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Multi Hand Pose Recognition System using Kinect Depth Sensor: Application to Medical Image Navigation
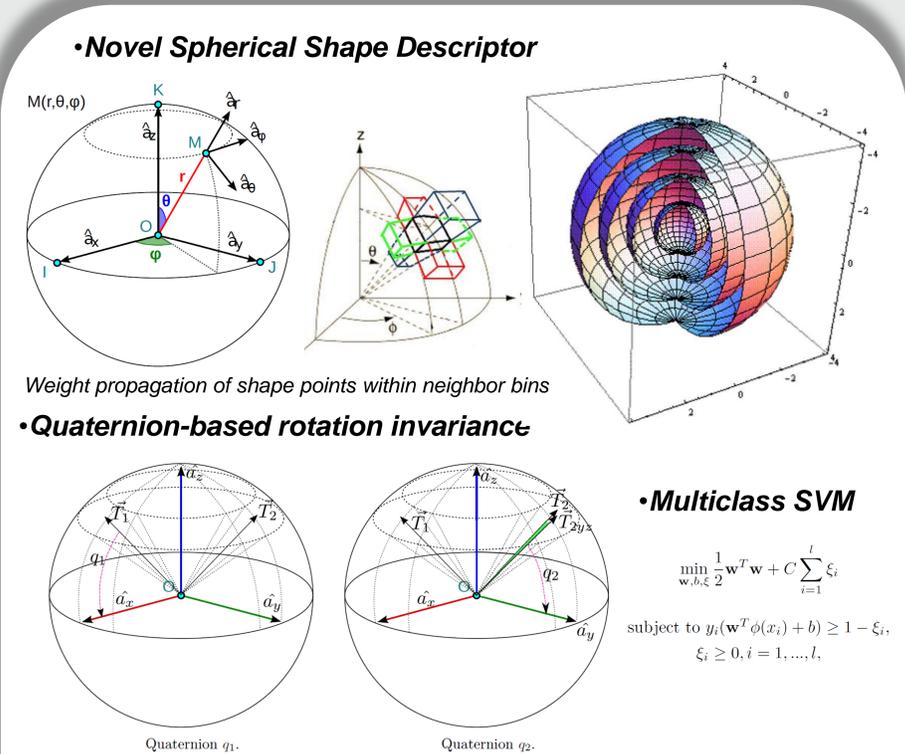
ABSTRACT

Hand pose recognition *is a hard problem due to the inherent structural complexity of the hand that can show a great variety of dynamic configurations and self occlusions. This work presents a* ***hand pose recognition pipeline*** *that takes advantage of RGB-Depth data stream, including* ***hand detection and segmentation***, ***novel hand point cloud description*** *using the novel Spherical Blurred Shape Model (SBSM) descriptor, and* ***hand classication using OvO Support Vector Machines***. *The system also includes a* ***probabilistic gesture recognition process considering hand pose labels and trajectory features***. *We have recorded a* ***hand pose dataset of multiple hand poses***, *and show the high performance and fast computation of the proposed methodology. The system is implemented using* ***Microsoft SDK*** *and is applied in a* ***real and robust medical image navigation application***.
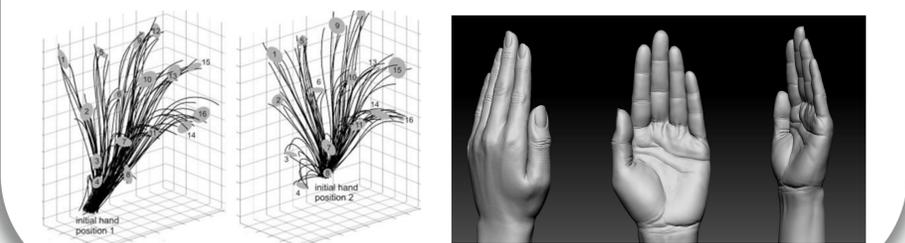
1. Motivation

- *Recognize hand poses and gestures with high visual variability.*
- *Introduce the recognition process in an automatic medical image navigation application.*

2. System

- **Novel Spherical Shape Descriptor**

Weight propagation of shape points within neighbor bins

- **Quaternion-based rotation invariance**

Quaternion q_1.

Quaternion q_2.

- **Multiclass SVM**

$$\min_{\mathbf{w},b,\xi} \frac{1}{2}\mathbf{w}^T\mathbf{w} + C\sum_{i=1}^{l}\xi_i$$

$$\text{subject to } y_i(\mathbf{w}^T\phi(x_i)+b) \geq 1 - \xi_i,$$
$$\xi_i \geq 0, i = 1,...,l,$$

- **Descriptor results improve state-of-the-art approaches (51 categories) [2]**

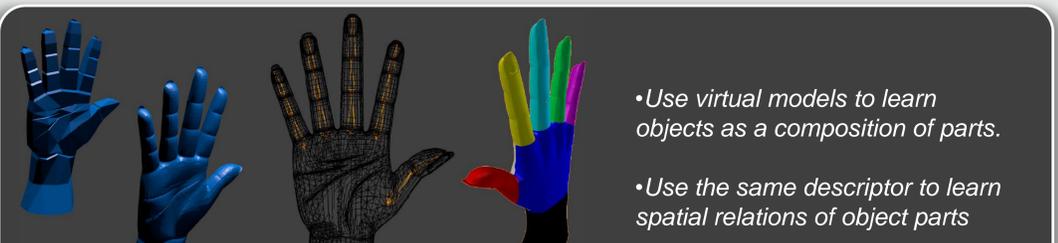| Methods	Papers	Depth
SIFT + Texton + Color Histogram + Spin Images + 3D Bounding Boxes	ICRA11A	64.7
Sparse Distance Learning	ICRA11B	70.2
RGB-D Kernel Descriptors	IROS11	80.3
Hierarchical Matcing Pursuit	ISER12	81.2
Ours	**ICPR Demonstrator challenge**	**85.13**

- **Probabilistic HMM gesture recognition using hand trajectories and hand labels**

3. Application: medical image navigation

- **Interface**

- **Medical imaging volume data sets [3]**

- **Application simulation**

4. Future work

- *Use virtual models to learn objects as a composition of parts.*
- *Use the same descriptor to learn spatial relations of object parts*

References

[1] Sergio Escalera, Alicia Fornés, Oriol Pujol, Josep Lladós, and Petia Radeva, Circular Blurred Shape Model for Multiclass Symbol Recognition, Systems, Man, and Cybernetics, Part B: Cybernetics, IEEE Transactions On, Volume 99, pp. 1-10, Digital Object Identifier: 10.1109/TSMCB.2010.2060481, pp. 1-10, IEEE Society, Hanover, USA, ISSN 1083-4419, 2010.
[2] http://www.cs.washington.edu/rgbd-dataset/dataset.html
[3] http://www9.informatik.uni-erlangen.de/External/vollib/