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Simultaneous localization and mapping for camera-based EEG electrode digitalization

Agenda

- Motivation
- Robotic Data Acquisition System Setup
- Problems and Solutions
- Results & Discussions
- Conclusion and Future Work

Camera calibration

Parameters	Calibrated values (OpenCV)	Calibrated values (Matlab)	Value in robot-guided data set
α_x	601.06	604.58	607.49
α_y	601.33	604.48	607.44
S	0.0	0.0	0.0
C_x	636.54	639.25	638.92
C_y	360.29	358.54	364.35

Table 1: Microsoft azure kinect calibration result

Hane-eye calibration

Camera	Translation error (mm)	Rotational error (deg)	Between
Kinect	$8.8\pm$ 0.2	0.7682 ± 0.0204	Marker-Kinect
Tracking camera	$0.18\pm 4.5 \times 10^{-6}$	$0.093 \pm 5.4 \times 10^{-5}$	Robot-Tracking Camera
Kinect	$1.28\pm 2.1 \times 10^{-4}$	$0.211 \pm 2.1 \times 10^{-4}$	Robot-Kinect

Table 2: Hand-eye, eye-in-hand calibration result

Metrics: Robot-guided

Metric	CAP_63 (55/63)	CAP_23_1 (20/23)	CAP_23_2 (19/23)
Absolute L2 norm	11.5 mm ± 5.0 mm	11.7 mm ± 4.0 mm	12.6 mm ± 5.5 mm
Post registration RMSE	3.7 mm ± 0.3 mm	6.8 mm± 2.0 mm	5.6 mm ± 1.2 mm

Table 3: 3D position error

Metric	CAP_63	CAP_23_1	CAP_23_2
Translation error	-1.4 mm ± 9.3 mm	16.3 mm ± 10.1 mm	12.1 mm ± 14.5 mm
Rotational error	4.1°± 1.7°	4.6°± 1.7°	6.7°± 3.4°

Table 4: Trajectory Comparison

Metric	CAP_63	CAP_23_1	CAP_23_2
Translation error	0.5 mm ± 2.1 mm	0.8 mm ± 2.9 mm	0.9 mm ± 3.3 mm
Rotational error	0.5°± 0.3°	0.7°± 0.4°	0.9°± 0.6°

Table 5: ICP vs ground truth comparison

Metrics: Robot-hand

Metric	CAP_63 (50/63)	CAP_23_1 (21/23)	CAP_23_2 (22/23)
Post registration RMSE	10.7 mm ± 2.7	14.6 mm ± 3.4 mm	19.3 mm ± 2.3 mm

Table 6: 3D position error

Metric	CAP_63	CAP_23_1	CAP_23_2
Translation error	-10.6 mm ± 50 mm	-15 mm ± 91 mm	-18.8 mm ± 60 mm
Rotational error	11°± 4°	16.8°± 11°	15.3°± 4°

Table 7: Trajectory Comparison

Metric	CAP_63	CAP_23_1	CAP_23_2
Translation error	4 mm ± 7 mm	7.1 mm ± 9 mm	8 mm ± 7 mm
Rotational error	1.1°± 0.6°	1.5°± 1°	1.4°± 0.8°

Table 8: ICP vs ground truth comparison

Agenda