

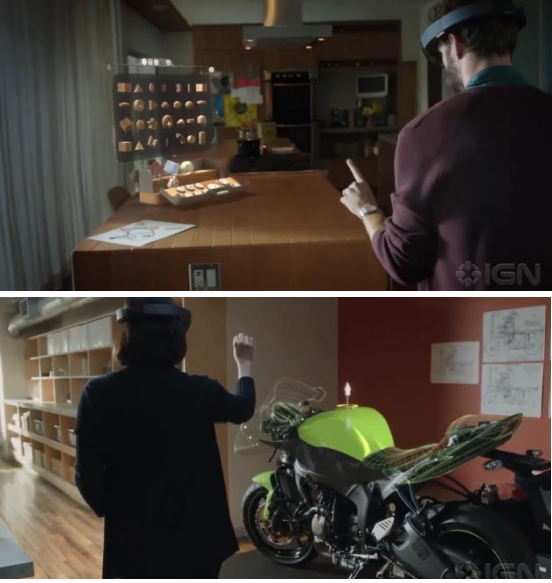
## Challenges in Hand Gesture-based VR Interaction

### Self-occlusions in Egocentric Viewpoint

- Fingertips occluded by the back of the hand

### Variances of a Gesture (speed, posture)

- Difficult to Generalize



MS HoloLens


>> **Direct Manipulation** (e.g. translocation) is **Difficult**

## Proposed Natural User Interface (Meta-Gesture)

### Meta-Gesture supports

- Orientation-aware Selection & Manipulation

- Identifying Partial Static Hand Shapes**
  - Summoning a functional object on the palm
- Classifying Movement Patterns of Hand Parts**
  - Manipulating the Functional VR Object



>> **User Summon a VR Tool & Activate the Function of the Tool**

## Process of the Proposed Framework

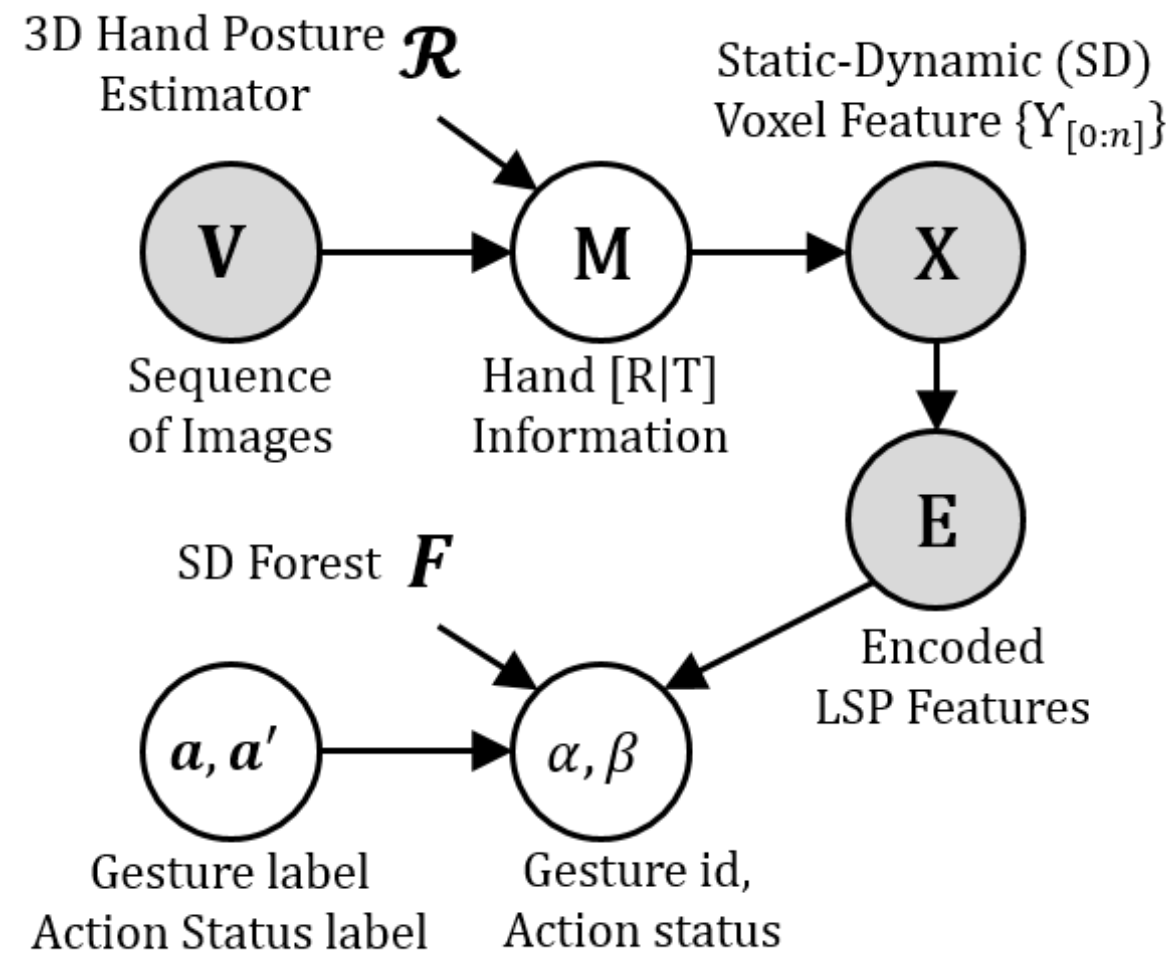
**M**: Palm Pose Estimation\*

↓

**X&E**: Spatio-temporal Voxel Coding

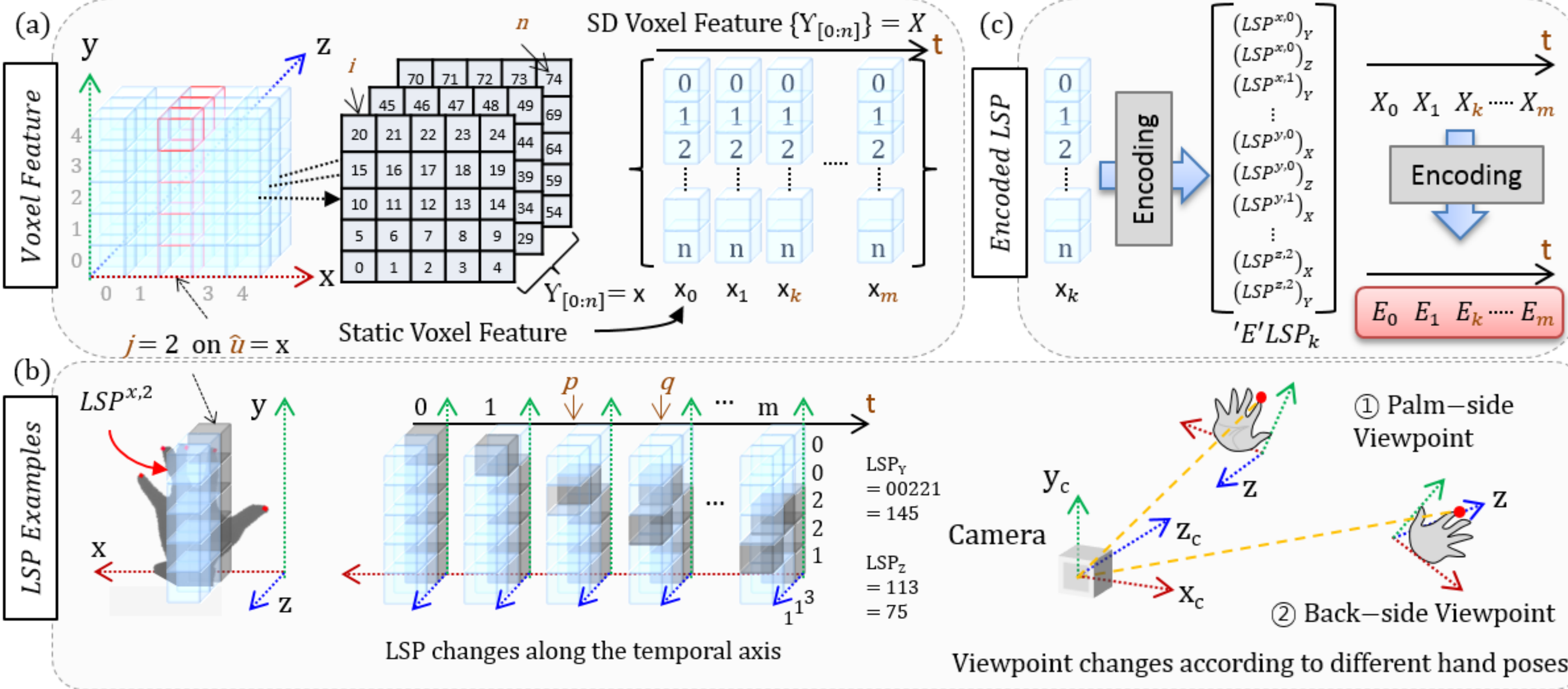
↓

**F**: Hierarchical Static & Dynamic (SD) Gesture Estimation



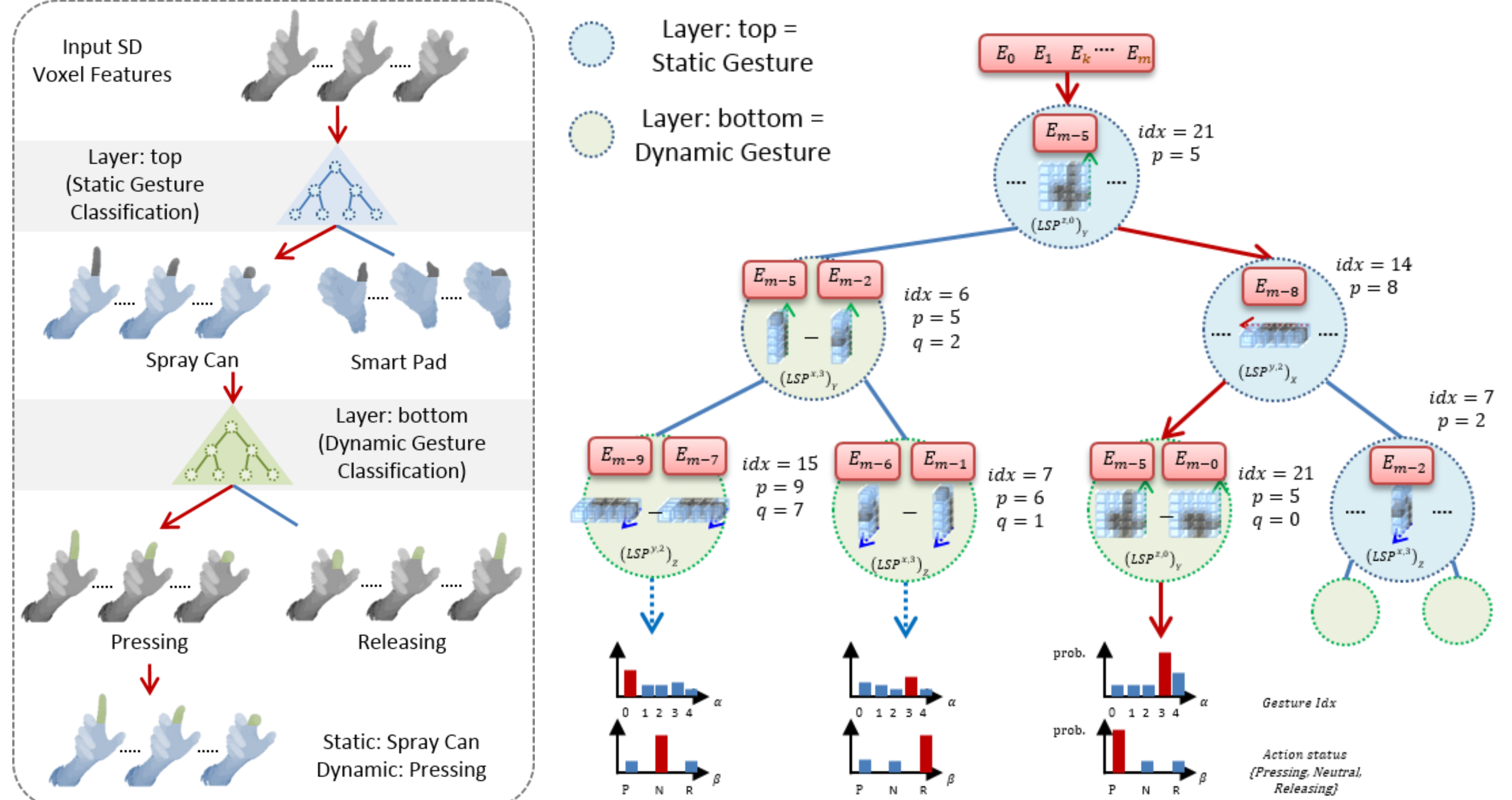
\* S. Melax, et.al., Dynamics based 3D skeletal hand tracking, GI'13, pp. 63-70, 2013.

## Static-Dynamic (SD) Voxel Feature



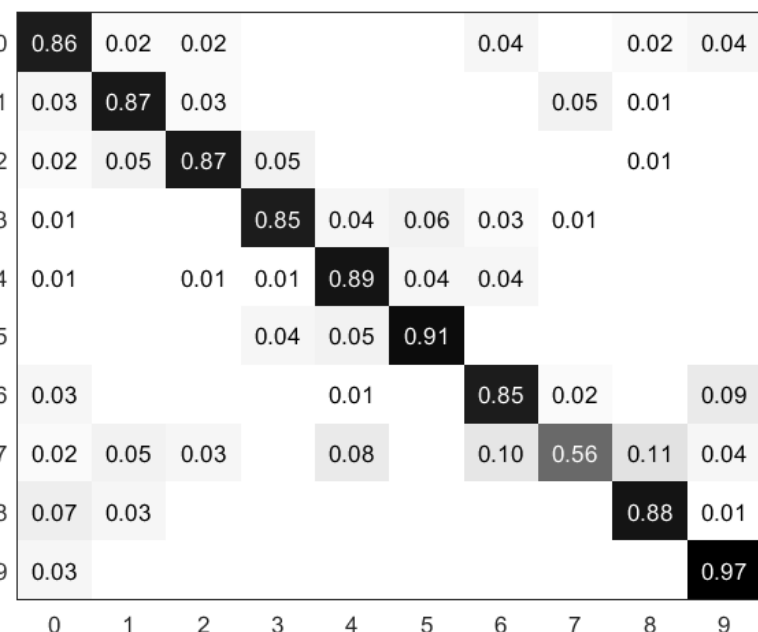
· LSP stands for Layered Shape Pattern

## Proposed Hierarchical Static-Dynamic Gesture Learning Model†

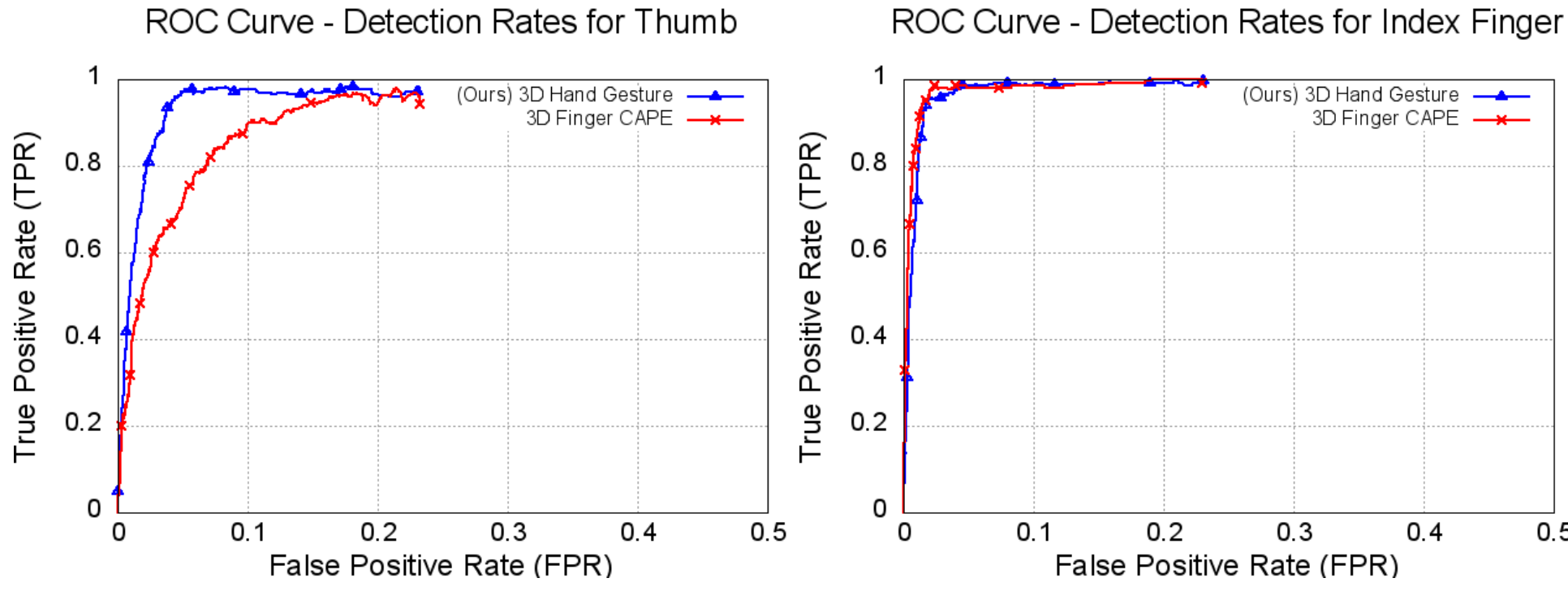


† Y. Jang, I. Jeon, T.-K. Kim, and W. Woo. Metaphoric hand gestures for orientation-aware VR object manipulation in egocentric viewpoint. IEEE Trans. Human-Machine Systems, 2016 (To appear).

## Experiments with Datasets



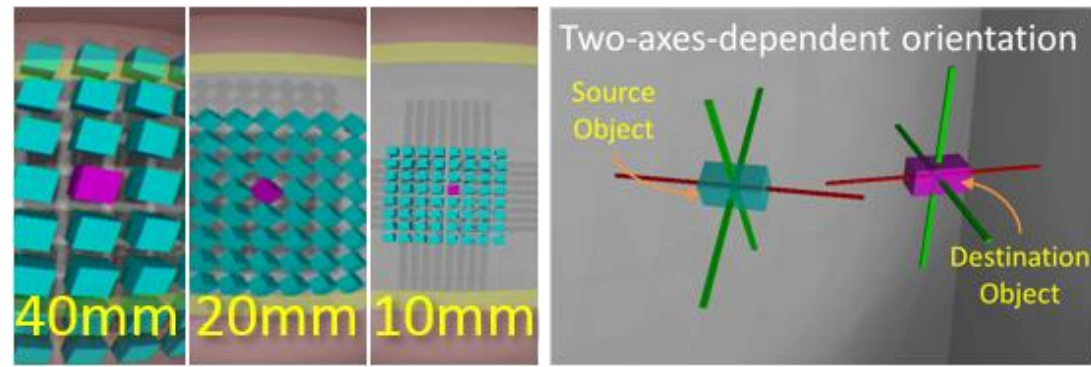
Confusion Matrix of Ten-digit Static Gestures: **91.36%**



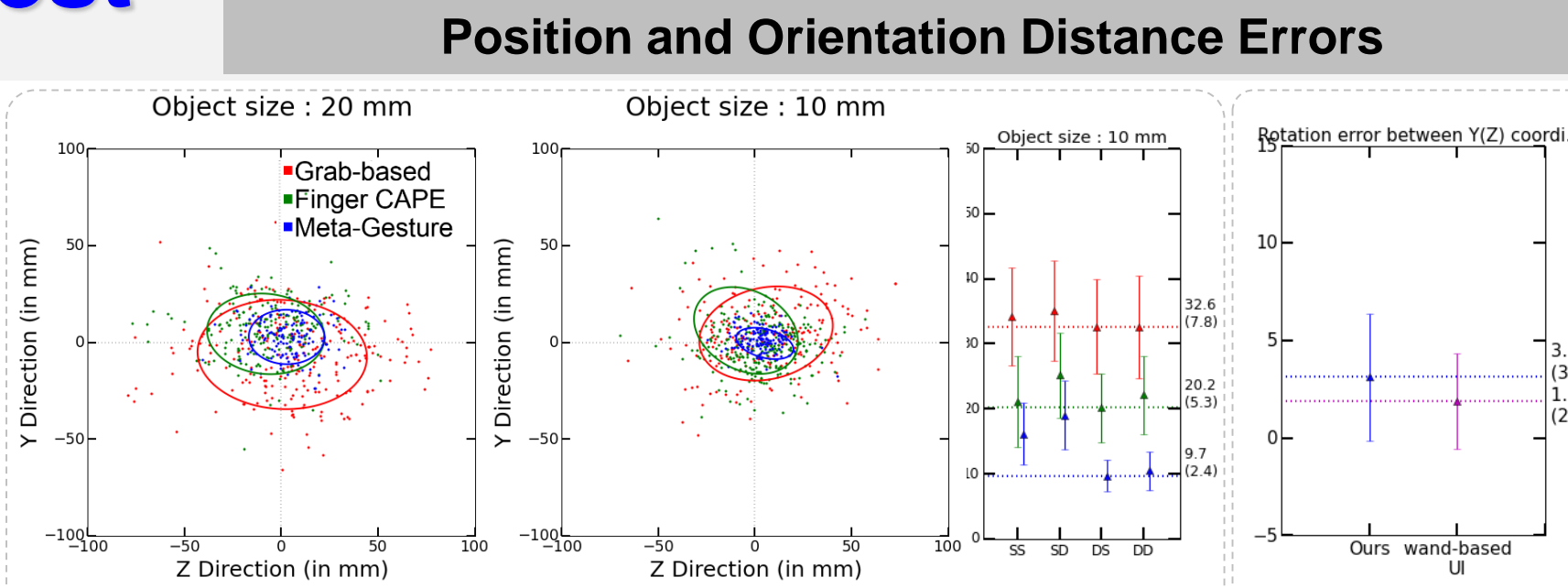
ROC Curves of Clicking Action Classification: (left) thumb (**Ours: 95.59%**, 3D Finger CAPE±: 89.80%) (right) Index finger (**Ours: 96.55%**, 3D Finger CAPE±: 96.90%)

† Y. Jang, et. al. 3D Finger CAPE: Clicking action and position estimation under self-occlusions in egocentric viewpoint. IEEE Trans. on Vis. Comput. Graph., 21(4):0–10, April 2015.

## Evaluation via User Test



VR Environment Setting for Experiments



Position and Orientation Distance Errors

Distance errors between the target and the estimated positions in a 'dense & dynamic scenario': Meta-Gesture shows **9.7 mm mean distance error**


Showing stable results **similar** to those of the **ground truth**

**Task 1: Purple Cube Selection**

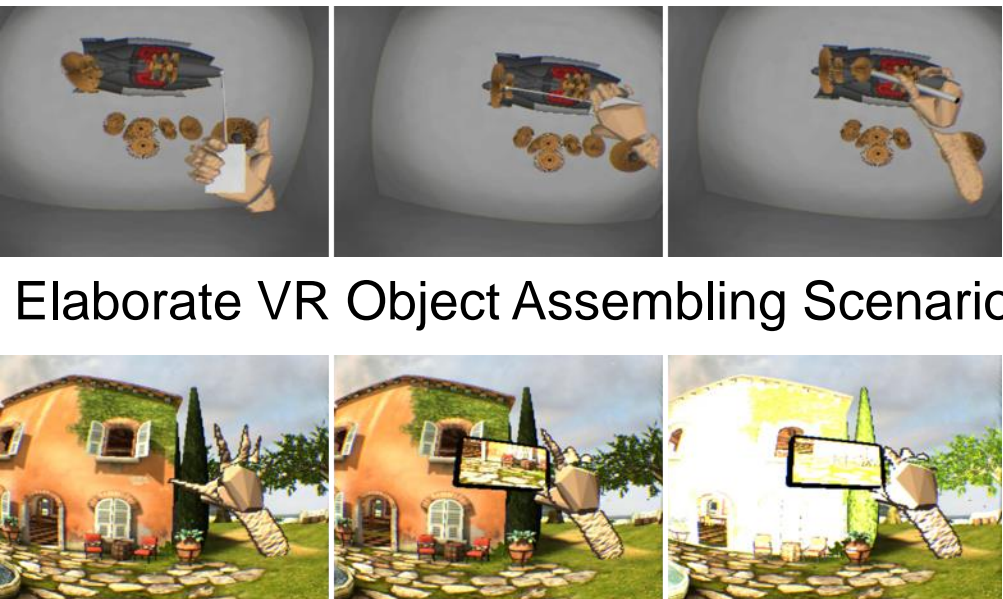
**Task 2: Manipulation**

- Matching Position & Orientation

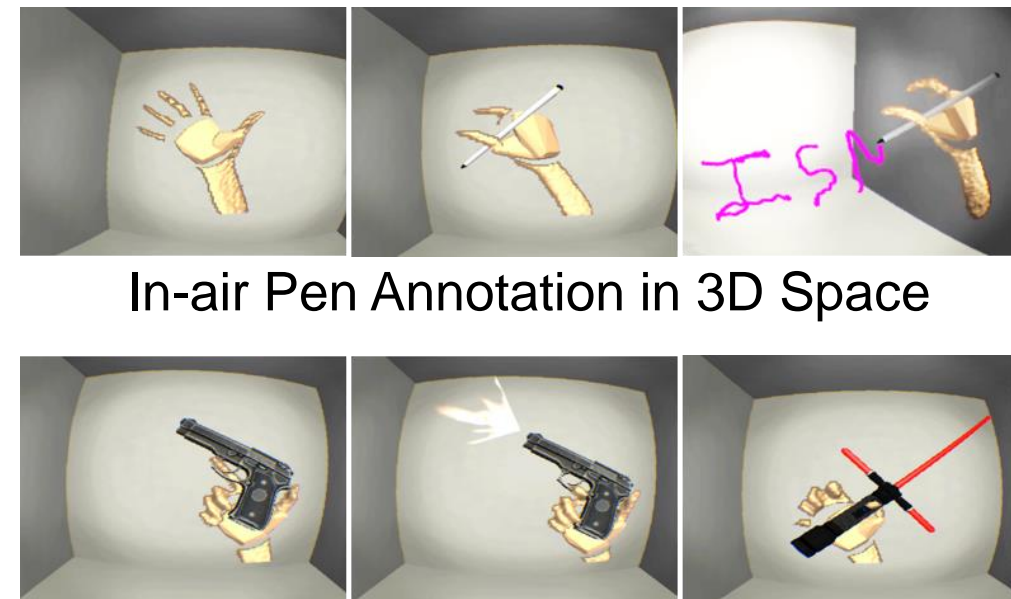
## Interactive Scenarios of using Meta-Gesture



User Experience for VR Spraying



AR Camera Application



Immersive Gaming

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