Pronunciation Assistance Based on Automatic Speech and Facial Recognition

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Pronunciation Improvement

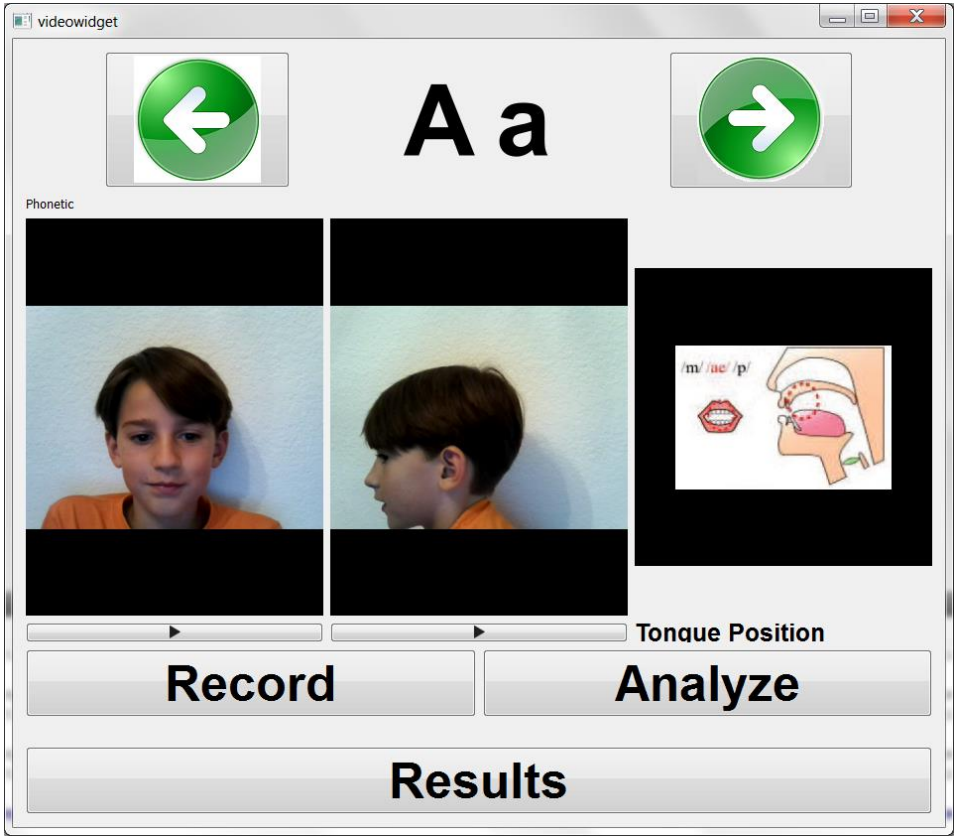
L2 learning assistance instructional tool.

Assessing student's pronunciation

Providing accurate corrective feed-back.

The model presented integrates speech and image recognition technology.

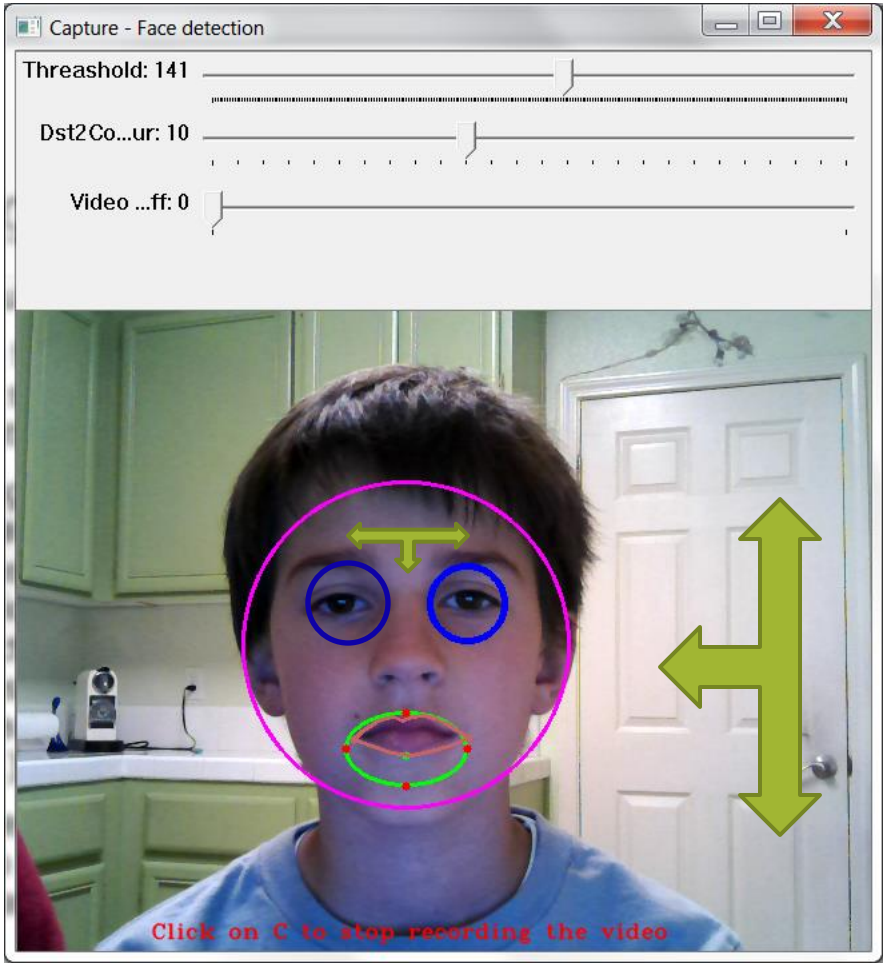
Providing feed-back and data to evaluate the model's performance.



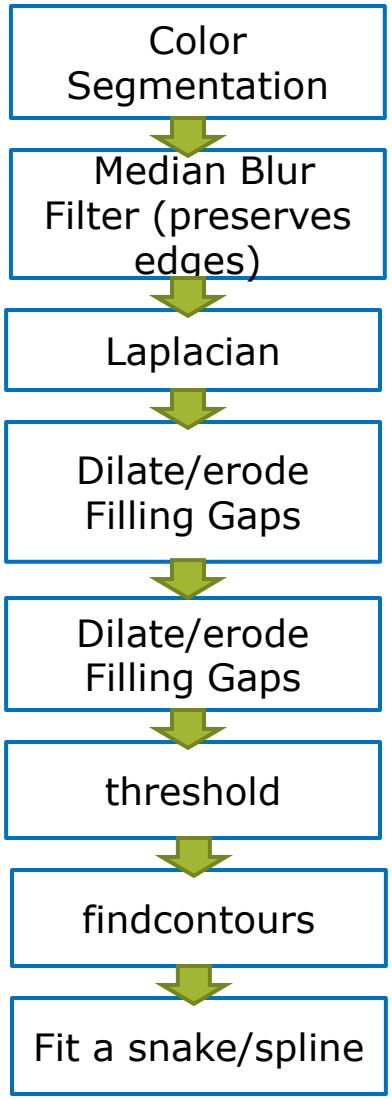
Lip Segmentation

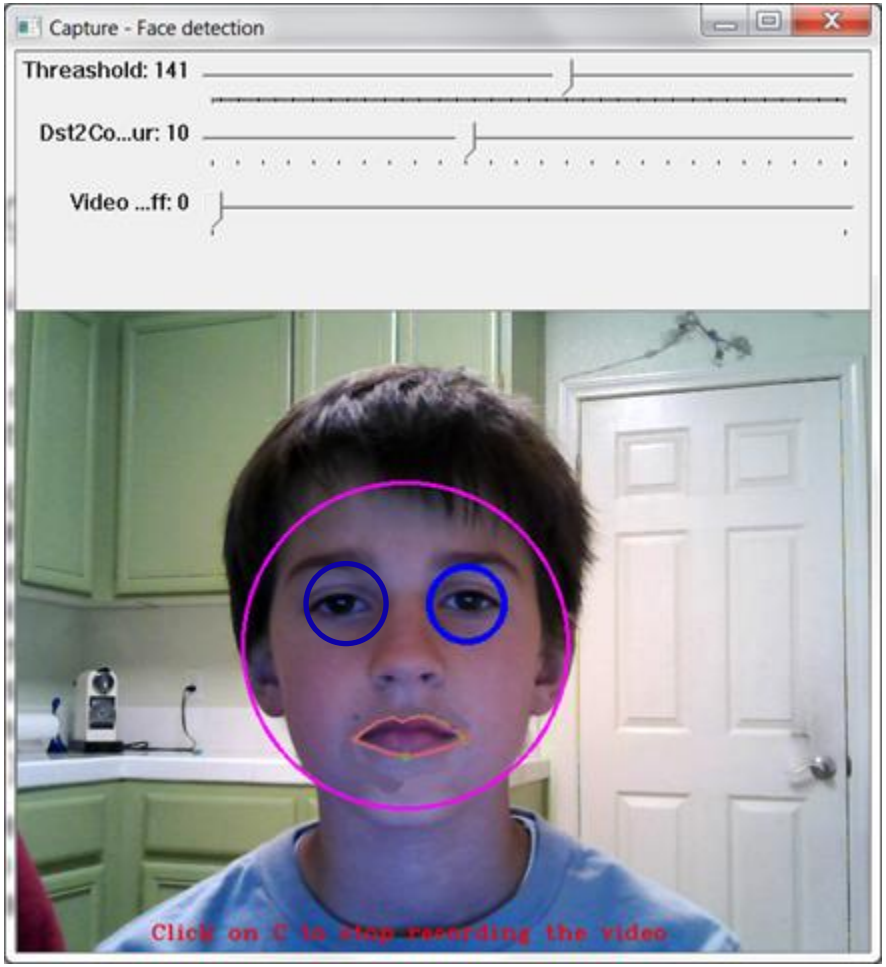
Location of Mouth:

- User will be front facing the camera so it relatively easy to locate the face.
- We are using OpenCV face detector Feature-based Cascade Classifier (Paul Viola and Michael J. Jones. Rapid Object Detection using a Boosted Cascade of Simple Features. IEEE CVPR, 2001)
- Using simple human face geometry to restrict the possible location of the mouth
  - 1/3 lower face
  - Between the eyes



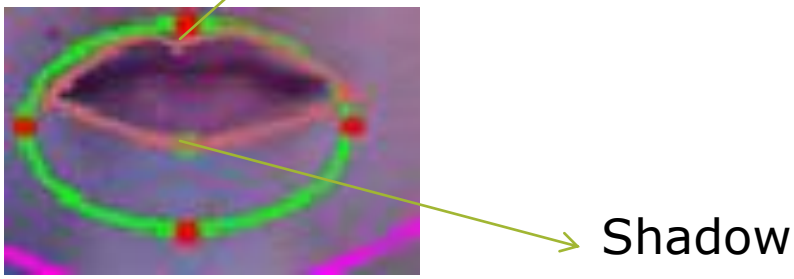
Lip Segmentation





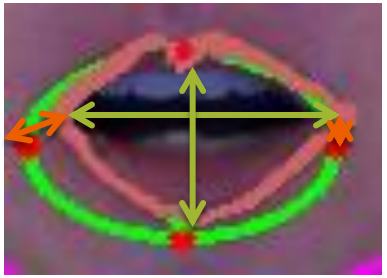
Pseudo Code for Lip Segmentation

- Lip segmentation using color only creates a very noisy image
  - Red is prevalent in both skin and lips
  - The difference between Red and Green values is higher on lips
- Luminance changes. Light sources usually comes from above the speaker
  - The top lip contour is illuminated, the bottom contour is in shadow
- Mouth geometry



Lip Movement tracking

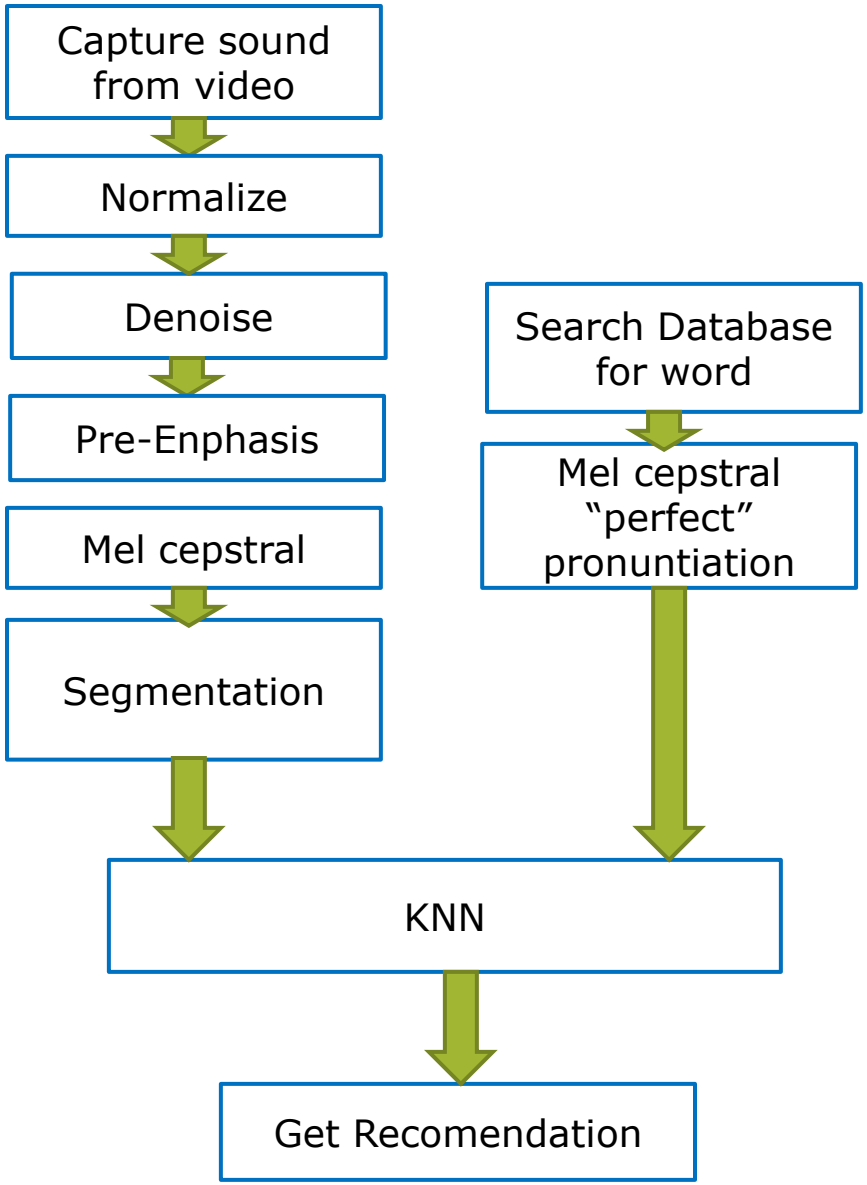
- Keypoints tracking
- Frame by frame we recalculate the 4 pints.
- Problems on the corners when mouth is wide open
  - Restrict search based on the mouth contour
  - Get minimal intensity for the contour



lip segmentation CPU vs GPU

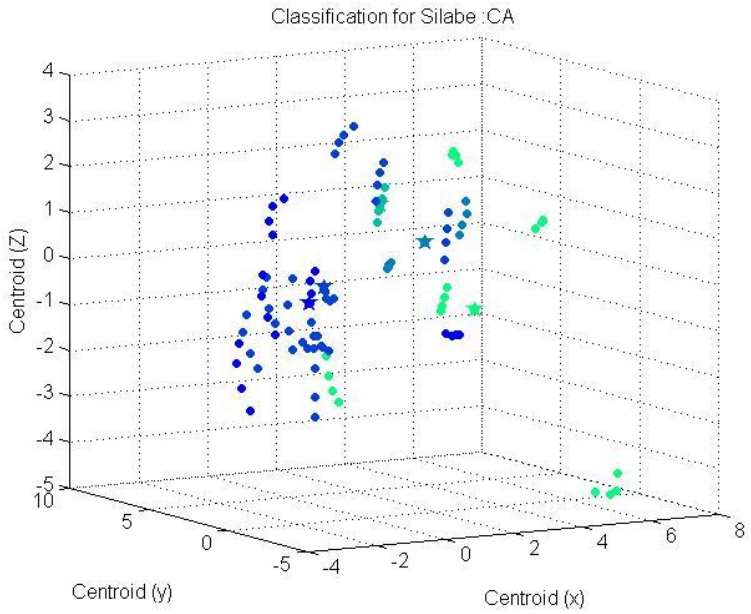
	CPU	GPU
Face Detection		
Mouth Detection		
Erode/Delate		
Blur Filter		
Spline		

Audio analysis



K-NN

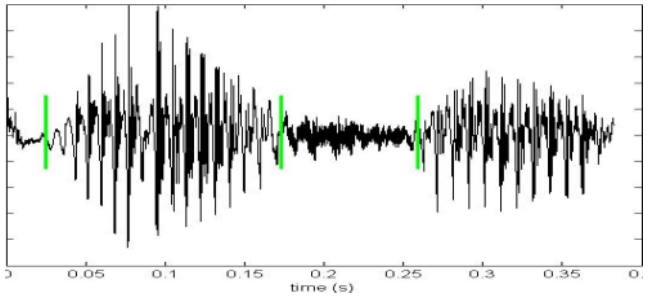
- Supervised classification algorithm
- Training Phase: Storing the feature vectors (MFCC coefficients) and class labels of the training samples
- The centroids for the different pronunciation rules are calculated (represented as starts)
- Classification Step: the user audio is “classified” (assign a recommendation for correcting pronunciation) by assigning which is most frequent among the k training samples

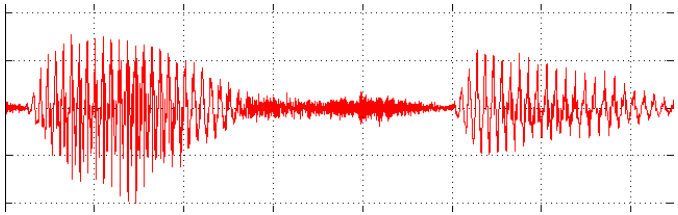


Total Samples: 70
Pro. Rules:
short a
long a
american a
wrong vowel
wrong consonant
totally wrong
Number of samples identified correctly: 62

Audio Rate

- Compare rate for each of the letters in the word
- Recommended things likes:
  - Make the a longer/Shorter
  - Etc

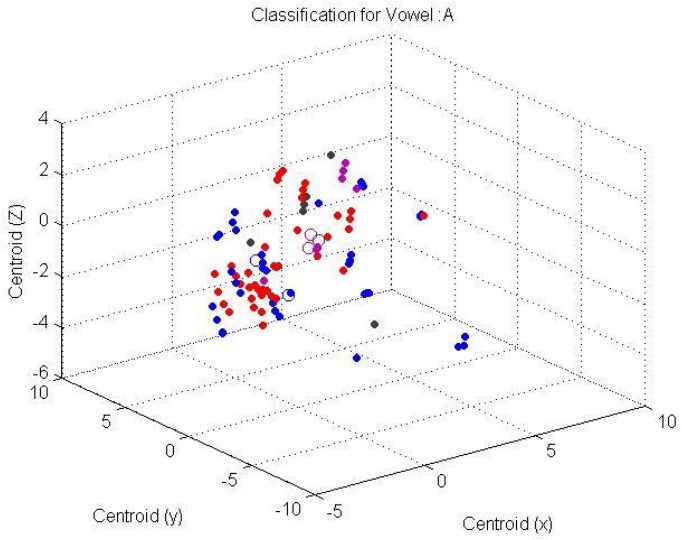


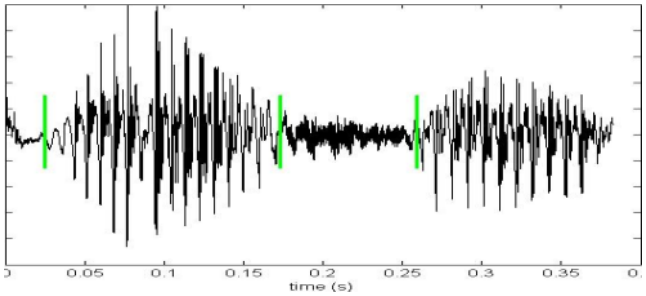


Results Audio Vowels :A

- Train User first with just vowels .
- Vowels have a stronger signal and
- Also only 5 vowels in Italian
- Classification is easy :
  - Wrong vowel
  - Length too short/long
- High Success rate
  - 2 errors in 70 samples

    (due to background noise)

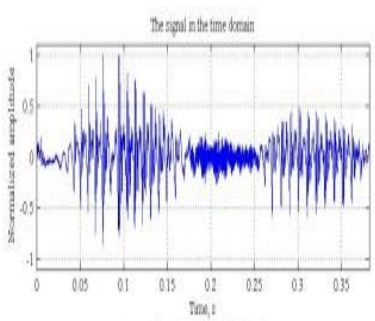


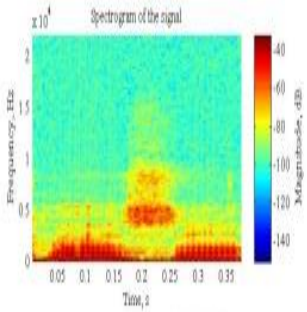


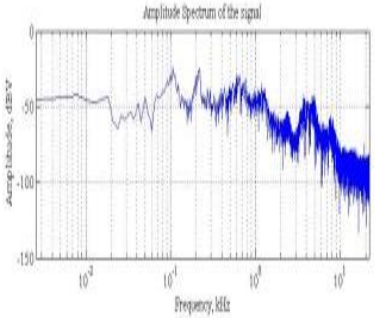
Results Audio: Ca

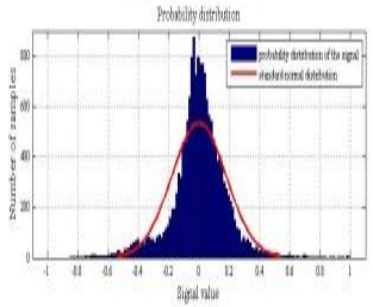
- Silabes

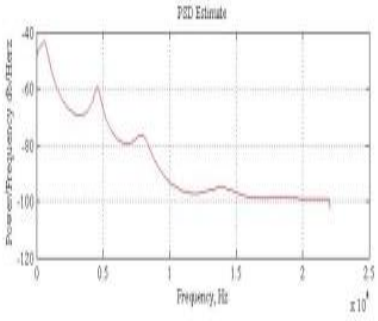
Results Audio: CASA

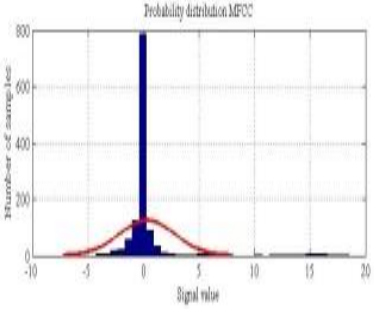


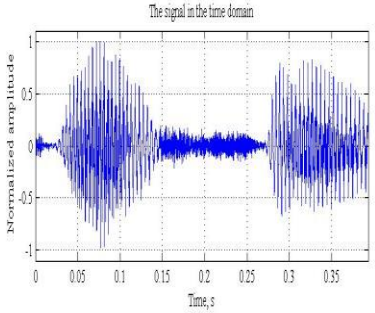


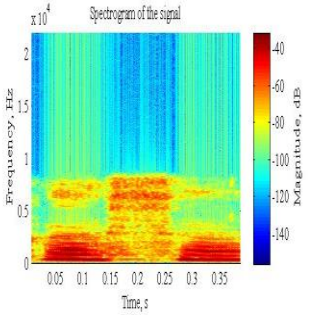


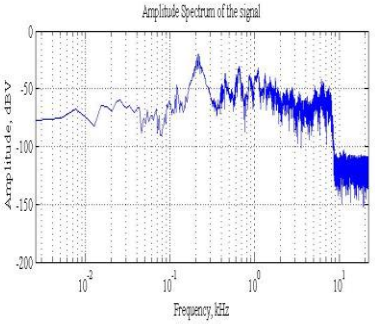


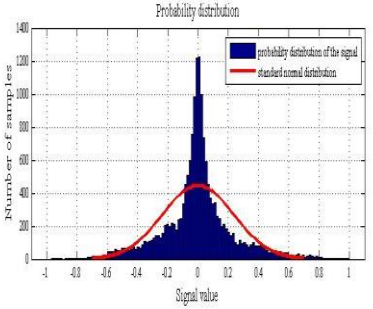


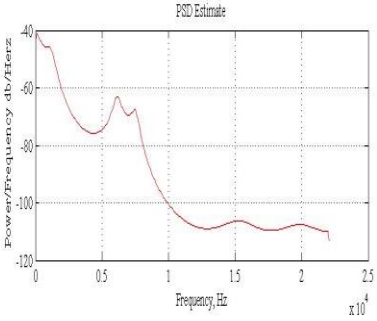


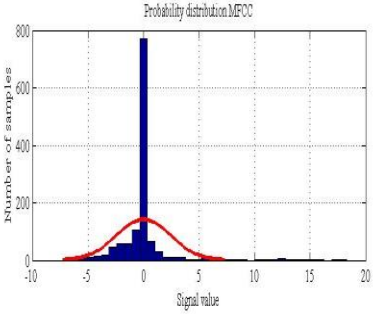










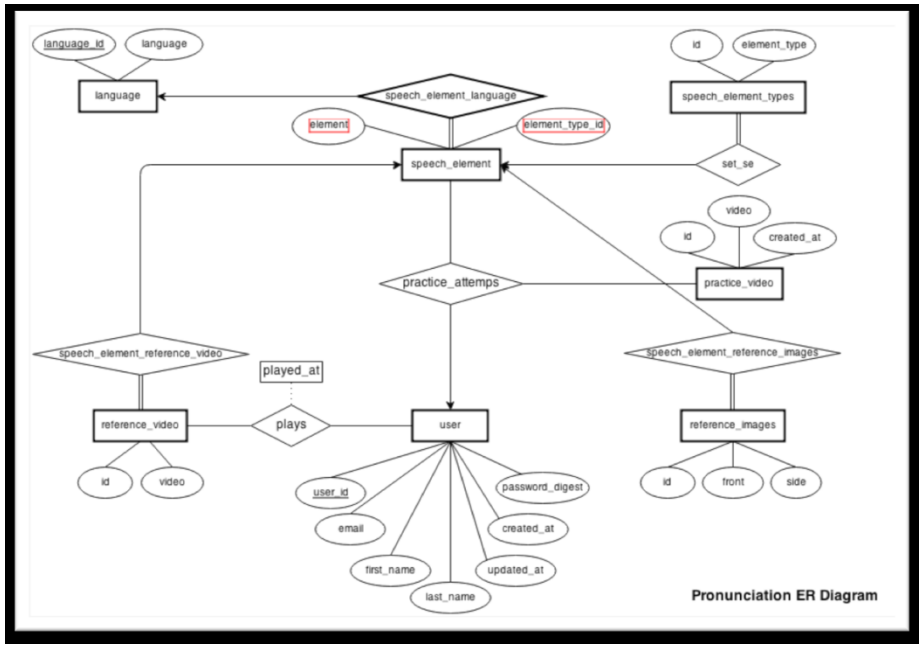


Results Audio: Word Segmentation into phones

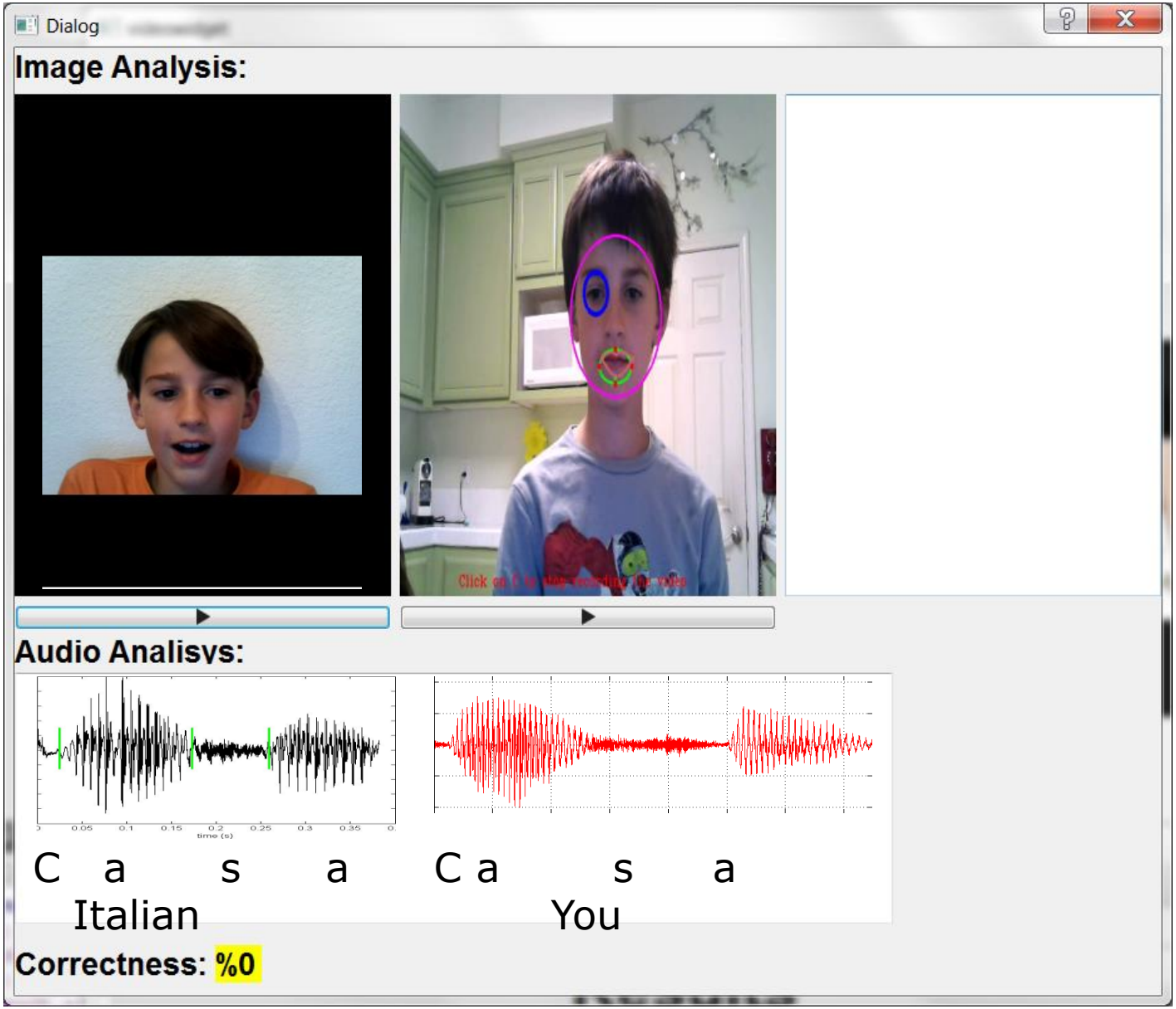
DataBase

- Around 5000 video/audio with “perfect” italian pronuntiation stored (right now only 100 hundred).
  - Using MariaDB Galera cluster in Amazon Web Services (AWS) by now
- Need to also store also videos from user , to replay. But this can be stored on user device
- Search and retrieval of the video is fast enough doesn’t seam too interesting to accelerate search on the GPU

Database Schema



Results


Dialog
Image Analysis:
Audio Analisys:
C a s a
Italian
C a s a
You
Correctness: %0

Conclusion

- Database currently stores rules for each word
- Should be change to automatically select rules that apply
- Combining Image and Audio help the pronuntiation
- The more you gesticulate the better we will give feedback
- Automatic evaluation and grading for educational pourposes

Questions