Workshop on Biometrics

Hierarchical Network for Facial Palsy Detection

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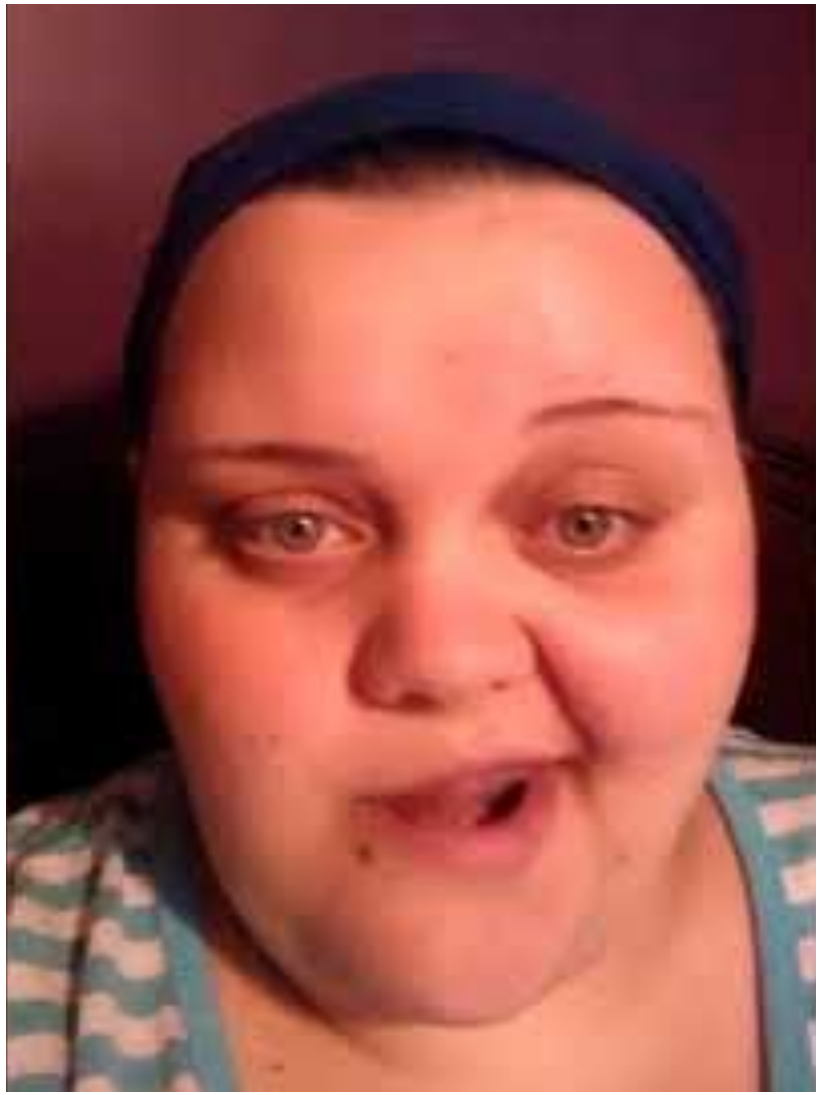

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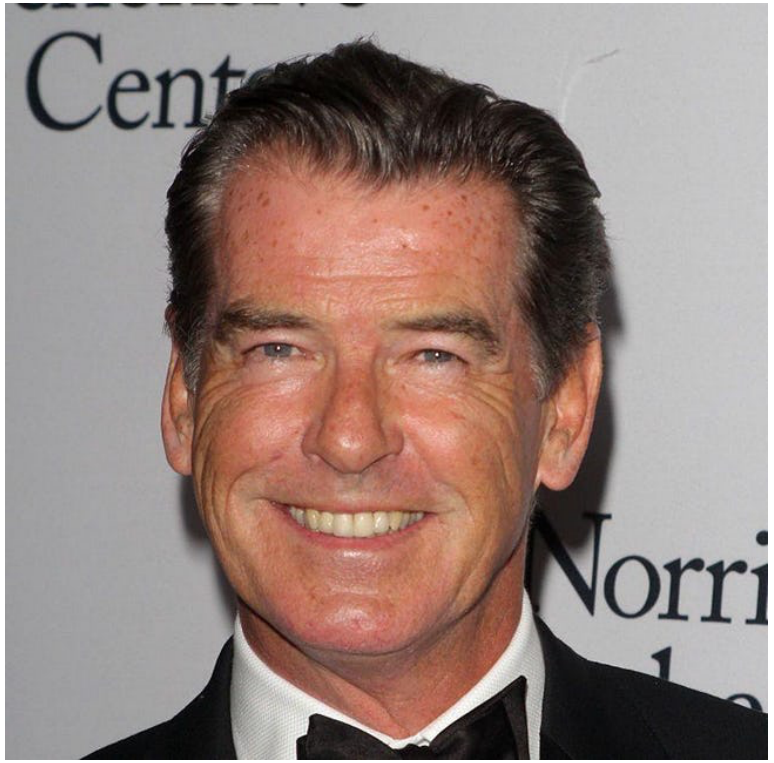
What is Facial Palsy?

- Also known as Bell's palsy, which is the most common type of facial paralysis, affecting 1/5,000 people a year.
- Temporary loss of muscle control in one side of the face, causing asymmetric facial deformation.
- Causes are not completely known, but herpes or syphilis could be responsible.
- People with diabetes and HIV are at higher risk of developing facial palsy.

Those that You Know



Pierce Brosnan

Sylvester Stallone

Angelina Jolie

Issues

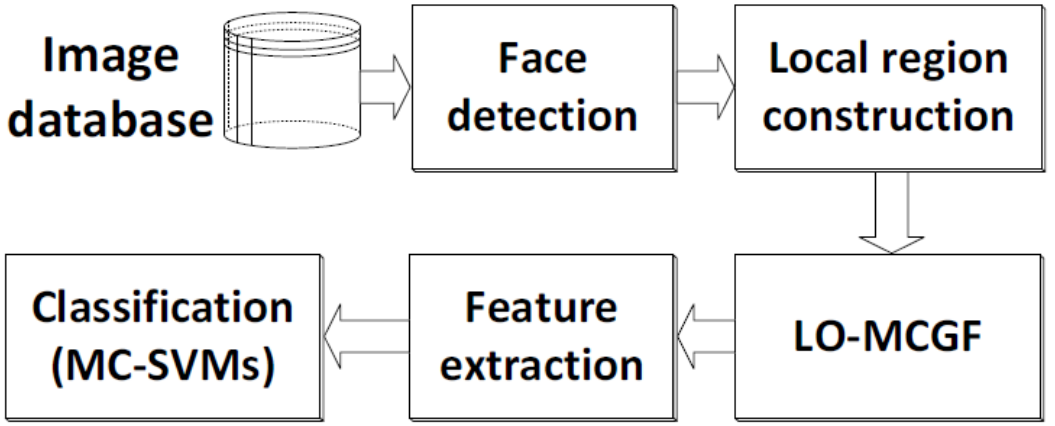
- Automatic detection/diagnosis is emerging recently; however, all use handcrafted features.
- Previous approaches were evaluated on proprietary databases, making performance comparison difficult.

Our Contributions

- First deep-learning approach for facial palsy detection, able to identify affected regions in a still image and the frequency of the syndrome in a video.
- Release of the first public database, labeled by clinicians, for facial palsy study.

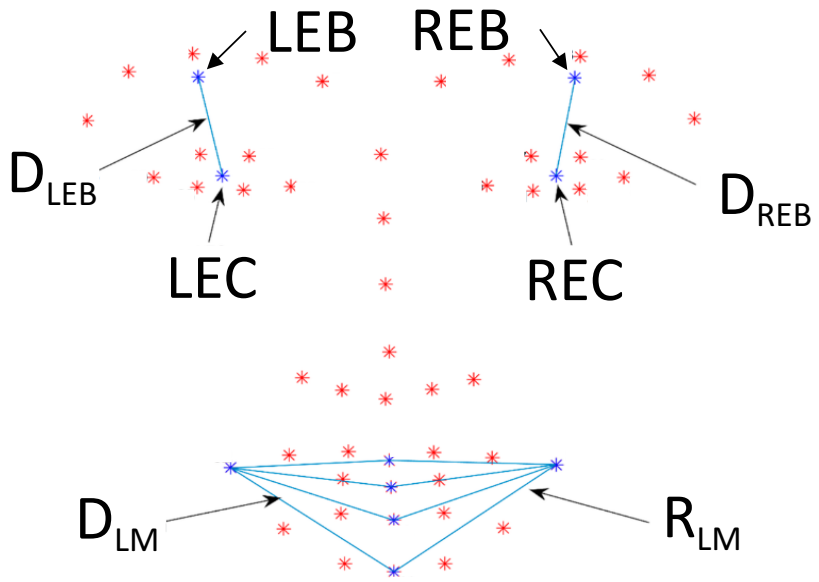
Just a Couple Years Ago

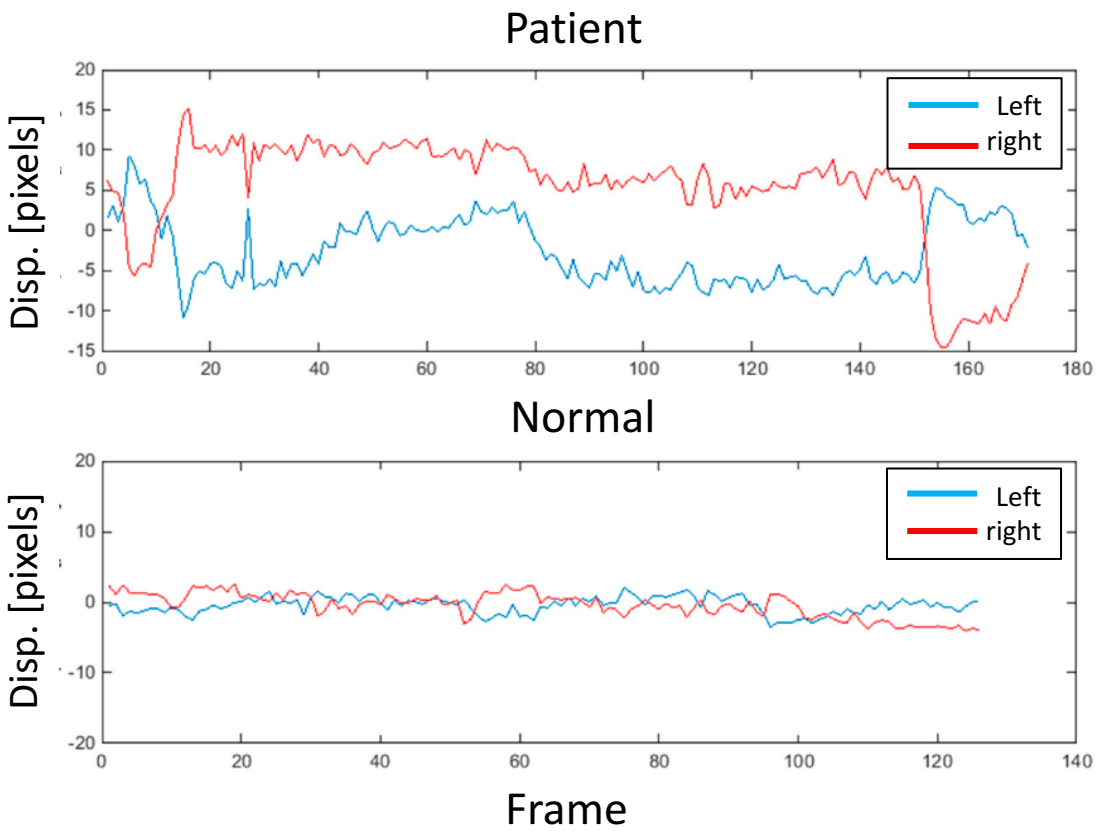
- The LO-MCGFs [2] use uniform pass-bands to enhance the desired spatial frequencies, and bounded filter support to specify the region of interest.



- The proprietary database provided by Osaka Police Hospital has 85 subjects (75 patients + 10 healthy volunteers).

[2] Ngo, Truc Hung, et al. "Quantitative analysis of facial paralysis based on limited-orientation modified circular Gabor filters." ICPR 2016.



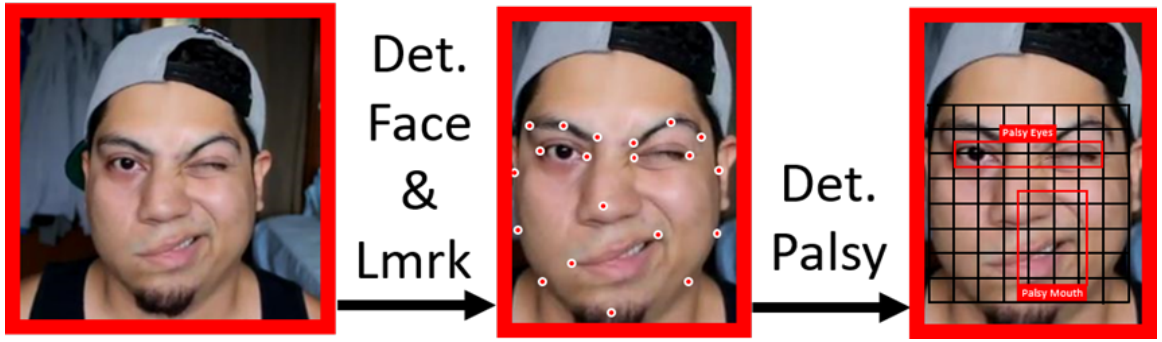


Given the facial landmarks, compute the asymmetric score using the landmark displacements at eye and mouth regions while the subjects change expression.

[3] Kim, Hyun Seok, et al. "A smartphone-based automatic diagnosis system for facial nerve palsy." Sensors 2015.

Proposed Network with 3 Component Nets

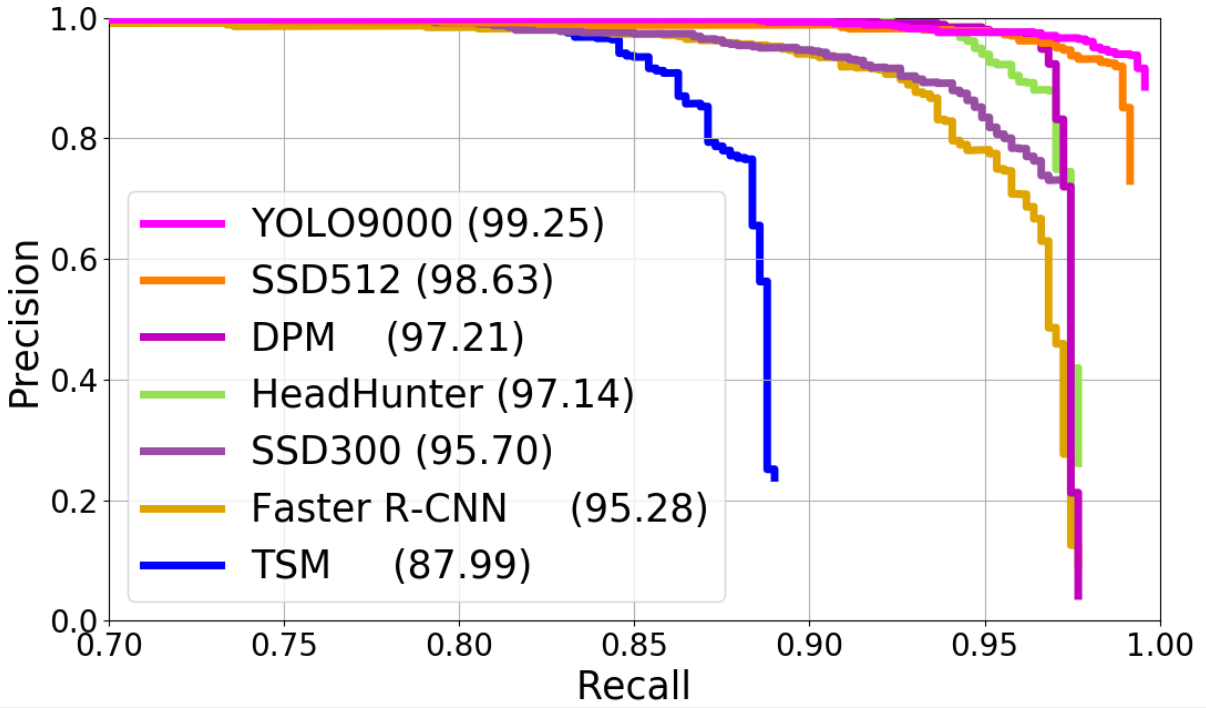
- FaceNet
  - YOLO-9000, retrained on WiderFace, yielding 99.25% AP on AFW.
- LandmarkNet
  - H.G. Face Alignment Network (ICCV 17) for locating facial landmarks.



- PalsyNet
  - Landmark-defined grid of 8×8 cells covering all possible palsy regions.

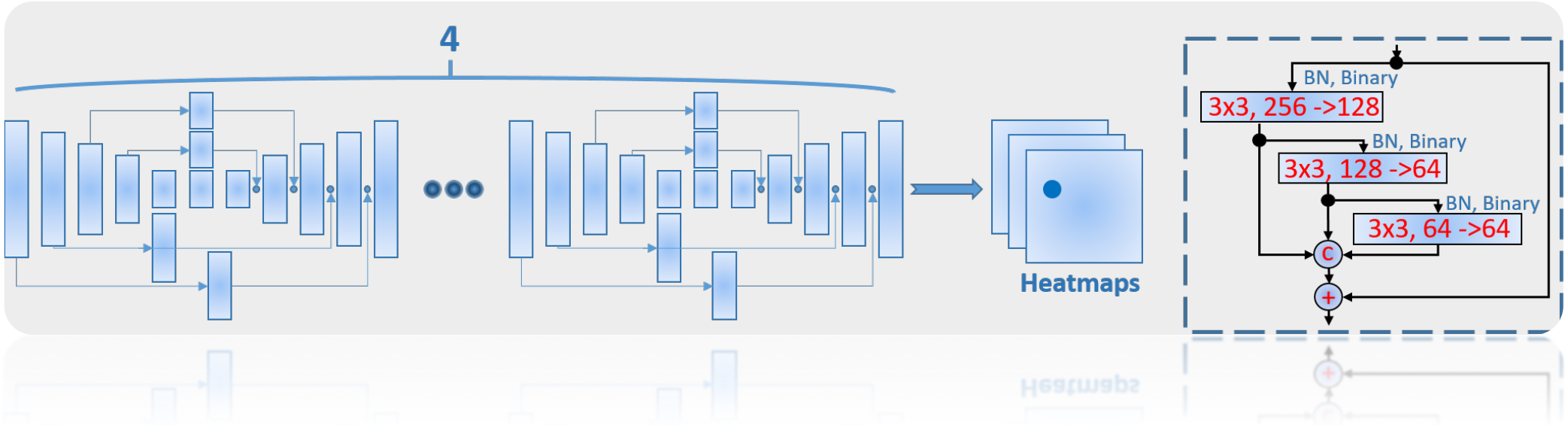
FaceNet Net_f

- Built on YOLO-9000 and retrained on the WiderFace database (393,703 labeled faces)
- AP 99.25% on AFW benchmark, better than DPM (97.2%), HeadHunter (97.1%), SSD-512 (98.6%) and Faster RCNN (95.3%).



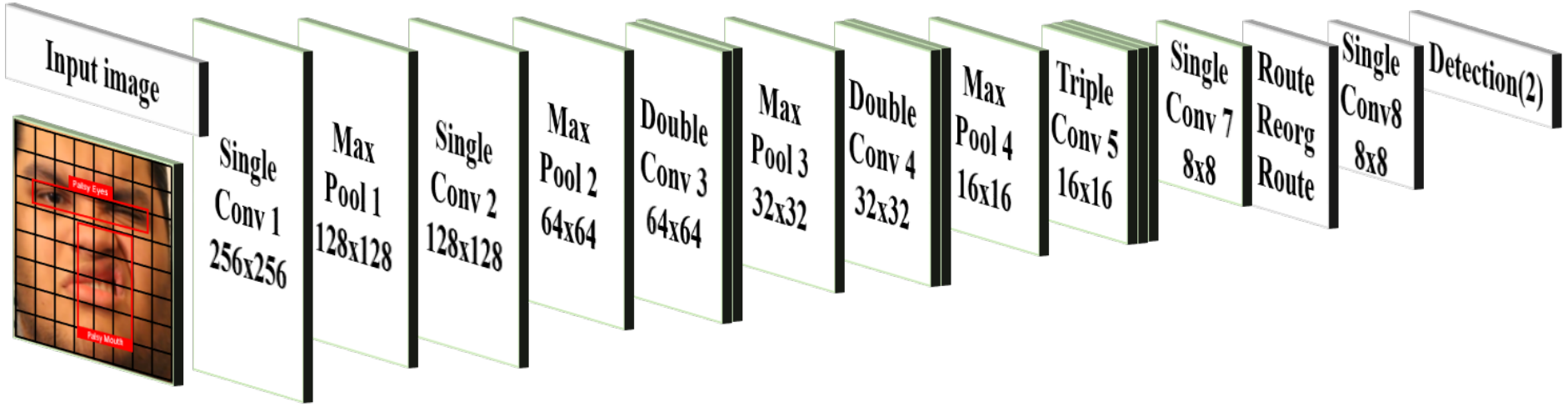
LandmarkNet Net_m

- LandmarkNet :
  - Face Alignment Network (FAN) built on Hour-Glass with bottleneck block replaced by residual block.
  - Hour-Glass consists of multi stacked hourglass modules allowing for repeated bottom-up, top-down inference.



PalsyNet Net_p

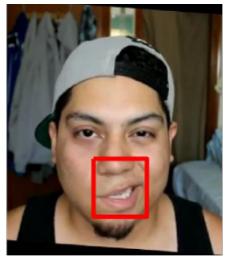
- Fewer layers: 11 convolution layers and 4 max-pooling layers (v.s. 19 convolution layers and 5 max-pooling in Darknet-19).
- Tailor-made anchor boxes for fast locating of palsy regions.



Facial Palsy Dataset

- 32 videos of 21 patients from YouTube;
- As the shortest facial palsy session lasts for a second, we convert each video into an image sequence with 6FPS;
- Manually labeled local palsy regions when the deformation intensity was considered sufficiently high by clinicians.

Facial Palsy Dataset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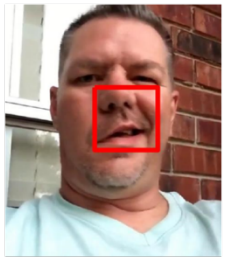
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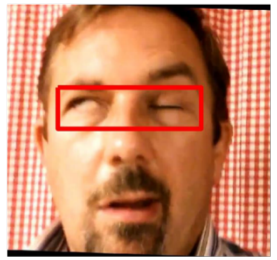
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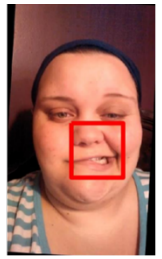
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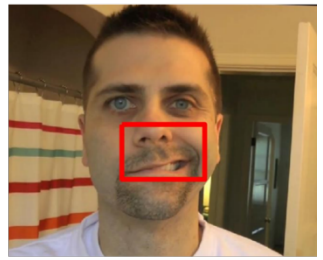
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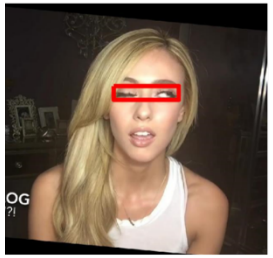
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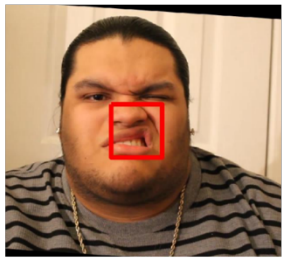
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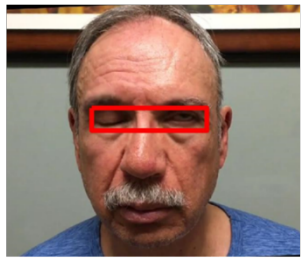
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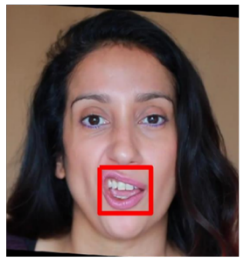
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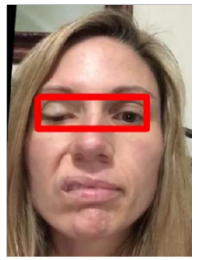
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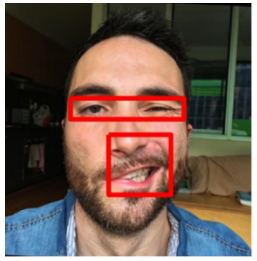
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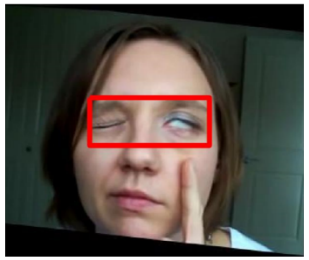
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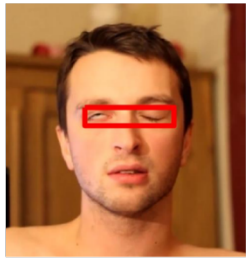
Person 13.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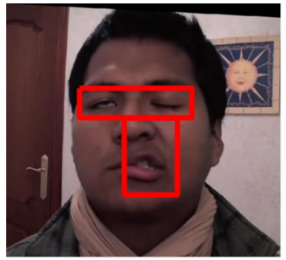
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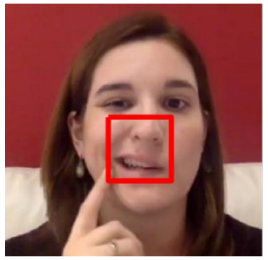
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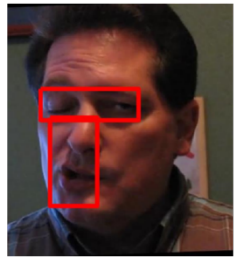
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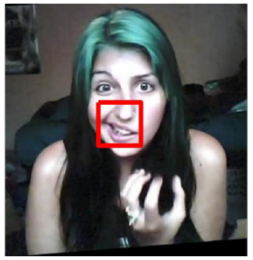
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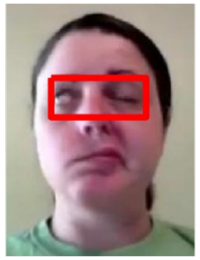
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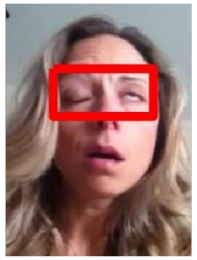
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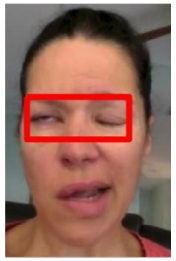

Person 21.

Data Labeling

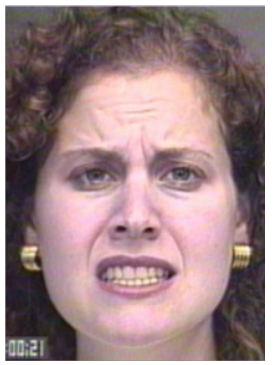
CK+ Included for Robustness

123 subjects, 593 image sequences with 7 expressions

0-Neutral

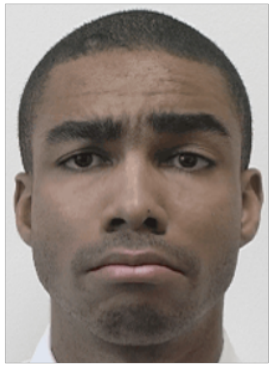
1-Angry

2-Contempt


3-Disgust

4-Fear

5-Happiness


6-Sadness

7-Surprise

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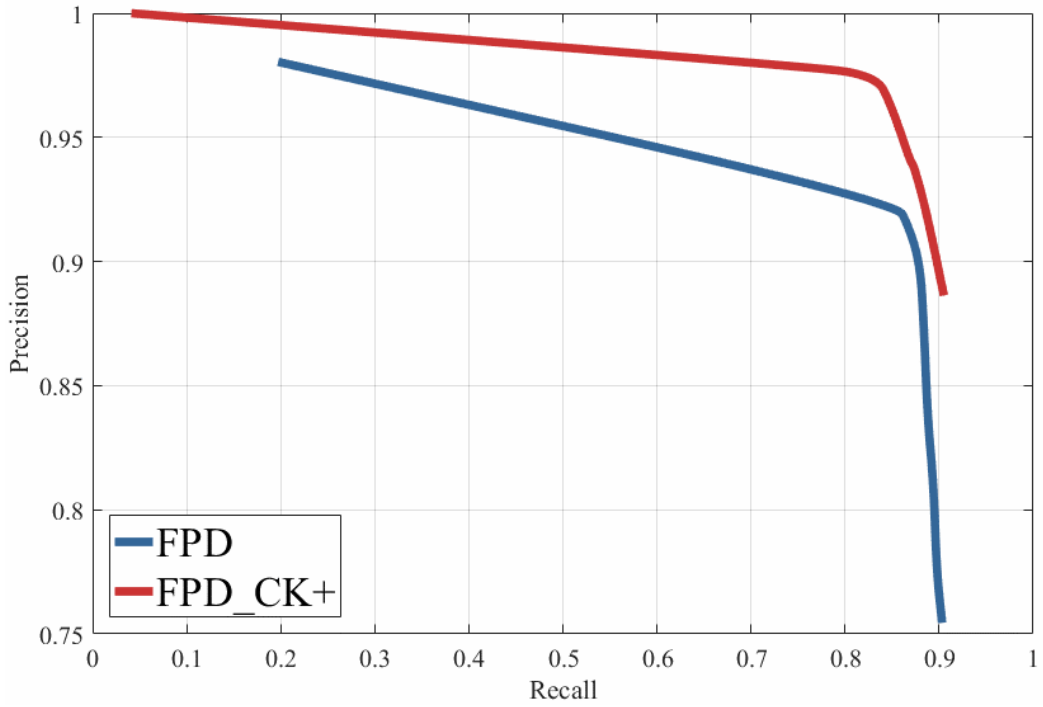
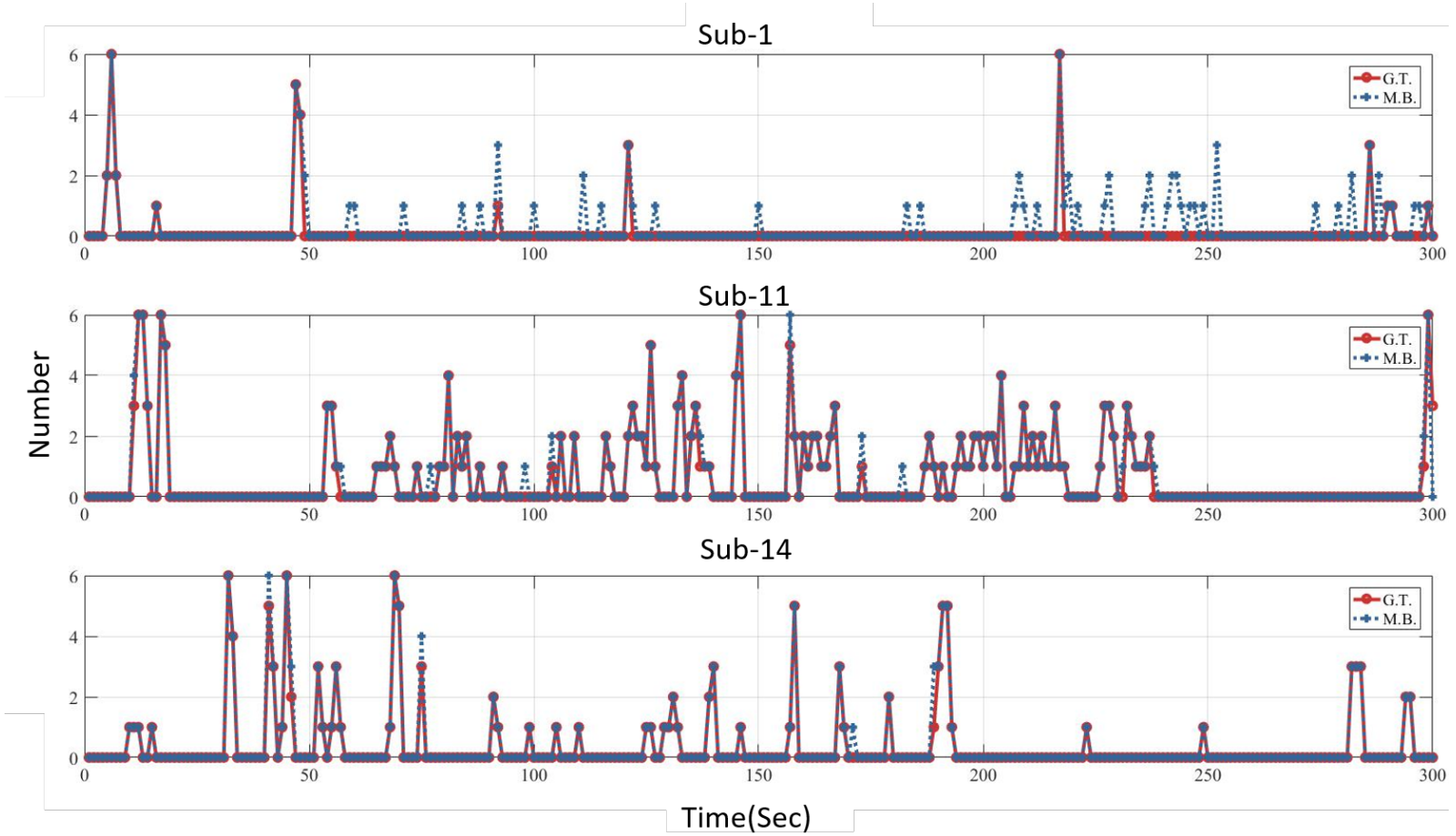
Performance Evaluation

- 21 leave-one-out on FPD and 5-fold cross validation on CK+
- Performance with and without CK+ expression dataset.



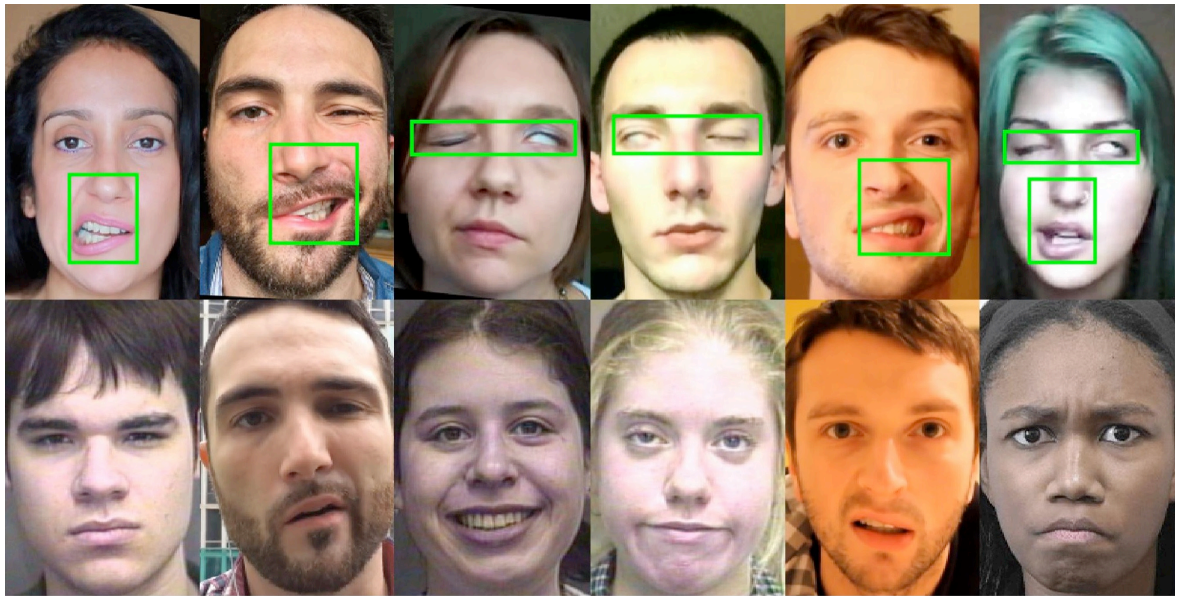
Frequency of Occurrence

- Detection of palsy-caused deformation over time when patients were talking.



Conclusion

- Identification of facial palsy formulated as detection of local regions, we propose a top-down hierarchical framework as a solution.
- A practical case study for the application/modification of deep learning framework for auto detection/diagnosis of (facial) medical disorders.



Our Team

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