# Automatic Adaptation of a Human Face Model for Model-Based Coding

Mauricio Hess
Geovanni Martínez

Image Processing and Computer Vision Research Laboratory (IPCV-LAB)

Escuela de Ingeniería Eléctrica
Universidad de Costa Rica

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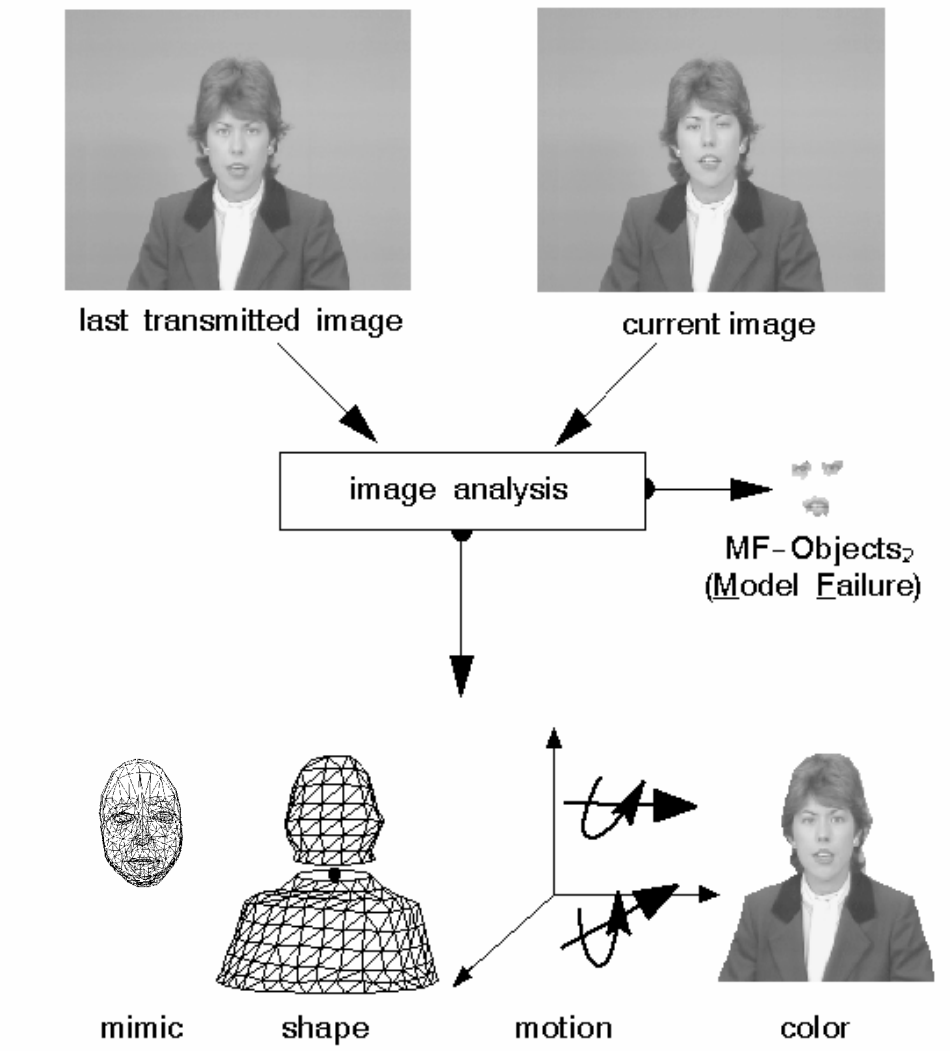
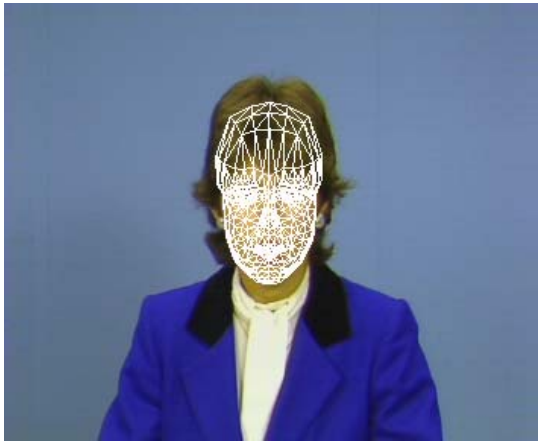
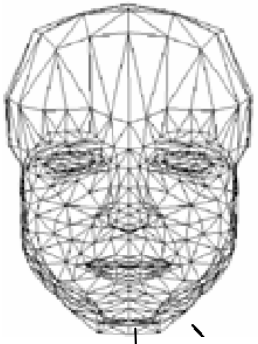
# Model-based coding



# Face model adaptation

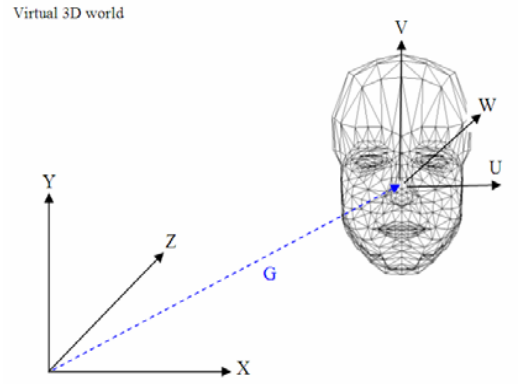
- Face segmentation
- Facial feature extraction
- Global adaptation
- Local adaptation





Adaptation algorithm

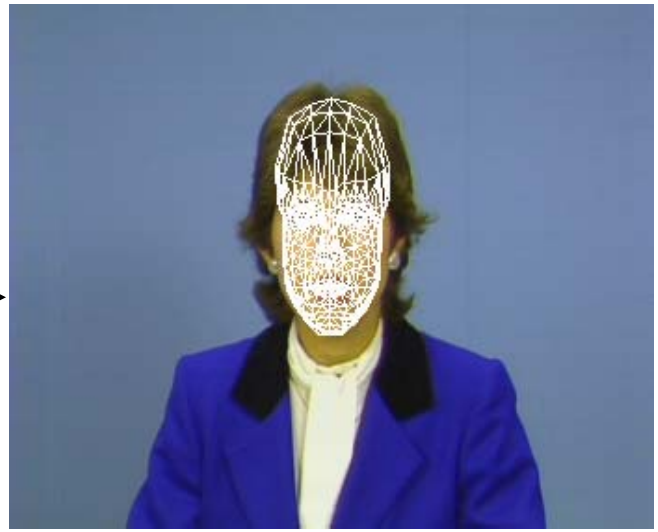
# Global adaptation (1)




Estimation of the rotation angles: $\delta R_Y$, $\delta R_Z$, $\delta R_X$,

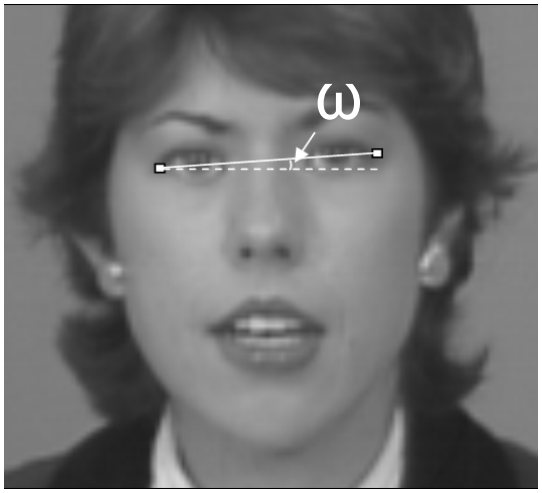
the scaling factors: $S_V$, $S_U$, $S_W$

and the 3D translation vector: $\delta \mathbf{G}$



# Global adaptation (2)

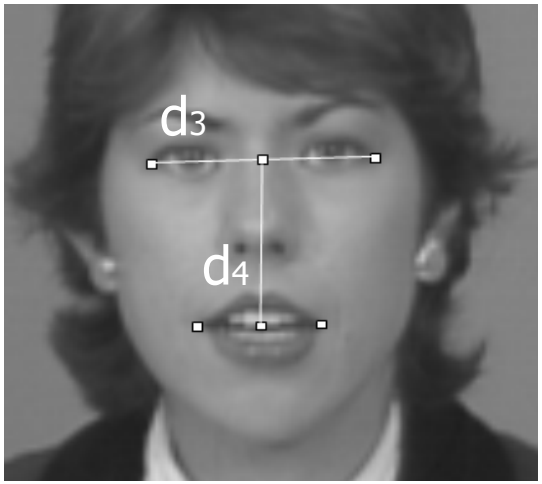
- Estimation of the rotation angles $\delta R_Y$ and $\delta R_Z$


  - For estimating $\delta R_Y$, the model is rotated until its quotient $d_1'/d_2'$ is very similar to $d_1/d_2$
  - $\delta R_Z = \omega$

# Global adaptation (3)

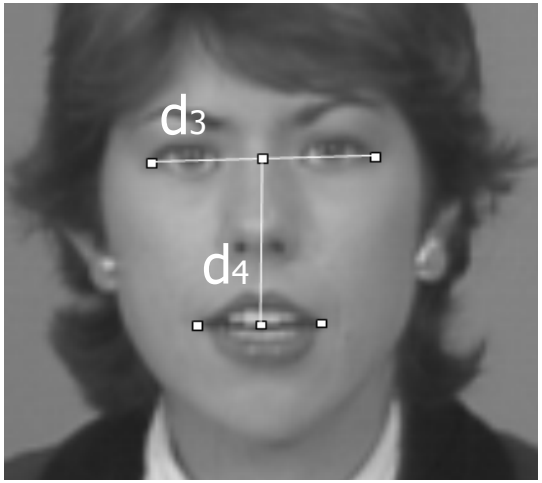
- Estimation of the rotation angle $\delta R_X$




  - For estimating $\delta R_X$, the model is rotated until its quotient $d_3'/d_4'$ is very similar to $d_3/d_4$
  - $\delta R_X=0$ if $d_3/d_4<1.44$

# Global adaptation (4)

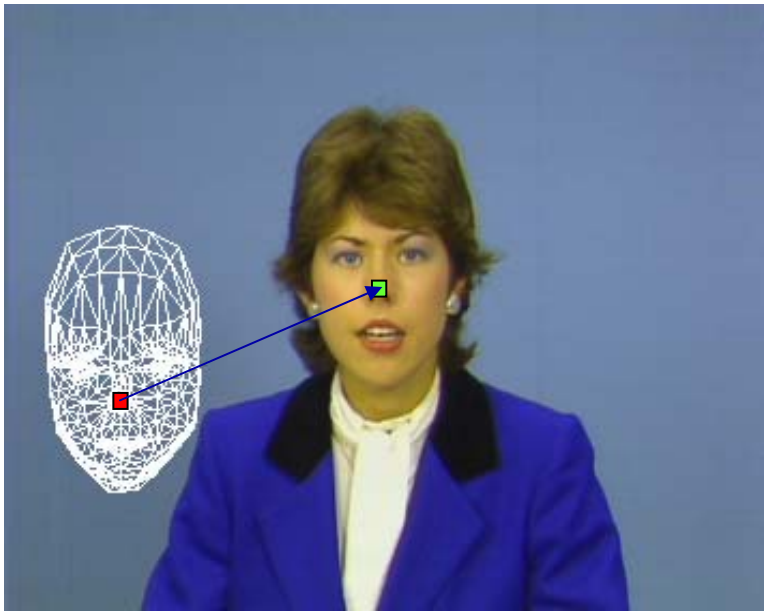
- Estimation of the scaling factors $S_V$, $S_U$ and $S_W$




$$S_V = \frac{d_4}{d_4'} \qquad S_U = \frac{d_3}{d_3'} \qquad S_W = \frac{1}{2}\left(S_U + S_V\right)$$

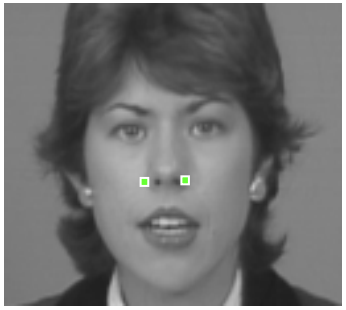
# Global adaptation (5)

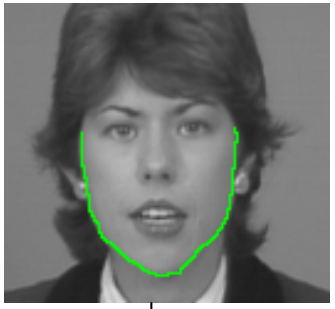
- Estimation of the 3D translation vector δ**G**

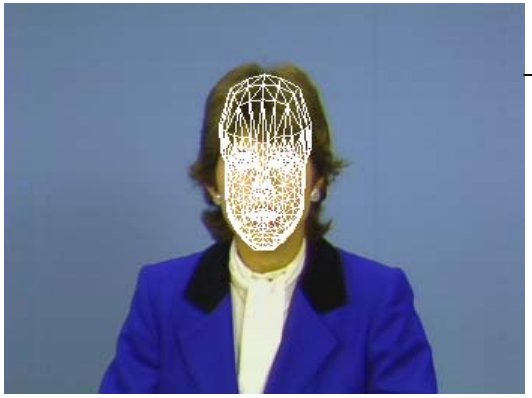


  - The model is translated until the projections of its mouth and eyes outer corners match those that had been extracted

# Local adaptation (1)

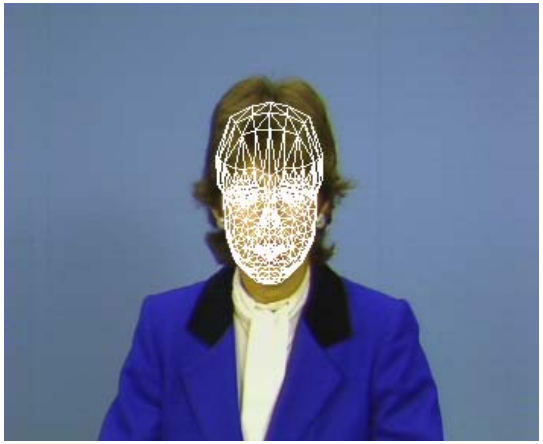






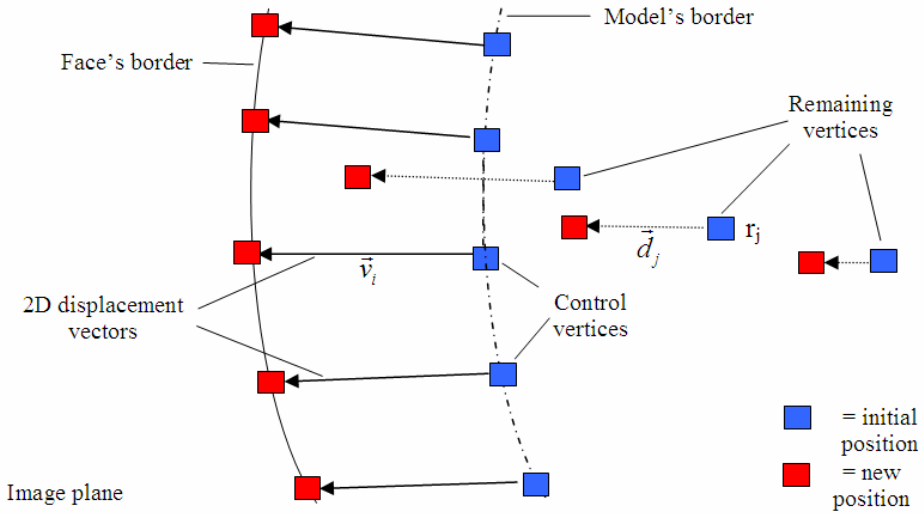
Moving the vertices towards the chin/cheek borders

and estimation of the nose scaling factors SU,nose and SV,nose



# Local adaptation (2)

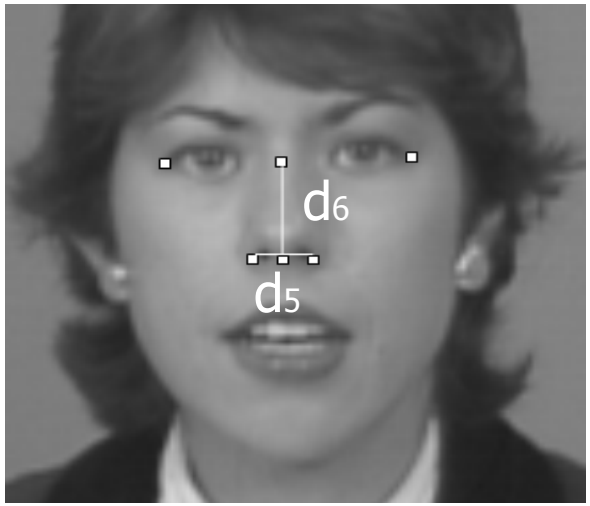
- Moving the vertices towards the chin/cheek borders




  - The control vertices are moved until their projections match the chin/cheek borders
  - The remaining vertices are moved proportional to the movements of the control points but inverse proportional to their distance to the control points

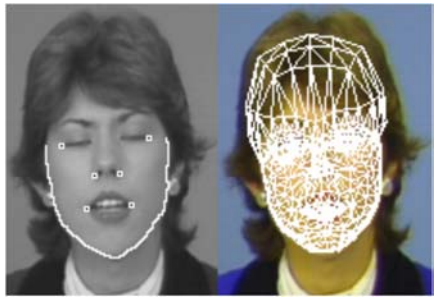
# Local adaptation (3)

- Estimation of the scaling factors $S_{U,nose}$ and $S_{V,nose}$

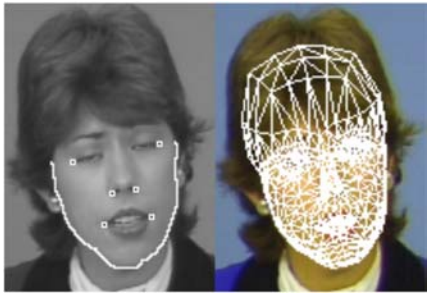



$$S_{U,nose} = \frac{d_5}{d_5'} \qquad S_{V,nose} = \frac{d_6}{d_6'}$$

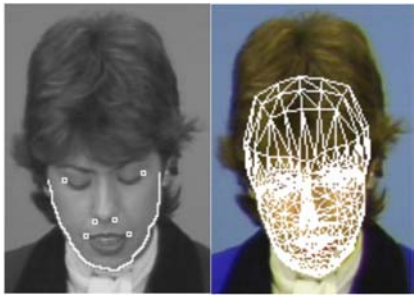
# Results and conclusions



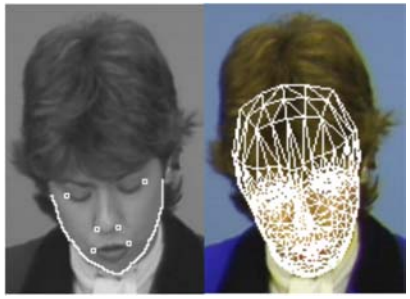
4th frame, Claire



29th frame, Claire



71st frame, Claire



106th frame, Claire

- The outer corners of the eyes are used for adaptation instead of the eyes centers
- The face rotation angle around X-axis is also estimated
- The nose scaling factor along V-axis is also estimated
- The adaptation is also possible even if the eyes are closed or the person is facing downward
- The average processing time was 0.015 seconds/frame