abnormal behavior builds a profile on the user's actions when they enter a room. The application of the shared structure HHMM, the estimation of a user's state of behavior, and the detection of abnormal behavior are the main contributions of this paper. When compared to a flat HMM, the experiment's user behavior data demonstrate that directly modeling shared structures improves recognition efficiency and prediction accuracy for the state of a human's behavior. Second, the ABPM-IMISBTI method is proposed to address the issue of insufficient text information analysis in the analysis of students' abnormal behavior by combining text information and student behavior multi-index data with long and short-term memory networks (LSTM). Last but not least, student achievement prediction is used as an example of verification in this paper. The experimental results demonstrate that the ABPM-IMISBTI method proposed in this paper can, in comparison to other prediction methods, improve the accuracy of student behavior predictions and swiftly identify abnormal student behavior in order to enhance the level of education management in universities and encourage the growth of safe campuses, smart campuses, and smart education. On university campuses, numerous information systems, including student return, behavior analysis, book borrowing, and class rate statistics, have been built. These systems collect a lot of data about students' daily studies, life, and other behaviors, creating a campus big data environment that is fairly complete. However, due to the widespread use of new media, college students surfing the Internet have generated a significant amount of network behavior data with multidimensional characteristics. Students' behavior is more diverse because they are exposed to a more complex and diverse social network environment. Prediction, early warning, and guidance of student behavior become more difficult as a result. Students with academic difficulties, psychological barriers, and life challenges—particularly those who may experience extreme events—are the groups that require college administrators' attention. How to properly integrate multidimensional data on student behavior, identify potential patterns of behavior, perform abnormal behavior analysis and early warning, give college administrators a complete understanding of the learning and living conditions of students, and provide accurate services and management.

10. DISADVANTAGES

Low interpretability of principal components. Principal components are linear combinations of the features from the original data, but they are not as easy to interpret. The trade-off between information loss and dimensional reduction. In the usage of existing LSTM method they are more complicated than traditional RNNs and require more training data in order to learn effectively. Second, they are not well-suited for online learning tasks, such as prediction or classification tasks where the input data is not a sequence.

11. PROPOSED METHOD

One of the most challenging areas of image processing, computer vision, and pattern recognition is human face recognition. First, a face must be found and then its features must be extracted before the human face can be recognized. The Viola-Jones Haar Cascade Classifier (V-J) and the Histogram of Oriented Gradients (HOG) are two of the most widely used face detection methods among the many that have been developed. The face detection methods of VJ and HOG were compared in this paper. HOG computed the classifier for each image in and scale of the image, applied sliding windows, extracted HOG descriptor at each window, and applied the classifier. If the classifier detected an object with sufficient probability that resembles a face, the classifier recorded the bounding box of the window and applied non-maximum suppression to increase accuracy. The V-J method calculate Integral Image through Haar-like feature with the process to create a robust cascade classifier. Based on the established algorithm, the experimental results demonstrate that the system successfully detected faces. This indicates that the application employing computer vision is capable of identifying faces and comparing the outcomes. The primary objective was to develop and implement a webcam-based system for real-time emotion recognition and evaluation of human emotions so that the resulting application could analyze the collected data. However, using just one camera, this system was unable to simultaneously identify and assess the emotional states of multiple people. Based on the Viola Jones detector (Haar Cascade Principle), the system detected the face in the image, extracted the facial features, and then classified the emotions. It worked in real time. This can be used in the development of artificial intelligence. Low latency. High level of accuracy. Real-time emotional states can be detected for certain emotions. The difference between the sum of the pixels in two rectangular regions determines the values of a two-rectangular feature. The areas are the same size and shape and are adjacent both horizontally and vertically. In a center rectangle, the sum is computed by a three-rectangular feature. Finally, the difference between diagonal pairs of rectangles is computed using a four-rectangular feature. In order to generate a number of filters that will be used as inputs by the Ada Boost training algorithm, the image is convolved with a variety of variations of these regions of varying sizes. Using the standard method, it would take a long time to calculate these features. A novel strategy known as the integral image was developed to cut this amount of time.

12. ADVANTAGES

Some Haar cascade benefits are that they’re very fast at computing Haar-like features due to the use of integral images (also called summed area tables). Haar cascade is an algorithm that can detect objects in images, irrespective of their scale in image and location. This algorithm is not so complex and can run in real-time. We can train a haar-cascade detector to detect various emotions like happy, sad, etc. Haar cascade uses the cascading window, and it tries to compute features in every window and classify whether it could be an object. As the result the high level of accuracy can be obtained.

13. FACIAL DETECTION AND DETECTION OF SIGNIFICANT FACIAL FEATURES

Using the Viola-Jones Detection algorithm, significant facial features are identified and extracted. The identified landmarks are then used to apply landmark detection to each rectangle surrounding the face. The boundary is ignored if the benchmark detection confidence falls below the threshold. The SDK shows each face's extracted facial points, head rotation, and a center point between the eyes.

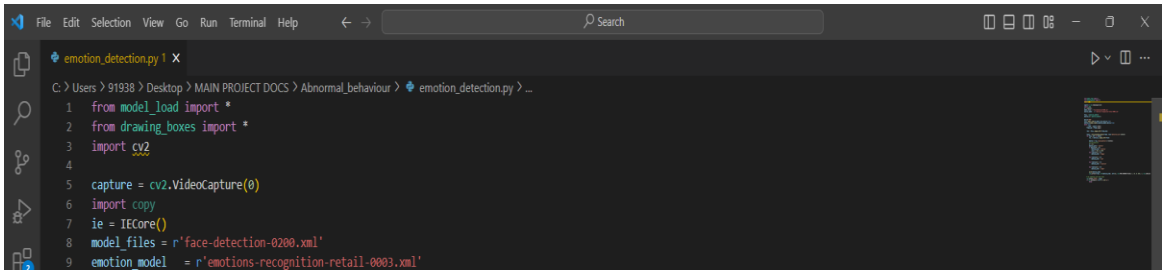


FIGURE 1. Extraction of Facial Features

The image area of interest, which is defined by the face orientation points, is the source of the Histogram of Oriented Gradient (HOG).

```
emotion_model   = r'emotions-recognition-retail-0003.xml'

face_ = openvino_model()
emotion_m = openvino_model()

device="GPU"
face_.model_load(ie,model_files,device,True)
emotion_m.model_load(ie,emotion_model,device,True)
```

FIGURE 2. Classification of Facial Action Points

To reflect the variety of real-world conditions, facial expression classification requires a large amount of data. "Single-frame labels that represent 10 symmetric FACS action units, 4 asymmetric (single-sided) FACS action units, 2 head movements, a smile, general expressivity, face, and gender facial extraction faults. "Placement of multiple landmarks that are automatically recognized. "Index of the fundamental performance of these database's detection algorithms."

```
while True:
    _,frame = capture.read()
    frame_new = frame.copy()

    res1 = face_.image_infer(frame_new)

    faces1 = draw_bounding_boxes(frame, res1['detection_out'][0][0])
    for face, attr in faces1:
        res_ = emotion_m.image_infer(face)

        emotion = res_['prob_emotion'].flatten()
        # print(emotion)
        th = 0.3
        emotion_pred = 'neutral'
        if emotion[0] > th:
            emotion_pred = 'neutral'
            color = (64, 0, 255)
        elif emotion[1] > th:
            emotion_pred = 'happy'

        elif emotion[2] > th:
            emotion_pred = 'sad'

        elif emotion[3] > th:
            emotion_pred = 'surprise'

        elif emotion[4] > th:
            emotion_pred = 'anger'

        print(emotion_pred)
        cv2.putText(frame, str(emotion_pred), attr[2], cv2.FONT_HERSHEY_PLAIN, 2, (0, 0, 255), 2, cv2.LINE_AA)
```

FIGURE 3. Emotional Prototype Modeling Using Emfacs

The comprehensive, anatomically based Facial Action Coding System (FACS) describes every facial movement that can be seen. It breaks down facial expressions into individual Action Units (AUs) of muscle movement. FACS is utilized in numerous personal and professional contexts. It is frequently used for research in a variety of scientific settings. Additionally, animators and computer scientists with an interest in facial recognition make use of it. FACS may also make it possible to be more sensitive and aware of subtle facial behaviors. Psychotherapists, interviewers, and anyone else who works in communications can benefit from these skills.

```
cv2.imshow('Video', frame)
if cv2.waitKey(1) & 0xFF == ord('q'):
    break
```

FIGURE 4. Emfcas

EMFACS, or Emotion FACS, is a selective form of FACS scoring in which the coders only give scores to behaviors that are likely to have an emotional impact. The coder searches the video for key combinations of events that have been found to suggest particular emotions in order to accomplish this. FACS coding is used to score the events in a video record that contain such core combinations; however, the coders do not code every event in the video. Therefore, EMFACS employs FACS selectively. Because one is not coding everything, EMFACS saves time. The disadvantage is that intercoder

agreement on EMFACS coding can be more difficult to achieve because coders must agree on two things: 1) whether or not to code an event (as a result of their online search of the video for the fundamental combinations) and 2) how to code the events they have chosen to code. Keep in mind that EMFACS coding still produces FACS codes; consequently, the data must be interpreted according to emotion categories.

```python
from model_load import *
from drawing_boxes import *
import cv2

capture = cv2.VideoCapture(0)
import copy
ie = IECore()
model_files = r'face-detection-0200.xml'
emotion_model   = r'emotions-recognition-retail-0003.xml'

face_ = openvino_model()
emotion_m = openvino_model()

device="GPU"
face_.model_load(ie,model_files,device,True)
emotion_m.model_load(ie,emotion_model,device,True)
while True:
    _,frame = capture.read()
    frame_new = frame.copy()

    res1 = face_.image_infer(frame_new)

    faces1 = draw_bounding_boxes(frame, res1['detection_out'][0][0])
    for face, attr in faces1:
        res_ = emotion_m.image_infer(face)

        emotion = res_['prob_emotion'].flatten()
        # print(emotion)
        th = 0.3
        emotion_pred = 'neutral'
        if emotion[0] > th:
            emotion_pred = 'neutral'
            color = (64, 0, 255)
        elif emotion[1] > th:
            emotion_pred = 'happy'

        elif emotion[2] > th:
            emotion_pred = 'sad'

        elif emotion[3] > th:
            emotion_pred = 'surprise'

        elif emotion[4] > th:
            emotion_pred = 'anger'

        print(emotion_pred)
        cv2.putText(frame, str(emotion_pred), attr[2], cv2.FONT_HERSHEY_PLAIN, 2, (0, 0, 255), 2, cv2.LINE_AA)

    # Do something with the frame
    cv2.imshow('Video', frame)
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break
```

FIGURE 5. System Architecture

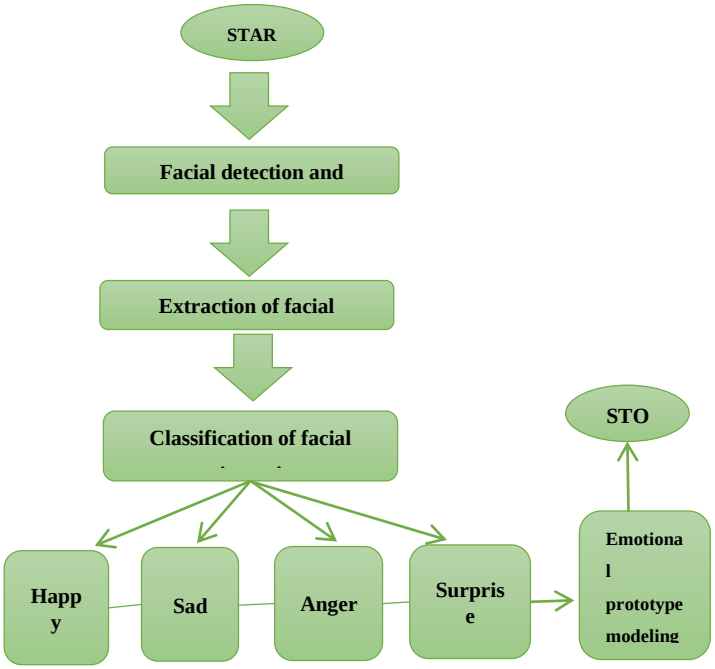


FIGURE 6. System Architecture

Emotions can be best expressed through facial expressions. Nowadays, human emotions are utilized in numerous ways. In essence, there are six universal feelings: happiness, sadness, fear, rage, disgust, and surprise. The domain of computer vision encompasses these feelings. Using numerous libraries and the Haar Cascade Algorithm for face detection, Facial Expression Recognition with Image Processing Systems proposes a novel method for recognizing facial expressions.

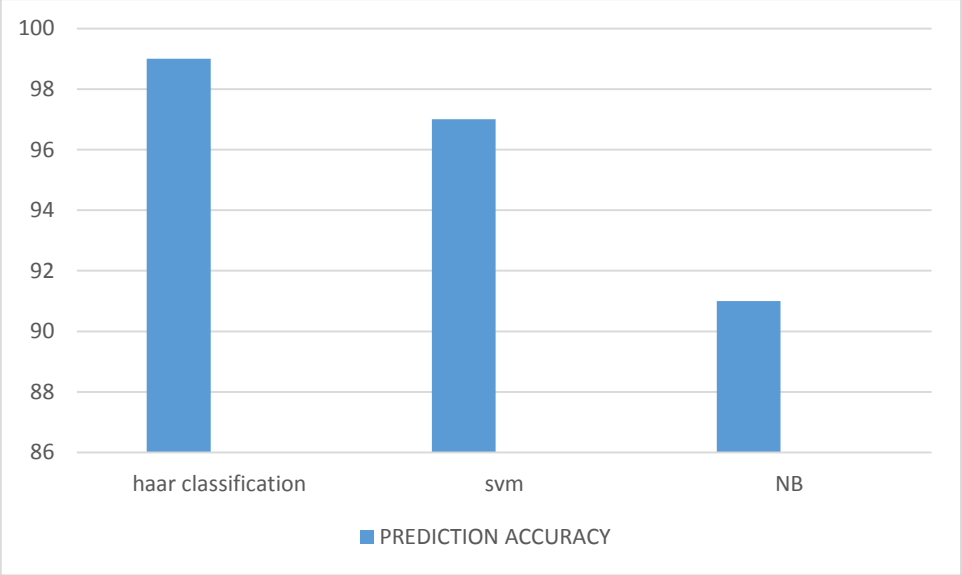
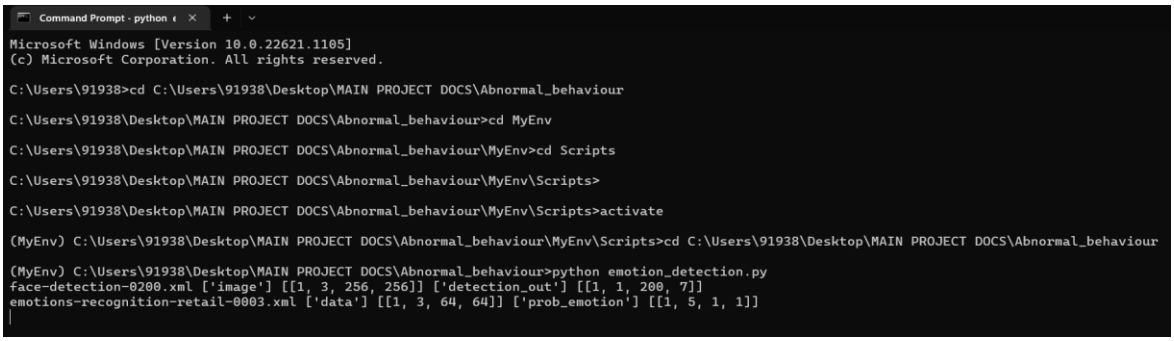
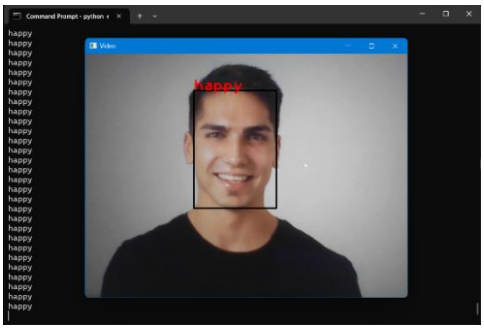
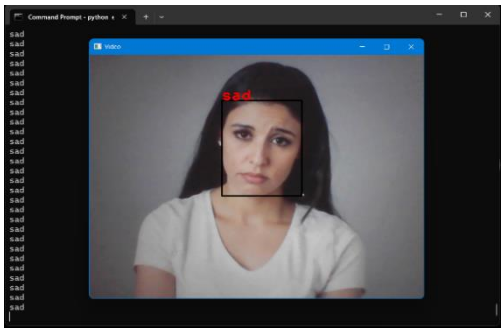


FIGURE 7. Result

14. OUTPUT







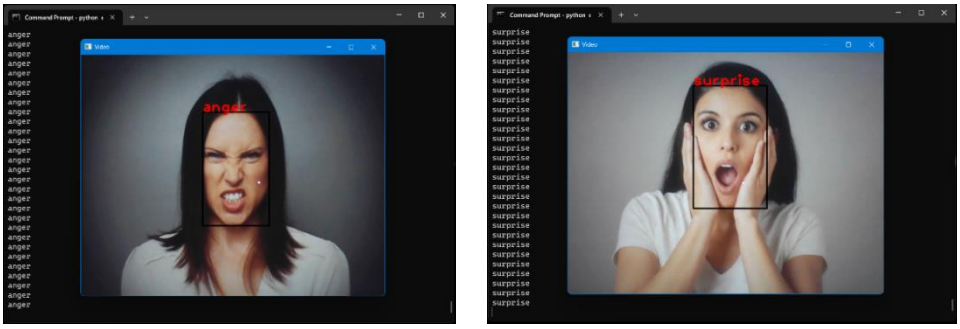


FIGURE 8. Output

TABLE1. Prediction Accuracy

ALGORITHM	PREDICTION ACCURACY
HAAR CLASSIFICATION	99
SVM	97
NB	91

The result in the output is that the facial expression is identified with the haar cascade algorithm to get the better result than the previous existing algorithm. As the expected output is gained that the persons face is either happy or sad, or depressed or anger all the various kinds of expression can be identified.

15. CONCLUSION

A method for recognizing human emotions is facial expression recognition. The captured series of images were used by the proposed system to identify the same. It extracts feature points efficiently by identifying the face from the collected images. The system accurately categorizes the live webcam as one of many universal feelings. The Haar Cascade algorithm, which is used to detect faces, works well and has an accuracy rate of about 99%.

REFERENCES

[1]. P.Augustyniak, et al. Seamless tracing of human behavior using complementary wearable and house-embedded sensors. Sensors, 14(5), 2014, p. 7831-7856.
[2]. K. Bahreini, R. Nadolski, & W. Westera. Towards multimodal emotion recognition in e-learning environments. Interactive Learning Environments, no. Ahead-of-print, 2014, p. 1-16.
[3]. V. Bettadapura. Face Expression Recognition and Analysis: The State of the Art. arXiv: Tech Report, (4), 2012, p. 1-27.
[4]. Y. Chen, R. Hwang, & C. Wang. Development and evaluation of a web 2.0 annotation system as a learning tool in an e-learning environment, Computers and Education, 58(4), 2011, p. 1094-1105.
[5]. C. Darwin. The Expression of the Emotions in Man and Animals. Oxford University Press, USA (1998).
[6]. P. Ekman. All Emotions Are Basic. In Ekman & Davidson (Eds.), the Nature of Emotion. New York: Oxford University Press, 1992, p. 15-19.
[7]. P. Ekman. Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. Psychological Bulletin, 115(2), 1994, p. 268-287.
[8]. P. Ekman, & W. Friesen. Facial Action Coding System: Investigator's Guide. Palo Alto, CA: Consulting Psychologists Press, 1978.
[9]. B. Fasel, & J. Luettin. Automatic facial expression analysis: A survey. Pattern Recognition, 36(1), 2003, p. 259-275.
[10]. M. Feidakis, T. Daradoumis, & S. Caballe. Emotion Measurement in Intelligent Tutoring Systems: What, When and How to Measure. Third International Conference on Intelligent Networking and Collaborative Systems, 2011, p. 807-812.
[11]. G. Giannakakis, M. Pediaditis, D. Manousos, E. Kazantzaki, F. Chiarugi, P.G. Simos, & M. Tsiknakis. Stress and anxiety detection using facial cues from videos. Biomedical Signal Processing and Control, 31, 2017, p. 89- 101. doi:10.1016/j.bspc.2016.06.020.
[12]. M.X. Huang, J. Li, G. Ngai, & H. V. Leong. StressClick: Sensing stress from gaze-click patterns. Paper presented at the MM 2016 - Proceedings of the 2016 ACM Multimedia Conference, 2016, p. 1395-1404. doi:10.1145/2964284.2964318.

[13]. Y. Juan, S. Dobson, & S. McKeever. Situation identification techniques in pervasive computing: A review. Pervasive and mobile computing, 8(1), 2012, p. 36-66.
[14]. D. Keltner. Born to be good: The science of a meaningful life. New York: WW Norton & Company, 2009.
[15]. A. Kumar, A. Kumar, S.K. Singh, & R. Kala. Human Activity Recognition in Real-Times Environments using Skeleton Joints. International Journal of Interactive Multimedia and Artificial Intelligence, 3(7), 2016, p. 61-69.