Detecting and Classifying Hands in Social and Driving Contexts

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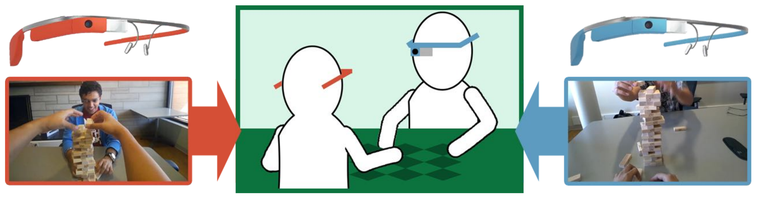
- We are interested in automatically **analyzing complex and dynamic interactions** from **first-person views**.
- To do this, we need to **robustly track hands** and **distinguish hand types** (my hands vs. your hands or left vs. right hands).
- We present an approach that **detects, distinguishes and segments hands** in real-world interactions using **visual features created through deep learning**.

- Hand detection and classification can provide helpful feedback to analyze **driver behavior** in active **safety systems for cars**.
- We demonstrate that our technique generalizes to such scenarios by applying it to the **VIVA 2015 challenge**.

1. Motivation

- We study egocentric hand detection, identification, and segmentation of interacting people in **realistic settings**.
- Evaluate the potential of **deep hand appearance models** to detect different hand poses and types.



2. Data Collection

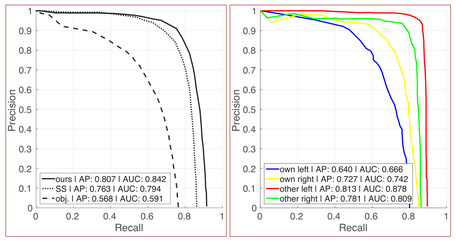
- Recorded synchronized first-person video from interacting subjects, using two **Google Glasses.**
- Four different actors, four activities, at three locations, for 4x4x3 = **48 unique videos.**
- Annotated 4,800 random frames with **pixel-level ground truth for 15,053 hands.**

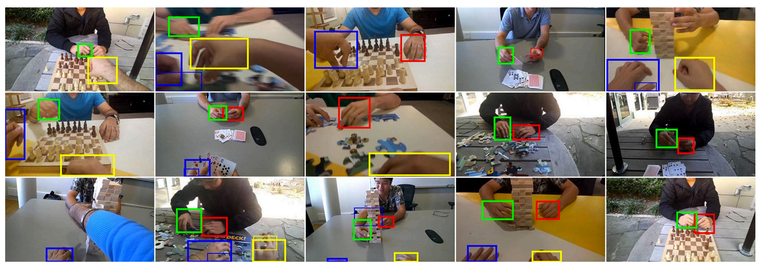
*Sample frames from our dataset. **Left**: Ground truth hand masks superimposed on sample frames, where colors indicate hand types. **Right:** Random subset of cropped hands according to ground truth segmentations.*

3. Hand Detection

- In first-person video, there are strong **spatial biases to hand location and size** for most natural actions.
- We use a **lightweight region proposal** technique that samples windows based on **skin color** and **spatial location**, yielding **better coverage** than other methods like “selective search” or “objectness.”
- We apply **convolutional neural networks (CNNs)** trained for a 5-way classification task between **own hands** (left/right), **other hands** (left/right), and background.

*Precision-recall for hand detection. **Left:** Results compared with other region-proposal methods. **Right:** Results for detecting four different hand types.*





Random detection results of own left, own right, other left and other right..

4. Segmenting Hands

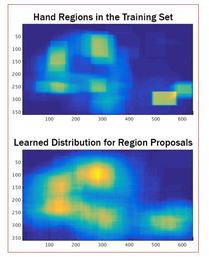
- We use our strong detections to initialize **GrabCut**, modified to use l**ocal color models** for hands and background.
- Yields **state-of-the-art results**.

***Top:** Segmentation examples on random frames. **Bottom:** Intersection/union results.*

Method	Own Hands		Other Hands		Average
	Left	Right	Left	Right	
Li et al.	0.395	0.478	0.534	0.505	0.478
Ours	**0.515**	**0.579**	**0.560**	**0.569**	**0.556**

VIVA Challenge

- We distinguish between the **driver’s left and right hands** and the **passenger’s left and right hands**.
- Cameras are either egocentric or mounted to the car (usually near the sunroof), imposing **spatial biases** on hand locations
- Our spatially sampled region proposals can cover **92% of hands** with only **500 windows** per frame.
- CNN evaluates proposed regions and distinguishes between hand types and background, yielding **state-of-the-art results** for **detection and classification**.



Some example detections for driver hands (left/right) and passenger hands (left/right). Most viewpoints observe people from the back/top, with some exceptions like first-person cameras or front-views from the A-pillar.

More Information:

- Full publications are currently under review (ICCV 2015, ICMI 2015)
- The “Egocentric Hand Interactions” dataset will be published online!

Challenge Results:

- A detailed quantitative evaluation can be found on the challenge website: **http://cvrr.ucsd.edu/vivachallenge/**

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