



Giving a Hand to Kinect



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PROBLEM STATEMENT

Track the 3D position, 3D orientation and full articulation (26 DoFs) of one (or more) human hand(s) given a sequence of RGB-D frames of the scene.

MOTIVATION

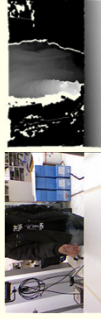
The markerless tracking of hand articulations is a **challenging problem** with **diverse applications** such as gesture recognition, H.C.I., H.R.I., understanding human grasping, robot learning by demonstration, etc.

MAIN IDEA

Employ a hand model. Produce full hypotheses of it and extract full-image features. Quantify the similarity of synthesized and observed features in parallel [5]. Use these scores to drive an iterative optimization process using Particle Swarm Optimization (PSO).

Observation

• RGB-D frames are acquired by a Kinect using **Microsoft SDK**.



• **Skin color** and **depth cues**, along with the **temporal continuity** assumption are used to **segment** the hand.



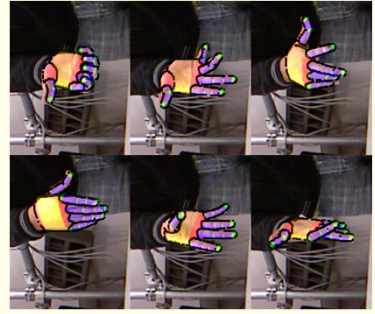
PROPOSED METHOD

Fit model to data

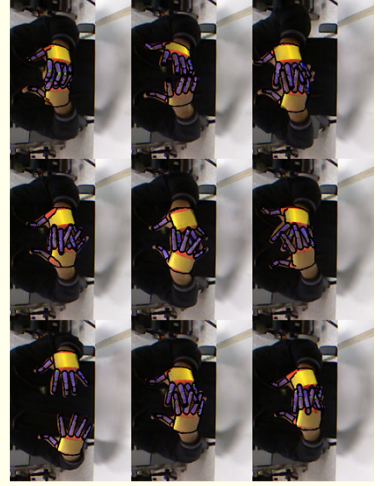
- Employ a parametric hand model [1] comprised of 15 cylinders and 22 spheres.
 - For a single hand: 26 DoFs, 6D global pose, 20 joint angles.
 - For two hands: 2x26 = 52 DoFs
- From a full configuration (all 26 or 52 DoFs of the hand(s) model), a **skin occupancy map** and a **depth map** can be **synthesized** by means of rendering.
 - These **maps** are used to quantify the **discrepancy** between **observation** and **hypothesis** (objective function).
 - The objective function also **penalizes physically implausible** configurations (inter- and intra-hand collision checking).
 - A **variant** of the **Particle Swarm Optimization** method searches in the model parameter space for the best scoring configuration.
 - **Efficient** evaluation of multiple hypotheses on the **GPU** [5].
 - Candidate poses for the **next frame** are obtained by **perturbing** the solution of the **previous frame**.

EXPERIMENTAL RESULTS

A single hand [3]



Two hands [4]



Single hand: 64 particles and 30 generations yield **20fps** on a modern PC
Two hands: 64 particles and 40 generations yield **4fps** on a modern PC
For the quantitative evaluation w.r.t. accuracy, tolerance to noise, computational budget, viewpoint invariance, e.t.c, check [3], [4]

3D hand tracking in CHALEARN:

Use the developed 3D hand tracking approach to recognize hand postures defined by the user on the fly!

STRENGTHS OF THE APPROACH

- Fundamental building block for countless applications.
- Tracking hand(s) with unconstrained motion.
- Non invasive markerless approach.
- Safeguards against physically implausible hand configurations.
- Careful design and exploitation of parallelism in a GPU implementation [5] lead to a computationally efficient system [1-4].

KEY REFERENCES

1. Oikonomidis, I., Kyriazis, N., Argyros, A.A., "Markerless and Efficient 26-DOF Hand Pose Recovery", *ACCV*, 2010.
2. Oikonomidis, I., Kyriazis, N., Argyros, A. A., "Full DOF Tracking of a Hand Interacting with an Object by Modeling Occlusions and Physical Constraints", *ICCV*, 2011.
3. Oikonomidis, I., Kyriazis, N., Argyros, A. A., "Efficient Model-based 3D Tracking of Hand Articulations using Kinect", *BMP&C*, 2011.
4. Oikonomidis, I., Kyriazis, N., Argyros, A. A., "Tracking the articulated motion of two strongly interacting hands", *CIIPR*, 2012.
5. Kyriazis, N., Oikonomidis, I., Argyros, A. A., "A GPU-powered Computational Framework for Efficient 3D Model-based Vision", *Technical Report TR420, ICS-FORTH*, 2011.



For more information, visit <http://cvr/code.ics.forth.gr/handtracking>



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