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AI-Based Student Emotion and Engagement Level Detection Framework

Paper ID: TA047

AGENDA

- Introduction
- Methodology
- Algorithm
- Results
- Limitations
- Future Scope
- References

Measuring engagement levels

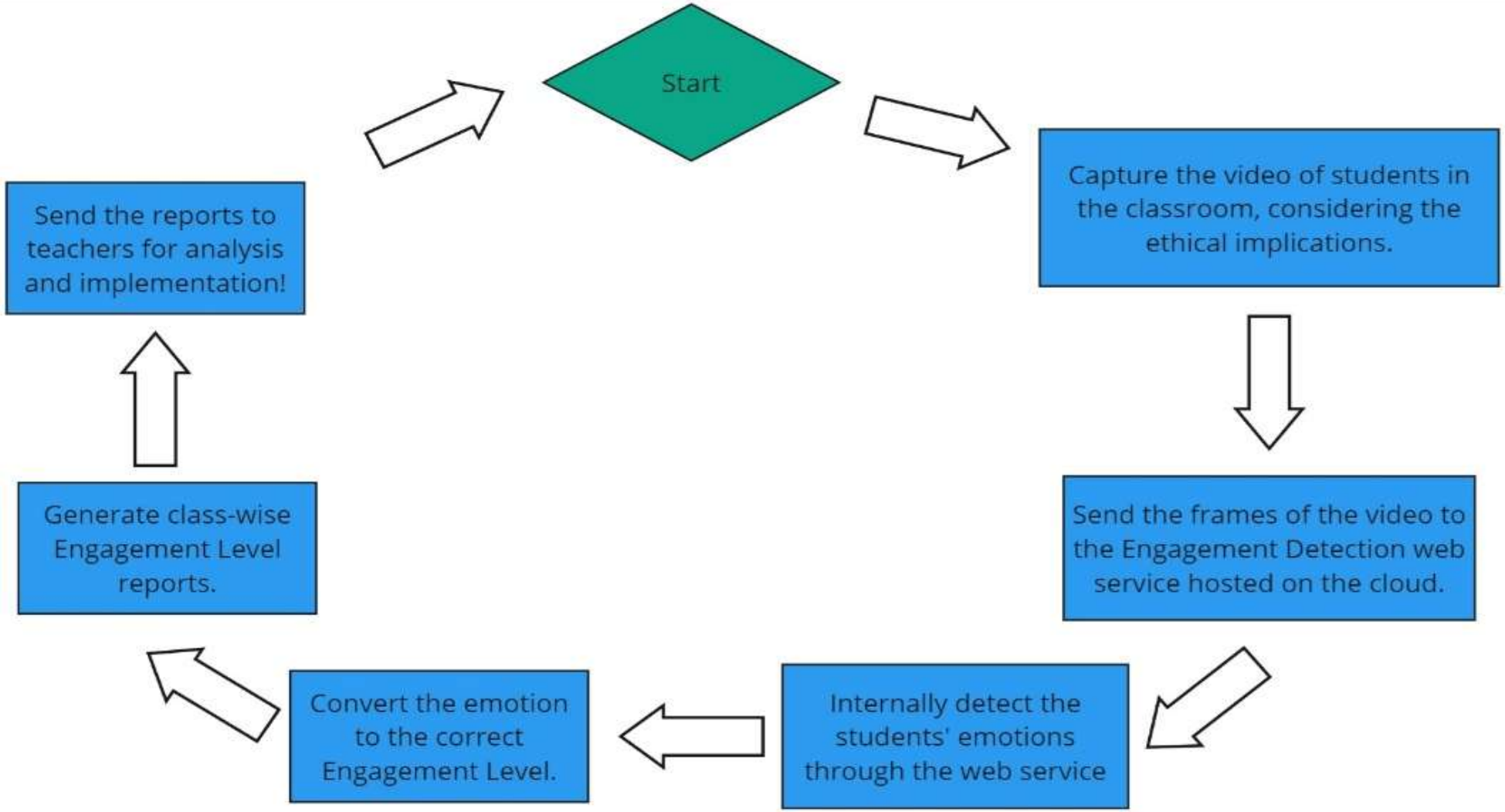
- Engagement levels decreased post Covid pandemic after students returned to school
- High student-to-teacher ratio in India
  - Difficult for teachers to assess individual student needs
- Teaching is more focused towards high-engaged students
- Design curriculum and interventions based on individual engagement levels
- Studies show higher levels of engagement are consistently associated with
  - better academic performance
  - lower dropout rates
  - higher levels of student satisfaction

Tools to measure Student Engagement levels

- Non-Technological Tools
  - Surveys and Questionnaires
  - Observation and Behavioral Data
  - Experience Sampling Method (ESM)
  - Psychometric Instruments
  - Qualitative Methods

- Technological Tools
  - Wearable Devices
  - Eye-tracking Technology
  - ***Emotion to Engagement - New***

Student Engagement Level Detection Process



Step 1: Video Capture and Ethical Considerations

Without data, the framework cannot produce results.

Video Requirements

- Camera must be at least 20 FPS
- It must be positioned at the front of the class, higher than the desks.
- It must capture as many students as possible at all times.

Ethical Challenges

- Obtaining consent to record students: School and Parents/ Guardians
- Videos cannot be stored. Have to be deleted after use.

Step 2: Video to Frames and Emotion Detection

Video is converted into frames.
Time interval between each prediction: 20 seconds.
Eg. 20 Seconds with a 20 FPS Camera means 1 per 400 frames captured.

On each individual frame, the Emotion Detection CNN is run.

- Emotions Detected: Ekman's 7 Basic Emotions
- Model Training: FER-2013, DEAP, SAVEE
- Model Testing: Data from Indian Classrooms (Aditya English Medium School)
- Final Emotion Detection Accuracy: 86%

Step 3a: Emotion to Engagement Model

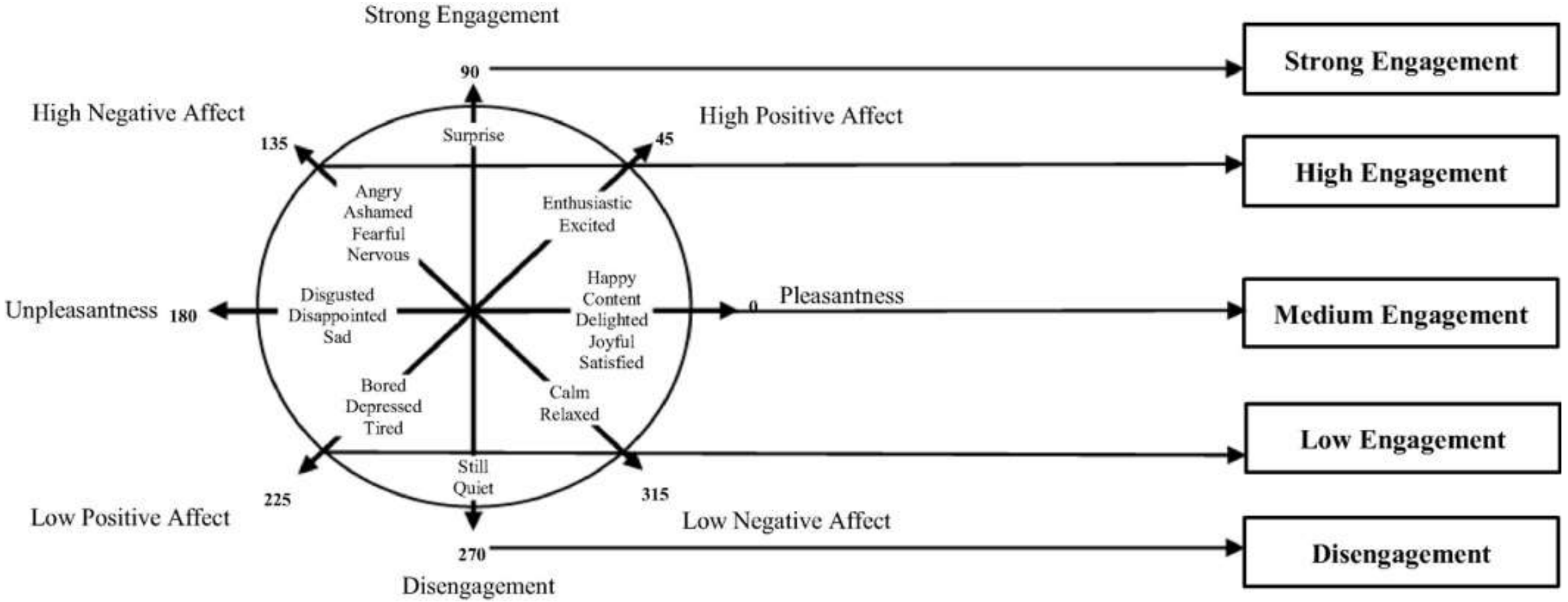


Fig. 2: Affective model proposed by Altuwairqi et al.

Step 3b: Creating Emotion to Engagement Index

- Fig. 2 shows correlation between primary emotions and engagement levels
  - FER model detects a subset of these emotions
- Table 1 shows the Index created of Emotion to a numerical Engagement Level value.
  - Linear Scale from 2 (lowest) to 5 (highest)
  - Value of 1 is not in use since disengagement is technically not possible unless the student is asleep or absent, both of which states cannot be detected in the FER model.

METHODOLOGY: INNOVATION

- Facial Emotion Recognition using Computer Vision
  - Used in classroom setting to determine student engagement
- Manual methods exist to measure engagement levels
  - Project proposes novel way using FER
- Scope of study limited to identifying 7 basic emotions
  - Happiness, sadness, disgust, surprise, anger, fear, and neutral emotion
- Combination of FER and engagement levels
  - Synthesizes new Computer Vision applications

METHODOLOGY: ENGAGEMENT MODEL

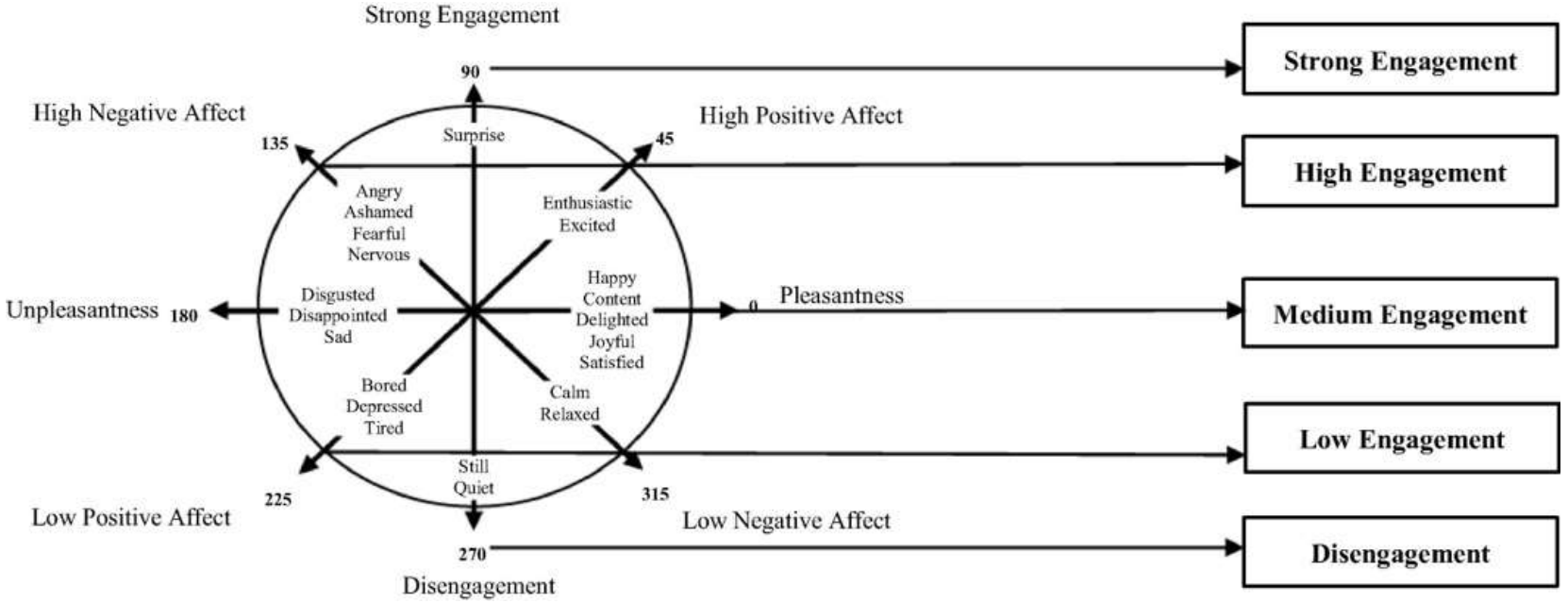


Fig. 2: Different Emotion Correlations to Engagement Levels

Engagement model proposed by Altuwairqi et al.

METHODOLOGY: EMOTION-ENGAGEMENT INDEX

- Fig. 2 shows correlation between primary emotions and engagement levels
  - FER model detects a subset of these emotions
- Table 1 displays engagement levels for detected emotions
  - Numerical values assigned on linear scale from 5 to 2
  - 5 is highest level of engagement, 2 is lowest
  - FER model does not measure emotions associated with disengagement
  - Value of 1 is not in use

Emotion	Engagement Level	Engagement Level - numerical value
Surprise	Strong	5
Fearful, Excited, Anger	High	4
Happy, Sad, Disgust	Medium	3
Neutral	Low	2

Table 1: Emotion - Engagement Correlation

CREATING ENGAGEMENT SCALE

- Emotions converted to numerical Engagement Level value
  - Correlation of emotions to engagement mapped through literature review
- New Emotion-based Affective model proposed
  - System ranks emotions according to engagement level
  - Surprise associated with high engagement, stillness with disengagement
- Student engagement categorized into five levels
  - Strong, high, medium, low engagement, and disengagement
  - Detected based on emotion detected
- Framework linked to Engagement Level web service
  - Successful detection of engagement level from photo
  - Images captured at 2-3 minute intervals from real-time video recording

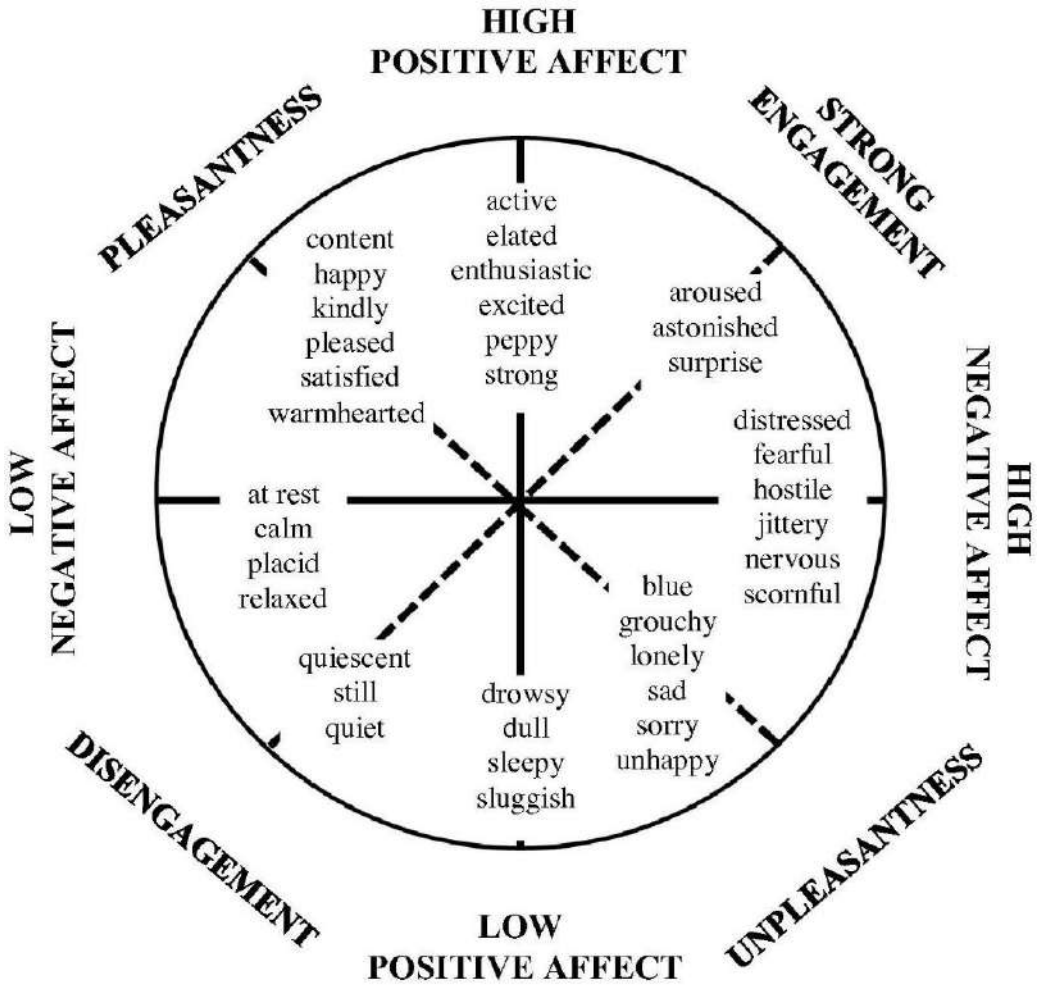


Fig 3: Emotion to Engagement Map (Altuwairqi et al)

METHOD: TRAINING AND OPTIMIZING THE MODEL

Datasets Used and Tested:

1. Affectiva-MIT Facial Expression Dataset: Faces of participants were partially covered with electrodes.
1. DISFA: Action Units (Spots) on the faces of participants hindered the model.
1. DEAP and SAVEE: Were used to make the model stronger.
1. FER-2013: The main dataset used. Comprised of various emotions/ participants, making it optimal.

ALGORITHM: ALGORITHM PROCESS

- Image Conversion
  - Image is converted to a pixel array
- Haar-Cascade Classifier
  - Identifies faces in the image
- Individual Face Processing
  - Each face is processed individually
  - CNN identifies displayed emotion and intensity
- Emotion Display
  - Prominent emotion is displayed
- Engagement Level Identification
  - Algorithm identifies engagement level of student

RESULTS

- Model Accuracy
  - Current accuracy stands at 86%

- Model Architecture
  - 6 Convolutional Layers, 6 Batch Normalization Layers
  - 6 Dropout layers, 3 Dense layers
  - 3 MaxPooling layers, and 2 Flatten Layers

- Emotion Detection
  - 7 primary emotions detected
    - Happiness, sadness, disgust, surprise, anger, fear, and neutral
  - Mapped to high, medium, and low engagement levels
    - Assigned Engagement score from 1 to 5

CHALLENGES

- Ethical
  - Consent of students and parents/guardians required for recording
- Recording Requirements
  - Backlight and improper lighting can skew data
  - Teacher training required for usage of this tool
- Student facial detection
  - Better results when student is looking up at the teacher
  - Difficulty in predicting engagement level when student is reading or writing on his desk

Current Progress

- Working with Science and Technology Cluster, Government of India organization
  - Initially working with 25 schools around Pune, Maharashtra, India
- Working with Eagle Robot Lab
  - Private Robotic organization in India building teaching robots
- Technology
  - Template matching to identify specific student

FUTURE SCOPE

- Pune Knowledge Cluster (PKC) shows interest in the service
  - Working with 25 schools in Maharashtra to plan digital curriculum content
  - Will assess impact of PKC's Digital Literacy Program
- Challenges include obtaining consent from parents
  - Consent obtained from Eagle Robot Lab, Aditya English Medium School, and PKC schools
- Collection of data and training algorithm is important for future
  - Collaboration with companies like Eagle Robot Lab and organizations like PKC
- Project can expand to more schools in India
  - Teachers can use suggested techniques to raise engagement levels
  - More schools have been shortlisted as candidates for deployment

THANK YOU