A Tracking Method for 2D canvases in MR-based interactive painting system


Previous study: MAI Painting Brush

We developed a painting system that imitates real world painting [1].

Painting result (Virtual)

User’s view

MAI Painting Brush

Real world

Problem & Solution

- The canvases are tracked by the magnetic sensor
- The users needed to detach and attach a sensor when they want to change the canvas
  (… or, we needed to prepare many receivers)

Solution: Installing vision-based tracking method

• Requirements
  - Occlusion robustness
  - Brush device
  - User holds the canvas

- Natural
  - Not to interrupt the user’s creativity
  - e.g.) Real objects
  - ARTag, ARTag

Implementation: Region-based tracking

[Descriptor]

Input image

Extracted region using MSER [2]

Extracted keypoints

[Matching]

Relevance Measure (r)

Sequence of r

Hash table

$r = \frac{\theta_1 I_2}{I_1 + I_2}$

$f(r_0, r_1, r_2) = \text{string of } r_0 - r_1 - r_2$

(System block diagram for tracking)

Input image

Extract regions

Retrieve region ID

‘Hash’ table

Tracked?

Compute homography

Update the hash table

[Converting coordinate]

Tracked canvas ($X'_c$) by the visual tracker

must be converted into sensor coordinate ($X_s$)

$X'_c = [\theta]_{x1}^{-1}[\theta]_{x2}X_s$

$X'_c$: canvas in camera coordinate

$X_s$: canvas in sensor coordinate

Evaluation

[Accuracy]

- Attached a magnetic sensor on the origin of the canvases in the tracker coordinate system
- Compared the positions form magnetic sensor and vision-based tracking.

The position is shifted in the y-axis due to the calibration error.

Apply local transformation on the camera coordinate system

High error due to occlusions and rotations.

Some keypoints are located outside the capture area which makes the accuracy decreases (a) or the tracking failure (b).

[Processing speed]

- Captured two markers for testing the speed of the visual tracking on the painting system
- Recorded the processing time
  - for detection and tracking
  - for painting or technically modifying the texture of the shape in the rendering pipeline

The number of points in the polygon contributes to the computation cost.

The overall speed of the system becomes 5-6 fps.

Conclusion & Future work

- We proposed a mixed reality-based painting system that uses a visual tracker as the canvas.
- The visual tracker that consists of region as the descriptor.
- When we use multiple visual trackers, we will be able to switch the various canvases freely without detaching and attaching the physical sensors.

For the future work, we are planning to
- extend our method to 3D objects
- implement the ID to each canvas in the case using multiple canvases at the same time.