BIWI Computer Vision

INTERACTIVE MULTIMODAL INFORMATION MANAGEMENT

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

Hough transform-based mouth localization for Audio Visual Speech Recognition

Gabriele Fanelli, Juergen Gall, Luc Van Gool

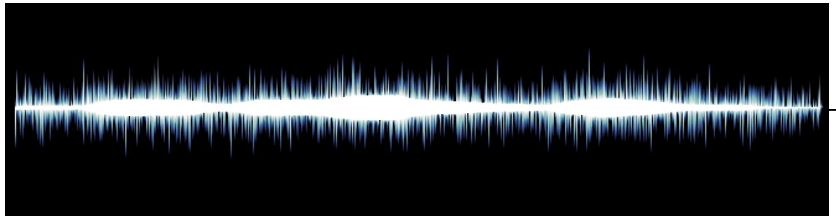
Overview

- Introduction
- Method
- Results
- Conclusions

AVSR - overview

Video Signal

Audio Signal



Visual Features Extraction

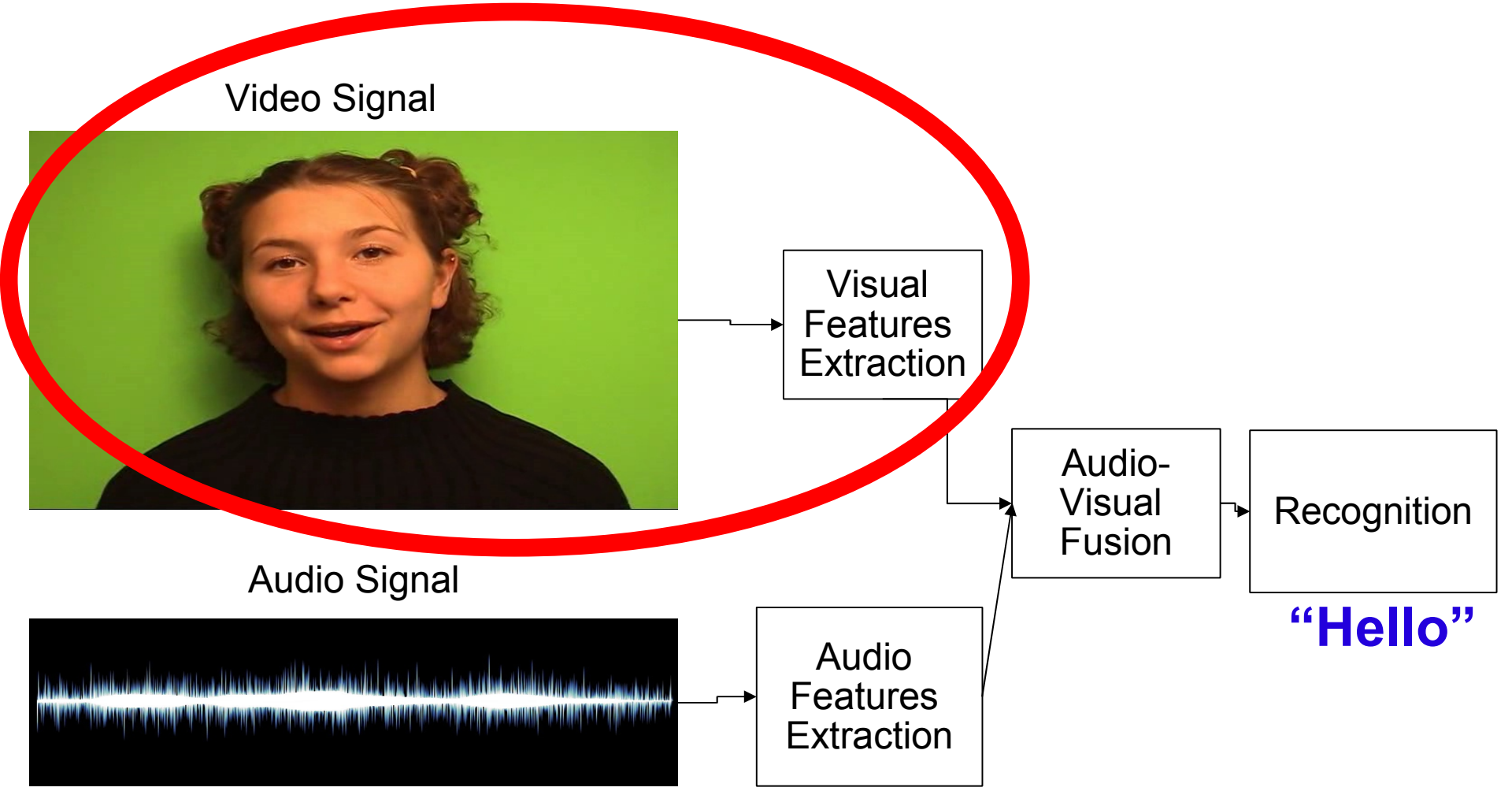
Audio Features Extraction

Audio-Visual Fusion

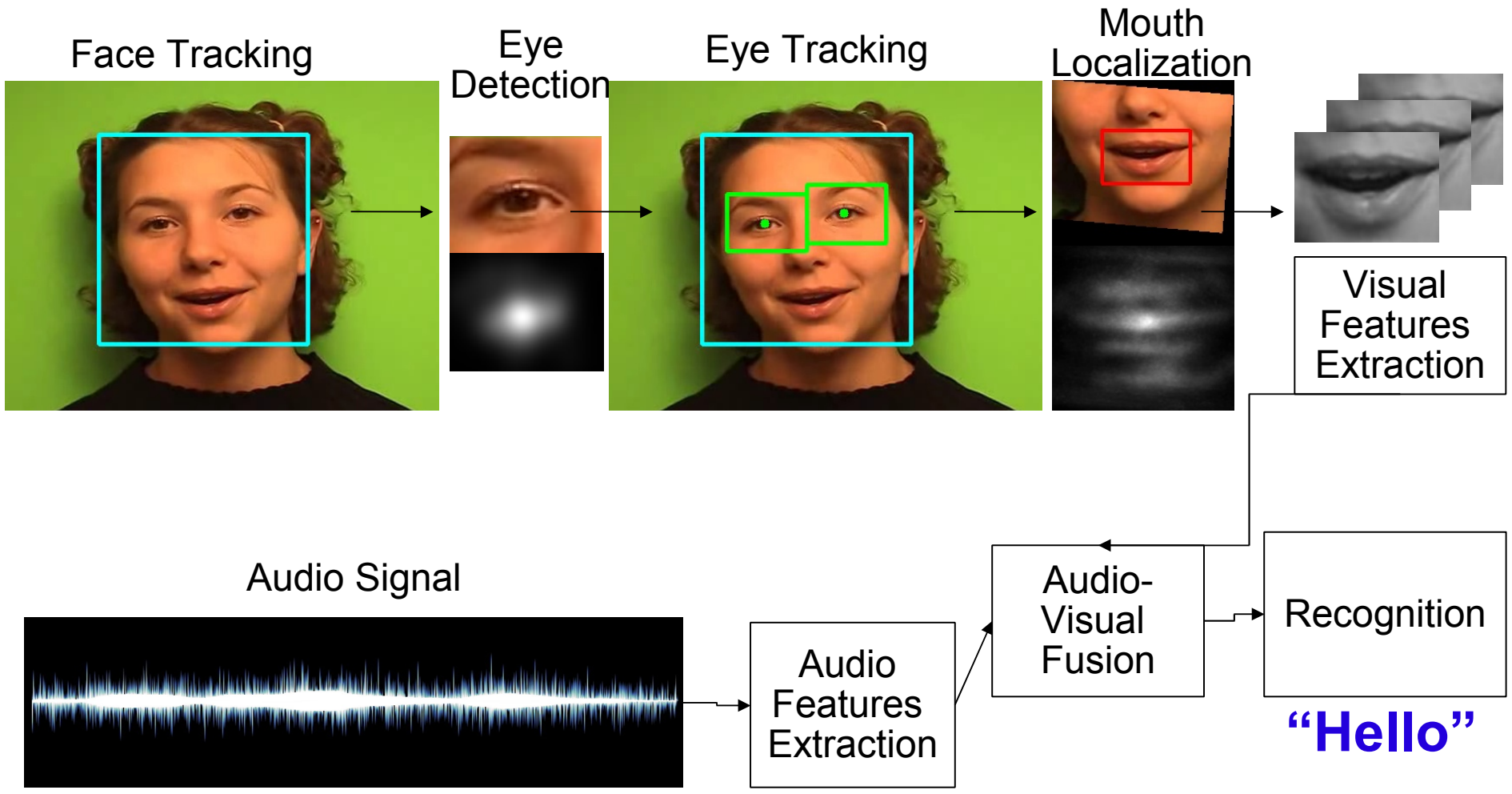
Recognition

"Hello"

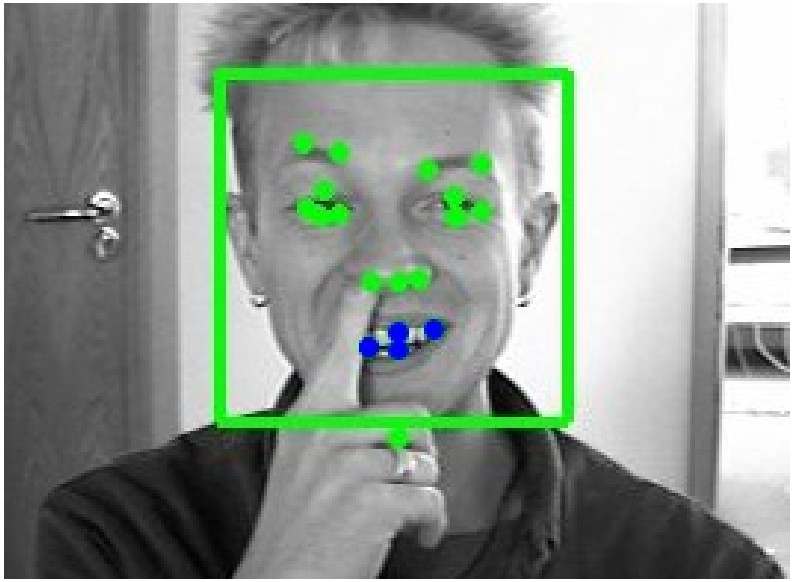
AVSR - overview

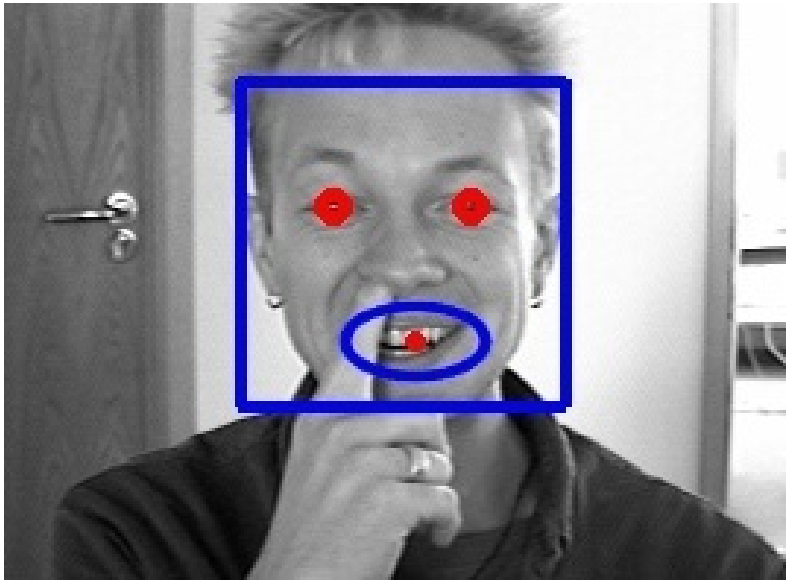


AVSR – our approach



Motivation

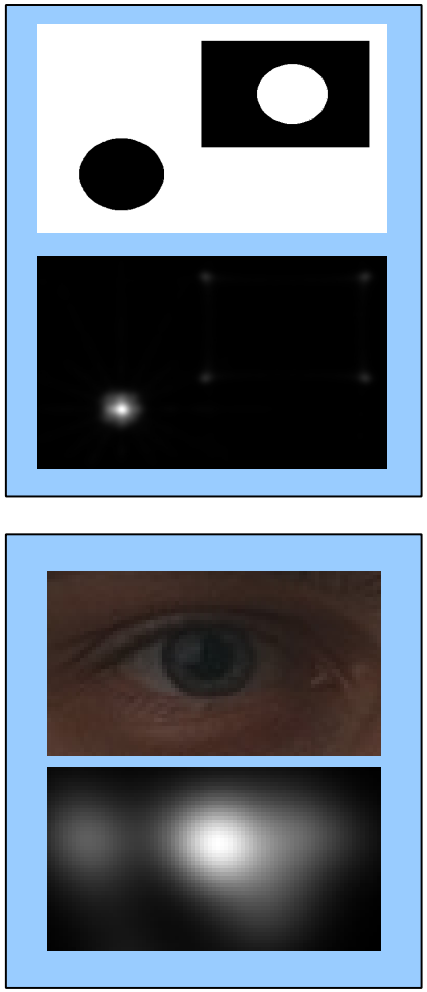




- Facial feature points detectors can fail because of:
  - Partial occlusions
  - Facial hair
  - Large mouth deformations

Eye detection based on isophote curvature

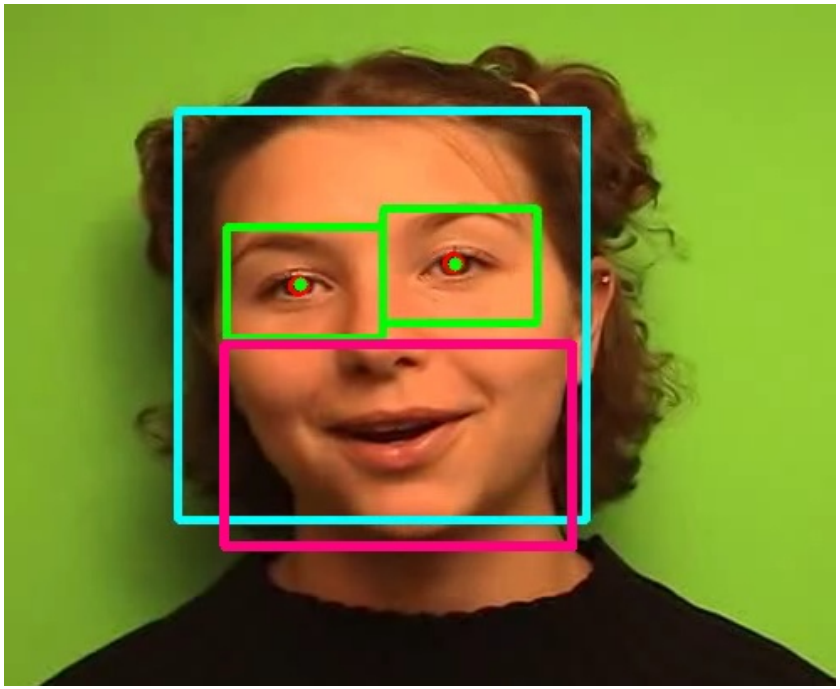
- Isophotes - curves of equal image intensity
- Each pixel votes for a radius, i.e., an eye center, with:
  - Length = reciprocal of the curvature
  - Direction = gradient
  - Orientation = bright to dark
- Votes from points with high curvedness are given higher weights
- The peak in the accumulator image is chosen as the eye center

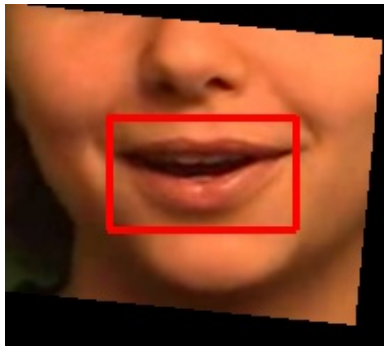


Ref. **Accurate Eye Center Location and Tracking Using Isophote Curvature**, R. Valenti and T. Gevers, CVPR08

Eye tracking

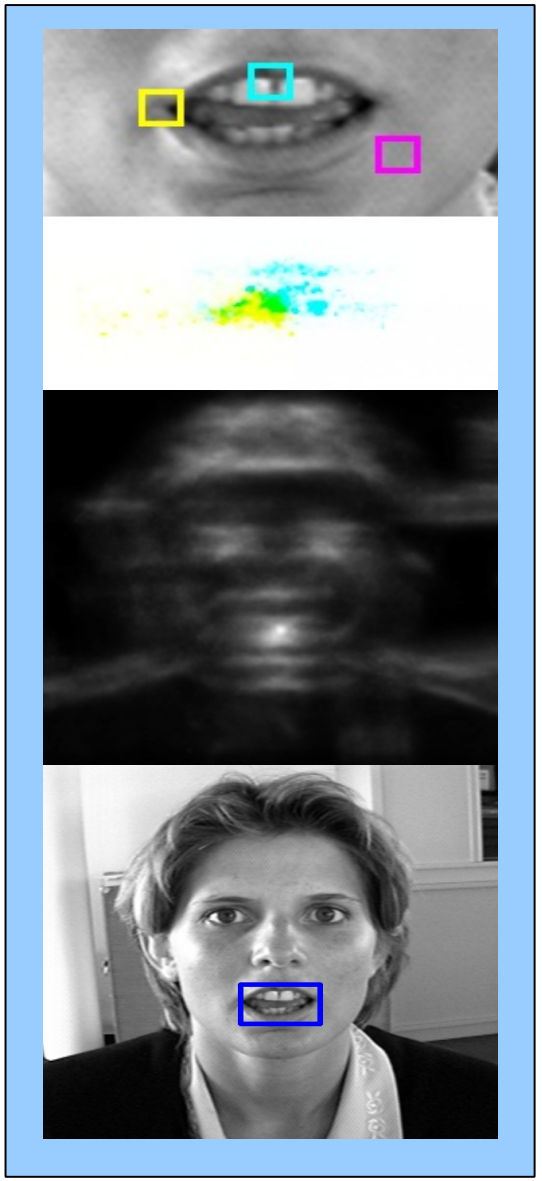
- Eye detection fails when the iris is not visible, e.g., blinks
- Kalman filters are employed to track the eyes' positions
- Located eyes tell us mouth's scale and rotation
- Mouth localization can focus on a scaled and rotated region of interest





HT-based mouth localization

- Hough transform-based methods are robust to large appearance and shape variations, partial occlusions
- Implicit Shape Model as random forest
- Position and appearance of a patch are learned and cast votes for the object's center
- Votes are summed up into a Hough image, peak is the mouth



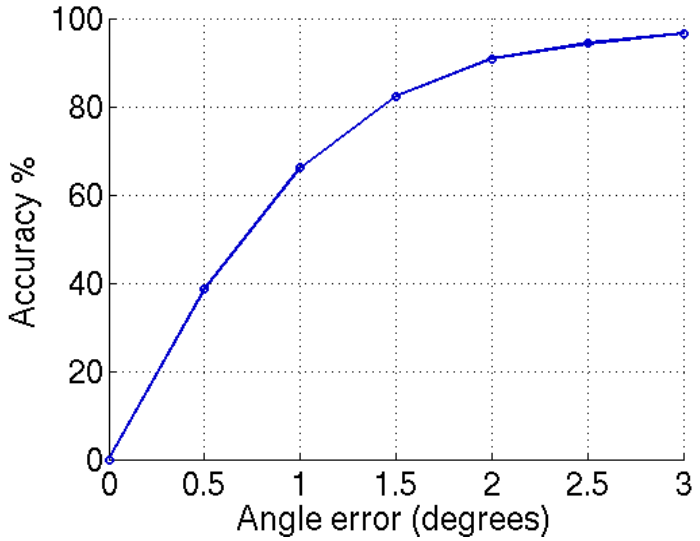
Ref. **Class-specific Hough Forest for Object Detection**, J.Gall and V. Lempitsky, CVPR09

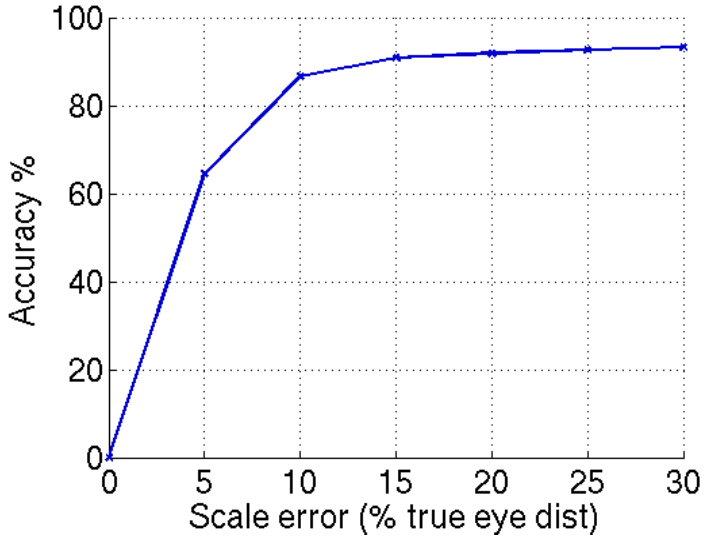
Audio-Visual Speech Recognition

- Audio-visual fusion and recognition is achieved by MSHMM, each modality being modeled as a Gaussian mixture
- We extract DCT features from the stream of normalized mouth images
- Audio features are mel-frequency cepstral coefficients
- First and second order derivatives are added in both modalities

Tests - scale and orientation

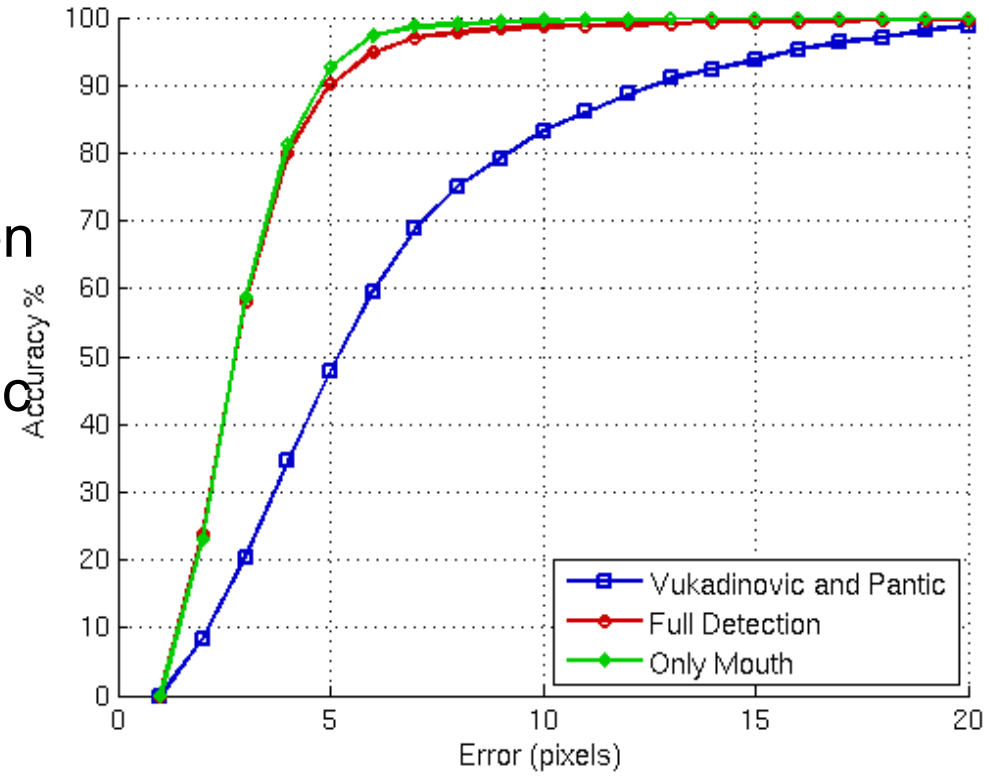
- BioID database
- 1521 images of 23 individuals
- Uncontrolled illumination
- Resolution 384x288
- Facial hair, talking people, glasses, eyes closed
- Ground truth locations available for eyes and other facial features





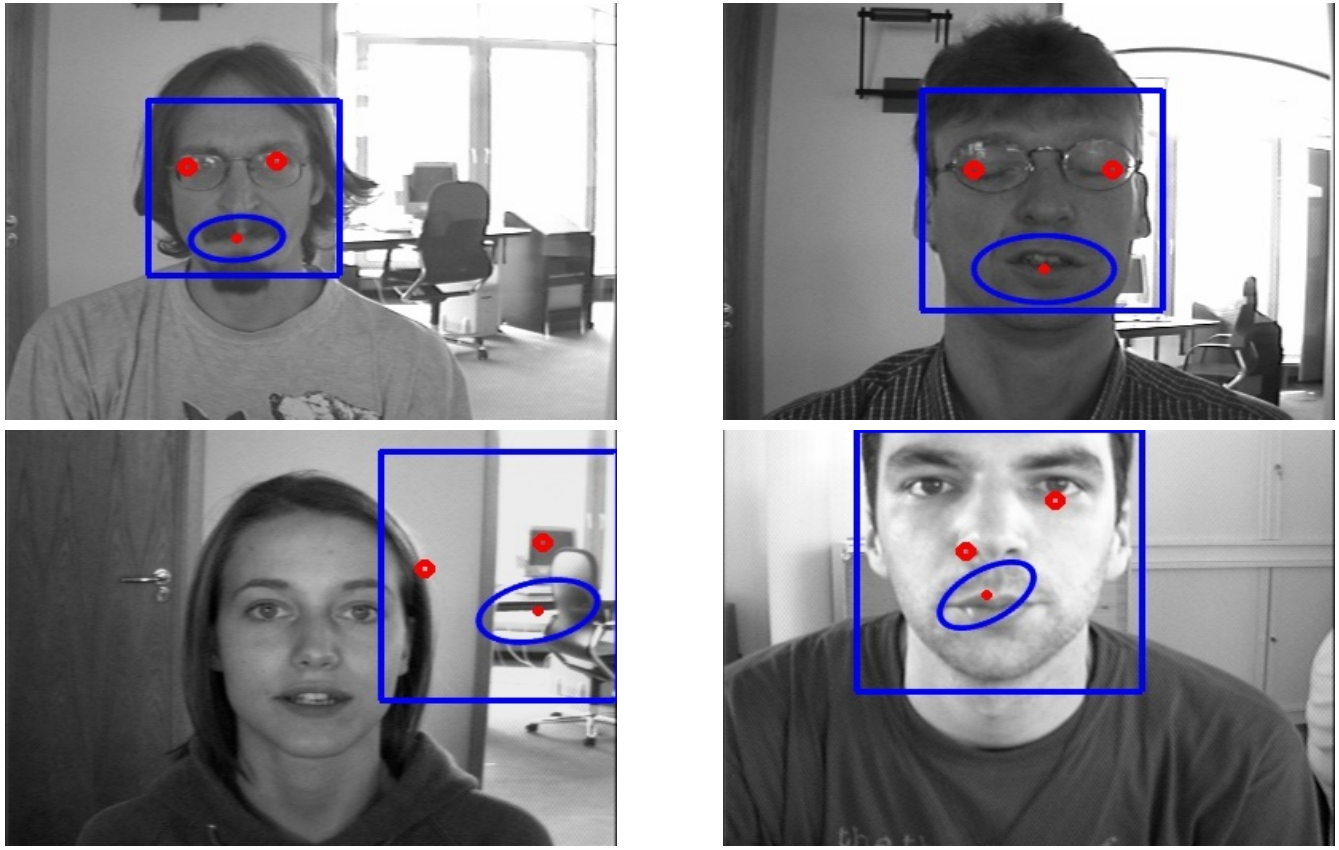
Tests – mouth localization

- Two tests:
  - Full pipeline
  - Eye locations given
- Compared to Vukadinovic and Pantic's point detector, ICSM05



Results - successes

Results - failures



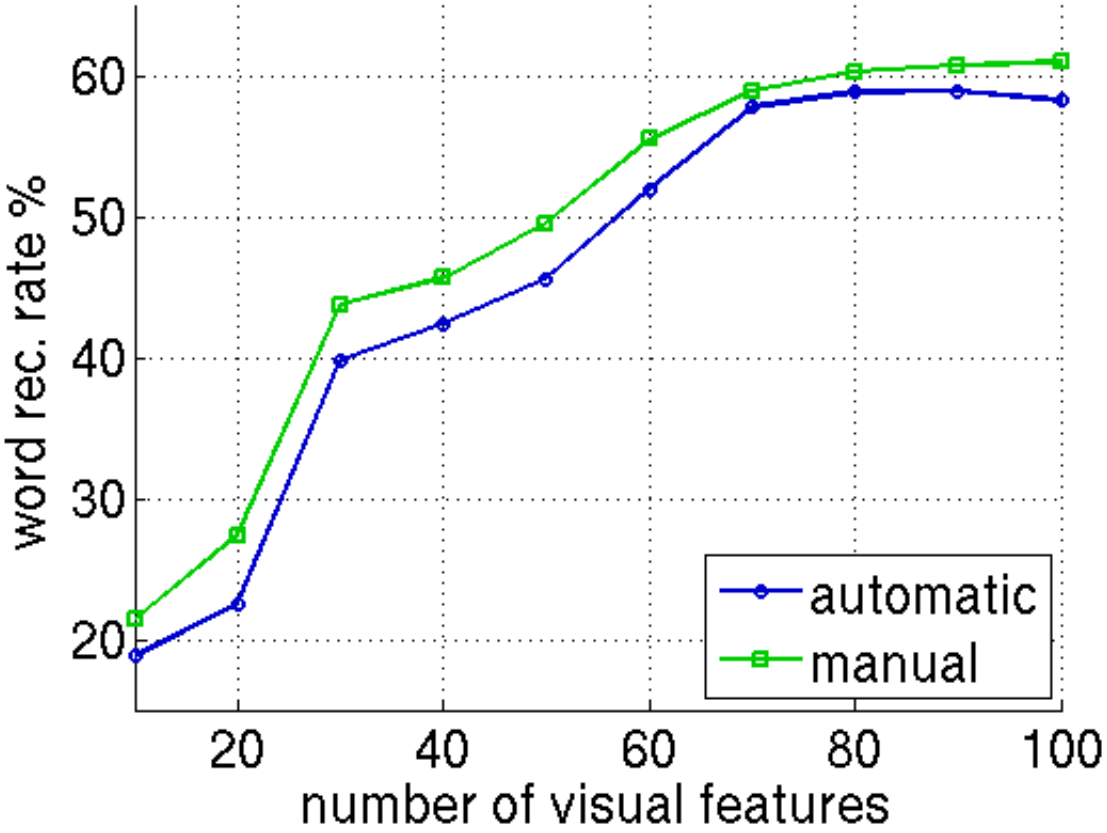
Mainly caused by wrong face and eyes detections

AVSR Experiments - CUAVE DB

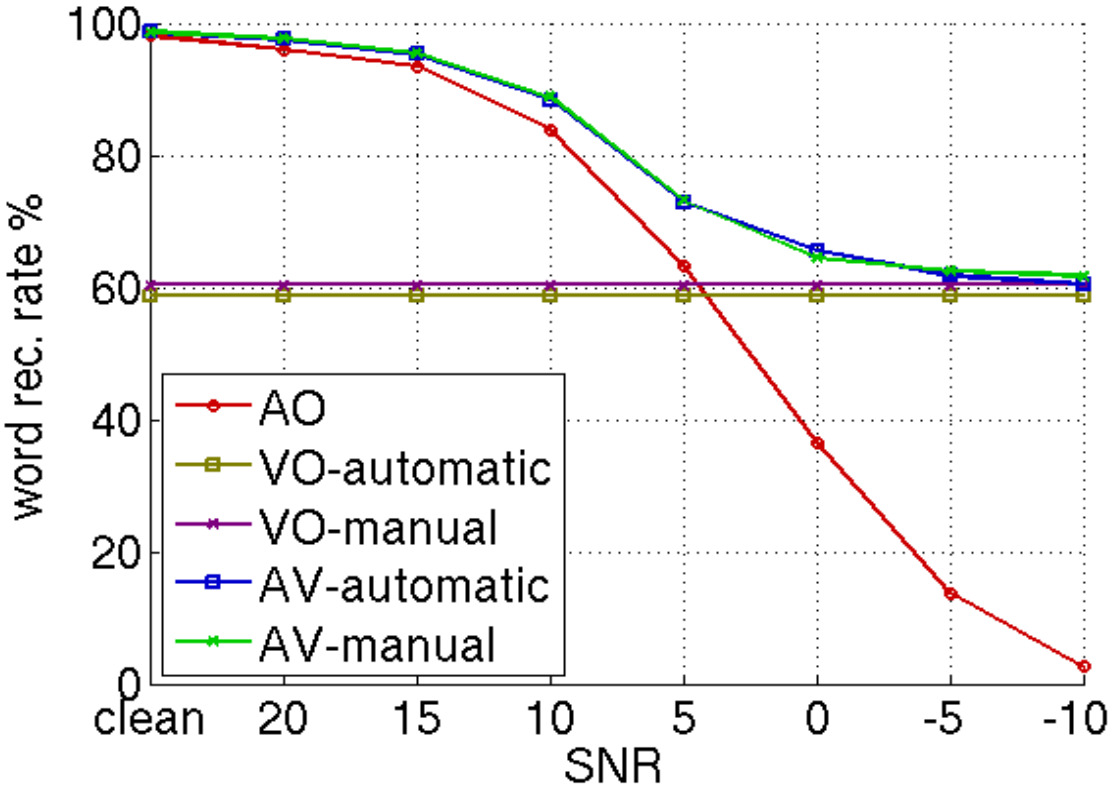
- 36 speakers
- Digits 0-9 in American English
- Good image conditions
- Faces are frontal

- DB split in 6 sets, train on 5, test on the 6th
- Audio corrupted by white noise at several SNR levels
- Mouth detector trained on the full BioID database

Tests – Video-Only Speech Recognition



Tests – AVSR



We acknowledge Dr. Mihai Gurban (EPFL) for providing source code for feature extraction and audio-visual speech recognition

Questions?