Deep Learning Approach for Identification of Students Emotion

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Abstract

Classroom teaching assessments are designed to give a useful feedback on the teaching-learning process as it is happening. The best classroom evaluations additionally serve as significant sources of data for instructors, helping them recognize what they taught well and what they have to deal with. In the report, The proposed a deep learning method for ***emotion analysis [1][2][3]****. This work focuses on students of a classroom and thus, understands their facial emotions. Methodology includes the preprocessing phase in which face detection is performed, and finally emotion prediction. Student engagement has been a key topic inside the educational training. The three specific styles of engagement of the students in a class are: behavioral, emotional, and cognitive. The time period behavioral engagement is commonly used to describe the scholar's willingness to participate within the getting to know system. Emotional engagement describes a scholar's emotional attitude toward learning. Cognitive engagement is a chief part of overall learning engagement. From the facial expressions the involvement of the students in the magnificence can be decided. Commonly in a lecture room it's far difficult to recognize whether the students are able to understand the lecture or not. So that you can know that comments form will be collected manually from the students. However, those feedbacks given by using the students will now not be correct. Hence they will no longer get proper comments. This hassle can be solved by means of the use of a facial emotion evaluation [4][5][6]. From the facial expression the emotion of the students may be analyzed. Quantitative observations are achieved in the lecture room wherein the emotion of students might be recorded and statistically analyzed. With the aid of the use of facial emotion we will directly get correct information approximately students understand potential, and determining if the lecture become exciting, boring, or mild for the students and the apprehend capability of the scholar is recognized by the facial emotions.*

Keywords:-*Deep Learning, Emotion analysis, Facial Expression, Confusion Matrix*

1. Introduction

A. School

- Who is the Target Group – CBSE & ICSE Schools
- What is the pain point – Effective teaching, better academic performance
- What is the solution – Teacher skill gap identification & training, Student strength & weakness identification & training
- What is the benefit – Better teaching, improved academic performance
- What is the advantage – Structured training, School can concentrate on Core activities
- How is the solution delivered – Assessment & training tips to
    1. Teachers
    2. Students
    3. Parents

Change is the only constant. In line with the change in time, expectations and demands also do change. One of the key ingredients to be successful is, to be able to adapt and meet the changing demands and expectations from time to time.

Current scenario:
Schools are no longer schools, they are educational institutions. From a simple teaching responsibility, schools are expected to be performing multidimensional activities.

B. Teacher
What is the solution – Assessment to do Gap analysis, Tips to bridge the gap

What is the benefit – Improved bonding & Better teaching techniques

How is the solution delivered – A detailed report about student emotion and his performance across the classed will help them to –

1. Improved relationship

2. Higher results with lesser efforts

Description: Behind every Sachin, there is a Ramakant Achrekar. Irrespective of whether your teachers are teachers by choice or by chance, they can be excellent teachers in practice and make an everlasting impact on the lives of the students. To be a beacon lighthouse for your students, is that not important for you to have a healthy emotional bondage?

Enlightment and performance of the student is the paramount motivator for a teacher. As a teacher would it not be interesting to know how did children felt in your class and how & where you can improve to influence them better. How you can transform yourself from teacher to coach and from Coach to mentor.

Now with the path breaking tool developed based on proven psychological principles and tested experiments,

- Every teacher can know about the gaps and
- Ways to bridge to become a world class teacher

Our Student Emotion Detection Project, helps the teacher to understand
1) Students potential,
2) Preferred teaching style,
3) Personality type and
4) Emotional intelligence.

This is designed to be a companion for every teacher -
1. helping the teacher to know about their strengths,
2. areas of improvement, tools, tips, and methods to improve themselves and their teaching

Benefit:
- This would help them to use their strengths better and work on areas to transform themselves from teacher to coach, and from coach to mentor.
- Would be remembered by their students for a life time.
- It would help the teacher to also become a counselor, guide, coach, and mentor. Our tool helps the teachers to place themselves on where they are on crucial parameters instrumental in developing this bondage and relationship

C. Students
- What is the pain point – Lack of understanding about the strengths, limitations, Lack of empathy & care
- How severe is the pain – Severe & long lasting
- What is the solution – Brain assessment, Modified teaching
- What is the benefit – Happy children, Better learning, Productive personality
- How is the solution delivered – By capturing the emotions of students through camera installed in classes

Dataset(s)

1. Dataset acquiring from various resources
2. Input is video which is sequence of Image

Face detection model used: Face detection is done using open-cvs'shaar cascade classfier.

Information about the data: The data consists of 48x48 pixel grayscale images of faces. The faces have been automatically registered so that the face is more or less centered and occupies about the same amount of space in each image. The task is to categorize each face based on the emotion shown in the facial expression in to one of seven categories *(0=Angry, 1=Disgust, 2=Fear, 3=Happy, 4=Sad, 5=Surprise, 6=Neutral)*.

train.csv contains two columns, "emotion" and "pixels". The "emotion" column contains a numeric code ranging from 0 to 6, inclusive, for the emotion that is present in the image. The "pixels" column contains a string surrounded in quotes for each image. The contents of this string a space-separated pixel values in row major order. test.csv contains only the "pixels" column and your task is to predict the emotion column. The training set consists of 28,709 examples. The public test set used for the leader board consists of 3,589 examples.

2. Overview of the process

A. Methodology

Emotion recognition (ER) based on natural facial images/videos has been studied for some years and considered a comparatively hot topic in the field of affective computing. However, it remains a challenge to perform ER in the wild, given the noises generated from head pose, face deformation, and illumination variation. To address this challenge, motivated by recent progress in Convolutional Neural Network (CNN), This research developed a novel deeply supervised CNN (DSN) architecture[11][12][13][14], taking the multi-level and multi-scale features extracted from different convolutional layers to provide a more advanced representation of ER. By embedding a series of side-output layers, our DSN model provides class-wise supervision and integrates predictions from multiple layers. PCA is used for dimensionality reduction in input data while retaining those characteristics of the data set that contribute most to its variance[7][8][9][10], by keeping lower-order principal components and ignoring higher-order ones. Figure 1. gives the basic idea of the process.

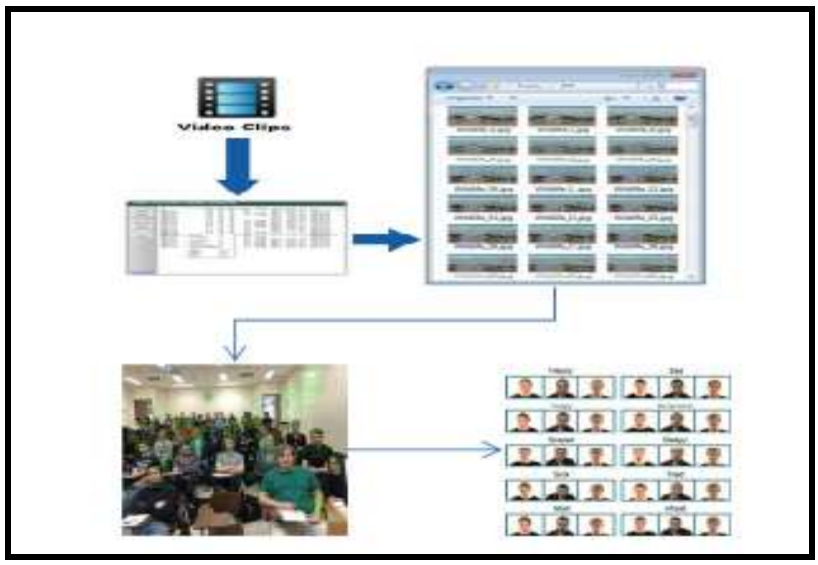

Fig 1.Block diagram of the process

B.System Architecture:
The system architecture consists of Video Capturing, face detection, frame filtering, and emotion classification. Input is in video format and the output will be emotion detection. Final output displays the count of active and non active students in the classroom.

C .Step-by-step walk through of the solution
Emotions of a student during the classroom engagement play a vital role in any learning environment whether it's in classrooms or in e-learning [15][16][17][18]. We use excite, disturb and moving pattern of eyes and head to infer meaningful information to understand mood of the student while engaged in classroom environment. Emotion detection methods have been in focus of the researchers across various disciples to understand the user involvement, effectiveness and usefulness of the system implemented or to be implemented. Our focus is on understanding and interpolating the emotional state of the learner during a learning engagement. Evaluating the emotion of a learner can progressively help in enhancing learning experience and update the learning contents. This research proposed a system that can identify and monitor emotions of the student in classroom environment and provide a real-time feedback mechanism to enhance the classroom learning aids for a better content delivery. Detection of eyes, head movement can help us understand learner concentration level [19][20]. Since our metric are captured from eyes and head movement we eliminate the need of any device usage that requires physical contact to the subject understudy. The proposed system helps to identify emotions and classify learner involvement and interest in the topic which are plotted as feedback to the instructor to improve learner experience.

3. Problem Statement

Student engagement has been a key topic inside the educational training. The three specific styles of engagement of the students in a class are: behavioural, emotional, and cognitive. The objective of the project is to capture the emotions of students through the cameras installed in class and provide the reports to respective domain to evaluate the gaps and come up with productive measure that will give improved results for domains given below.

1) School
2) Teachers
3) Students

Students, when fully attentive, do quite well in learning the subjects line markings under most driving conditions. Computers are not inherently good at doing the same. However, humans have a disadvantage of not always being attentive, while a computer is. As such, if we can train a computer to get as good as a human at detecting emotions, since it is already significantly better at paying attention full-time, the computer can take over this job from the human. From the computer's perspective, the problem is around detecting an emotion and generating a report for each student.For the purposes of this work we will work with an Emotion Model which states that there are six basic tentative emotions:

- Anger
- Disgust
- Fear
- Sadness
- Happiness
- Surprise

4. Objectives Identification

The main objective in this is to **IDENTIFICATION OF STUDENT EMOTION**.

- Can the school get a helping hand, professional help to perform non-core activities while the school continues to focus on core teaching activities?
- Can the school provide inclusive education where computer with our model also can play an active role?

5. Model evaluation

A. Info on Model:

Commonly used CNNs for feature extraction include a set of fully connected layers at the end. Fully connected layers tend to contain most of the parameters in a CNN. Specifically, VGG16 contains approximately 90% of all its parameters in their last fully connected layers. Recent architectures such as Inception V3, reduced the amount of parameters in their last layers by including a Global Average Pooling operation. Global Average Pooling reduces each feature map into a scalar value by taking the average over all elements in the feature map. The average operation forces the network to extract global features from the input image. Modern CNN architectures such as Xception leverage from the combination of two of the most successful experimental assumptions in CNNs: the use of residual modules and depth-wise separable convolutions. Depth-wise separable convolutions reduce further the amount of parameters by separating the processes of feature extraction and combination within a convolutional layer.Here the evaluation criteria are illustrated in two-class cases. The TP, FN, TN, FP are defined in Table 1.

Table 1. Evaluation criteria of two-classes cases

	Predicted Positive	Predicted Negative
Actual Positive	TP (True Positive)	FN (False Negative)
Actual Negative	FP (False Positive)	TN (True Negative)

Then for the precision and recall of first class, we have:

$$P = TP/TP + FP$$

$$R = TP/TP+FN$$

For emotional facial classification problem, the evaluation criterion of AU occurrence is the F1-measure, which is the combination of recall and precision. For an AU with precision P and recall R, it is calculated as:

$$F1 = 2PR / P+R$$

The main objective of the project is to understand the mood of a student in the classroom. The first step of collection of data involves capturing the video of the students in a classroom. As part of this task we have tried capturing videos from various classrooms, but there were a lot of technical issues faced like position of the video, no proper clarity of faces, not all faces being captured etc. To overcome this issue we decided to take predefined datasets for training and we started exploring various papers published that are related to our project. The Work are still in the process of finding the right dataset suitable for our requirements and will be ready with the right dataset.

6.Comparison to benchmark

- We initially thought of a program that will capture the emotions from surveillance camera with any fixed angle. However, when we tried to extract the emotions from such camera, the model was unable to execute the results efficiently.
- The improvement that we had to adopt was to record a video with one fixed angle of students with a duration of 30 mins, using a Mobile and Handy camera. With this fixed angle we had to record videos of students of different classes.
- Sourcing relevant data for our model was a difficult task. We had to take permission from a school and record video of live students while the class was going on. This video was used to train and test our model.
- This research achieved to capture the emotions of multiple students in class with our model, by tagging a unique ID to each student and capturing the emotions and making a note of emotions over a period of time.

7. Visualization(s)

Data visualization is the representation of data or information in a graph, chart, or other visual format. It communicates relationships of the data with images. This is important because it allows trends and patterns to be more easily seen. That fact showcases the importance of data visualization.

Data visualization is the graphic representation of data. It involves producing images that communicate relationships among the represented data to viewers of the images. This communication is achieved through the use of a systematic mapping between graphic marks and data values in the creation of the visualization

Data visualization refers to the techniques used to communicate data or information by encoding it as visual objects (e.g., points, lines or bars) contained in graphics. The goal is to communicate information clearly and efficiently to users. It is one of the steps in data analysis or data science.

Below is the visualization indicating the different emotion of a video that was used to train our model. The output of same is captured as image, showing the different emotion outcome with percentage.

Fig. 2. Video output with captured emotion

The results of emotions captured from the video is generated in the format of reports. The sample report format, subject wise, linked to emotions is displayed below.

Table 2. Mathematics students emotion report of 7 captured students

Name	Anger	Disgust	Fear	Sadness	Happy	Surprise
Student 1	15%	5%	10%	10%	60%	0%
Student 2	15%	0%	20%	10%	50%	5%
Student 3	5%	10%	15%	20%	50%	0%
Student 4	15%	0%	15%	5%	55%	10%
Student 5	20%	0%	5%	15%	50%	10%
Student 6	10%	5%	10%	15%	55%	5%
Student 7	15%	5%	10%	10%	60%	0%

Table 3. Science students emotion report of 7 captured students

Name	Anger	Disgust	Fear	Sadness	Happy	Surprise
Student 1	15%	5%	10%	10%	60%	0%
Student 2	15%	0%	20%	10%	50%	5%
Student 3	5%	10%	15%	20%	50%	0%
Student 4	15%	0%	15%	5%	55%	10%
Student 5	20%	0%	5%	15%	50%	10%
Student 6	10%	5%	10%	15%	55%	5%
Student 7	15%	5%	10%	10%	60%	0%

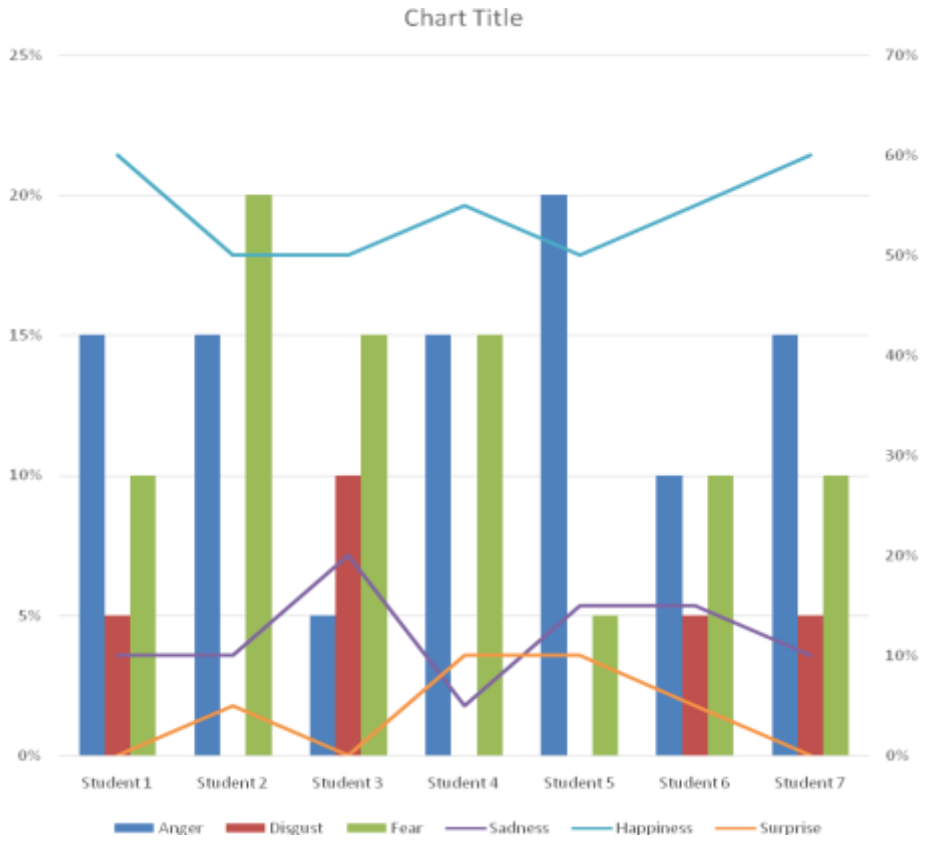

Fig.3. Comparative bar chart of students emotion

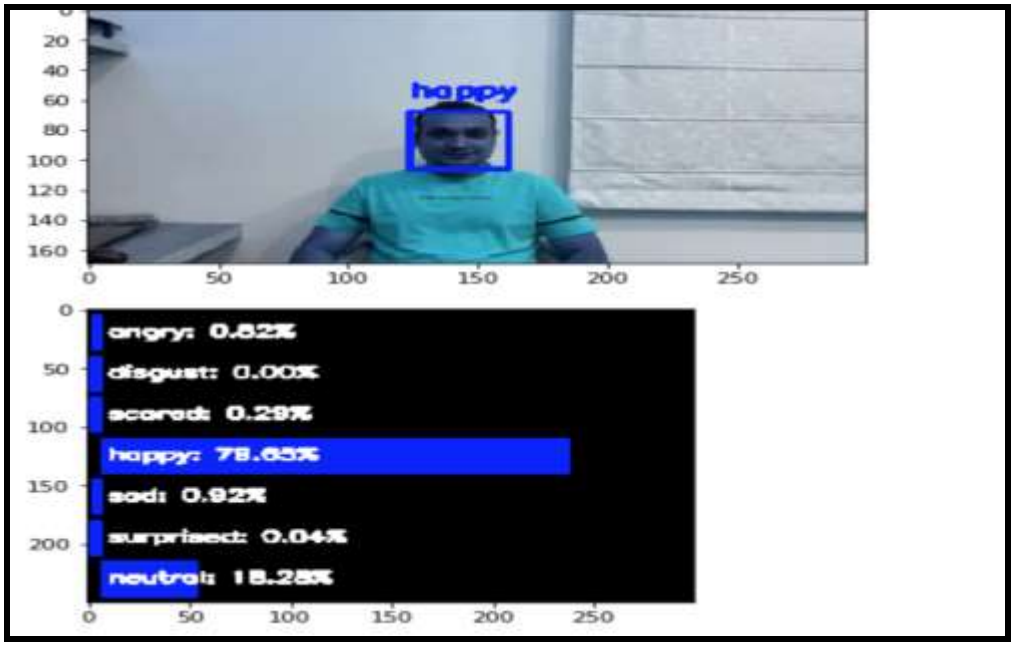

Fig. 4. Happy emotion outcome of captured image

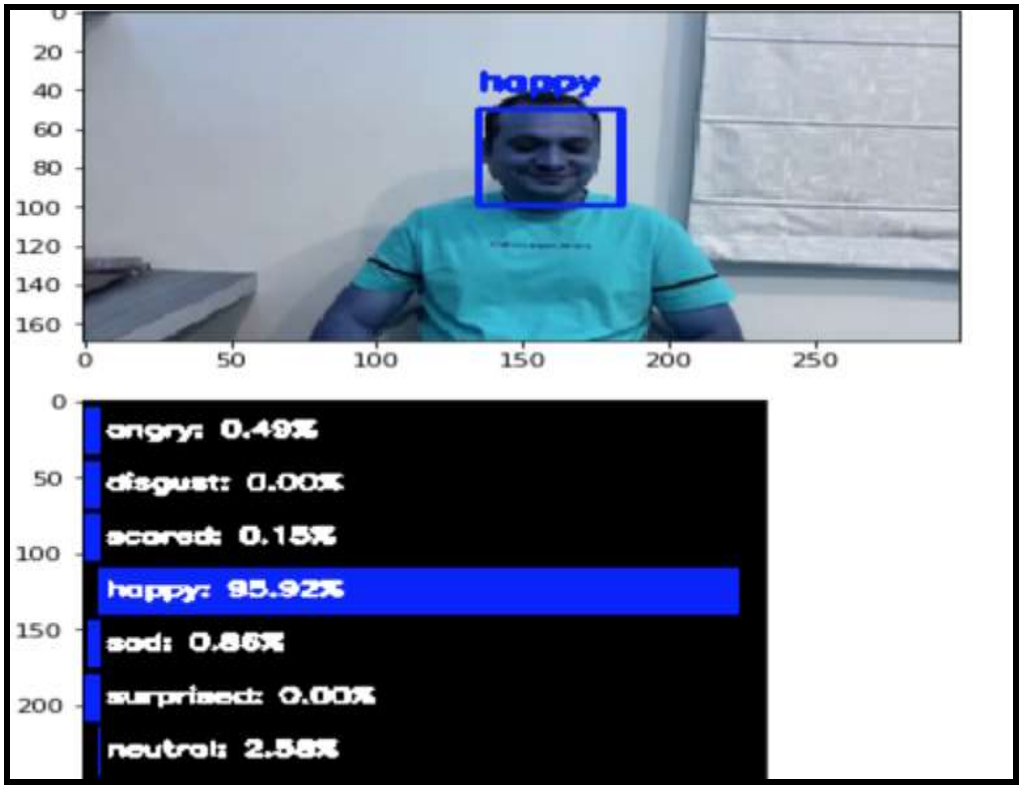

Fig. 5. Happy emotion outcome of captured image

Fig. 6. Neutral emotion outcome of captured image

8. Limitations

Deploying a facial recognition project can be a challenging task.

1. Ensuring **high accuracy with minimizing complexity** can be challenging. Neural Network method has good accuracy in prediction, but its computation complexity is very high.
2. The artificial neural network of multiple hidden layers possesses excellent ability of the feature learning, and the features that have been learned are better at capturing the nature of the data, thereby facilitating visualization or classification. Layer wise training is used in this research to avoid difficulties of training the network [25][26][9][4].

The major challenges were:

1) To find the relevant quality data to test model
2) To capture the emotions for any type of video with any angle
3) The quality of the video was expected to be HD format
4) The challenge was to capture the emotions of students not facing the camera

9. Closing Reflections

Research had to spend good amount of time for identifying the business goal and excavating a road map in achieving same. Things like,

- Data collection,
- Data analysis,
- Data preparation,
- EDA of data,
- Modelling of data,
- Evaluation of data,
- Final deployment

It was learnt during the course of development that the major time was spent of gathering and preparing the data. This work have learnt from our mistakes and from next time, and will try to optimize our outcome by better planning in the direction of identifying business goal and laying a proper road in achieving it as a team.

10. Conclusion

This research will help School Management with a dashboard to view following details:

- Teacher wise analysis
- Standard wise / Subject wise analysis
- Mapping teacher to Students & Parents
- Profile based analysis
- Peer to Peer analysis
- Progress analysis
- Mapping of Standard / subject to profile and needs analysis

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