

Geometric Registration for Mixed Reality Using Embedded Wall Posters as AR-Markers

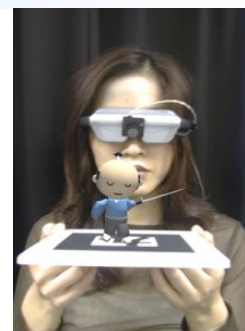
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Mobile Computing and Reality Media Lab.

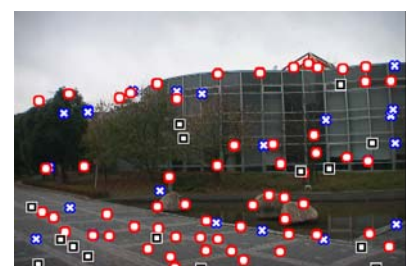
Vision-based geometric registration for MR

- ▶ Fiducial markers
 - ▶ Fast and robust detection
 - ▶ High quality and portability
 - ▶ Impairing scenery



ARToolKit
[Kato et al. 02]

- ▶ Landmark in environment
 - ▶ Using known natural feature points or online detection of them
 - ▶ Not impairing scenery
 - ▶ Not so stable

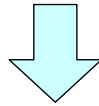


[Taketomi et al. 08]

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Our research concept

Achieving good balance between **the elegance** with regard to the environment and **robustness** of the registration



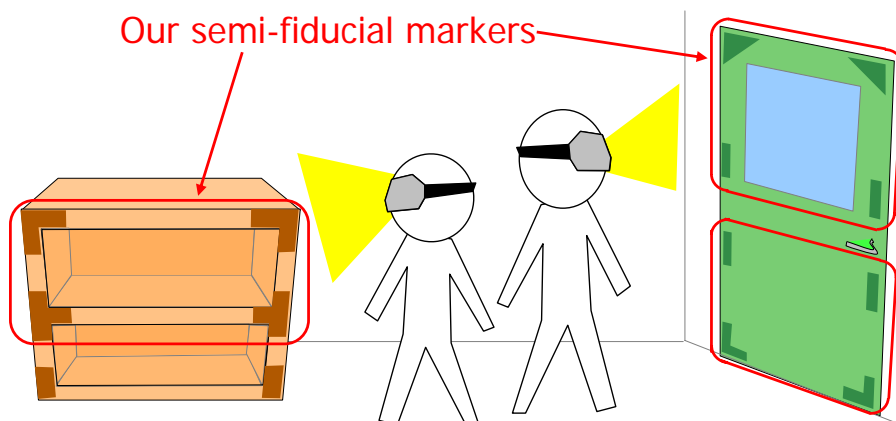
Semi-Fiducial INvisibly Coded Symbols (SFINCS)

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Our previous work

We proposed **the visual AR/MR markers** which are

- 1) colored similarly to that of the background object,
- 2) placed at the corners of real objects.



R. Tenmoku, Y. Yoshida, F. Shibata, A. Kimura, and H. Tamura:

“Visually elegant and robust semi-fiducials for geometric registration in mixed reality,”

Proc. 6th Int. Symp. on Mixed and Augmented Reality (ISMAR 2007), pp. 261 - 262, 2007.

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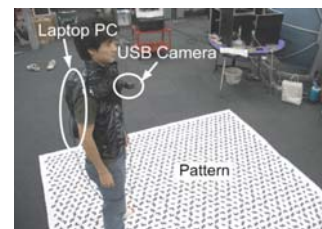
Our previous work

video

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Related works

- ▶ Invisible markers [Nakazato et al. 05]
 - ▶ Using **translucent retro-reflective markers** and an **infrared camera**
 - ▶ **Invisible** for normal cameras and human eyes
 - ▶ Complicated system configuration
- ▶ Pattern-printed wallpapers [Saito et al. 06]
 - ▶ Using pattern-printed **wallpapers** or **carpets** and a **normal camera**
 - ▶ Changing environments significantly



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Our approach

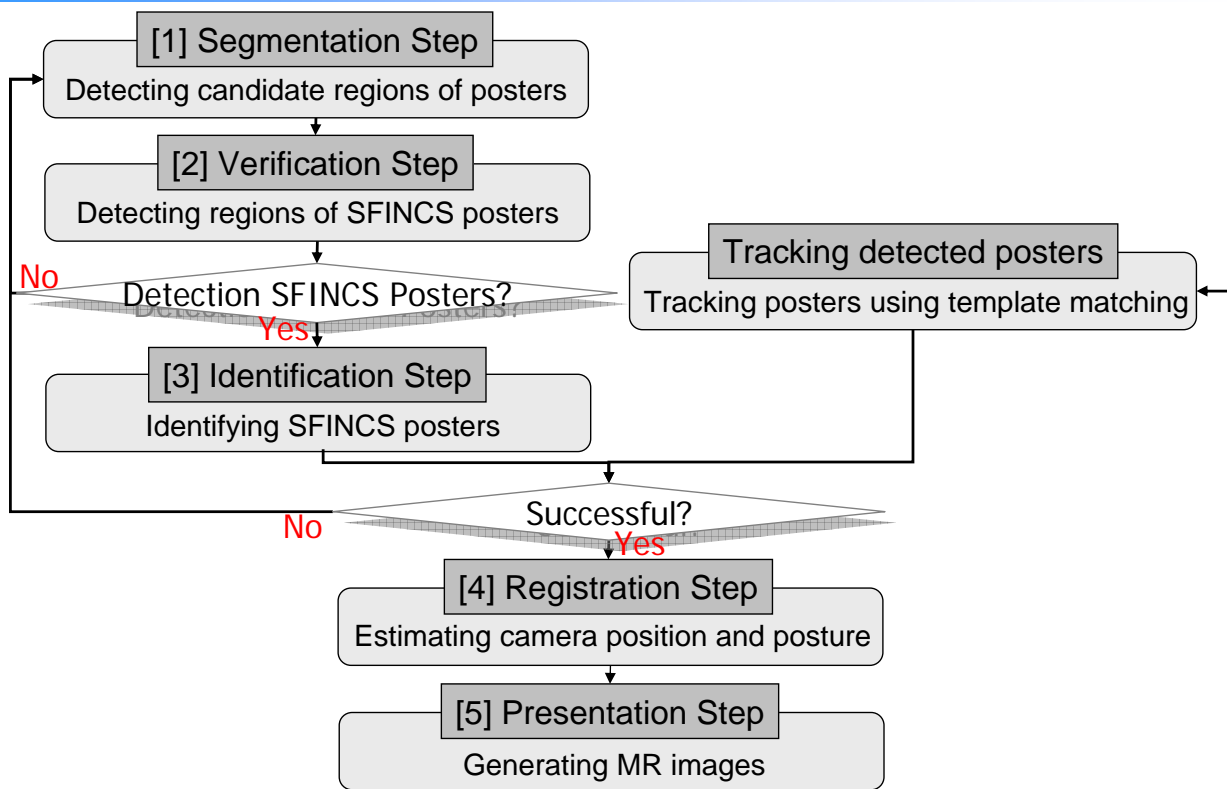
Wall posters are used as AR markers.

- ▶ Recognizing SFINCS posters using **design rules**
- ▶ Embedding **position IDs** into each poster
- ▶ Real-time geometric registration without impairing scenery



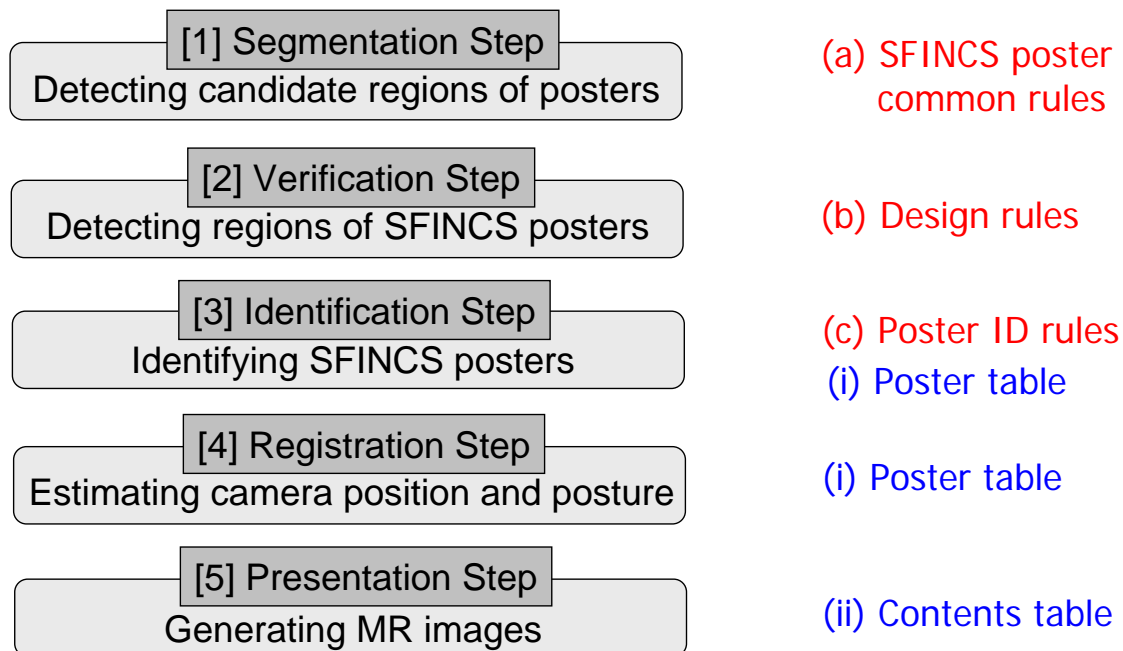
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Flowchart of the framework



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Required data



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Rules

- ▶ SFINCS poster common rules
 - ▶ These rules are used in the **segmentation step**.
 - ▶ The shape of every SFINCS poster is **rectangle** whose aspect ratio is $1:\sqrt{2}$.
 - ▶ The background color of posters are **not same** as that of background object.
- ▶ Design rules
 - ▶ These rules are used in the **verification step**.
- ▶ Poster ID rules
 - ▶ These rules are used in the **identification step**.

Design rules and poster ID rules are established by the provider of MR applications.

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Segmentation Step

Detecting **quadrangle regions** as candidate regions of posters

1. Applying **edge detector** for input images
2. Detecting **vertical line segment edges** above a certain length
3. Investigating a line segment edge between each end point of vertical lines
4. Detecting **quadrangle regions** above a certain area



Verification Step

The system sifts candidate regions to **detect only SFINCS poster regions**.

1. Inverse projection transformation for candidate regions
2. Verifying if candidate regions **satisfy design rules**
3. Detecting **only** SFINCS poster regions



Identification, registration, and presentation steps

The system **estimates ID numbers** of detected SFINCS posters.

The **position and posture** of camera is calculated using poster positions.

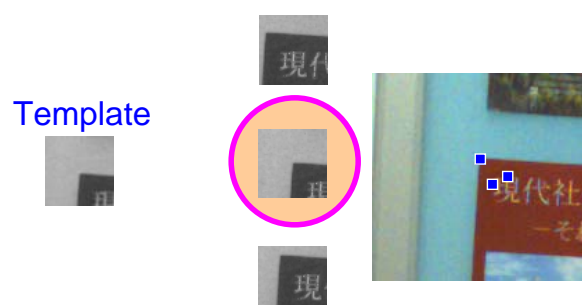


MR images are generated based on the camera position and posture.

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Tracking detected posters

- ▶ Tracking 4 corner points of SFINCS posters
 - ▶ **Images around the corner points** in previous frame are defined as template images.
 - ▶ **Natural points** around the corner points are detected.
 - ▶ Images around detected points are **compared** with template images.
 - ▶ The **most similar point** is recognized as the corner point in the current frame.

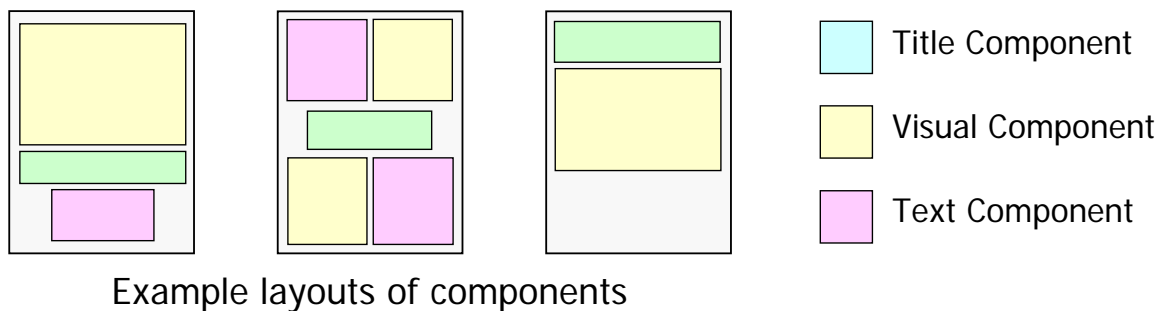


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Layout rule scheme

The rule scheme using **layout of components** of a poster: **title**, **visual**, and **text** components

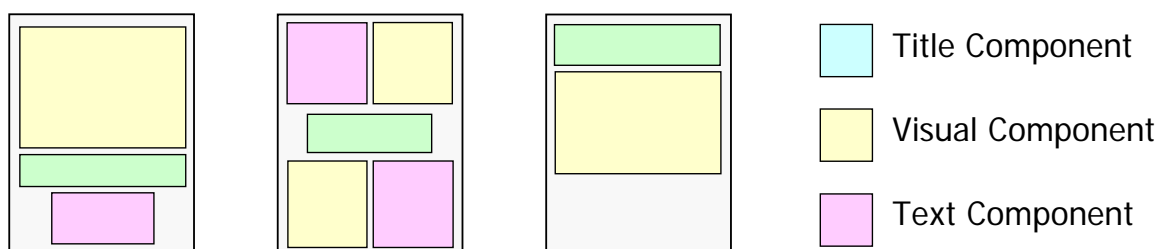
- ▶ Judgment functions of each component is applied partly.



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Components of poster

- ▶ Title component
 - ▶ Single or double lined strings and drawn by single color
 - ▶ The title color is highly visible against the background color
- ▶ Visual component
 - ▶ Composed by a photo
- ▶ Text component
 - ▶ Multiple lined strings drawn by single color



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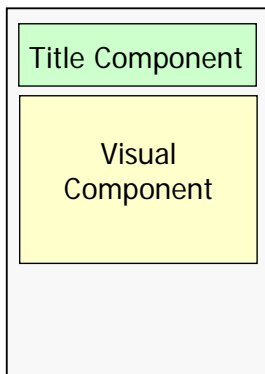
Example rule set R_1

▶ Design Rules

- ▶ The layout of SFINCS posters are as shown below.
- ▶ The background of each poster is **plain colored**.

▶ Poster ID Rules

- ▶ Poster ID is embedded into colors of each component.



layouts of components



Example posters of R_1

Coloration rule scheme

The rule scheme using characteristics of the **poster coloration**

- ▶ The system uses constraints of **color histograms** of posters as design rules.

For example,

- Posters use only chromatic colors.
- Posters use a certain color as a main color.

Example rule set R_2

▶ Design Rules

- ▶ The poster is constructed by **two chromatic colors** (key color A and B) and some achromatic colors.

▶ Poster ID Rules

- ▶ Poster ID is embedded into **hue values of key color A and B.**



Example posters of R_2

Experiment

MR images are generated using the proposed method.

▶ Using R_1 and R_2 rule set

Experimental conditions

▶ Desktop PC

- ▶ CPU: Intel Core 2 Duo 1.86GHz
- ▶ Memory: 1.0GB

▶ IEEE camera, FLEA2 (PointGrey Research)

▶ Input image size: VGA (640*480)



video

Discussion

- ▶ Rule set
 - ▶ R_1 : simple algorithms, similar design posters
 - ▶ R_2 : more flexibility in designing
- ▶ Processing time and robustness
 - ▶ Proportional to **the number of detected quadrangles**
 - ▶ **Not** proportional to **the number of registered posters**



This method is especially efficient
when many SFINCS posters arranged.

Conclusion

- ▶ We propose a geometric registration method using visually unobtrusive flat posters as AR markers.
 - ▶ The design rules are used for detecting registered posters effectively.
 - ▶ Two kinds of rule schemes and two example rule sets are introduced.

- ▶ Future work
 - ▶ Improving algorithm of each step
 - ▶ Developing SFINCS poster toolkit