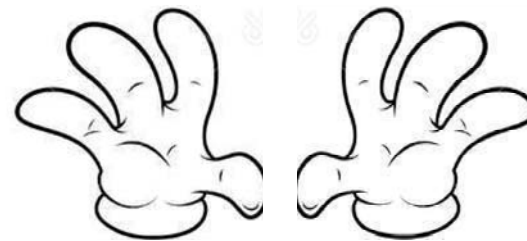
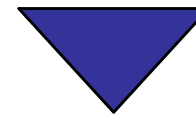
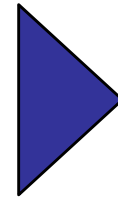


# Selecting Home Appliances with Smart Glass based on Contextual Information

Ubicomp 2016

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# Introduction- Control home appliances



Free your hands

And



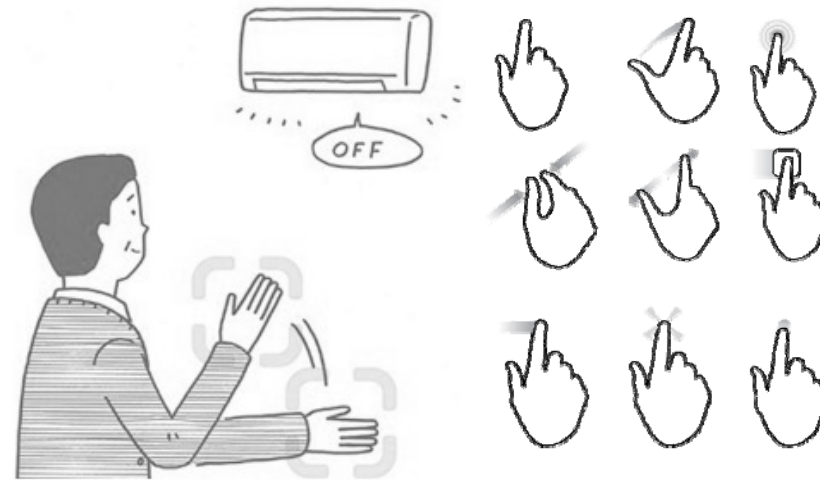
In more direct way

# Approaches for Home Appliances Control

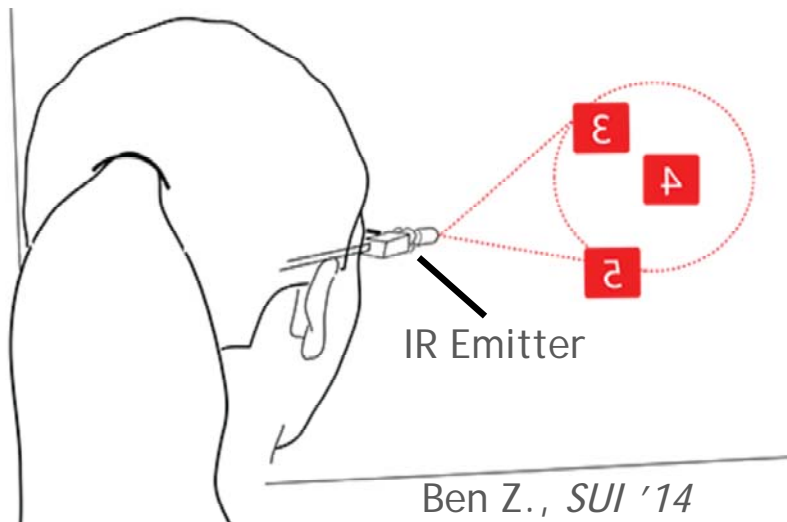
Voice



Gesture



IR



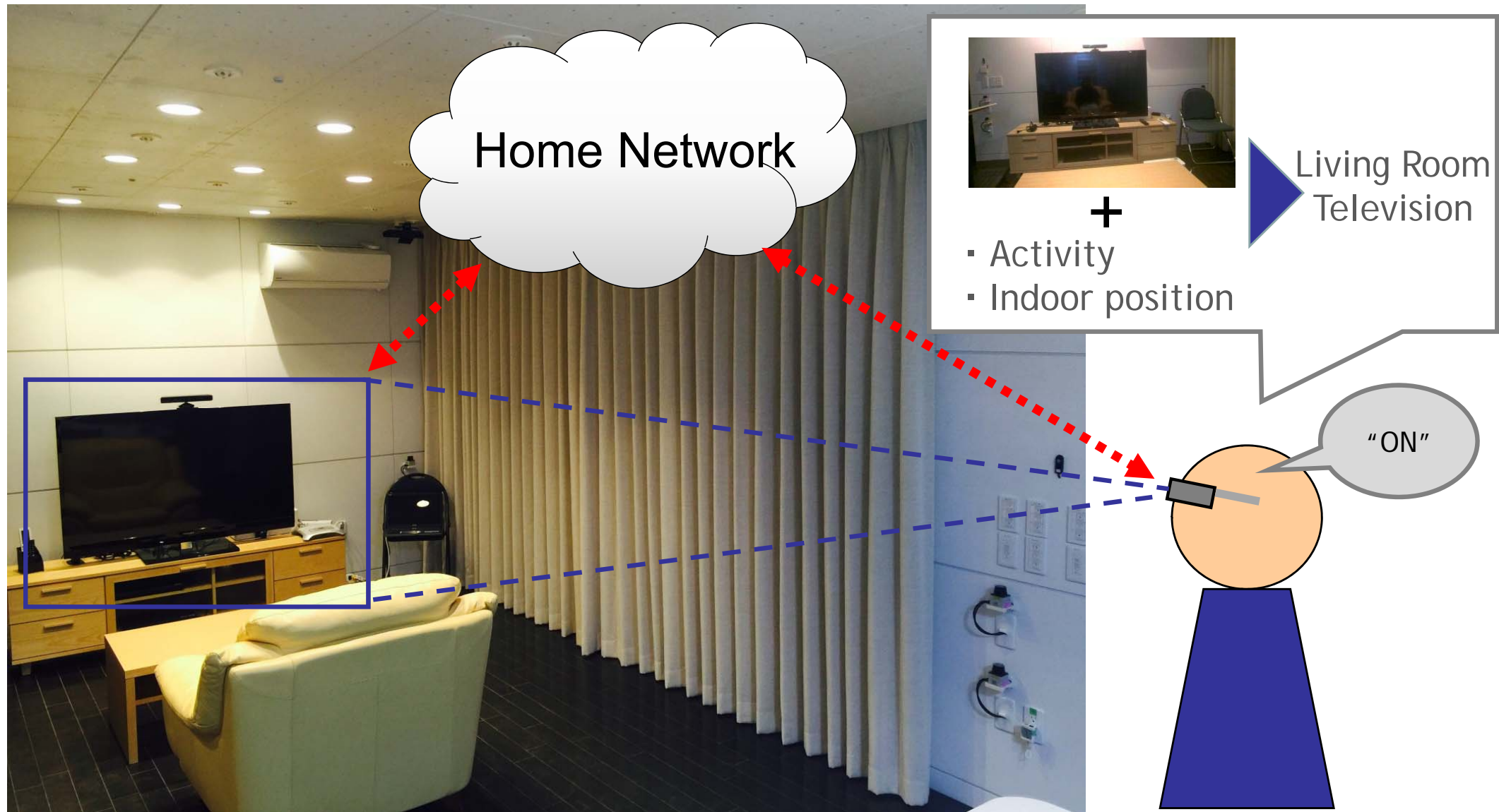
Wearable Camera



Shi F., 06

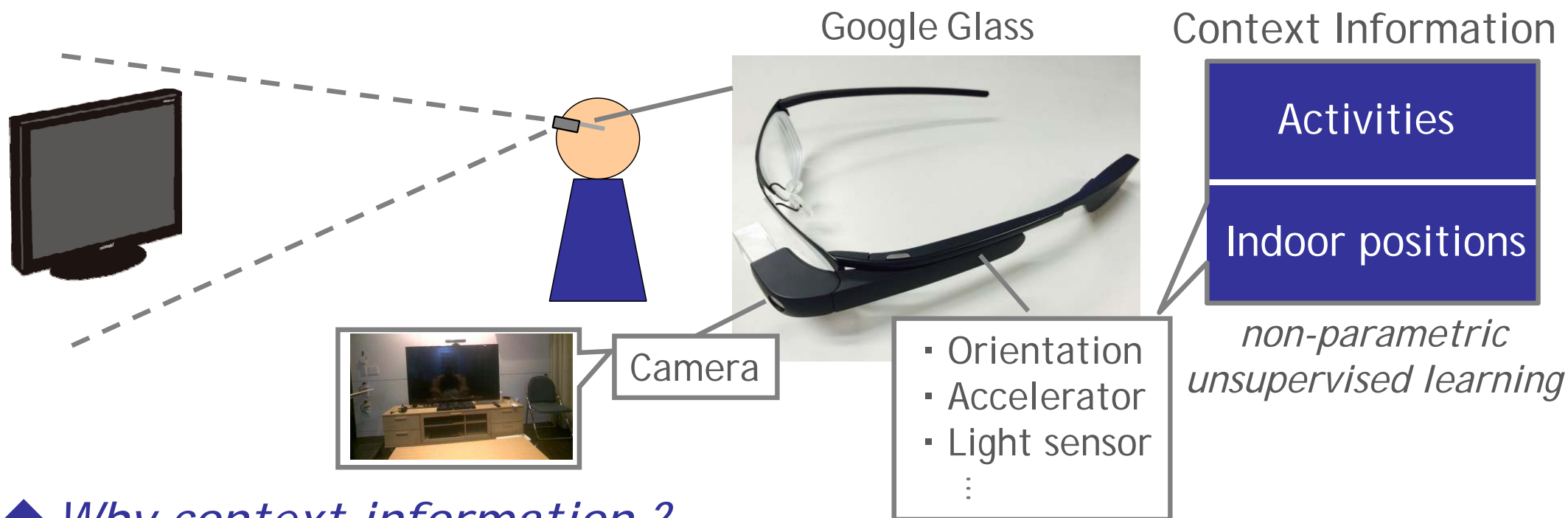
Wearable  
Camera

# Our Approach





# Feature of Our Approach - Context-aware appliance selection

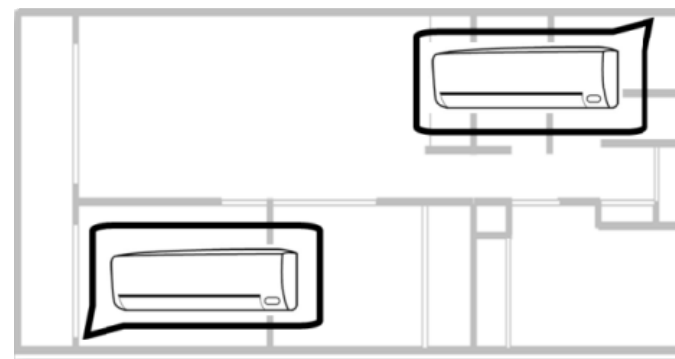


## ◆ Why context information ?

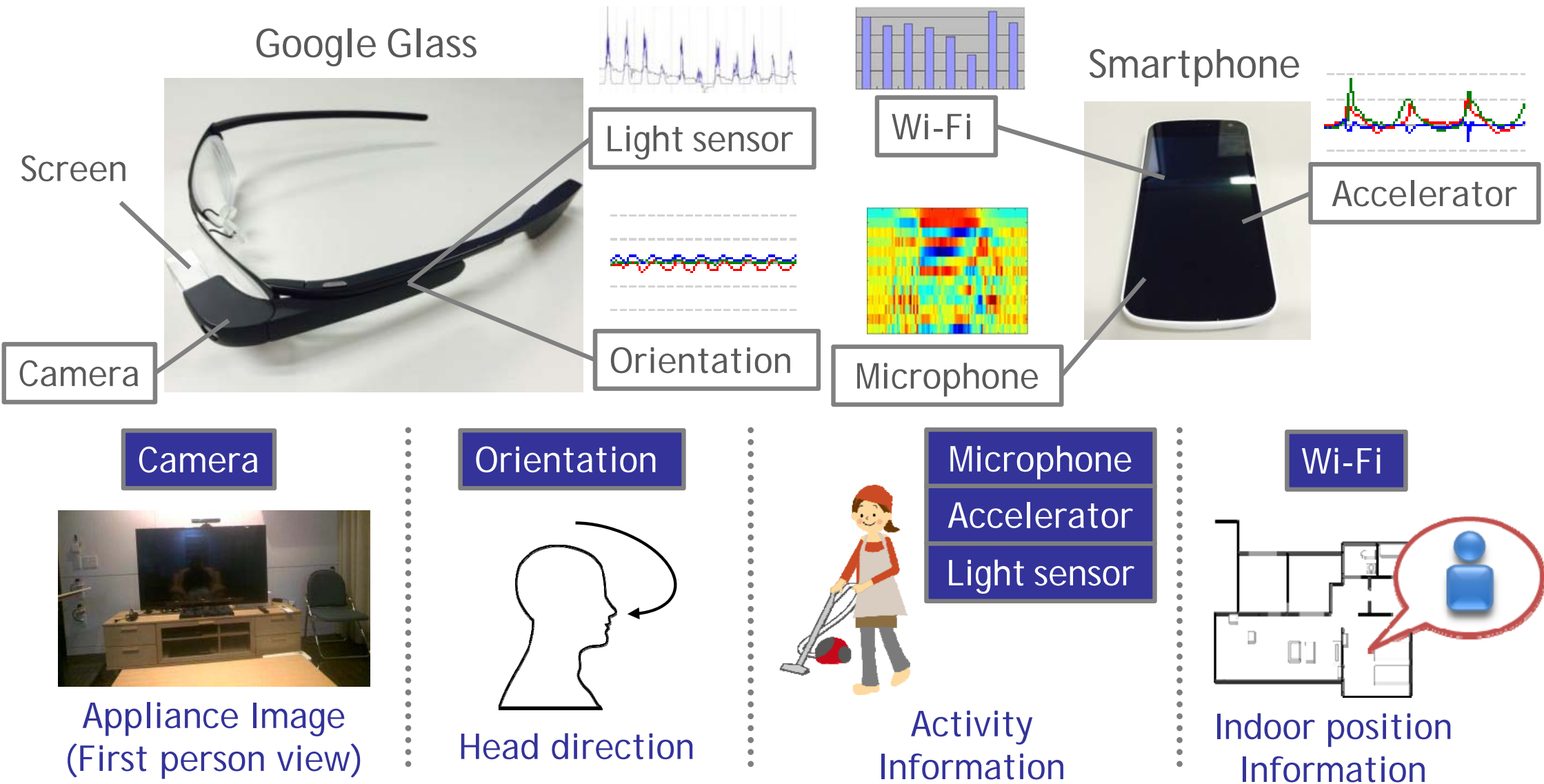
Related to the home appliances



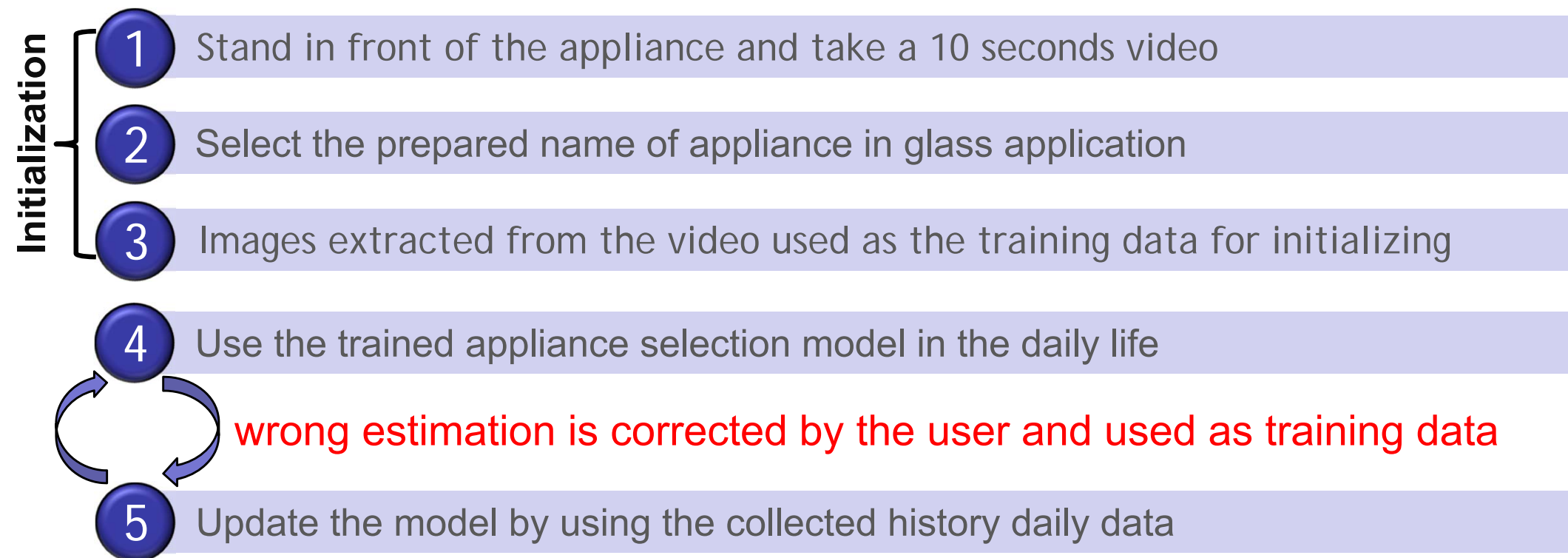
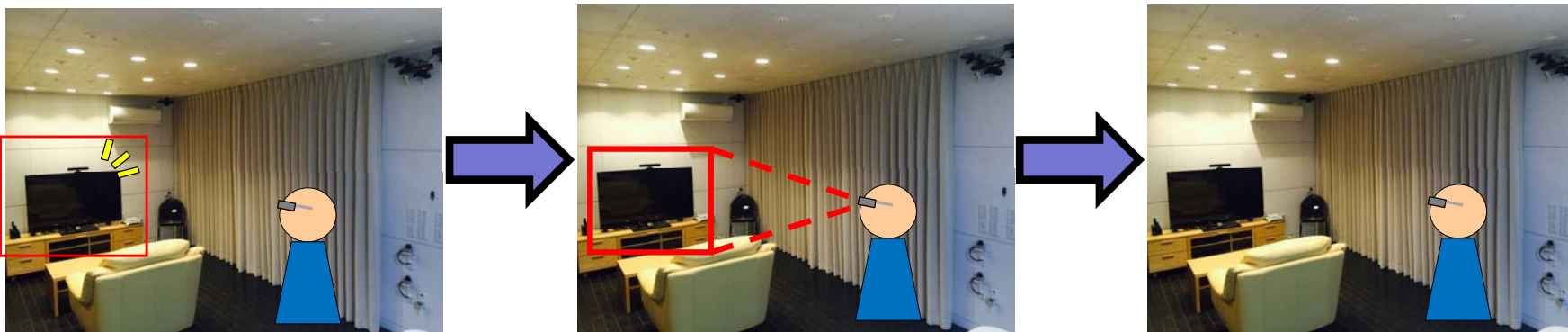
Distinguish between different appliances



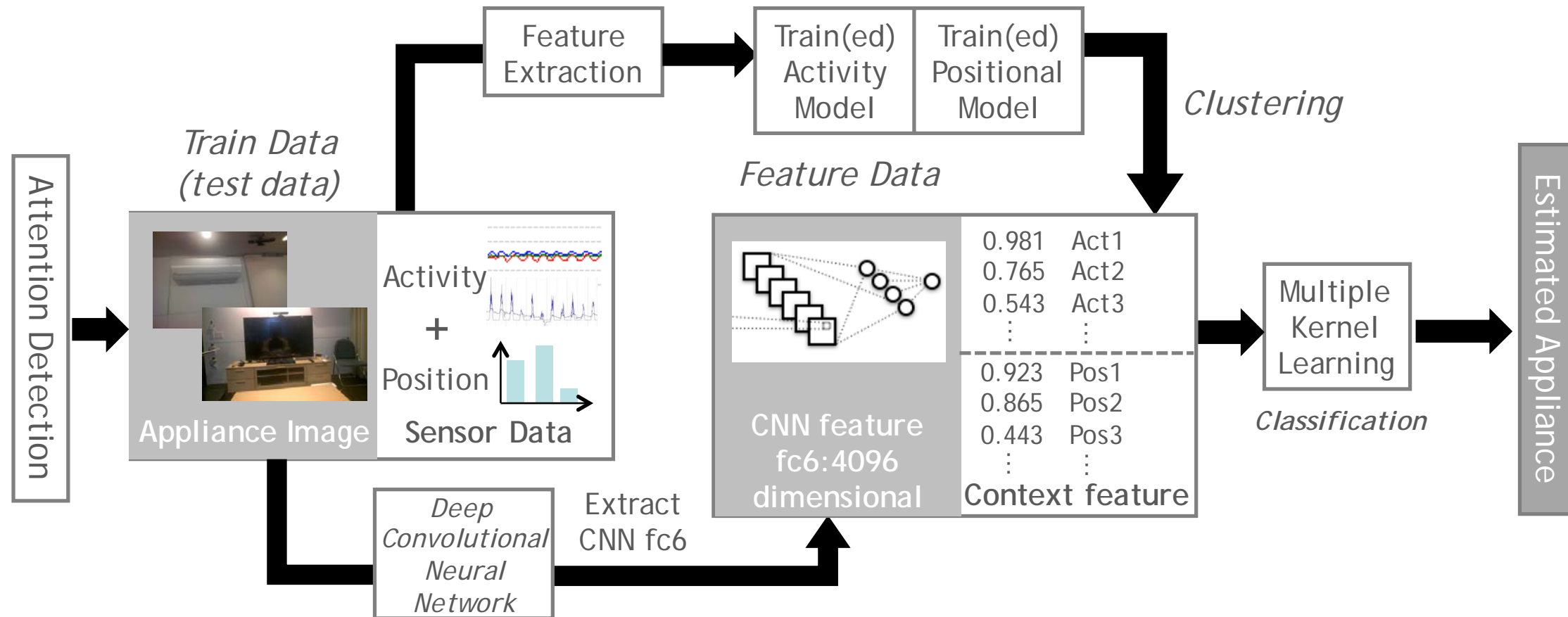
# System Overview- Sensors Used in Our System



# System Overview- Initialization and Model Update



# Proposed Method



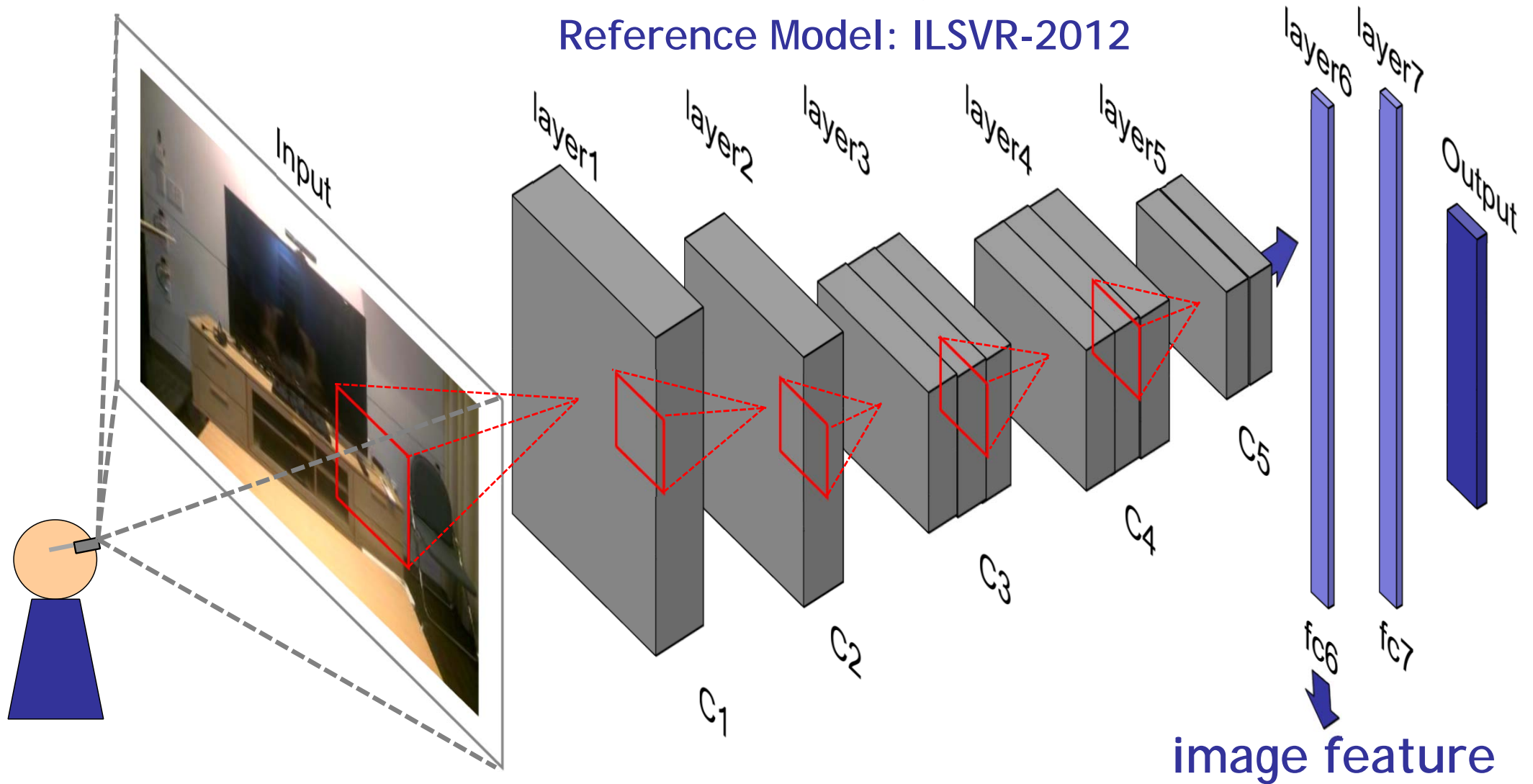
- 1 Detect the user's attention using orientation data
- 2 Extract the attention time's image feature and estimate the activity & position (*IGMM*)
- 3 Extracted above information as the input of appliance selection model (MKL)



# Proposed Method - Image feature extraction with DCNN

CaffeNet

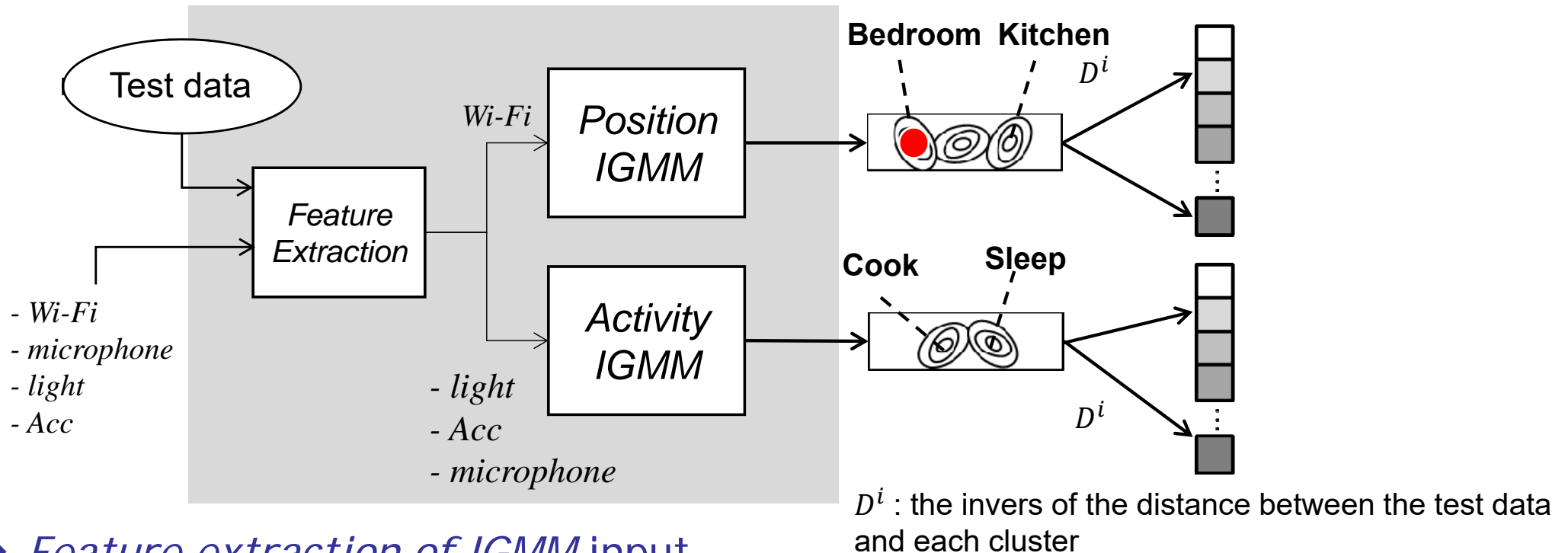
Reference Model: ILSVR-2012



# Proposed Method- Unsupervised activity recognition and indoor positioning

## ◆ *Learning Activity and Position Model*

- Use non-parametric learning approach *IGMM* for activity and position clustering



## ◆ *Feature extraction of IGMM input*

**Accelerator** 3-axis combination signal

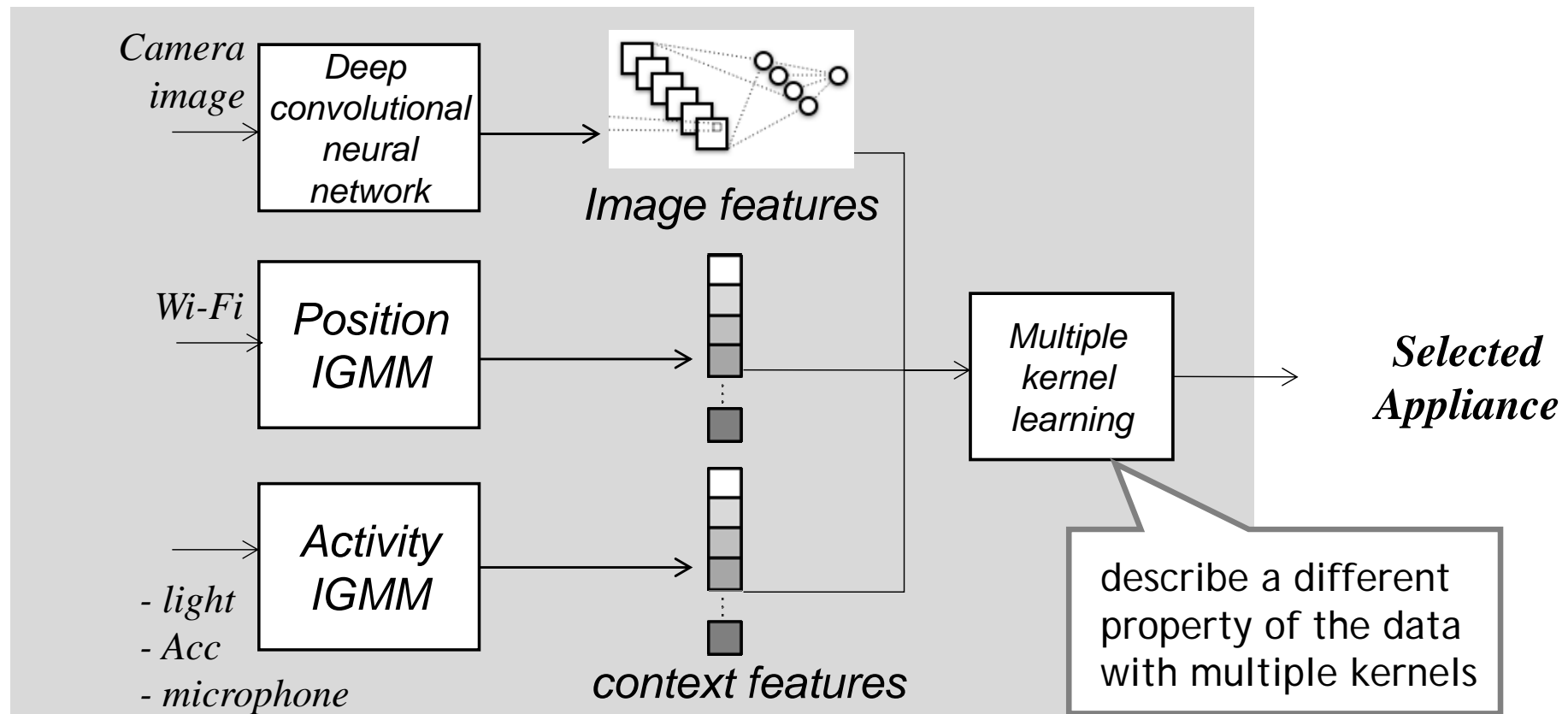
**Microphone** Average MFCC components

**Light sensor** Average of illumination

**Wi-Fi** Signal strength values

# Proposed Method - Appliance selection using MKL

- ◆ *A linear combination of multiple base kernels for image and context feature*



- ◆ *Multiple Kernel Learning*

$k_{img,*}$ : polynomial kernel (for image)     $k_{context,*}$ : radial basis function (for context)

**Decision Function** :  $f(x_*) = a^T (e_{img} k_{img,*} + e_{context} k_{context,*}) + b$

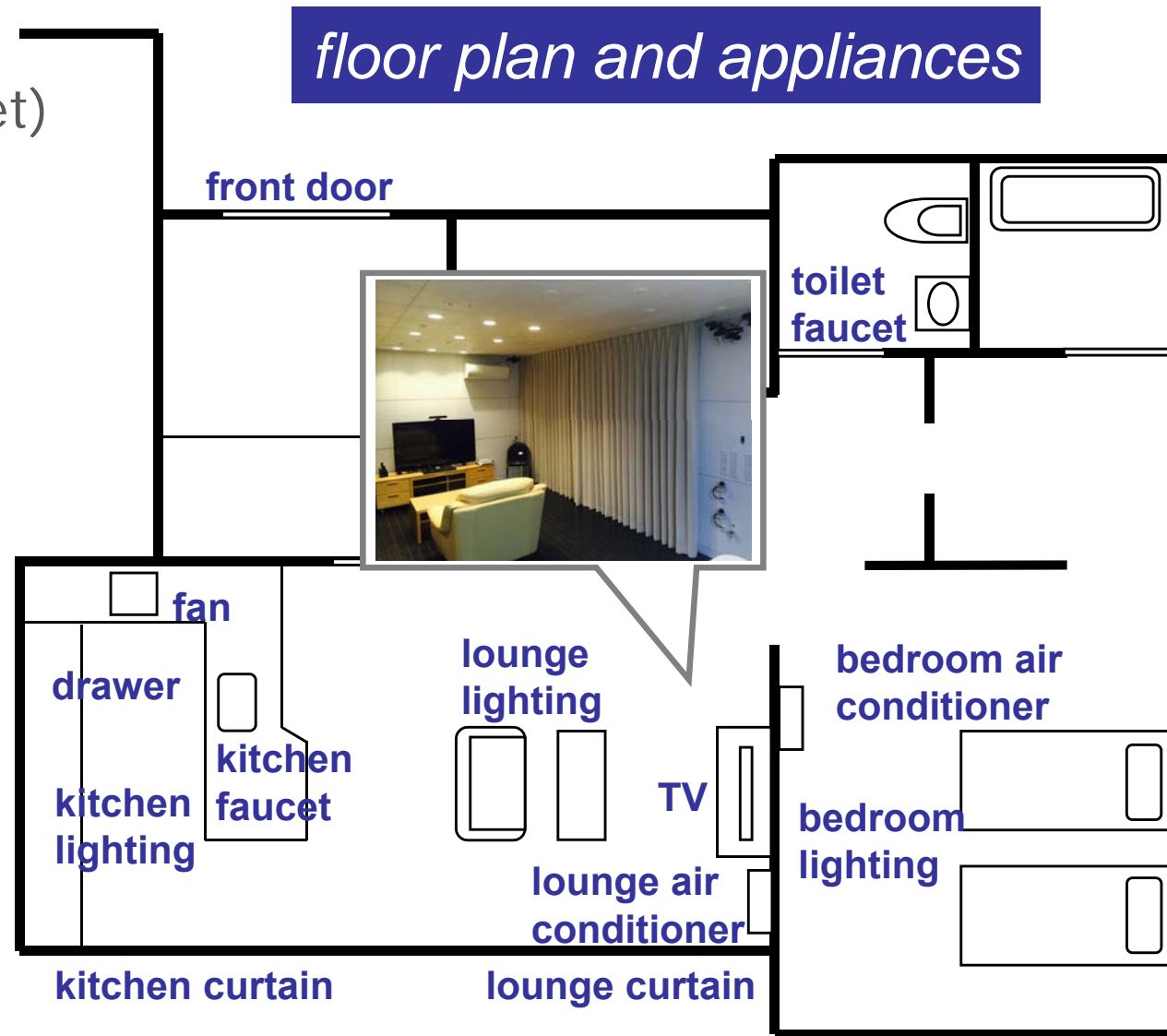
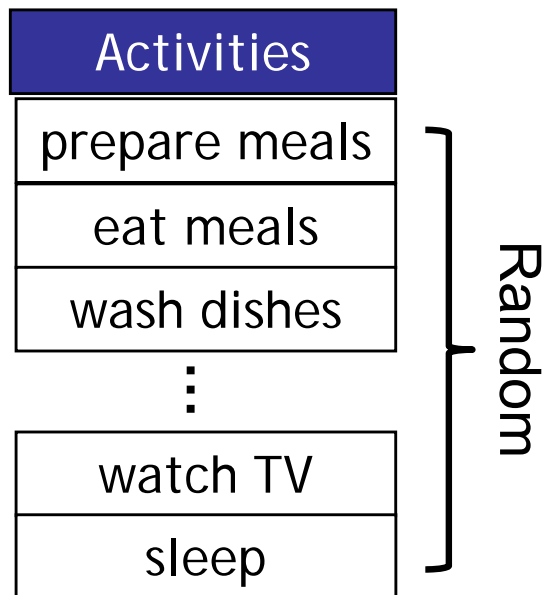
# Evaluation - Data set

## ◆ *Device for data collection*

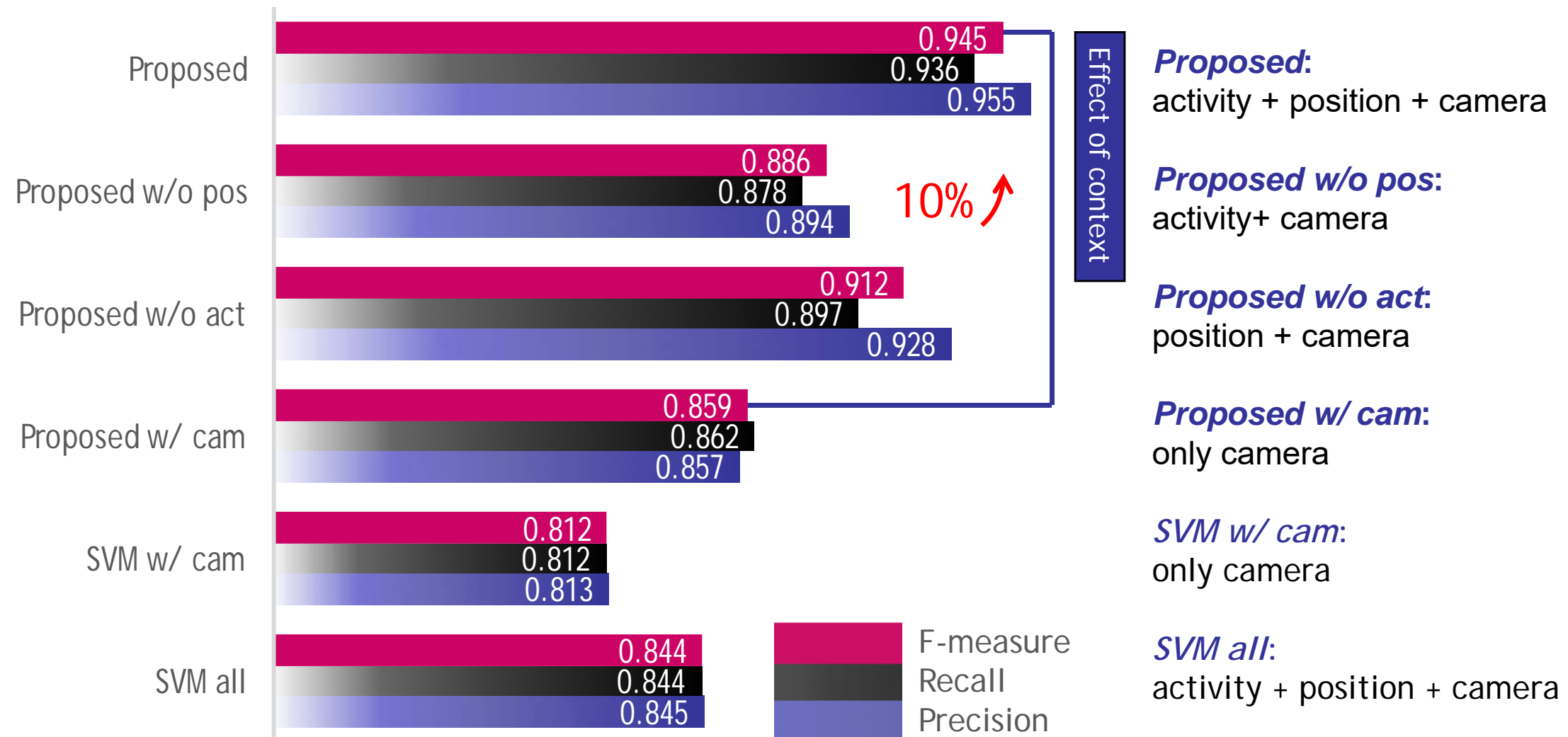
- Google Glass, Nexus 5 (in pocket)
- Sampling rate : 30Hz

## ◆ *Semi-naturalistic collection protocol*

- Activities follow the instruction
- 3 users X 10 sessions activities



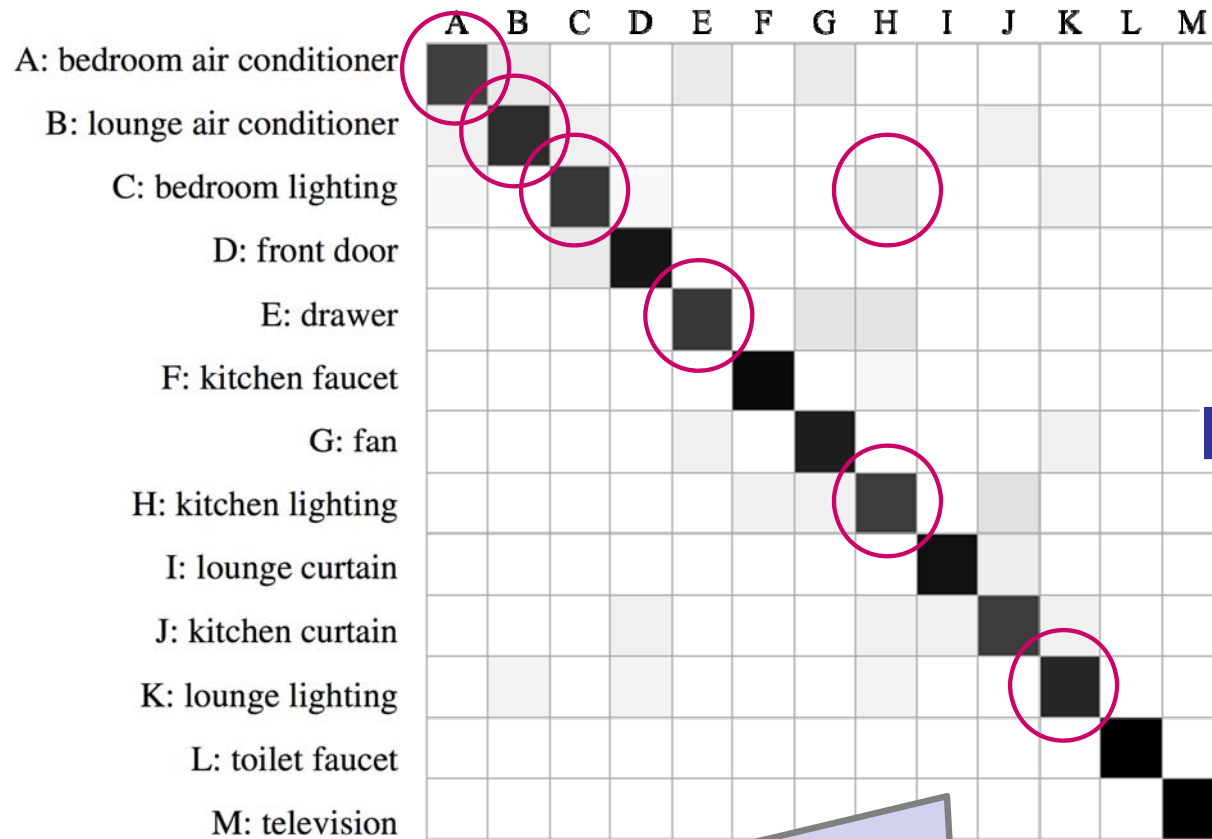
# Evaluation Result - *Leave-one-session out cross validation*





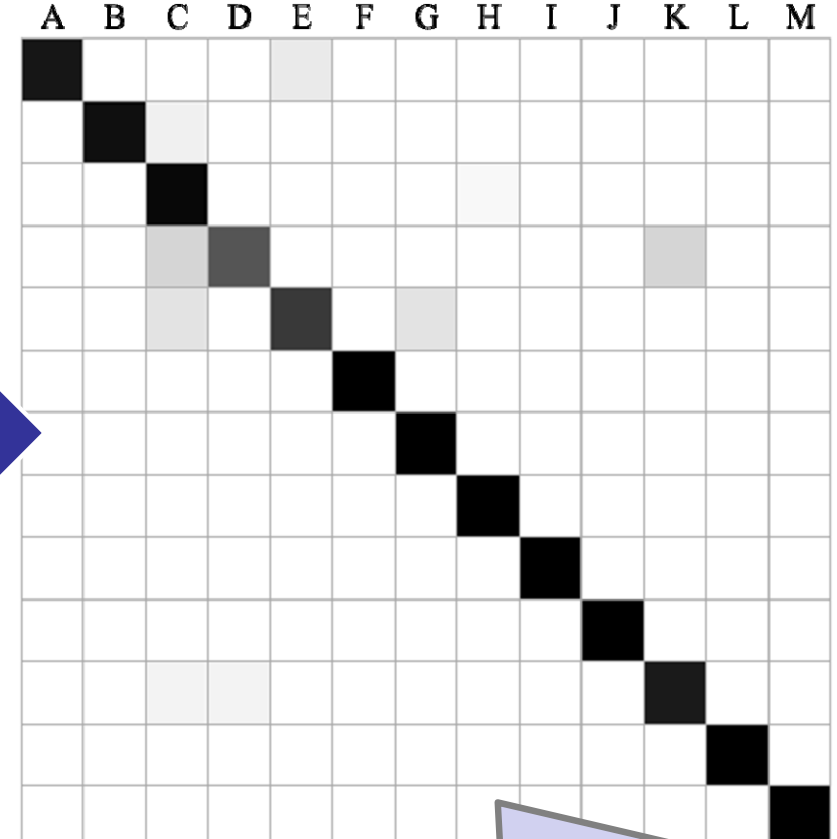
# Evaluation Result - Confusion Matrix

Visual confusion matrix of *Proposed w/ cam*



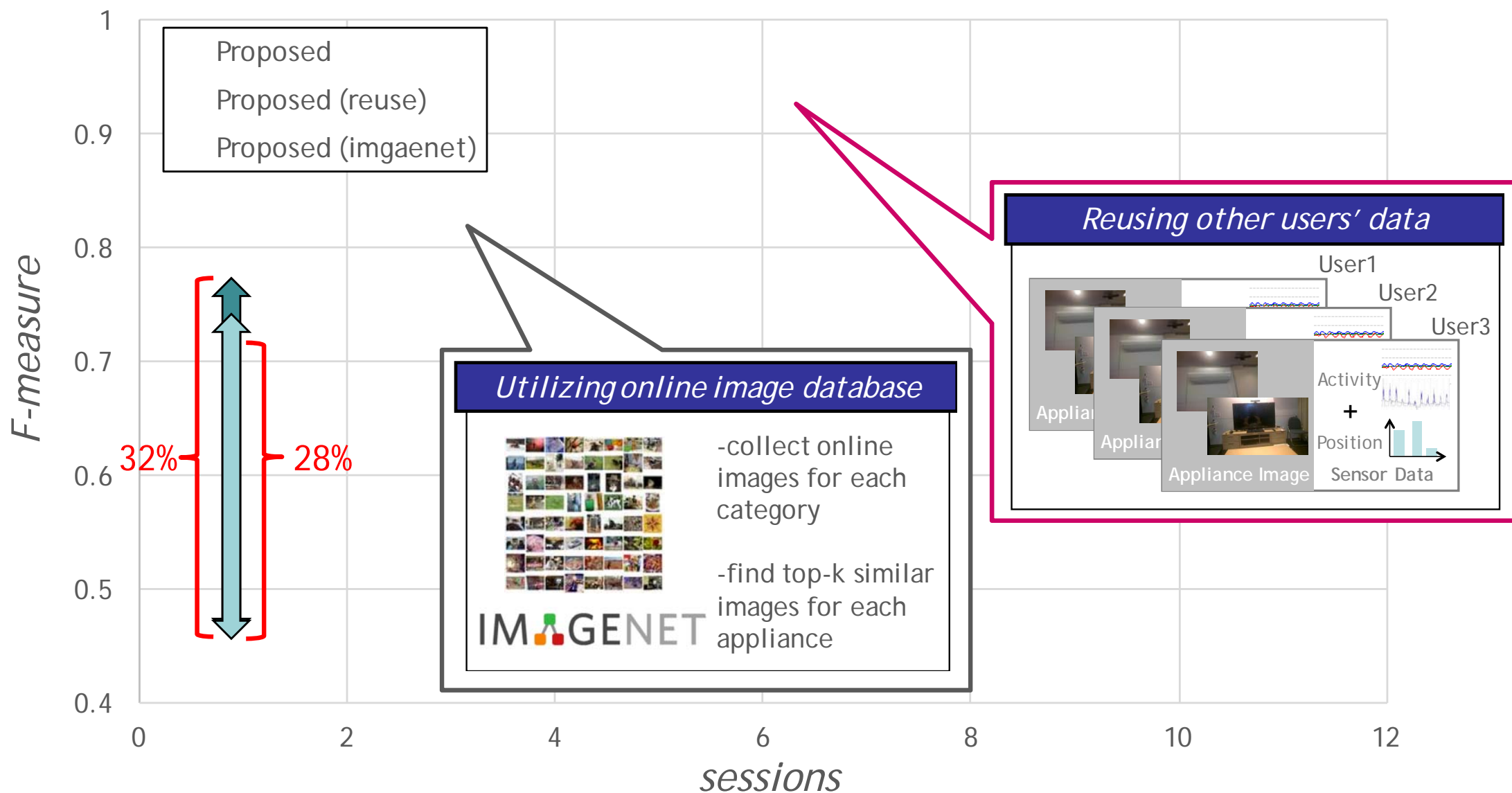
- air conditioner and lighting were relatively poor
- can't distinguish between kitchen lighting and bedroom lighting
- drawer performed not well

Visual confusion matrix of *Proposed*



- air conditioner and lighting were increased about 14% on average of F-measure
- F-measure improved by about 10% on total average

# Evaluation Result - Transition of Average F-measures



# Conclusion

- ◆ We proposed a new method of appliance selection with a smart glass based on position and activity contextual information
- ◆ The effectiveness of contextual information in an appliance selection task has been confirmed in a real experiment environment.
- ◆ Context based method can also be used to enhance the performance of such other appliance selection approaches as speech, gaze direction, and beacon- based approaches