Improving Action Units Recognition Using Dense Flow-based Face Registration in Video

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1. Introduction

Goal:

Align faces with non-rigid muscle motion in real-world streaming video in real-time and boost facial AU recognition performance
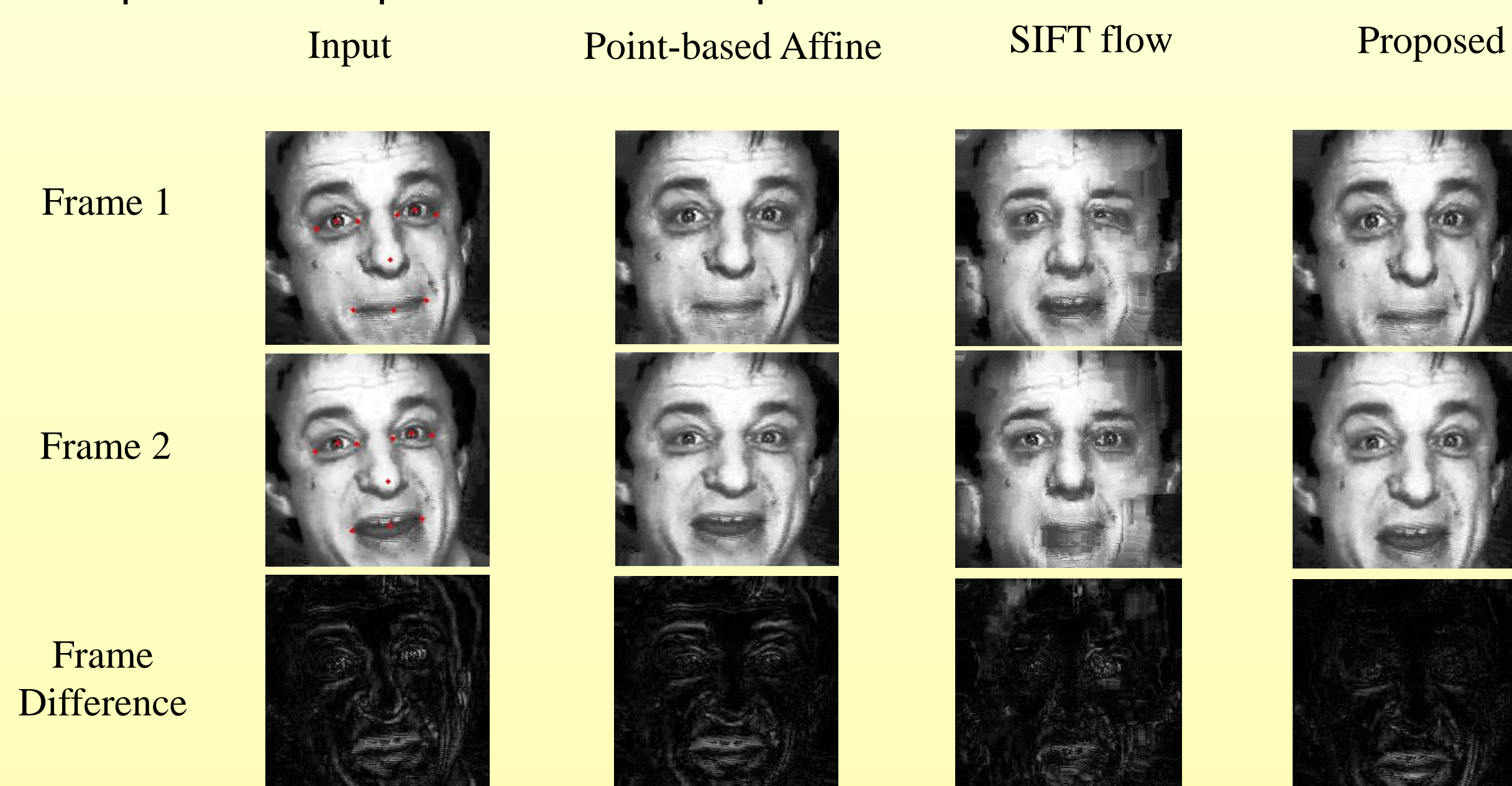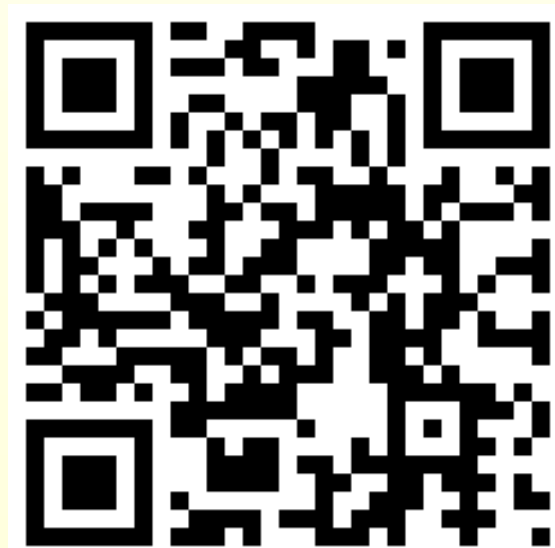
Please scan the QR code for demo and code

Challenge:

- Rigid head motion and non-rigid muscle motion
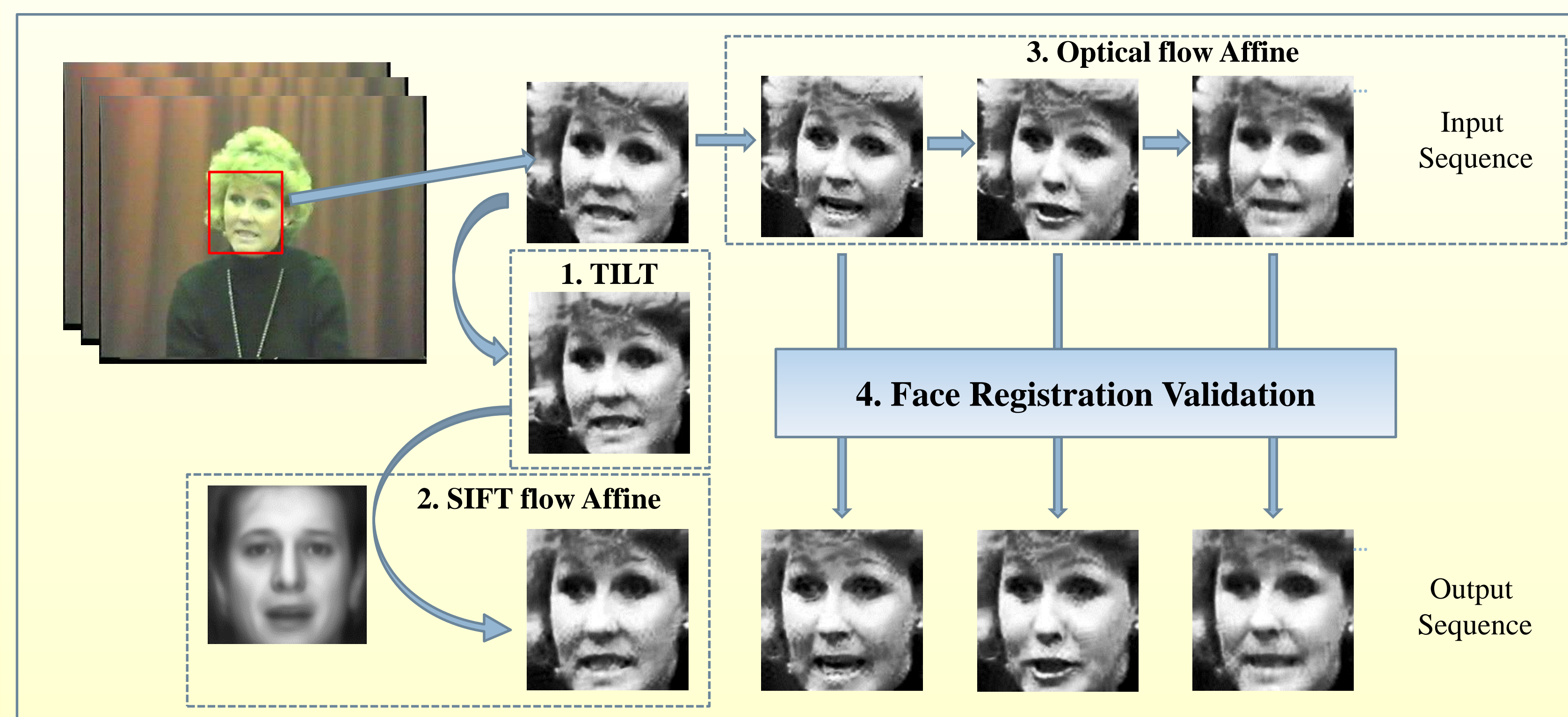- Streaming data and changing resolution on face

Solution:

- Use holistic SIFT flow and optical flow based affine transform
- Warp the first frame to a reference with canonical pose, expression, and illumination
- Warp the subsequent frames to its previous frame

Input | Point-based Affine | SIFT flow | Proposed
Frame 1
Frame 2
Frame Difference

2. Technical Approach

1. **TILT**
2. **SIFT flow Affine**
3. **Optical flow Affine**
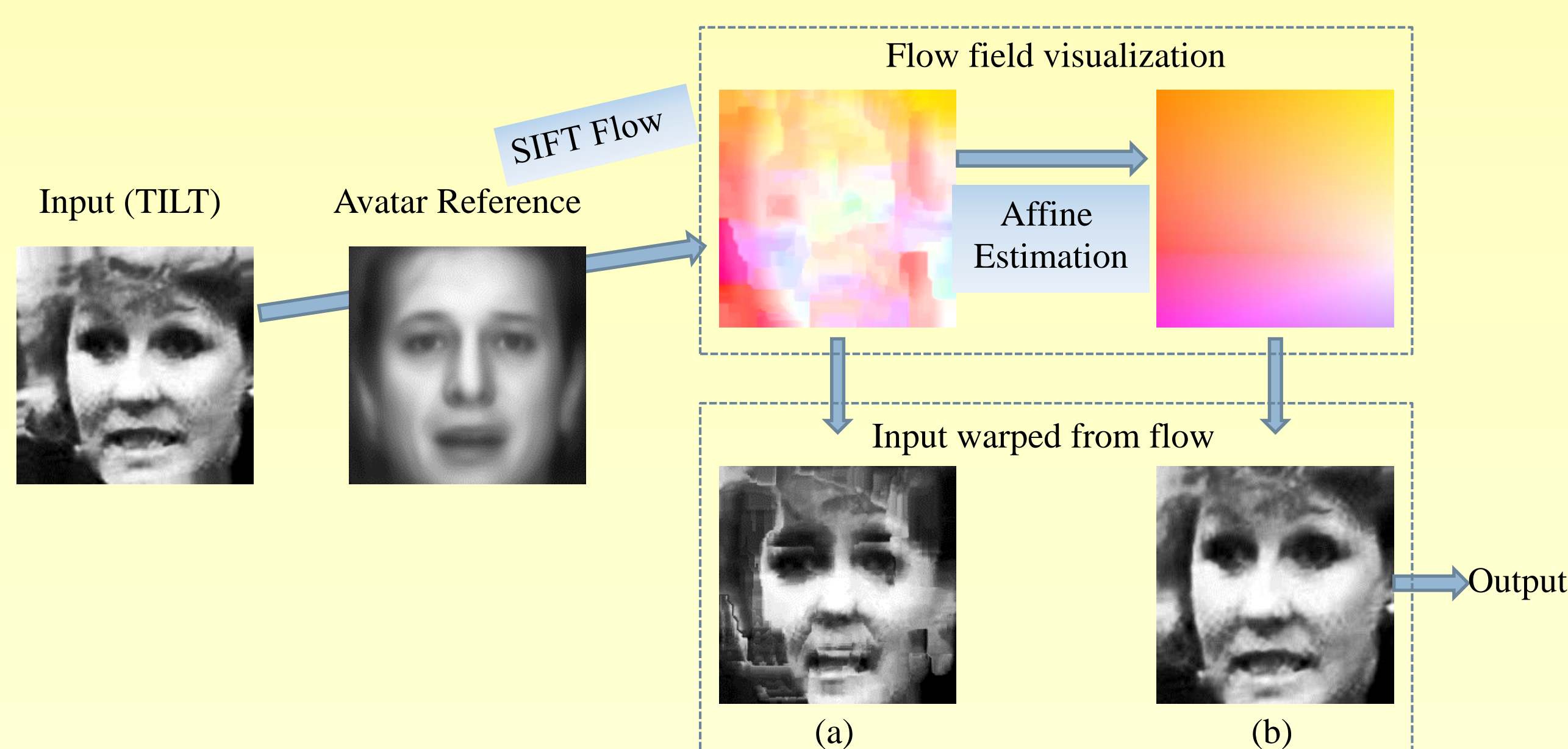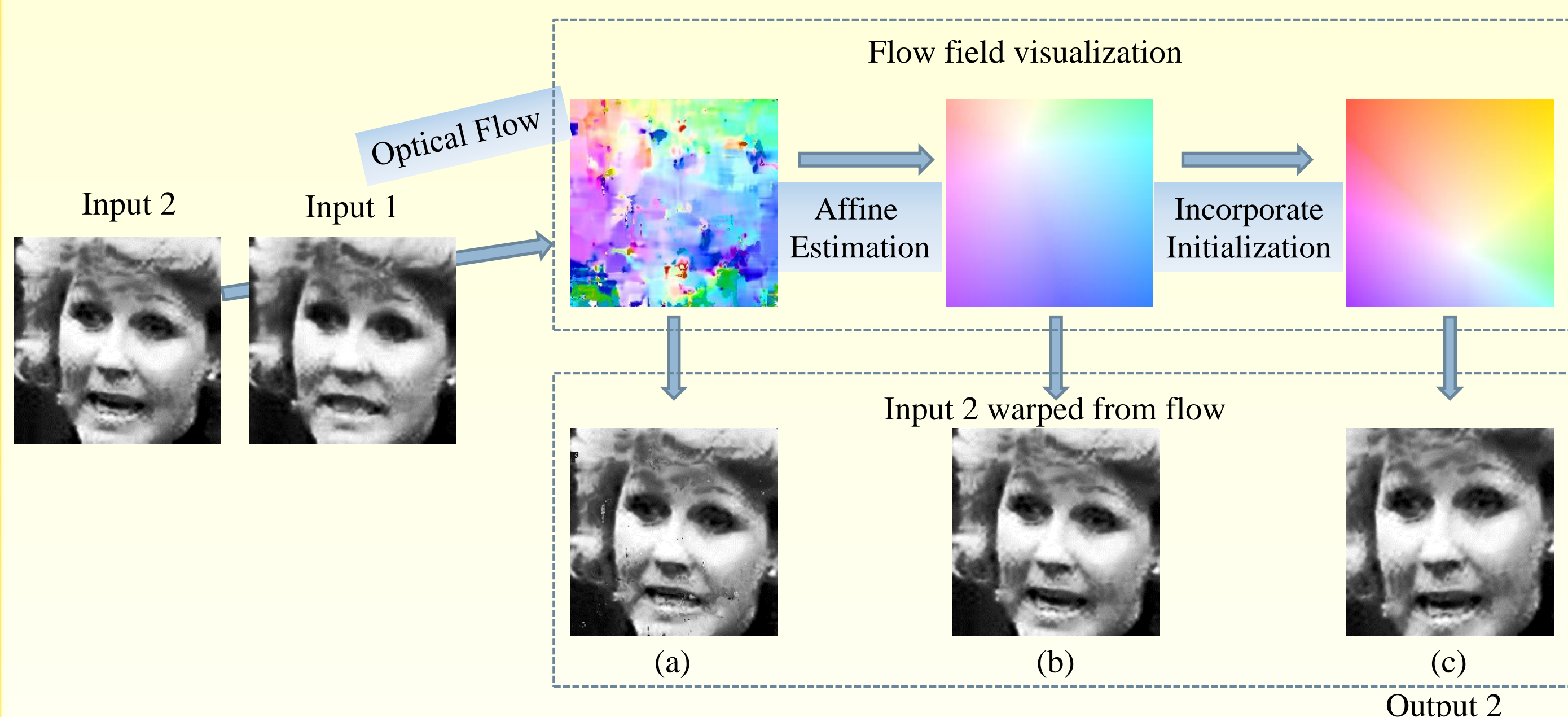4. **Face Registration Validation**

Input Sequence
Output Sequence

1. Transform Invariant Low-rank Texture (TILT): recover the symmetric structure and in-plane rotation
2. SIFT flow Affine: compute SIFT flow of the first frame w.r.t. the reference frame, estimate the affine transform based on the flow vector, record the warping matrix
3. Optical flow Affine: compute the optical flow between consecutive frames, estimate the affine transform, warp the image based on the cumulated affine warping matrix
4. Registration Validation: validate the current registration result using the binary classification model trained with linear SVM on HOG feature
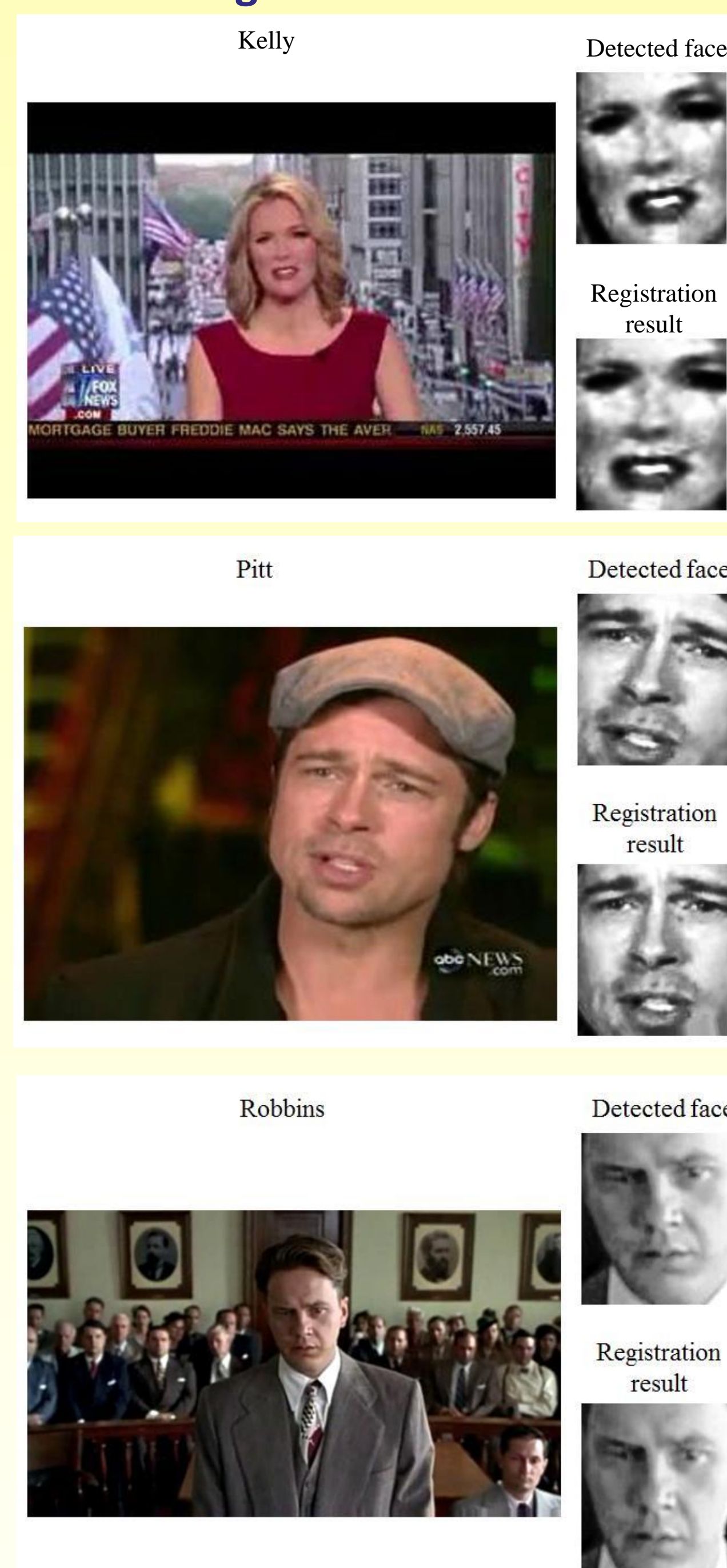
3. Results

Flow-based affine warping: for the first frame

Input (TILT) | Avatar Reference
SIFT Flow
Flow field visualization
Affine Estimation
Input warped from flow
(a) (b) Output

Flow-based affine warping: for the subsequent frames

Input 2 | Input 1
Optical Flow
Flow field visualization
Affine Estimation | Incorporate Initialization
Input 2 warped from flow
(a) (b) (c)
Output 2

Registration Results

Kelly — Detected face — Registration result
Pitt — Detected face — Registration result
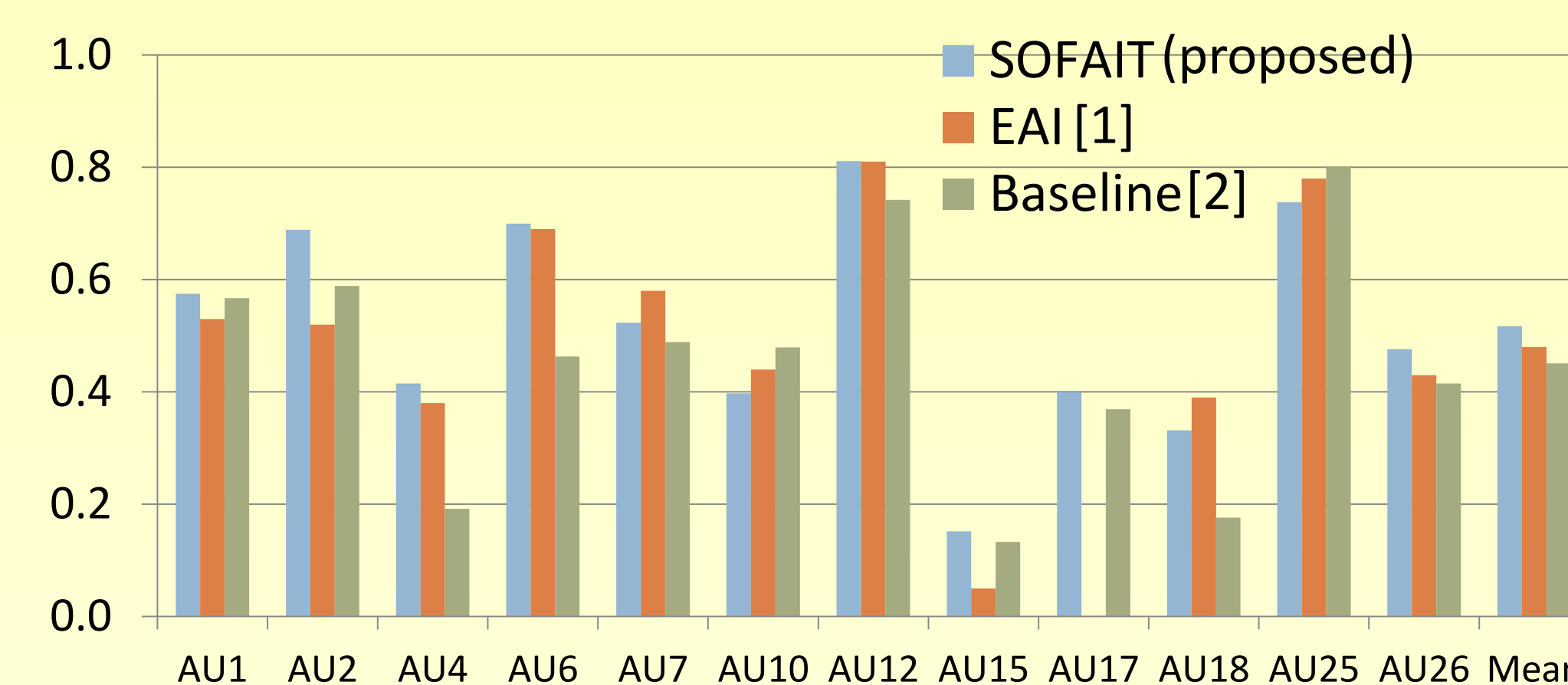Robbins — Detected face — Registration result

The improvement of AU recognition

We demonstrate SOFAIT face registration technique by facial action unit (AU) recognition on FERA Challenge Dataset

SOFAIT (proposed), EAI [1], Baseline [2]
AU1 AU2 AU4 AU6 AU7 AU10 AU12 AU15 AU17 AU18 AU25 AU26 Mean

4. Conclusions

- Introduced a video-based real-time face registration technique
- Utilizes holistic dense flow-based information, and therefore, robust to detection error, noise, and low image resolution
- Generates temporally smooth registration results
- Boosts AU recognition performance

5. Reference

[1] Yang et al.: Understanding Discrete Facial Expressions in Video Using an Emotion Avatar Image. IEEE Trans. SMC-B (2012)

[2] Valstar et al.: The First Facial Expression Recognition and Analysis Challenge. FG Workshop on FERA Challenge. (2011)

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