

A panorama-based technique for annotation overlay and its real-time implementation

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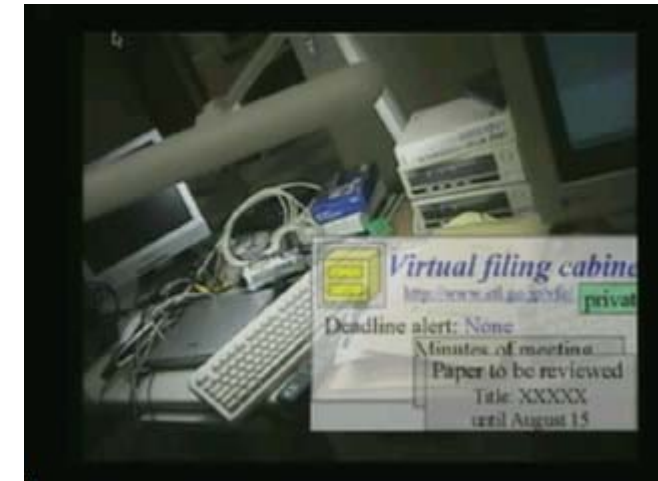
Research targets

- ◆ To realize annotation overlay on real-world objects on the user's view of the real-world.

Navigation

Virtual reminder

Wearable display
CCD camera



Actual outputs of our system

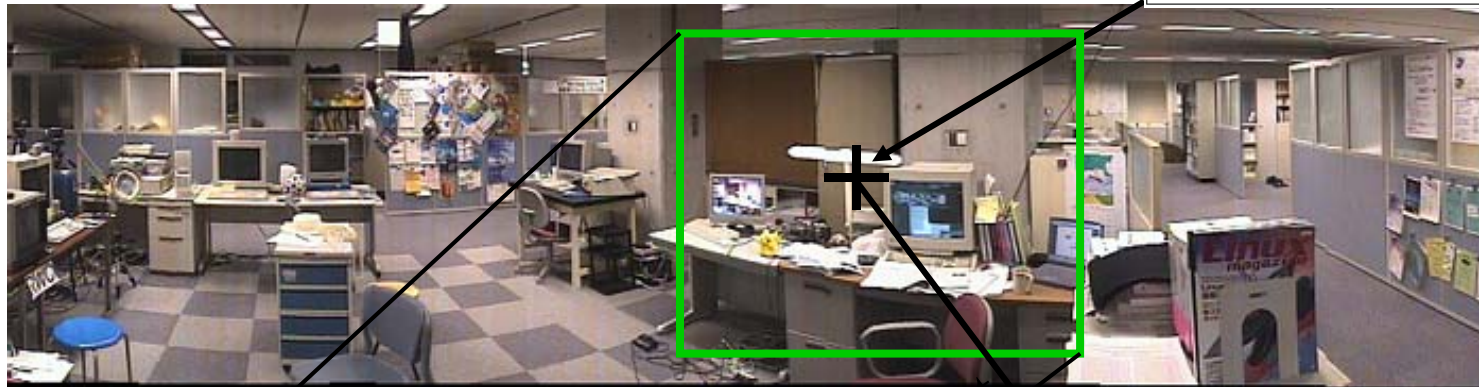
Previous works

- ◆ Artificial markers (fiducials)   
 - problems:
 - difficulty to apply large-scale applications
 - fiducials need to be captured closely
- ◆ Dedicated sensors such as gyro, GPS, IR beacon, etc.
 - problems:
 - applicable environments restricted
 - sensor precision limited

Our approach: panorama-based

- ◆ A **panoramic image** is used as a source of information about the position of annotation on video frames.

A referred panoramic image



From camera →



An input frame

Image alignment

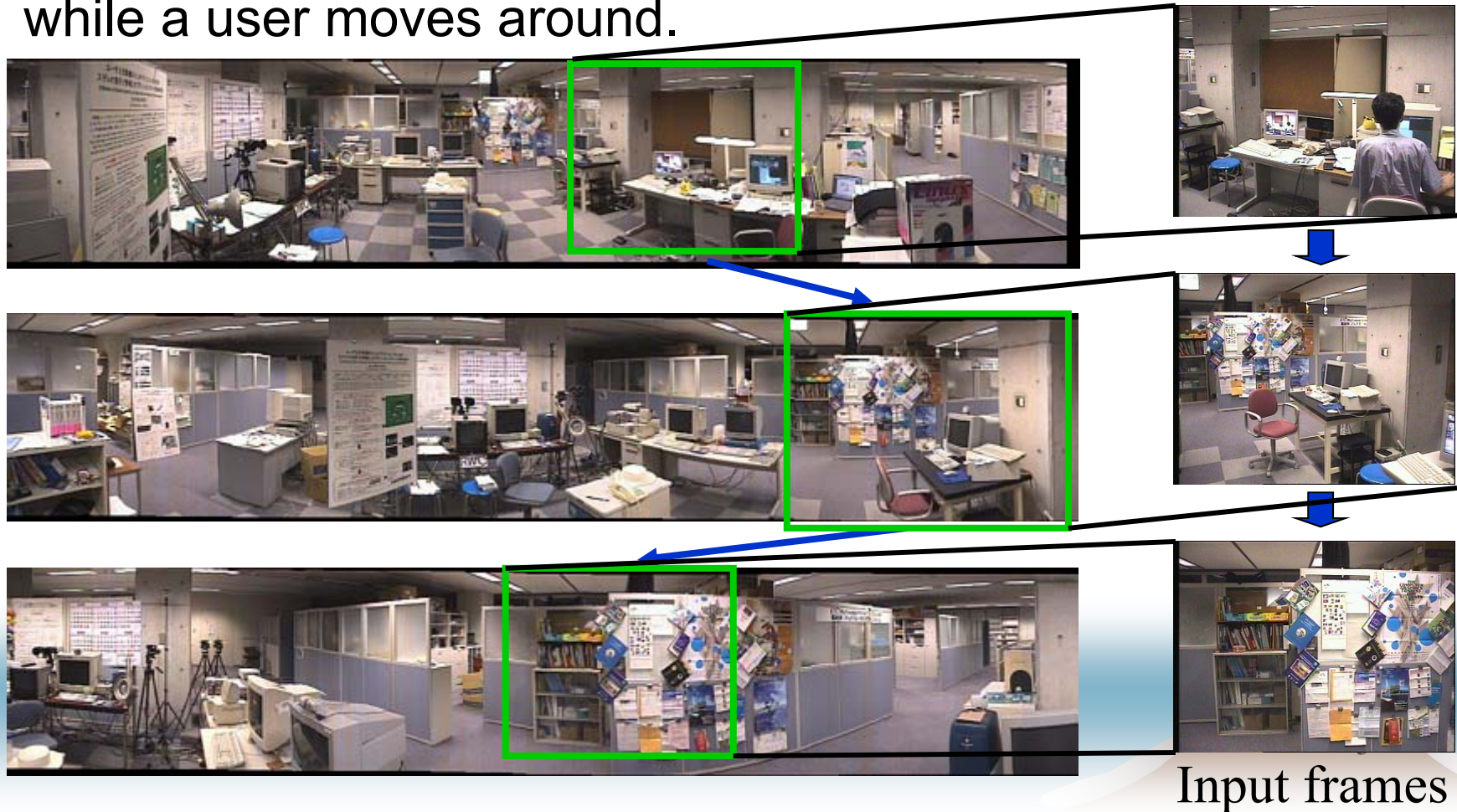


Annotated frame

→ To display

Our approach: a set of panoramas

- ◆ A set of panoramic images are used to cover a large-scale environment.
The referred panorama is appropriately switched while a user moves around.



Our approach: requirements

- ◆ Image alignment between a panorama and an input frame
- ◆ To search for the panorama that includes the input frame
- ◆ To switch the referred panorama if necessary

Image alignment

- Image alignment between the panorama and an input frame
 - a gradient-based motion estimation is used.

Since the gradient-based method requires **affine transform** the estimated parameters to be small.

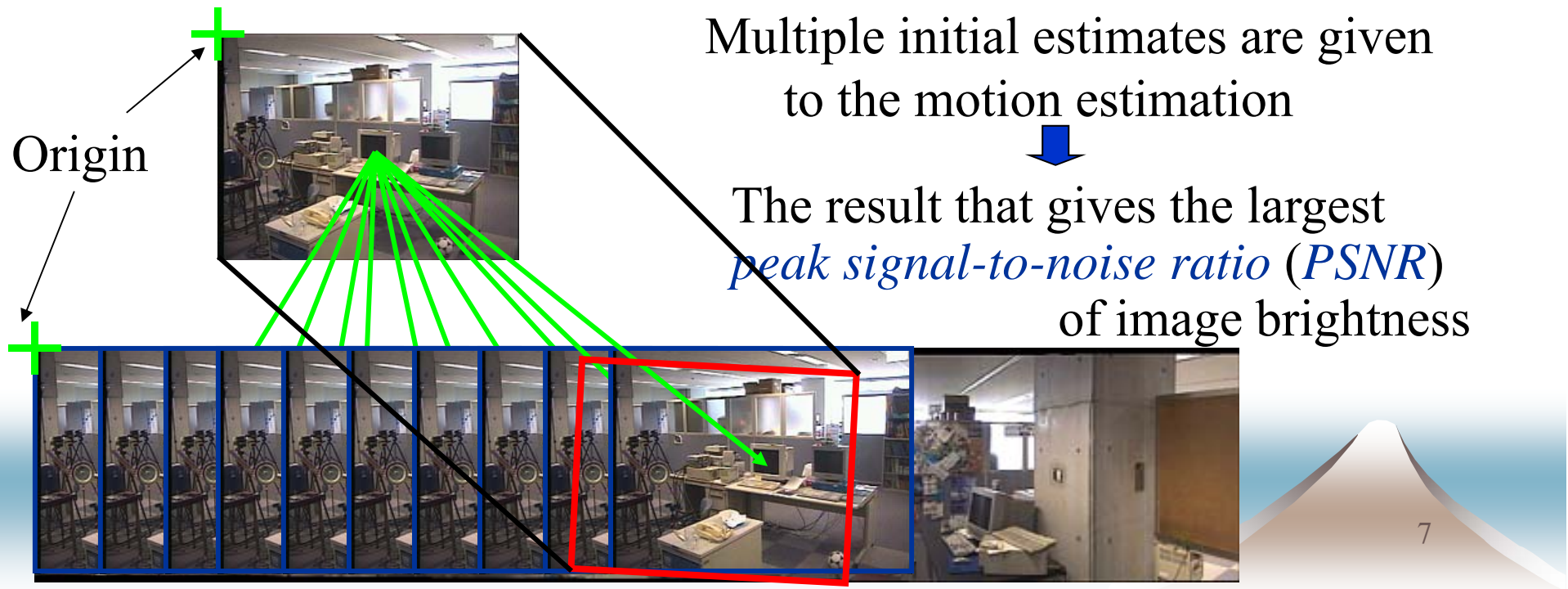
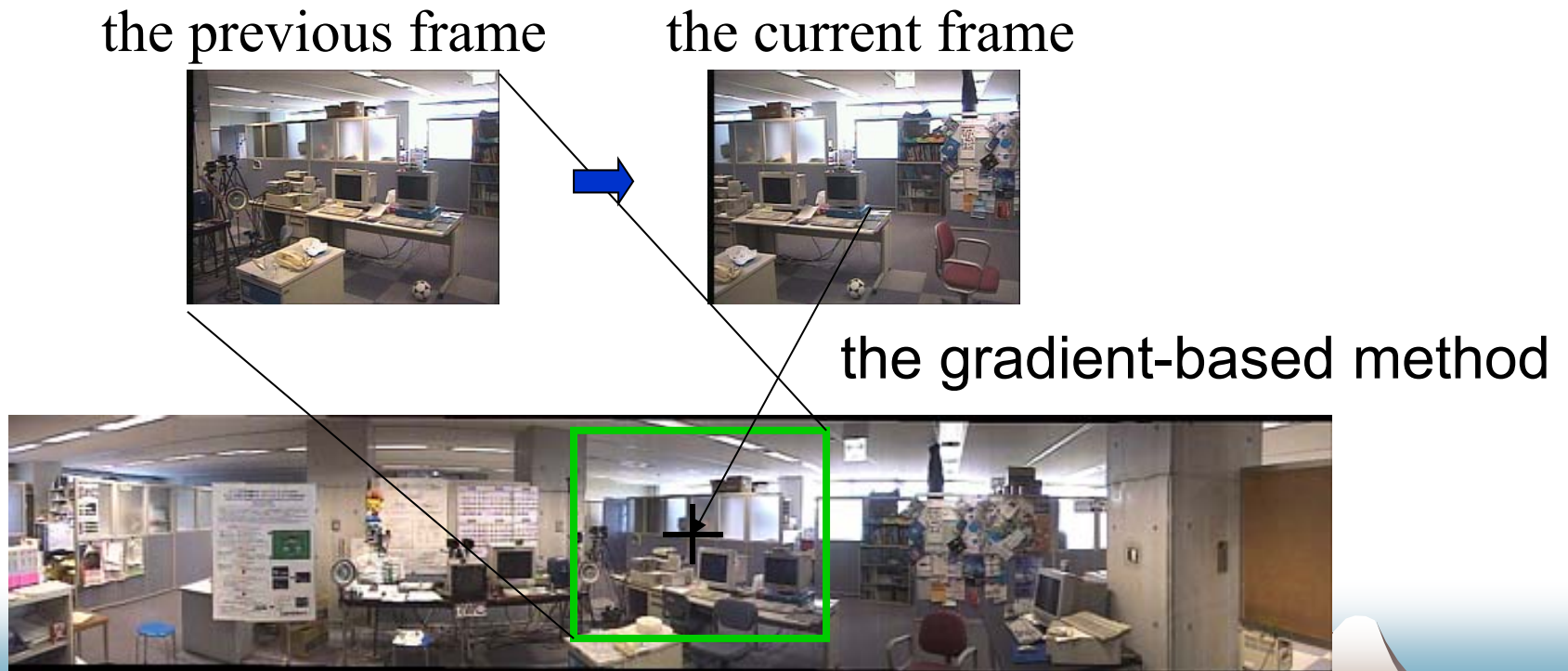


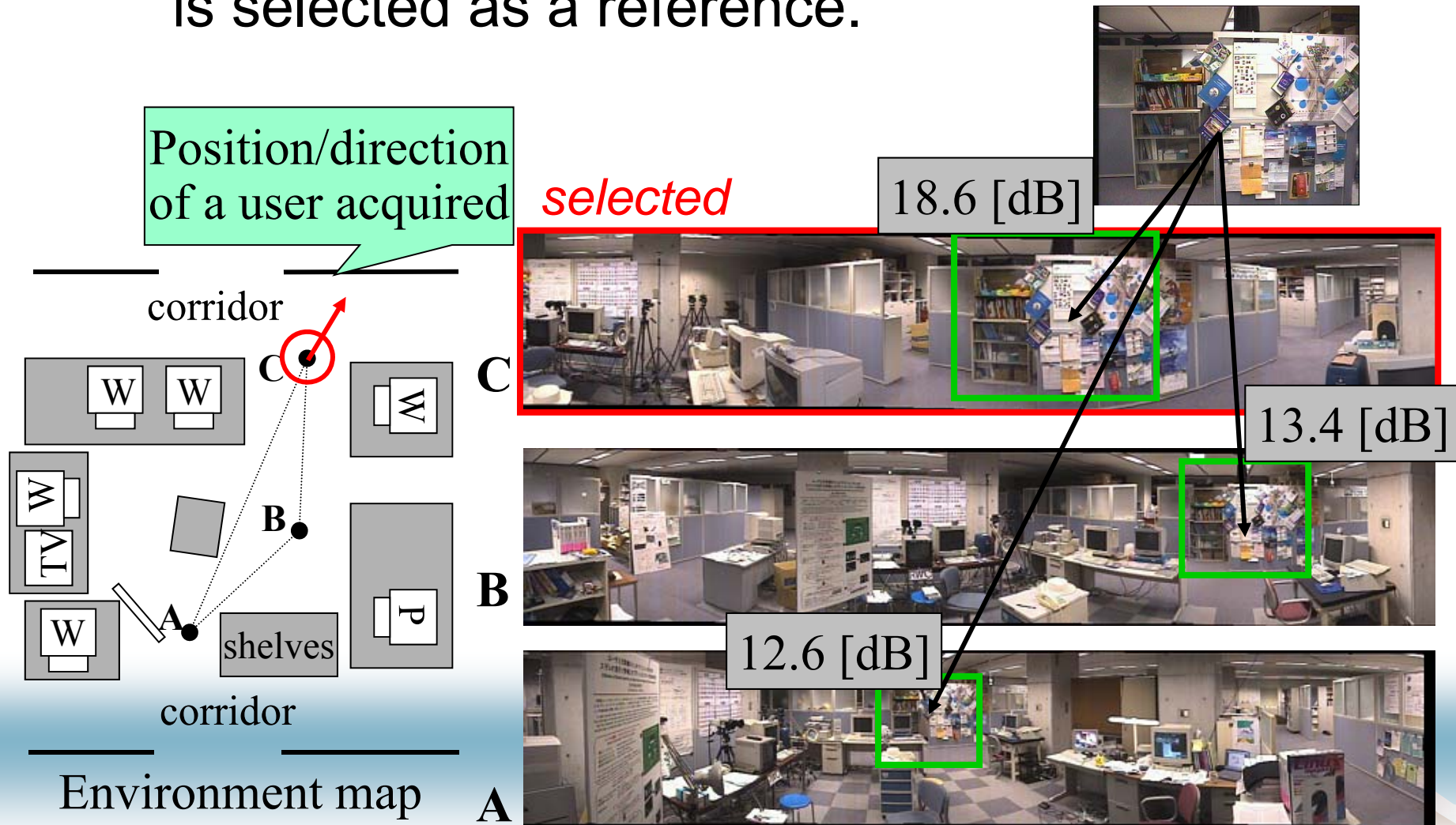
Image alignment

- ◆ The previous result of image alignment is used as the initial estimate.



Search for the referred panorama

- The panorama that gives the largest PSNR is selected as a reference.



Scale factor

- ◆ If PSNR value of image alignment is above a threshold, the scale factor will be considered.

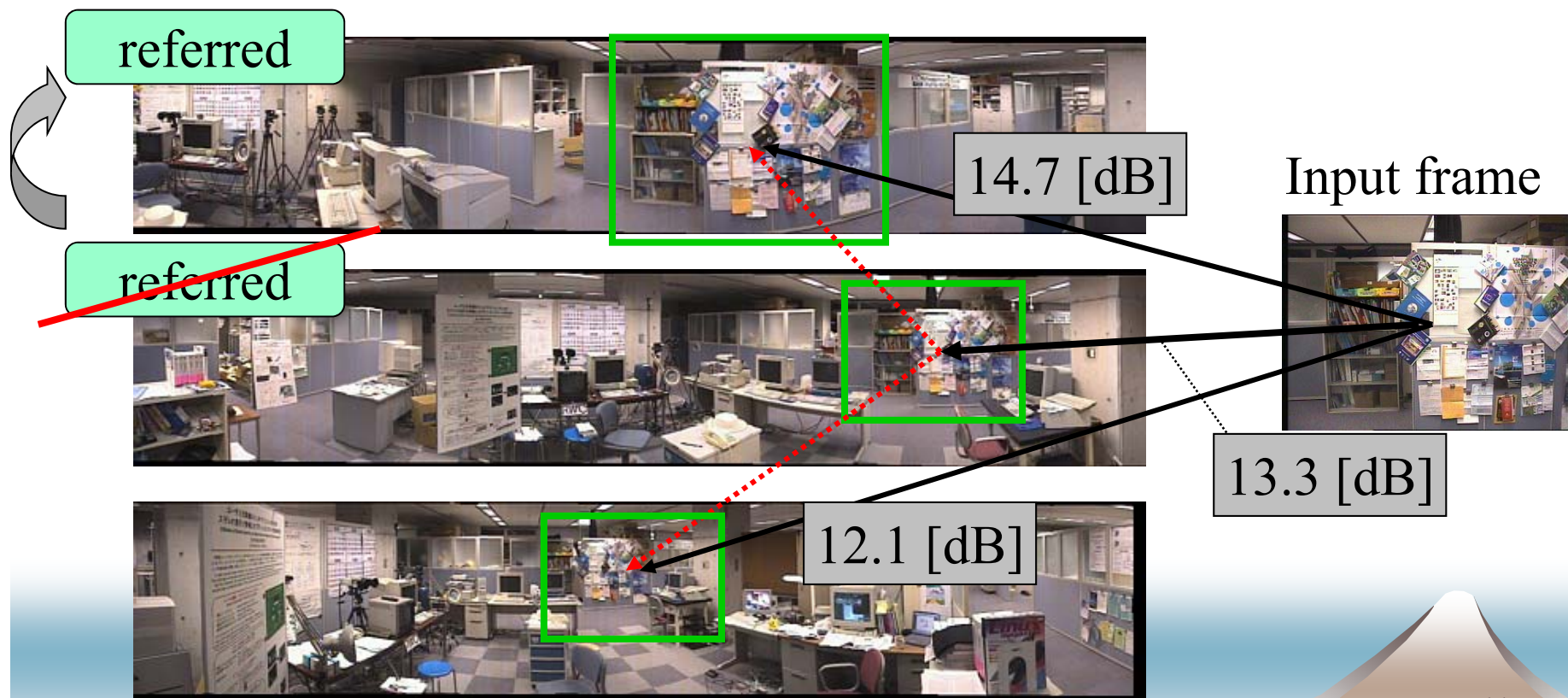
A set panoramic images



$$\mathbf{A} = \begin{bmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ 0 & 0 & 1 \end{bmatrix} \Rightarrow s = \sqrt{\det \mathbf{A}}$$

Switching the referred panorama

- ◆ The referred panorama is switched to the neighboring panorama if its PSNR is larger.



Neighborhood relationship

- ◆ Neighborhood relationship of panoramas
 - Two panoramas that share the same scene are regarded as being adjacent to each other.

Represented by three characteristics:

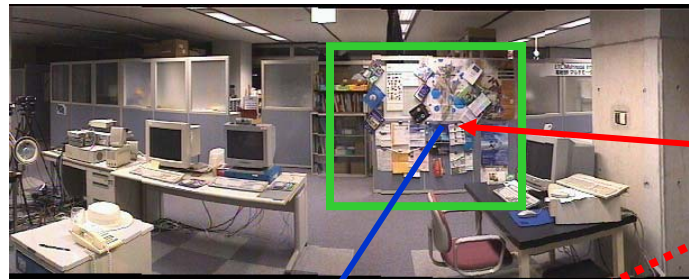
Region Adjacent to: Transformation parameters

R_k

I_{P_j}

$A_{R_k:P_i \rightarrow P_j}$

adjacent
 I_{P_i}
 I_{P_j}



Input frame I_f



Implementation

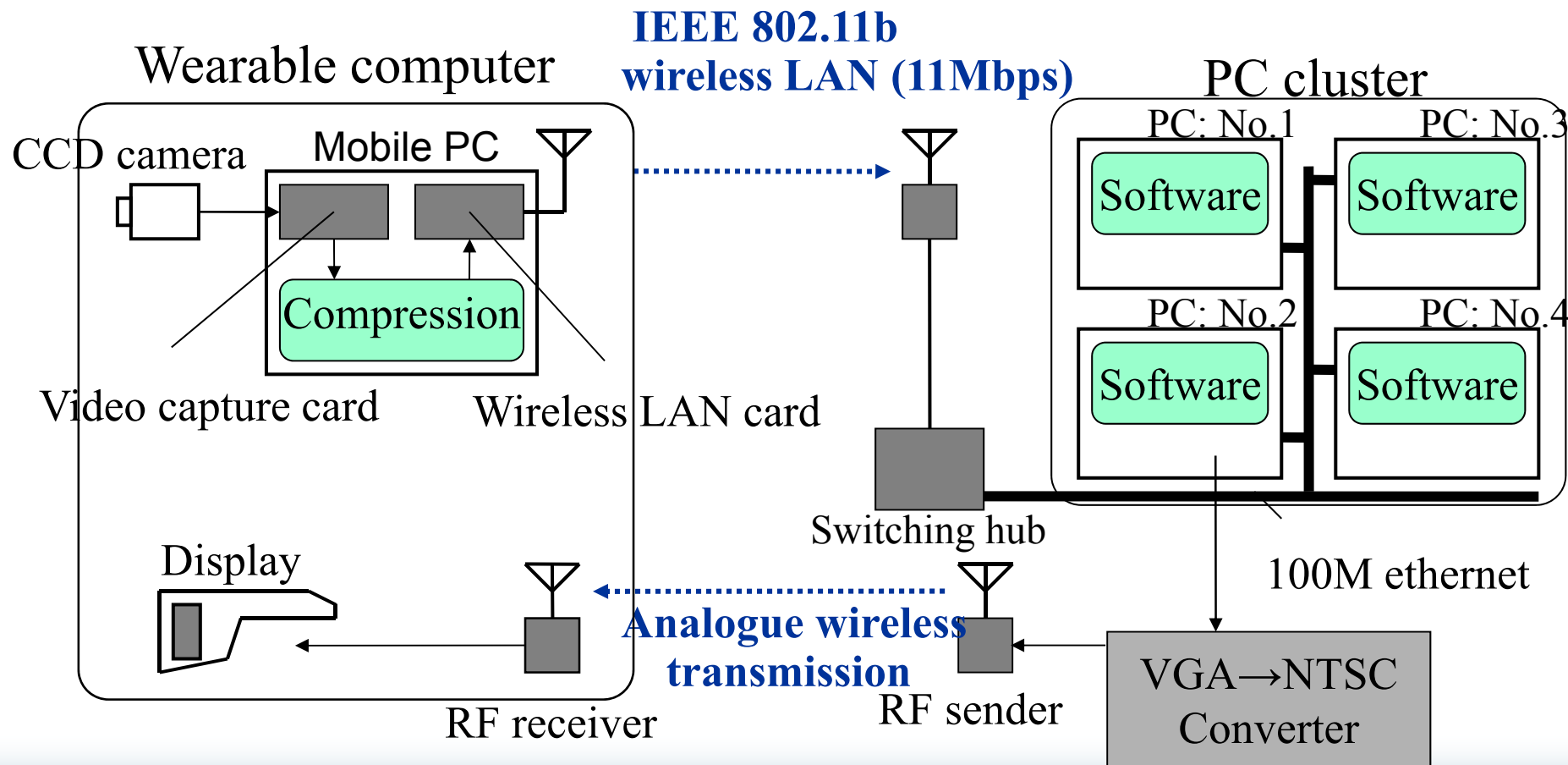
- ◆ The method is implemented as a software on our **Wearable Vision System**.
 - [PVM library](#) is used to achieve distributed computing
 - [POSIX thread](#) is used to exploit multi-processing.
 - PC cluster consisting of 5 conventional PCs
 - 2 PentiumIII-500MHz (Dual), 3 PentiumII-450MHz (Dual)
 - 5 PCs are connected by 100M ethernet.
- ◆ Input/Output device **input frame: 320x240 24-bit color**
 - Small color CCD camera (Toshiba IK-SM43H, f=4mm)
 - Head-worn display (MicroOptical Clip-on Display)

CCD camera



Head-worn display

Implementation



Results



Online-output video frames overlaid with annotations

Summary

- ◆ A panorama-based method of annotation overlay is proposed, implemented and evaluated.
 - The proposed panorama-base method for annotation overlay worked properly.
 - Its software implementation achieved near real-time processing.