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National Institute of Advanced Industrial Science and Technology
AIST

A benchmark data generation tool using walking simulation and virtualized reality models for evaluating AR visual tracking

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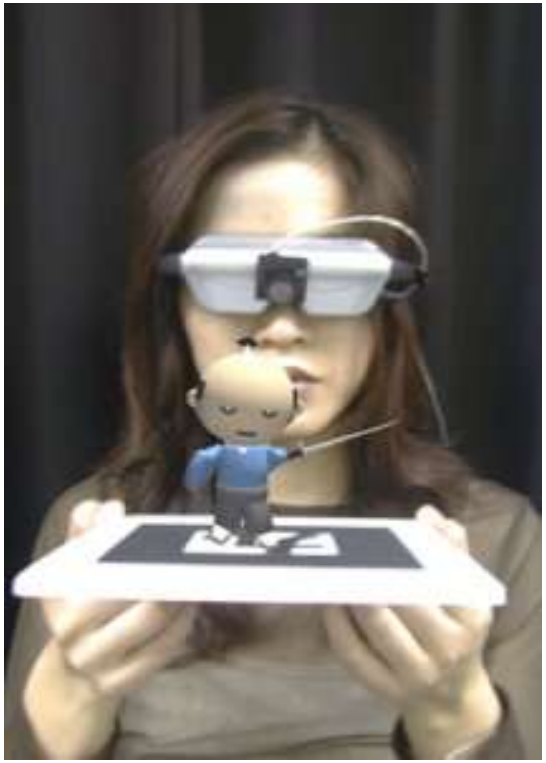
KJMR2012
(April 13-15, 2012)

Camera parameter estimation for AR/MR



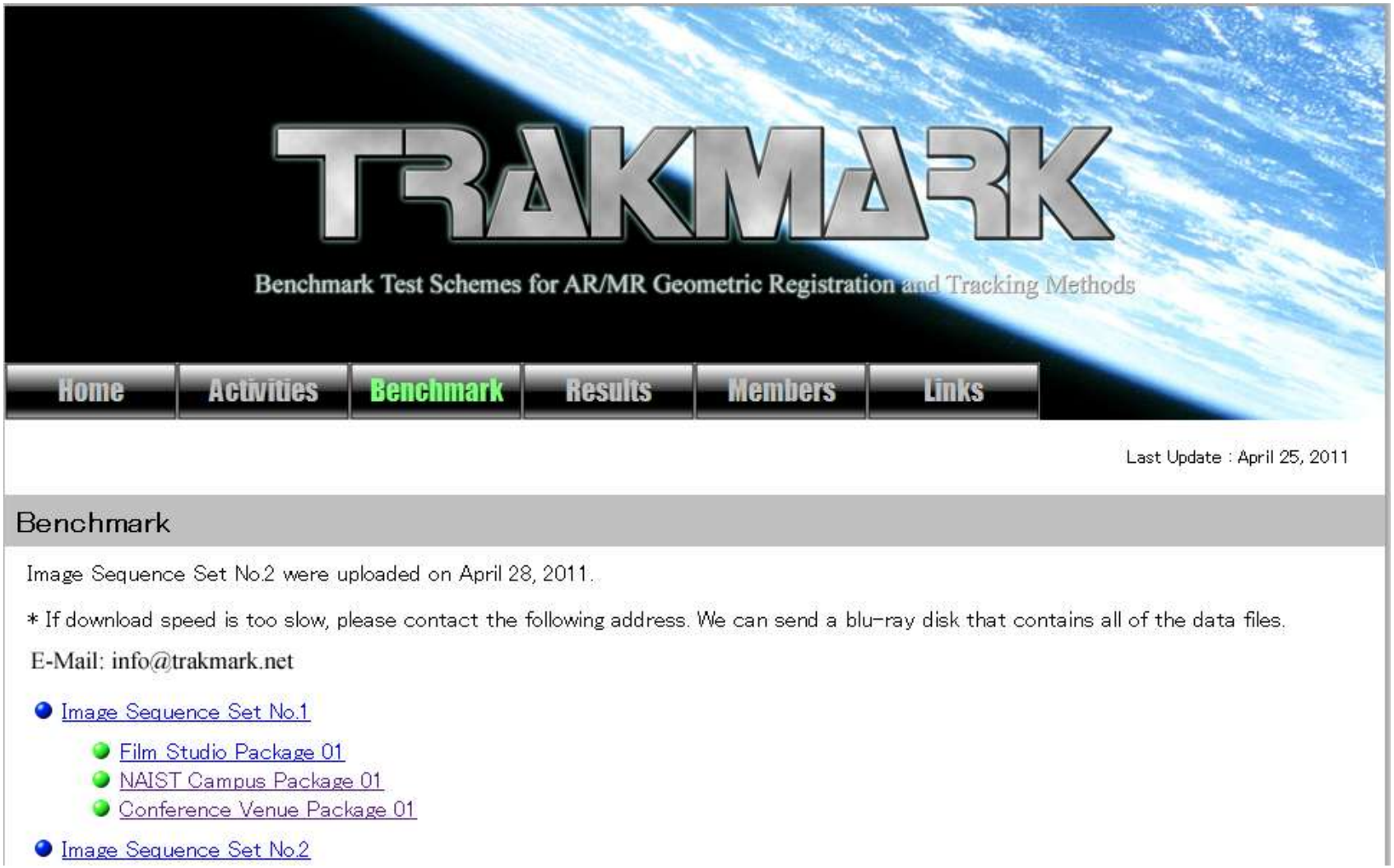
ARToolKit
(Kato, et al, IWAR99)

DTAM(*)
(R. A. Newcombe, et al, ICCV2011)

Ground truth data of camera parameters and feature points are needed for benchmarking.

TrakMark~

Benchmark Test Schemes for AR/MR Geometric Registration and Tracking Methods



TrakMark~

Benchmark Test Schemes for AR/MR Geometric Registration and Tracking Methods

Film Studio Package

NAIST Campus Package

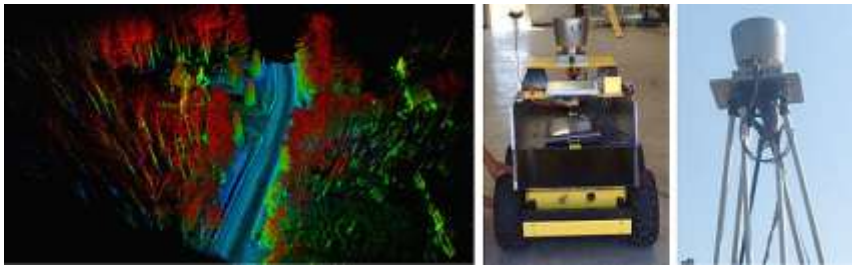
Conference Venue Package

Generation of ground truth

- For benchmarking･･･
  - Ground truth is needed.
    - Robot arms for obtaining extrinsic camera parameters

KR 5 SIXX R650
（KUKA）

    - Range sensors for obtaining 3D positions of feature points



Omnidirectional
range sensor: LiDAR
(Velodyne)

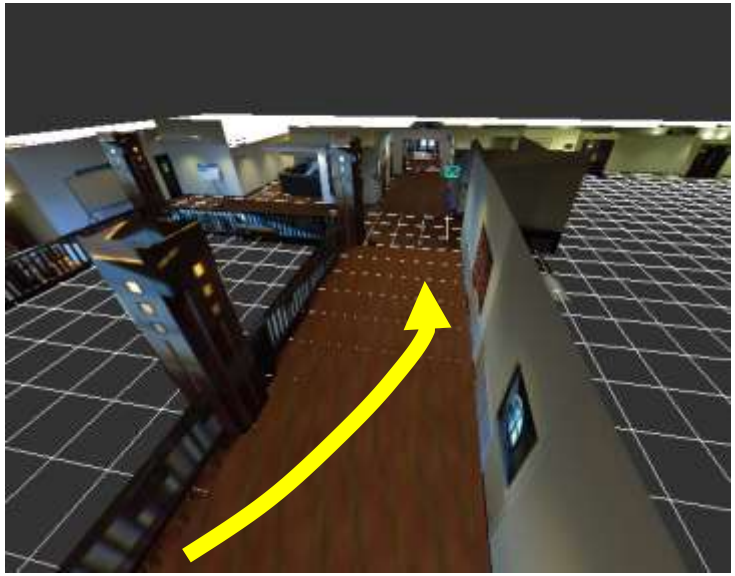
Making ground truth data is costly in real environment.

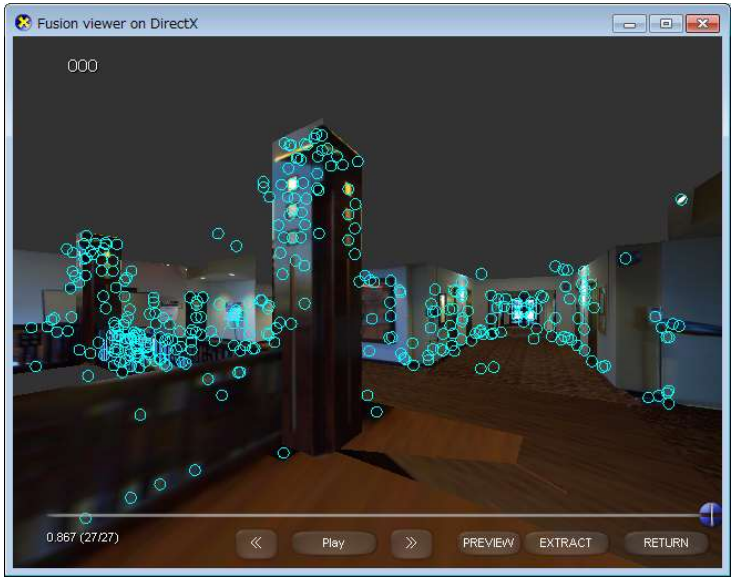
Our goal

Developing a tool to generate data sets for benchmark using virtualized reality models

Merits of using virtualized reality models

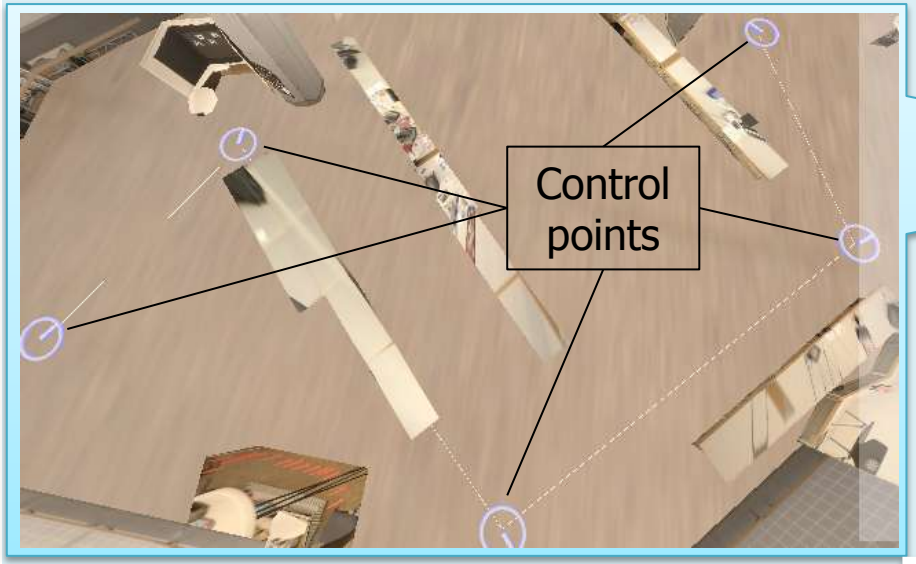
- ✔Making ground truth data
- ✔Any camera path and any feature points

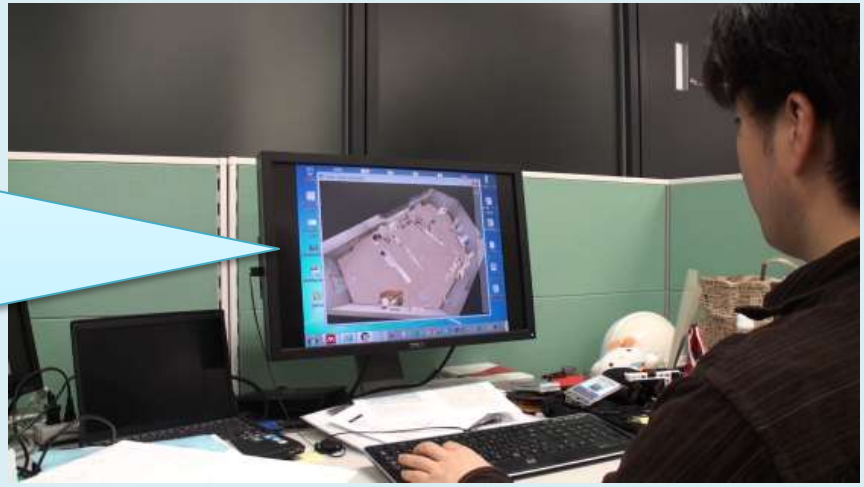




Outline of the tool

Interface to generate camera parameters

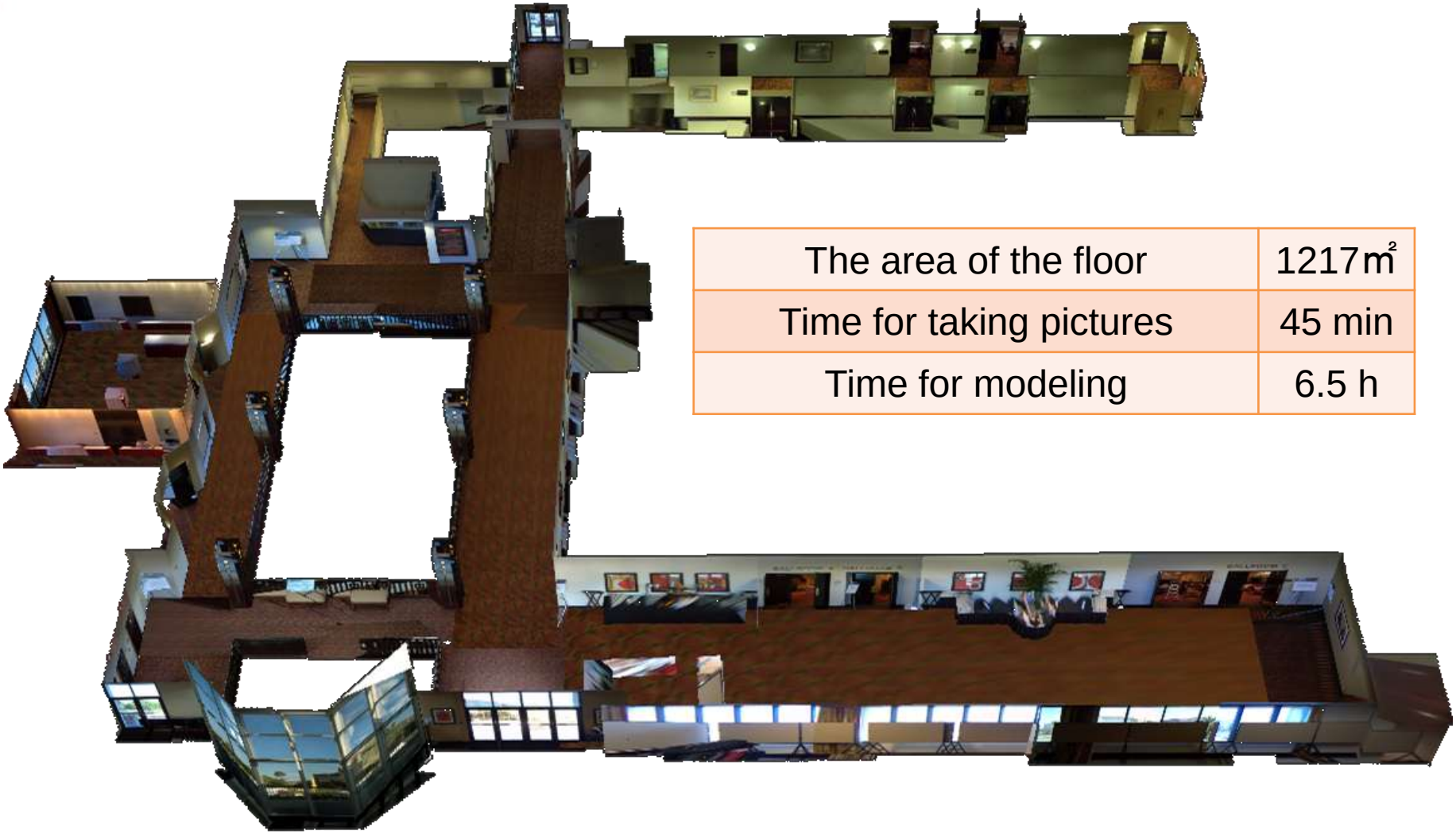




The user sets control points with mouse clicks.

Generated images

A sample of virtualized reality model

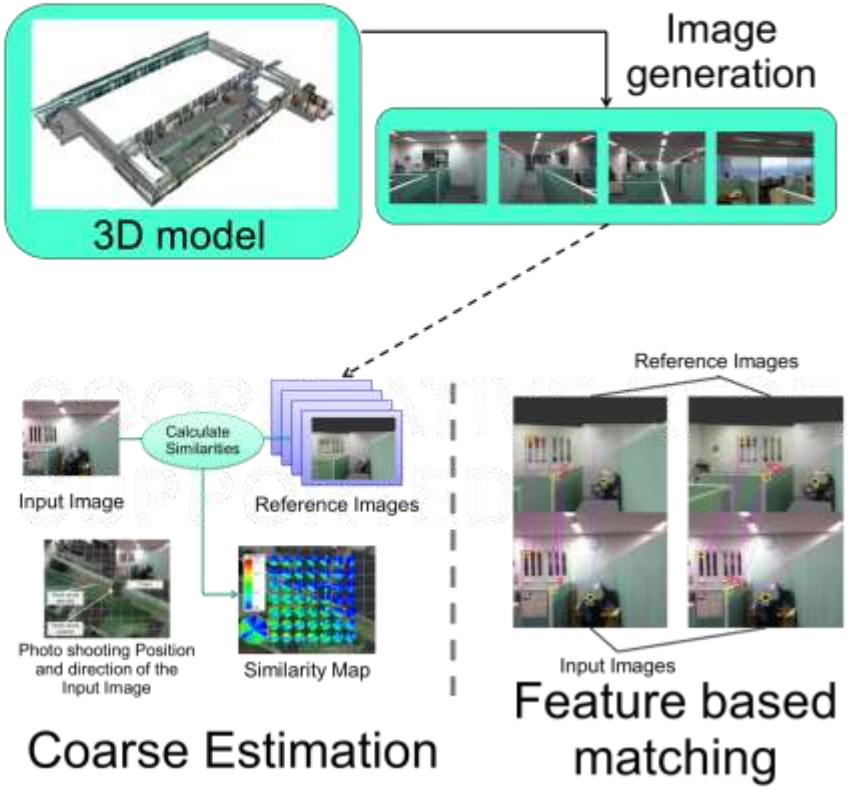


The area of the floor	1217㎡
Time for taking pictures	45 min
Time for modeling	6.5 h

The Venue of ISMAR2009

Model-utilization for related applications

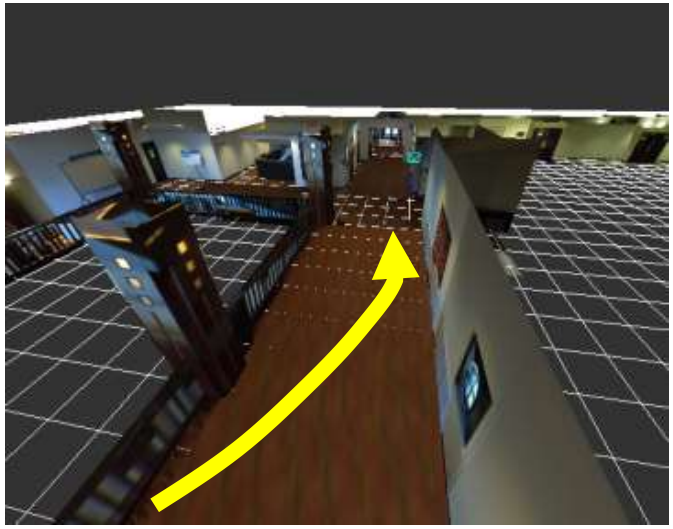
- 3D model for image based tracking



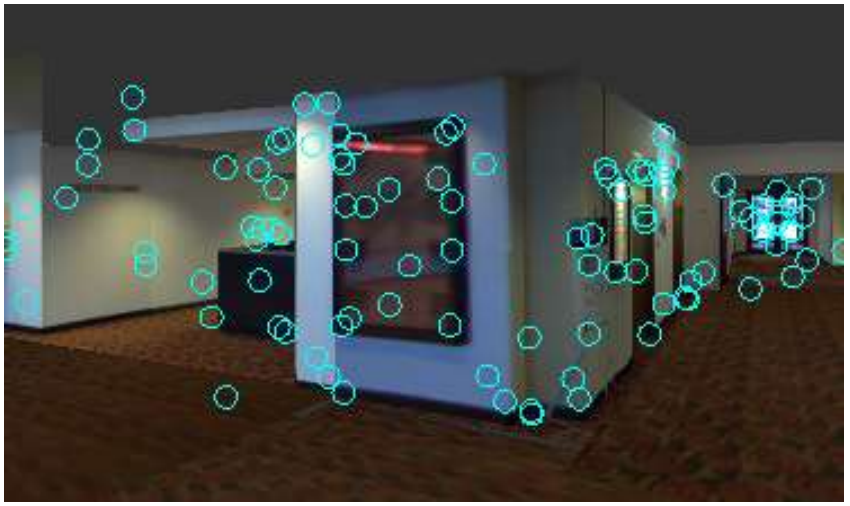
- 3D model for map matching

- 3D model for Augmented Virtuality

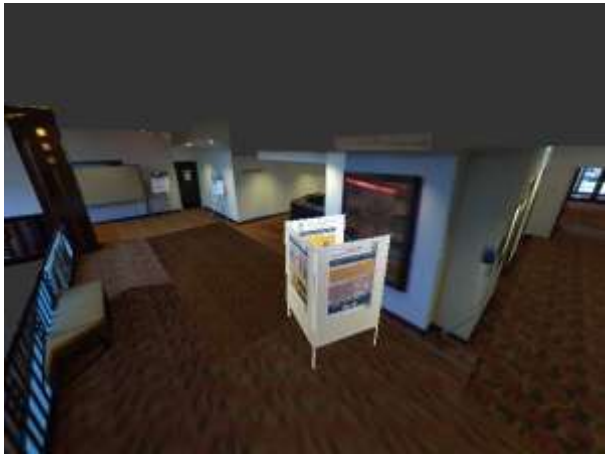
Functions of the tool

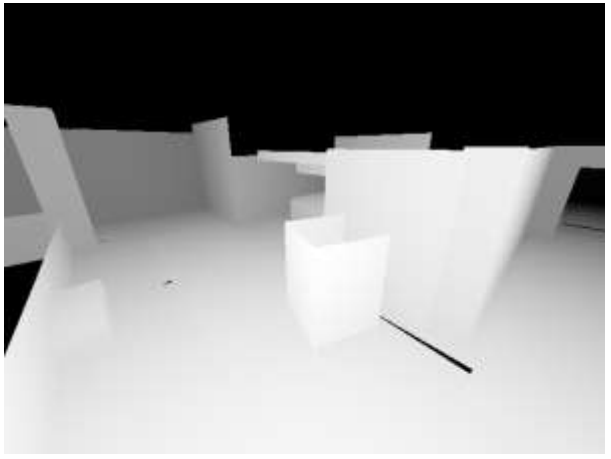


Camera parameters generation with human walking motion



Interest points generation





Output of depth data

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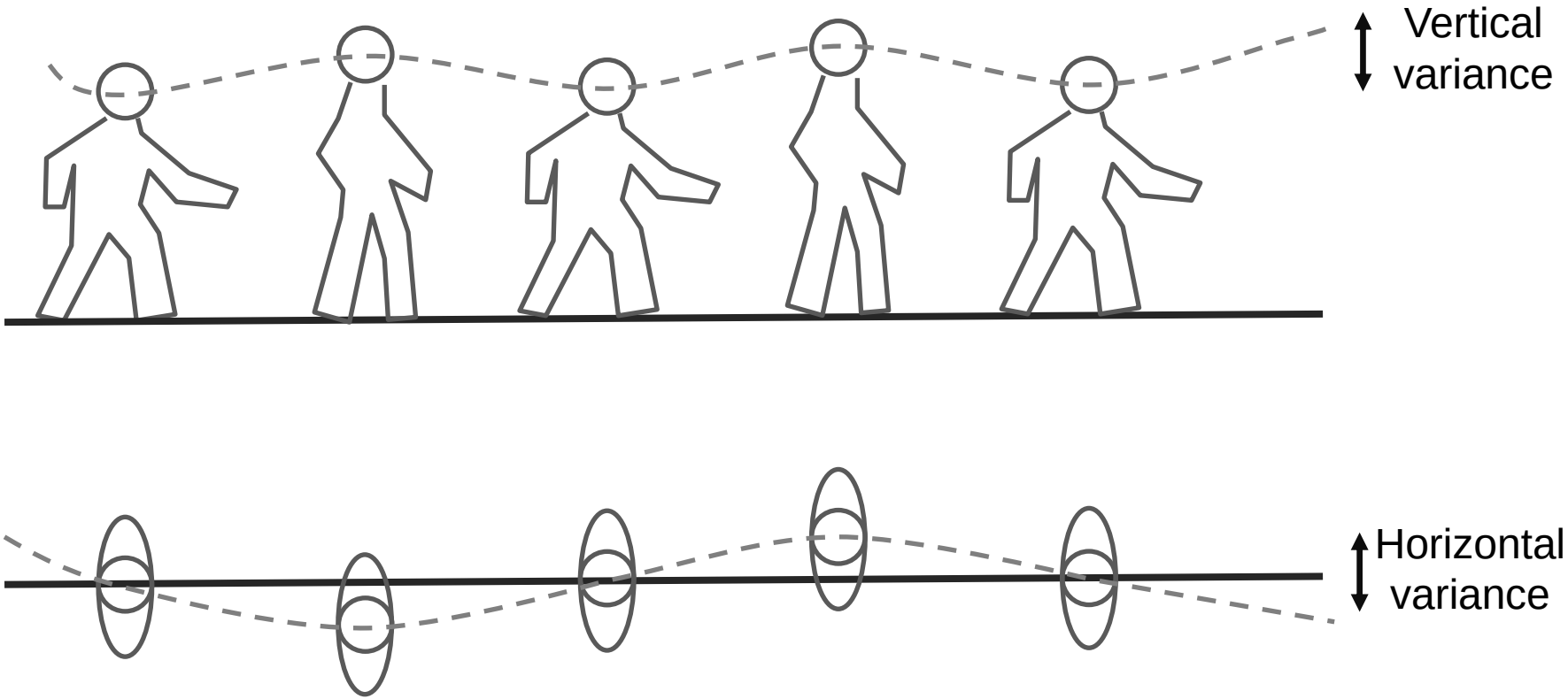
Camera parameters generation with human walking motion

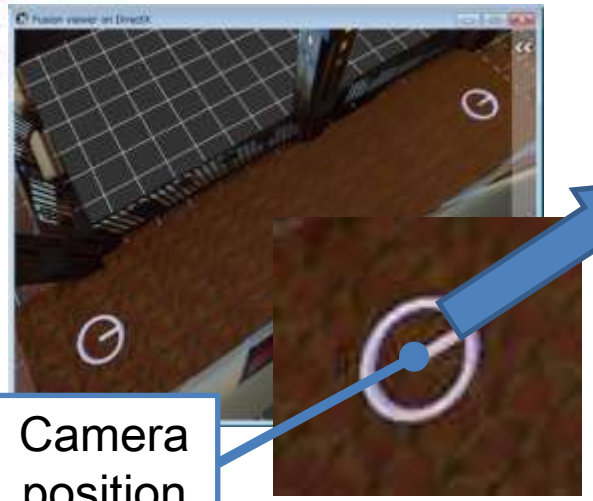
Head and hand movements with human walking

Parameters for setting camera effects

The user sets vertical and horizontal variances.



Example of a sequence



Parameter settings

- Basic height 1600 [mm]
- Vertical variance 50 [mm]
- Horizontal variance 80 [mm]
- Walking step length 650 [mm]
- Walking speed 900 [mm]

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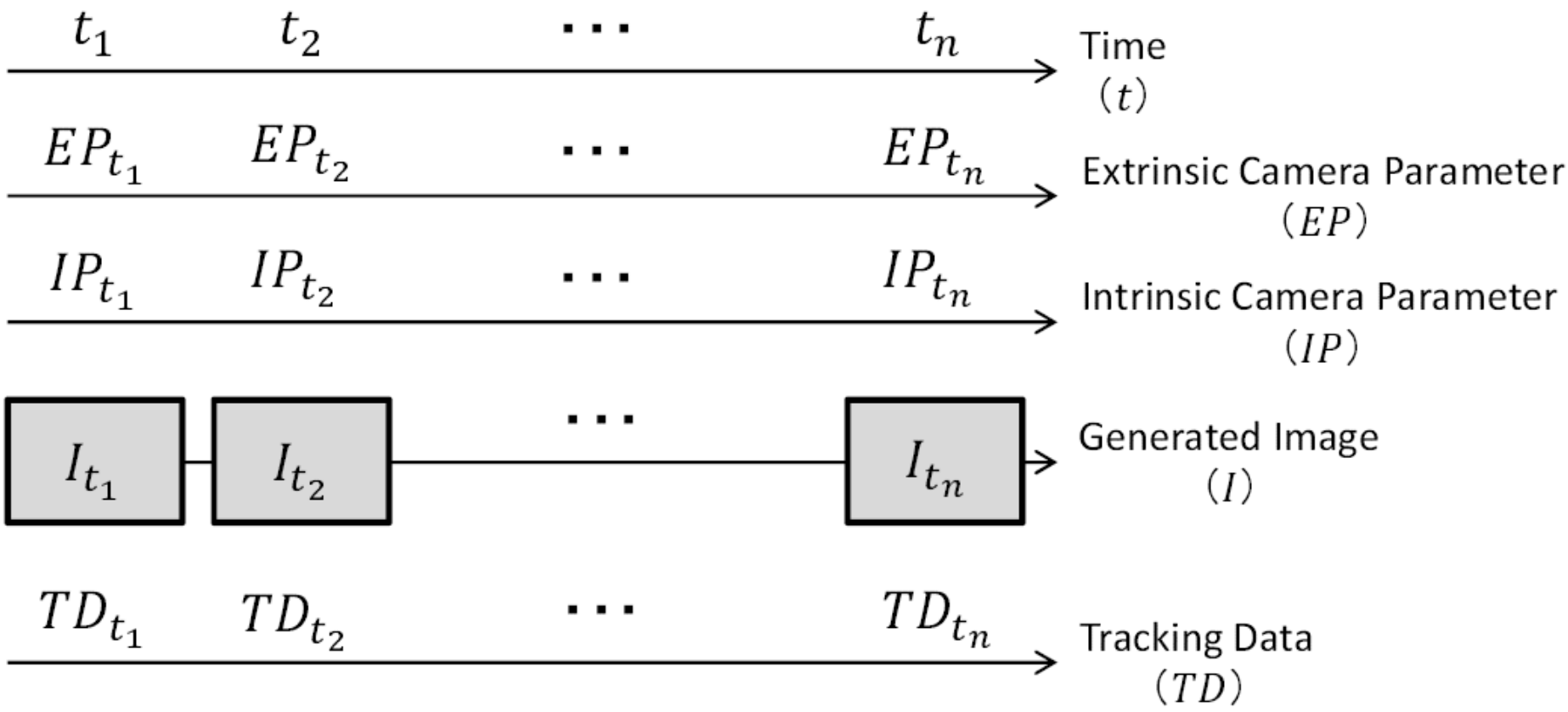
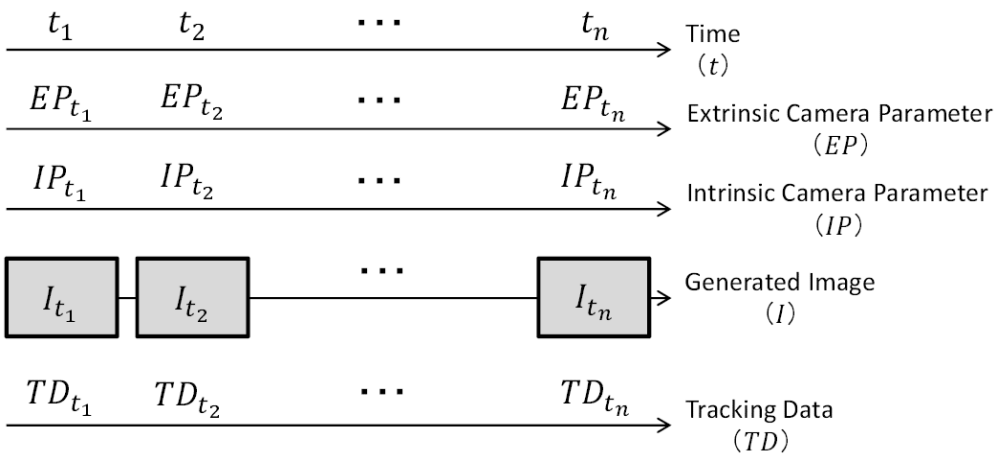
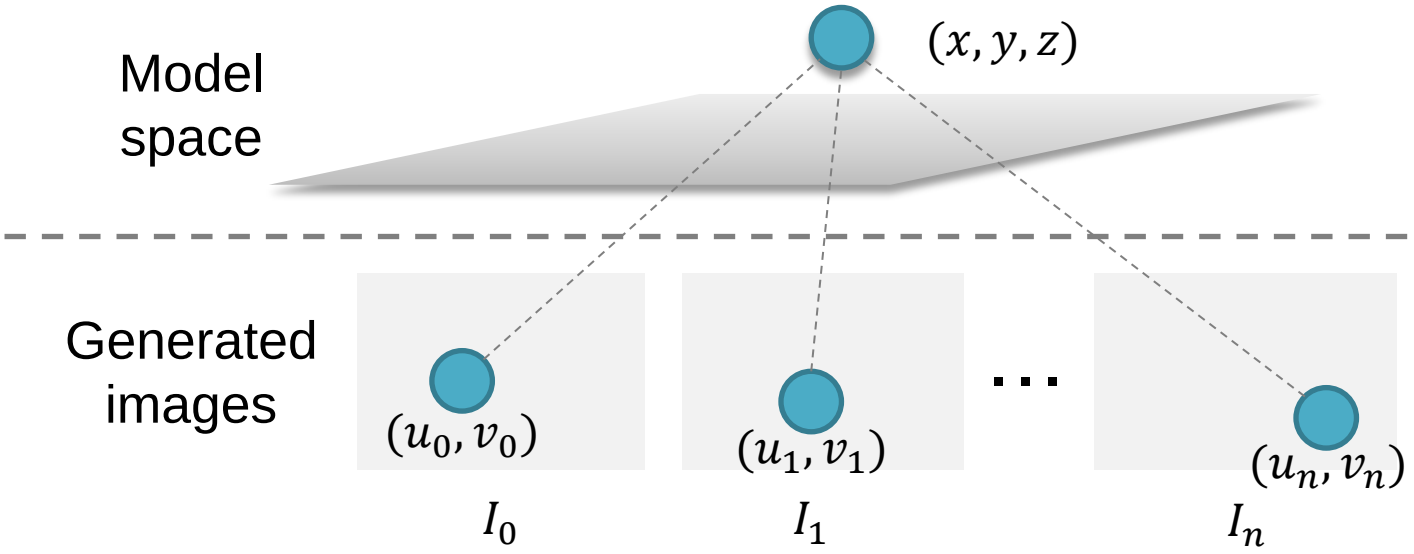
Interest points generation

Outline of the data sets



Outline of the data sets





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Example of interest points

Comparative result of interest points generation

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Applications

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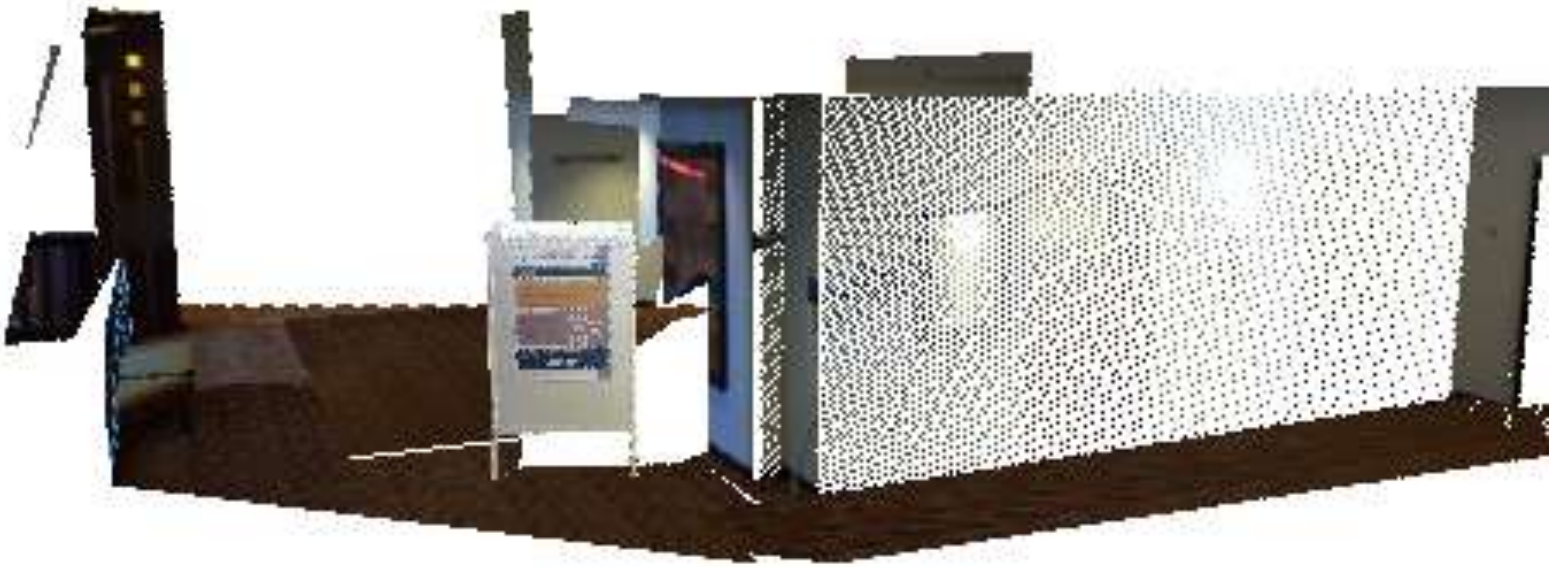
Simulations of 3D reconstructions



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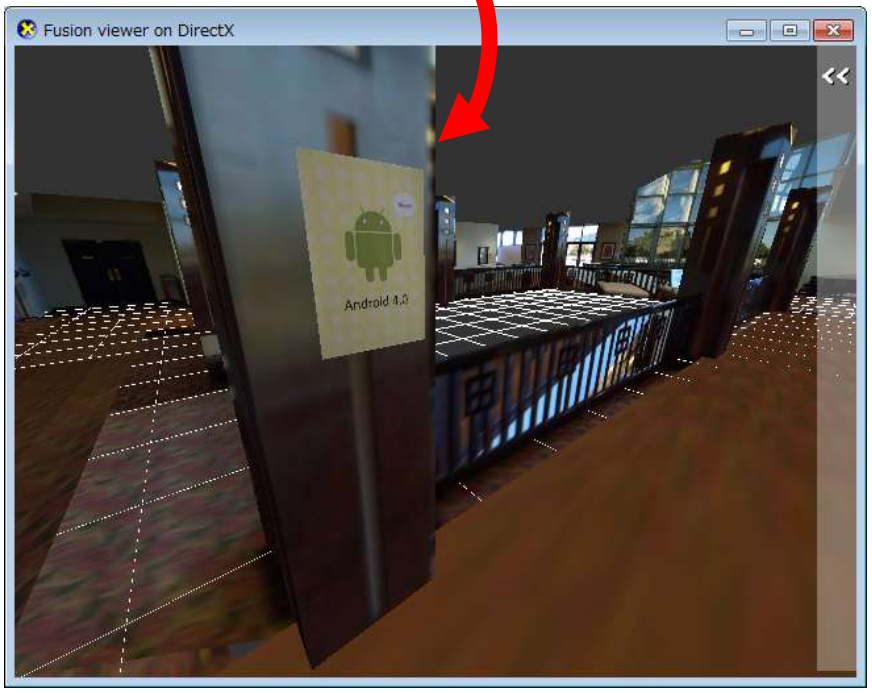
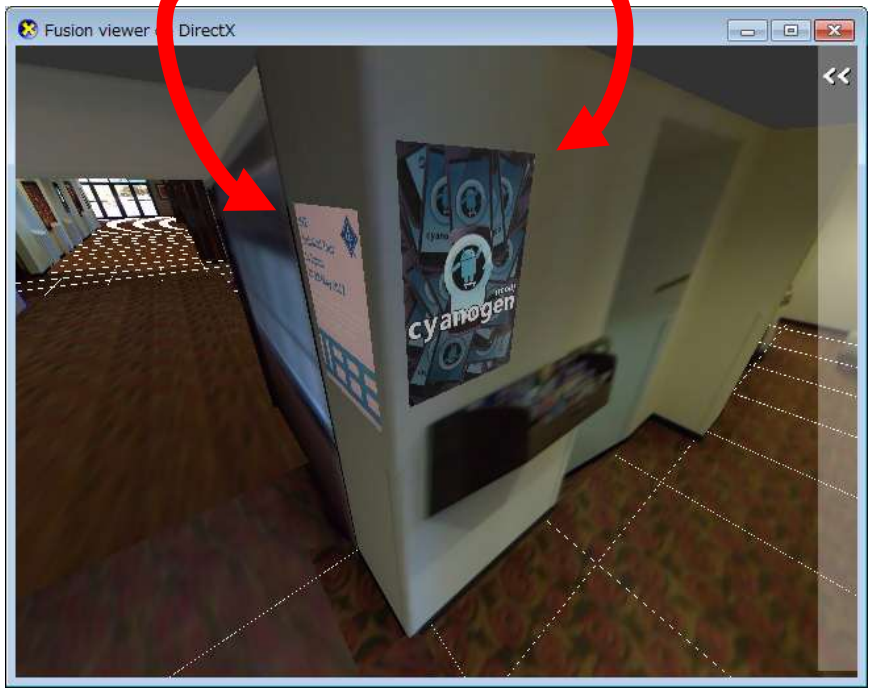
Generating data sets with additional contents





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Released contents in TrakMark

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Released contents ~ ISMAR2009

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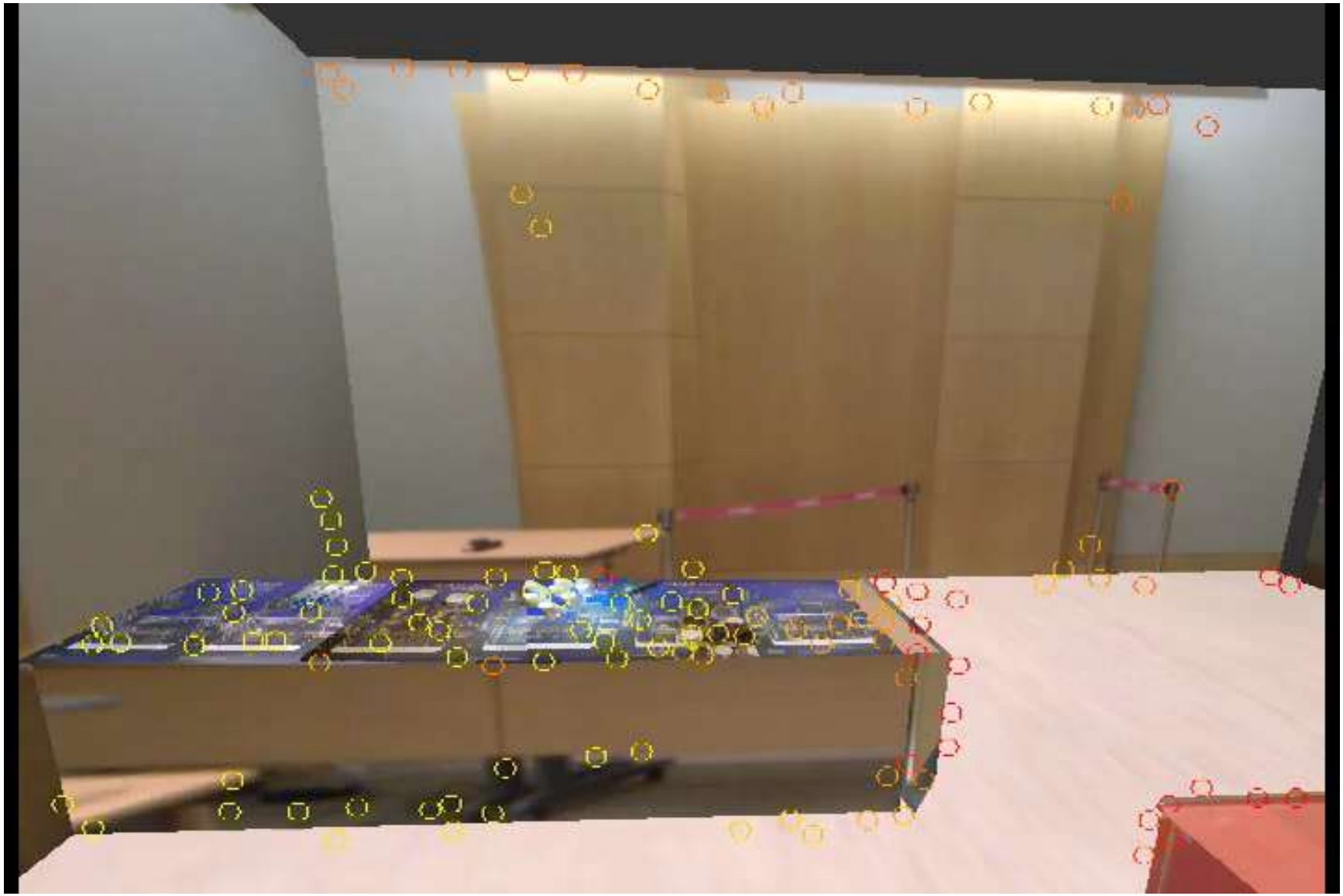
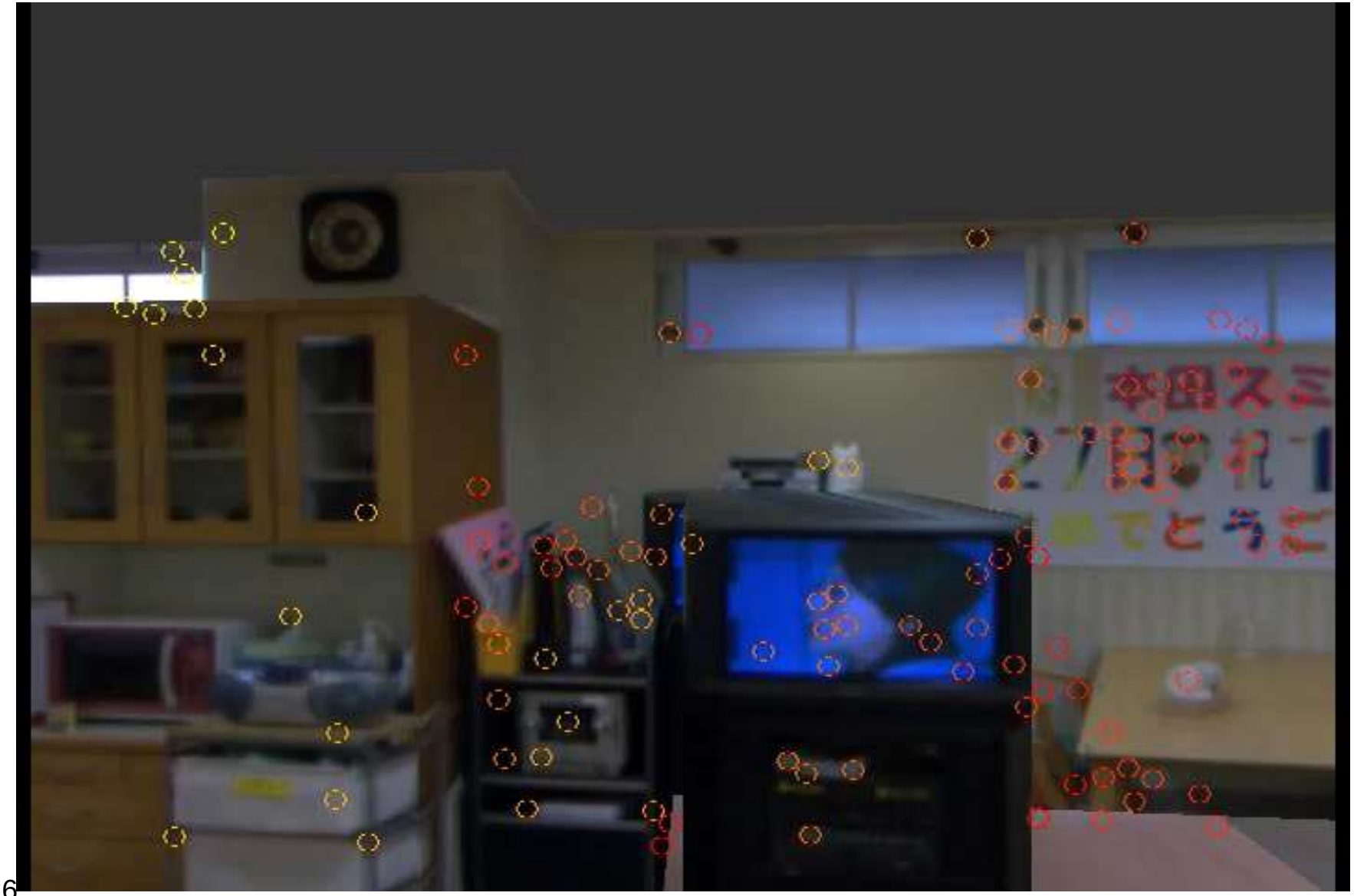
Released contents ~ ISMAR2010



Released contents ~ Nursing home



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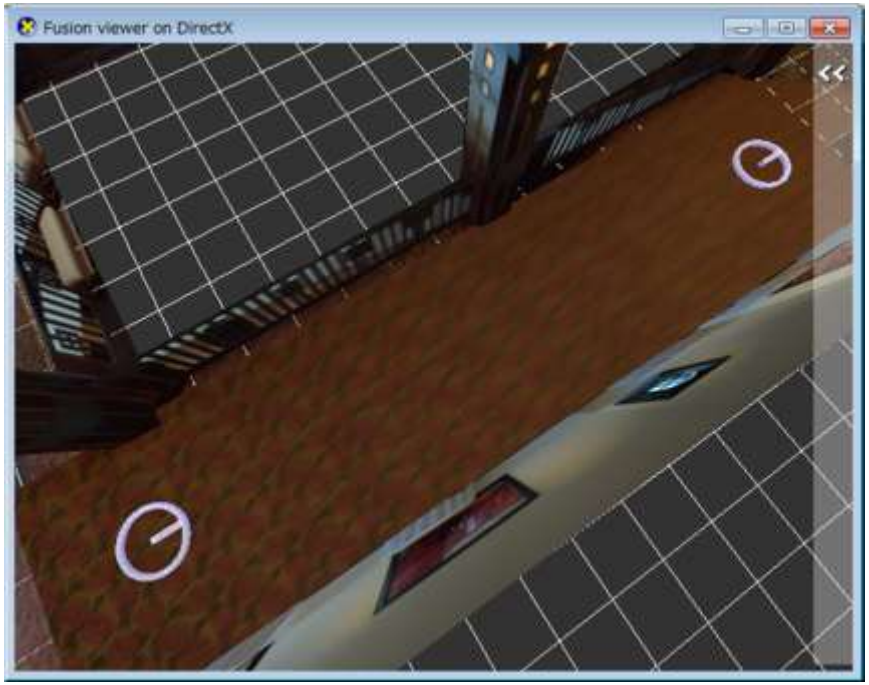
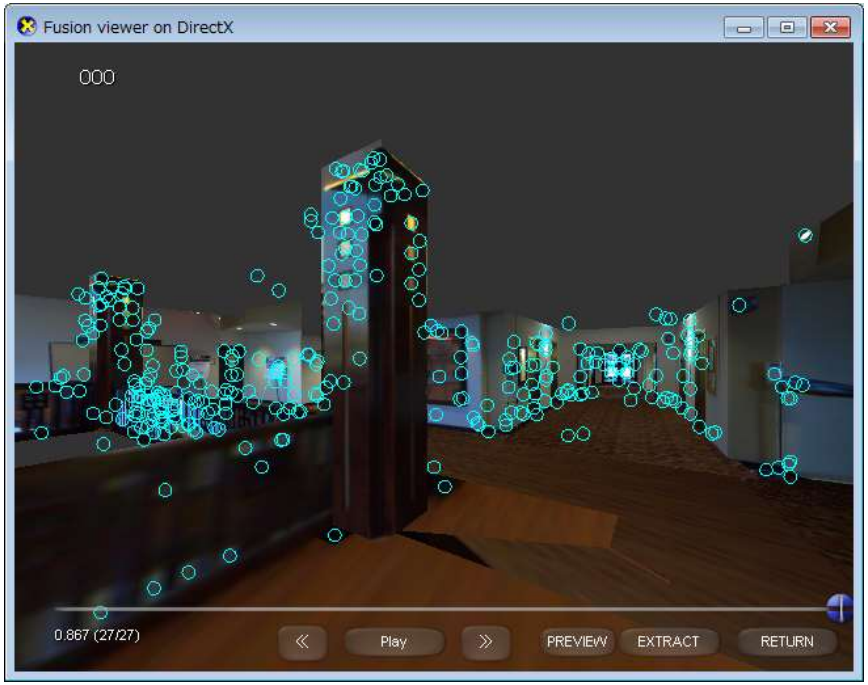
Released contents ~ Japanese restaurant

Conclusion

The tool for generating benchmark data sets

- Using virtualized reality models
- Generating camera parameters with human walking motion
- Manual and automatic interest points generation
- Output of depth data





Future works

- Additional functions of the tool
  - Motion sensors' data for camera parameter generation
  - Introducing camera effects
    - Blurring, Defocus, Specular, …
  - Additional object in model environment
    - Markers for visual tracking
    - Occluders (walking person, …)

Future works

- How to distribute the data sets
  - Which format is better for 3D models?
  - How to distribute the tool ?
    - Good data sets generated by the tool are to be added in TrakMark data sets
    - Provisions of parameter sets (for example, camera parameters) are acceptable for the tool
    - Too many versions of the tool / data sets are to be prevented …

Acknowledgements

The authors thank Hiroyoshi Tsuru from the University of Tsukuba and Shiori Suetsugu from Ritsumeikan University for their experiments using our data sets.

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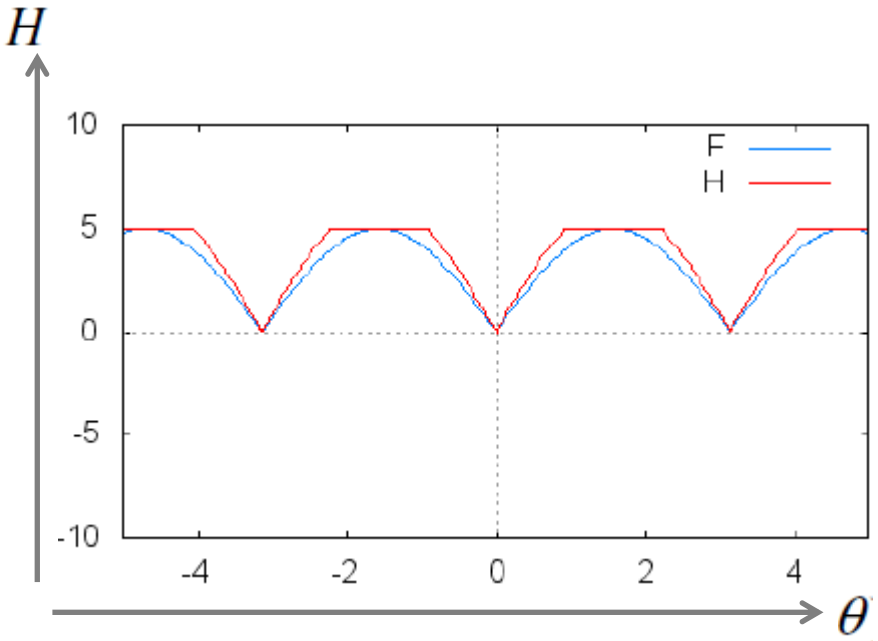
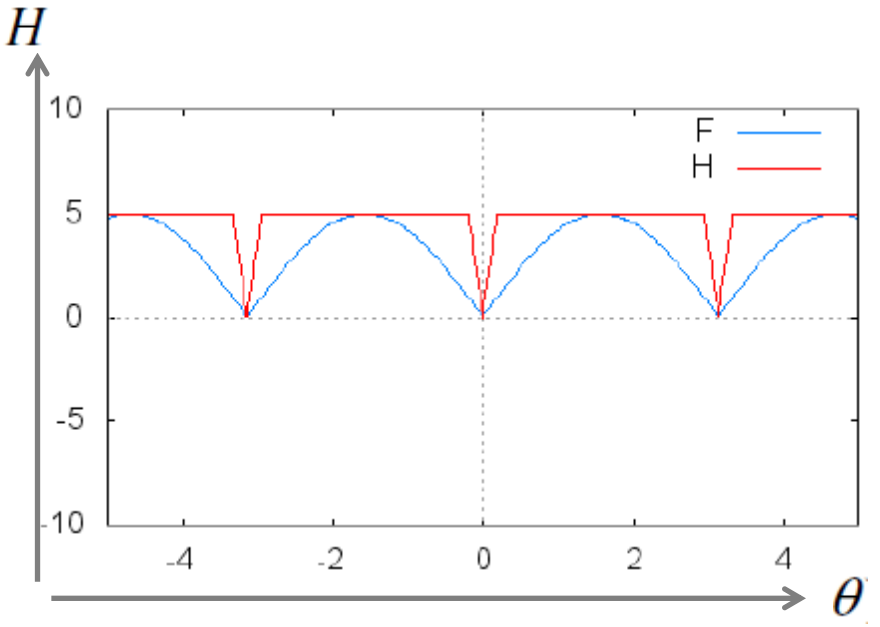
Appendix :
a formula for calculating vertical translation of a camera

$$H(H) = \begin{cases} \dfrac{h(\theta)}{1-\alpha} & h(\theta) < (1-\alpha)A \\ A & h(\theta) \geq (1-\alpha)A \end{cases}$$

$$h(\theta) \equiv A\left|\sin\theta\right|$$



α = 0.2



α = 0.8