A Stereo Vision Approach for Cooperative Robotic Movement Therapy

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Robot-assisted rehabilitation system

Movement therapy is an integrating part of stroke rehabilitation. We present a device for the re-education of upper limb movements in hemiparetic patients where a light-weight robotic arm follows the movements of the healthy arm that wears a sleeve equipped with flat round reflective markers. The marker position is detected by a stereo camera system and a robust and real-time algorithm provides the tracking.

Image Processing

1. Acquire images
2. Find object markers (ROIs) \textsuperscript{[1]}
3. Subpixel precise contour fitting \textsuperscript{[2]}
4. Compute centres
5. Triangulate 3D points

Processing Pipeline

Calibration
- Camera Params
- Hand-eye \textsuperscript{[3]}

Communication
- OpenIGTLink \textsuperscript{[4]}

Robot Path Planning
- RRT-connect \textsuperscript{[5]}

Quantitative Evaluation

Accuracy in working volume
- Total translation error 0.5 mm

Partial Occlusion
- Up to 50\% occlusion

Computation Time
- Tracking 9.42 ms $\pm$ 1.44 ms
- System latency 318.70 ms

Conclusion

We introduce a robust real-time marker-based tracking algorithm that provides the necessary information to reproduce the movement of the healthy arm with the impaired one. First trials with healthy subjects show the feasibility of this approach. Finally, this work opens the way towards gesture-controlled robots in rehabilitation.