Real-time Eating Action Recognition System on a Smartphone

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Introduction (1)

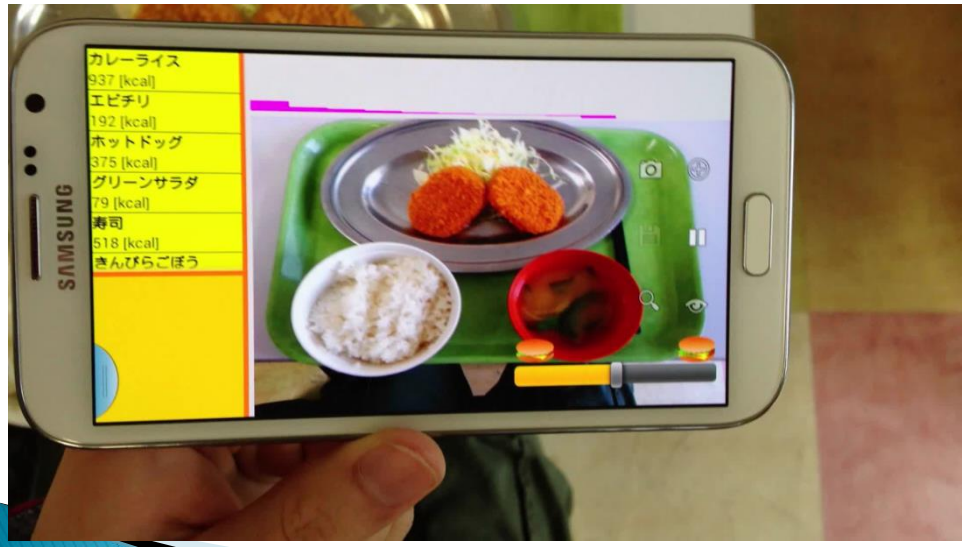
- Food recording habit is helpful for diet
- However to record foods, people have to
  - —take photos
  - —input food names
  - —estimate calories

Give up recording soon !!

Introduction (2)

- Food recording app by **image recognition**
  - It requires taking meal photos before eating

    ⟹ inappropriate for sharing large platter, hot pot, or BBQ



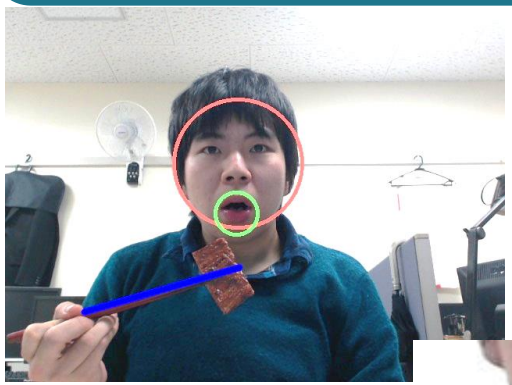
Objective

- **A novel food recording system**
  - Is applicable even for food sharing situation
  - Recognize eating action during a meal
  - Record all eaten foods, calories and amounts

smartphone

Monitoring eating action

Processing Flow

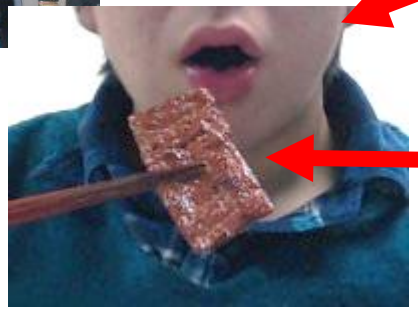


Mouth detection

Chopsticks detection

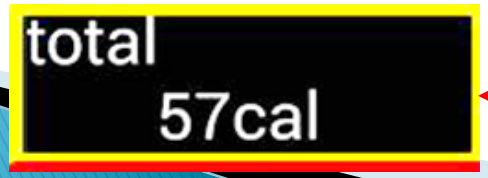
If they come close

Eating region detection



Food item classification

Update total calories

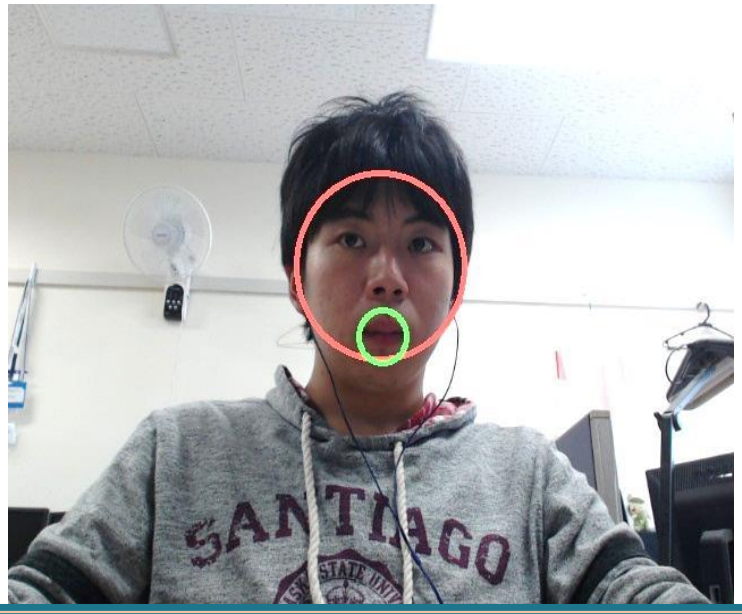


Mouth detection

1. Detect a face
2. Detect a mouth from the face region

(We used face and mouse detectors in OpenCV.)

Without face detection

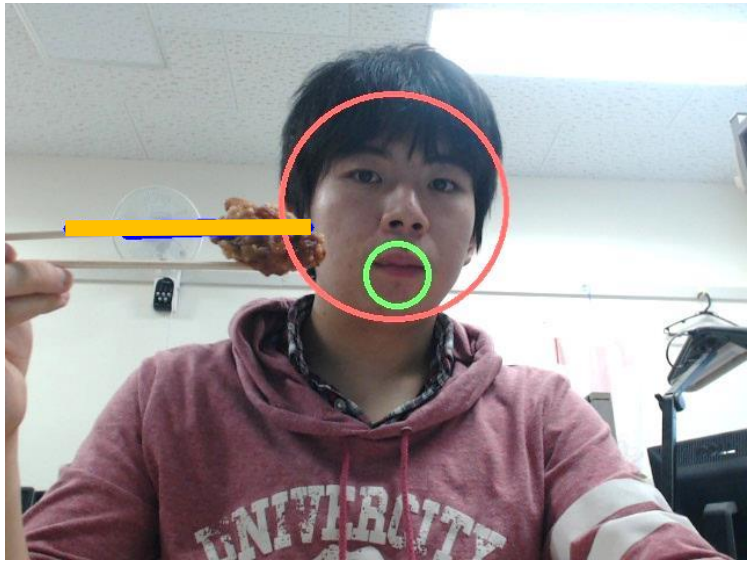


With face detection

Chopsticks detection

1. Detect moving areas
   by background subtraction
2. Detect lines from the moving areas
   by Hough transform

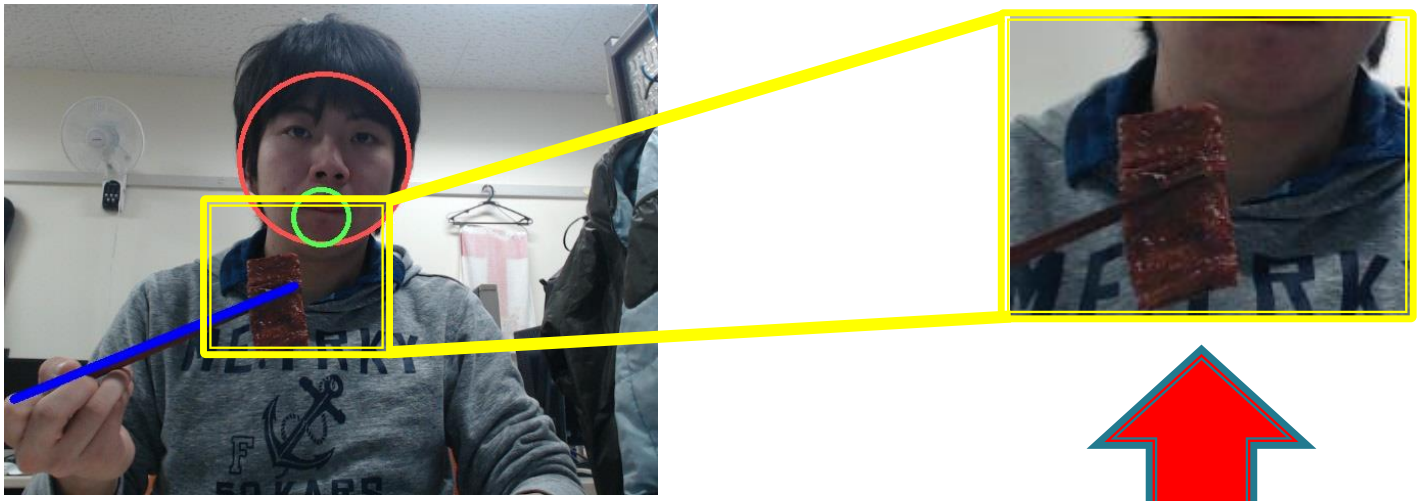
The entire image



Only moving area

Eating region detection

- If mouth and chopstick regions come close to each other ⇨ **"eating"**



Eating region
containing a food item

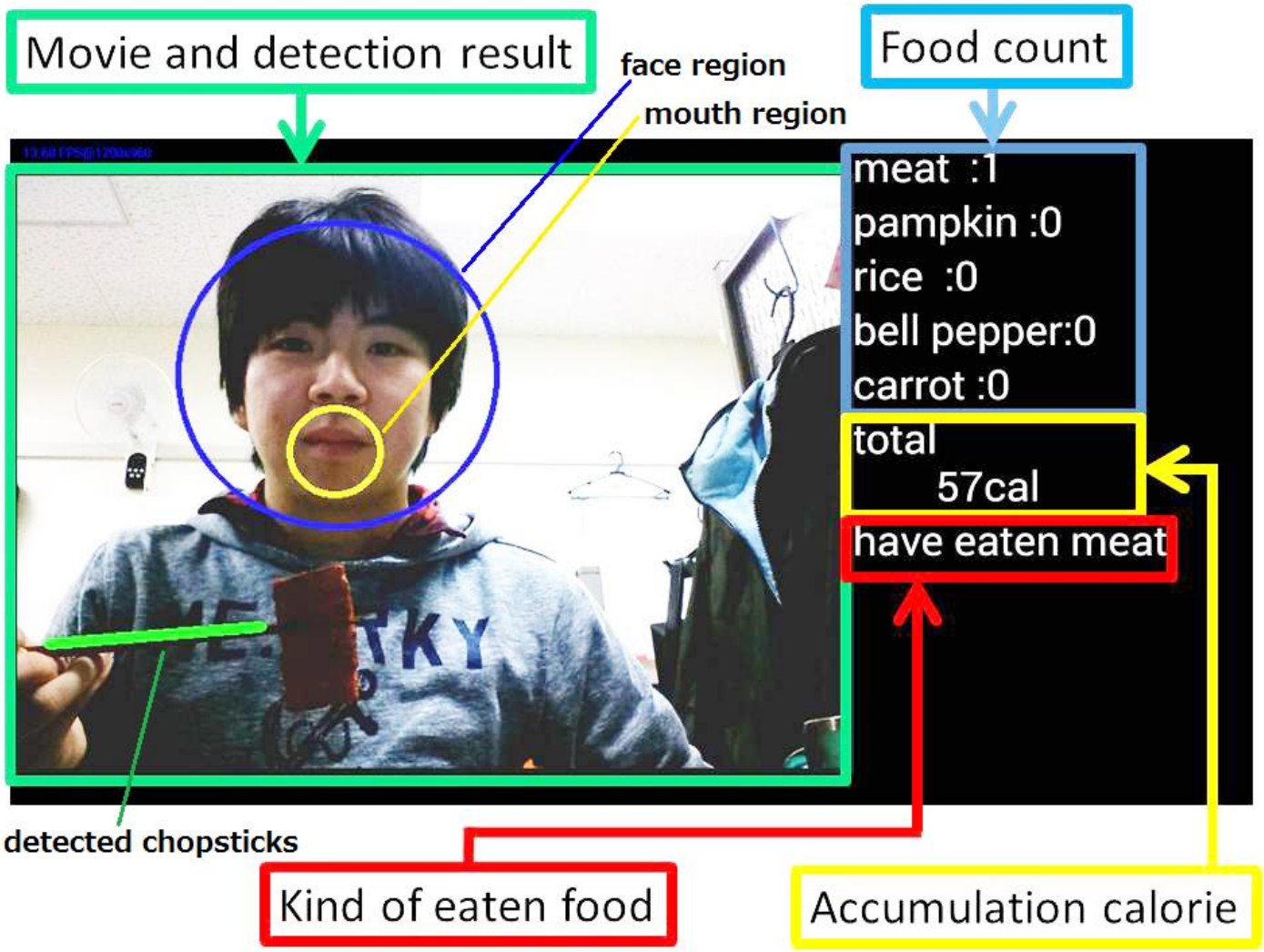
Food Classification

- Fusion of two Image features
  1. Bag-of-features with ORB
  2. HSV color histogram

- Classifier : Linear SVM

  →fast χ^2feature map (Vedaldi al et. PAMI12)

System screen: Grill Cam



Current target meal of Grill Cam

- Target meal: **'Yakiniku Grill'**
  - **Japanese-style BBQ**: grill thin-sliced meat & vege.

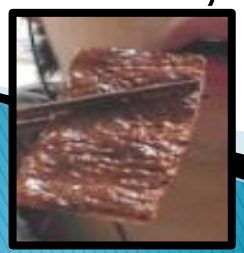
Sharing a grill

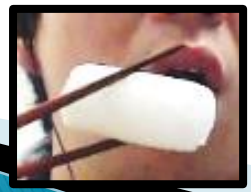
outdoor

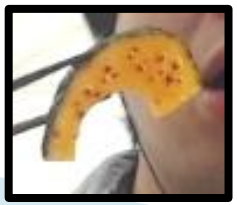
Yakiniku alone

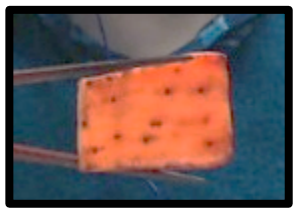
- Target food items for classifiction:
  5 kinds of typical items in Yakiniku

Meat, Rice, Pumpkin, Bell pepper, Carrot









Experiments

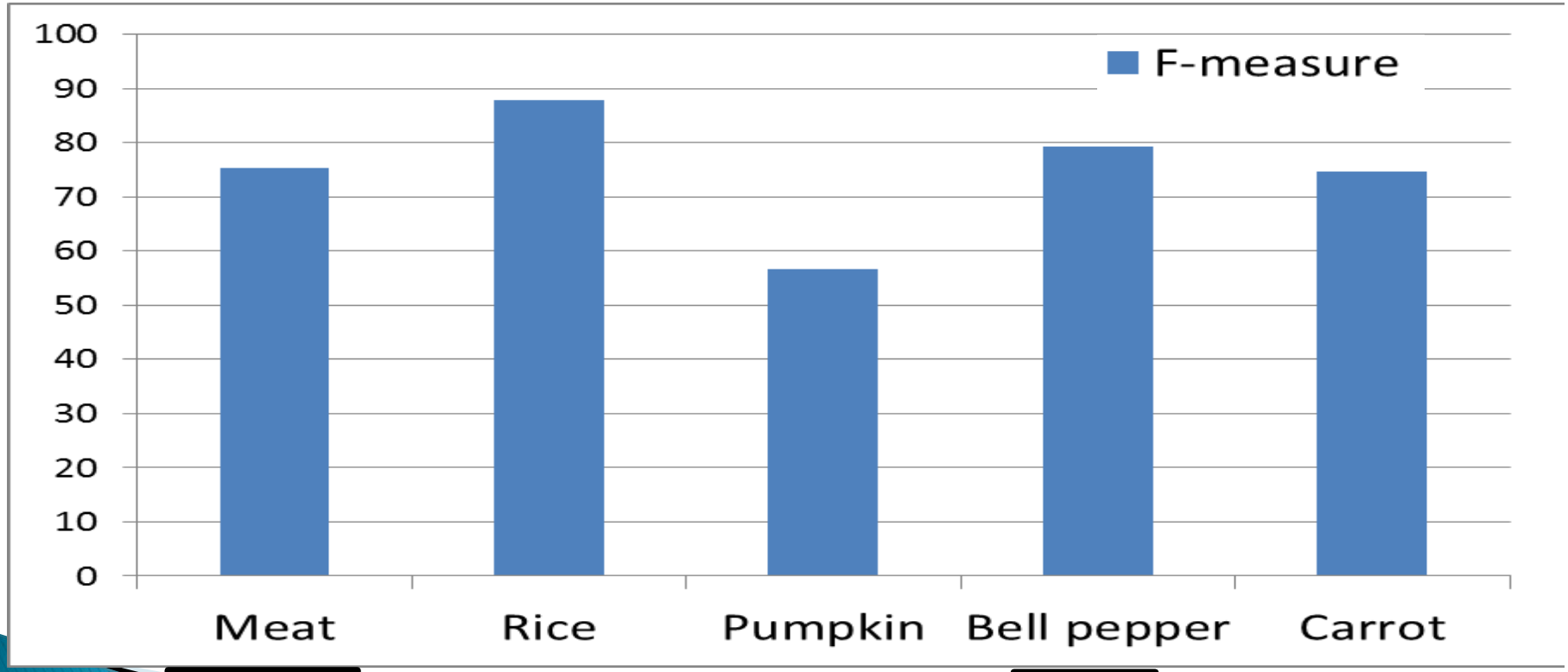
1. Evaluation of
   food classification accuracy

2. User study on system usability

Classification accuracy results

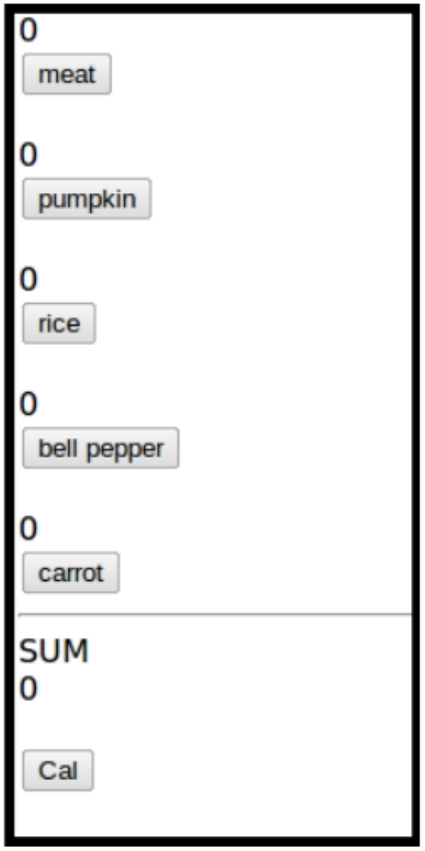
#Training images : 450 #Test images : 50

Classification accuracy : 74.8%



User study (1)

- Comparison of two systems:
  - Baseline system:
    manual recording system
    by touching food item buttons
  - Proposed system
    eating action recognition
- 5-step evaluation
  - 5 (better) .... 3 (soso) .... 1 (bad)
- Two questions for five subjects



Screen of the baseline system

User study (2)

- Two questions for five subjecs:

1. **How easy to take eating record ?**

   Baseline system: 2.0

   Proposed system: 4.8

2. **How easy to see calorie intake during meal ?**

   Baseline system: 3.0

   Proposed system: 3.4

Better than the manual baseline system

Conclusions

- A novel food recording system
  - Recognize eating action during a meal
  - Record all eaten foods, calories and amounts
  - Is appropriate for food sharing situation such as “Yakiniku”
- Accuracy: 74.8%
- User study: Effective,
  but need to improve UI

Future works

- Add other types of meals:



- Improve classification accuracy:
  → Fisher Vector
- Estimate the food volume

Thank you for your attention !

Yakiniku alone with Grillcam !

Chinese food recognition

- Mapo doufu
  - Tofu, Minced meat…

- Shrimps in chili sauce
  - Shrimps, Onion…

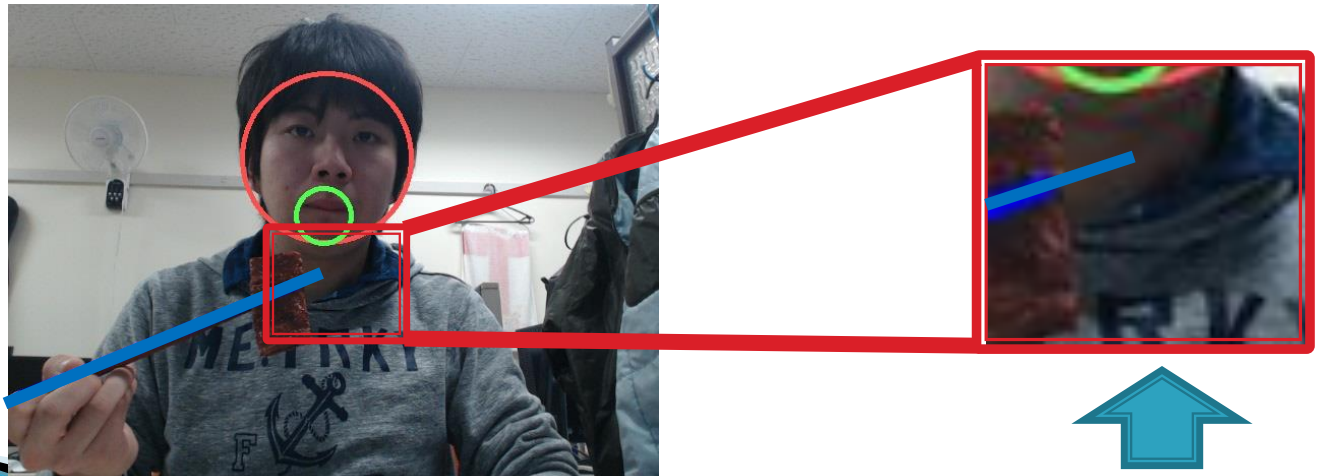
- sweet-and-sour pork
  - Pork, Carrot, Pineapple…

- Eat some food items in one bite

→Pre-defined fixed calories is average calories

Mouth and Chopsticks detection accuracy

- Mouth detection accuracy is high
- Chopsticks detection accuracy is not high
  - There are lines in background
  - Detected Chopsticks are longer than the actual



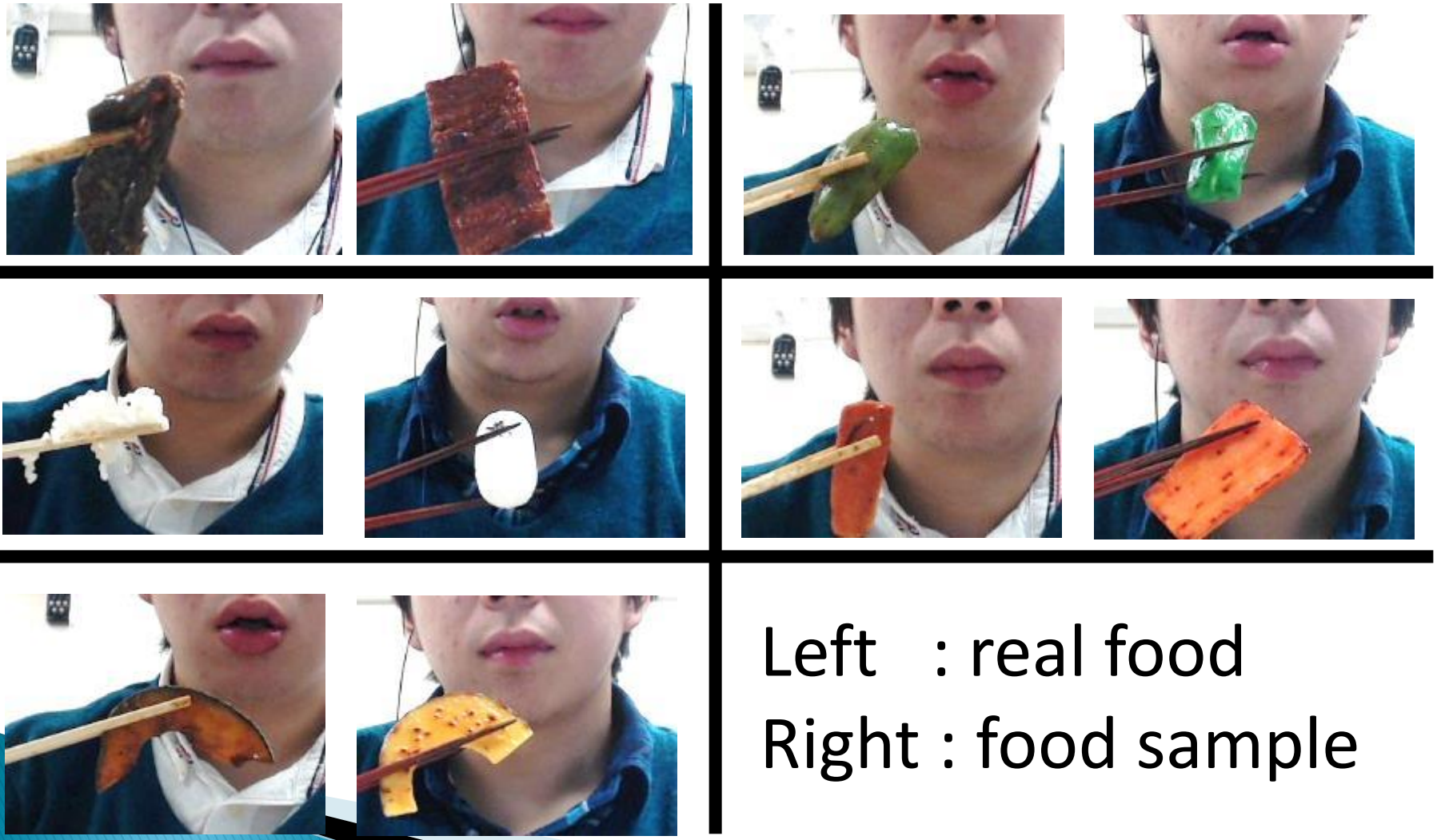
False Eating region

Another tableware

- Fork and knife are straight
  - Can be same method as chopsticks detection

- If eat sandwiches or onigiri
  - We have to detect hand

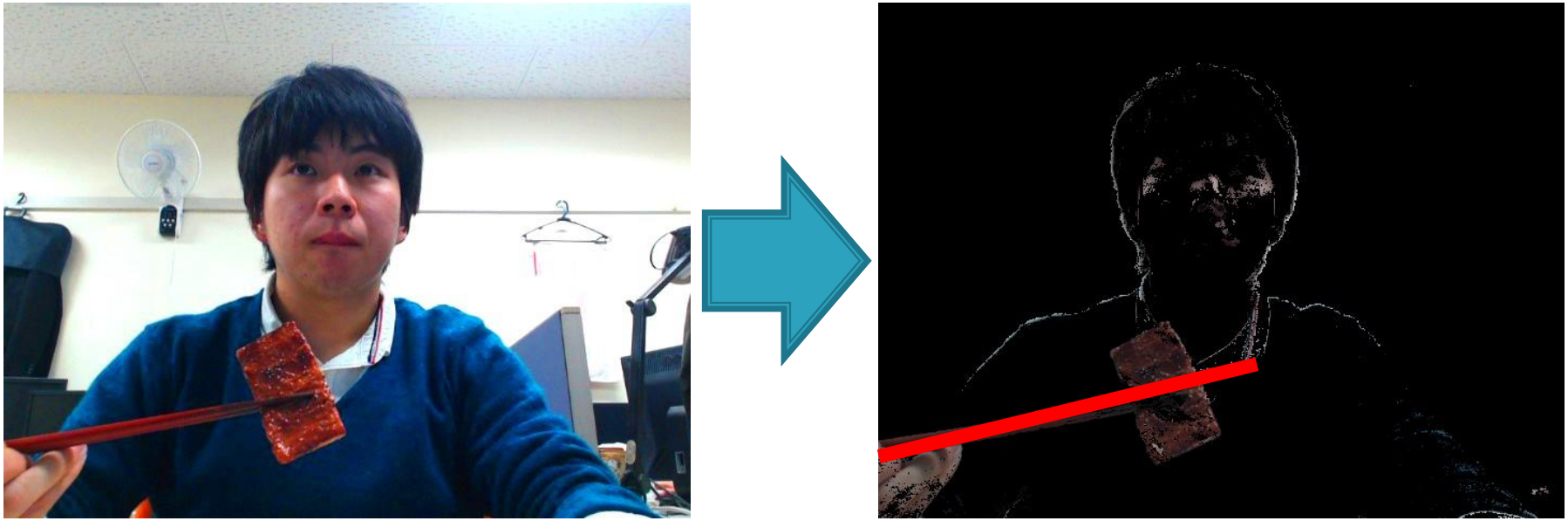
Real food and food sample



Left : real food

Right : food sample

Front part detection



Problem

- Mixture of real foods and food samples for training image set
  - food samples are not good for training image set

Food sample

Real Food

GrillCam: A Real-time Eating Action Recognition System toward Accurate Estimation of Food Calorie Intake

Koichi Okamoto and Keiji Yanai
The University of Electro-Communications, Tokyo

Introduction (1)

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- However,
  - —take photos
  - —input food names
  - —estimate calorie
  - —etc…

Quit recording soon !!

Introduction (2)

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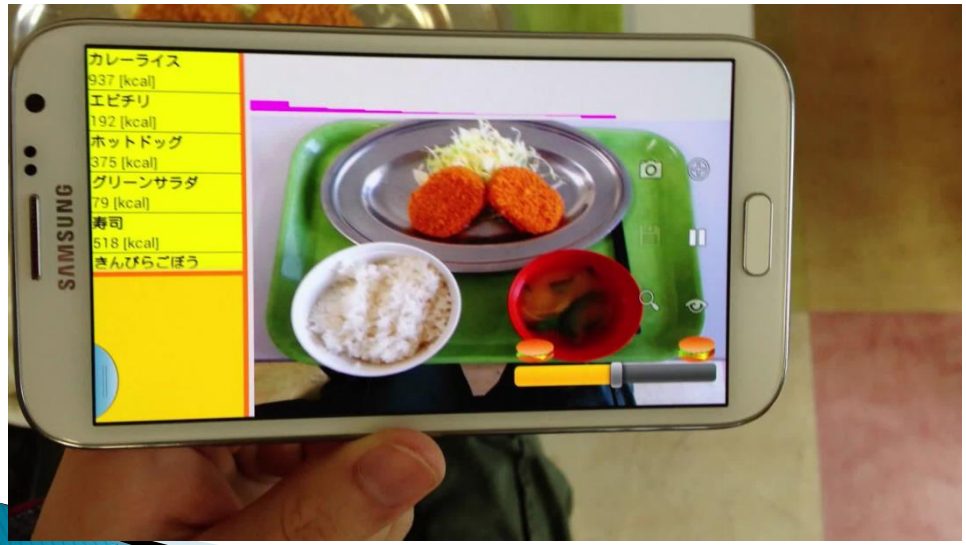


Our proposed system : GrillCam

Very new type of mobile food recording system

- Recognize eating action during meal
- Automatic recording all the eaten food

  ⇒ food item category, calorie, amounts…

smartphone

Monitoring eating action

Processing Flow

Capture frame

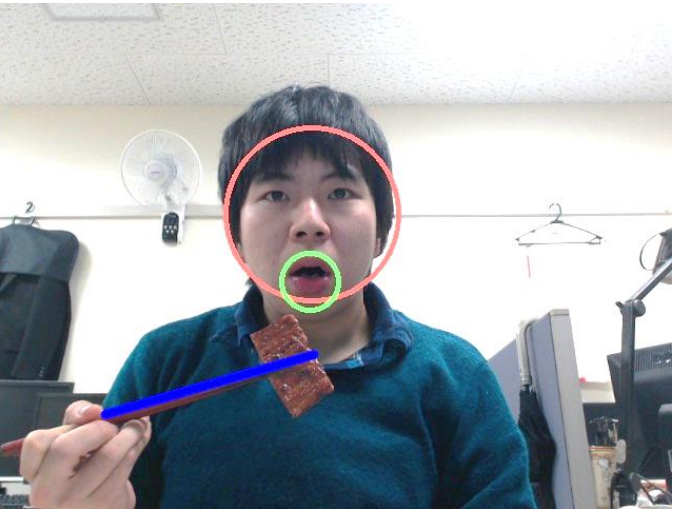
Mouth detection

Chopstick detection

segmentation

Classification of food item

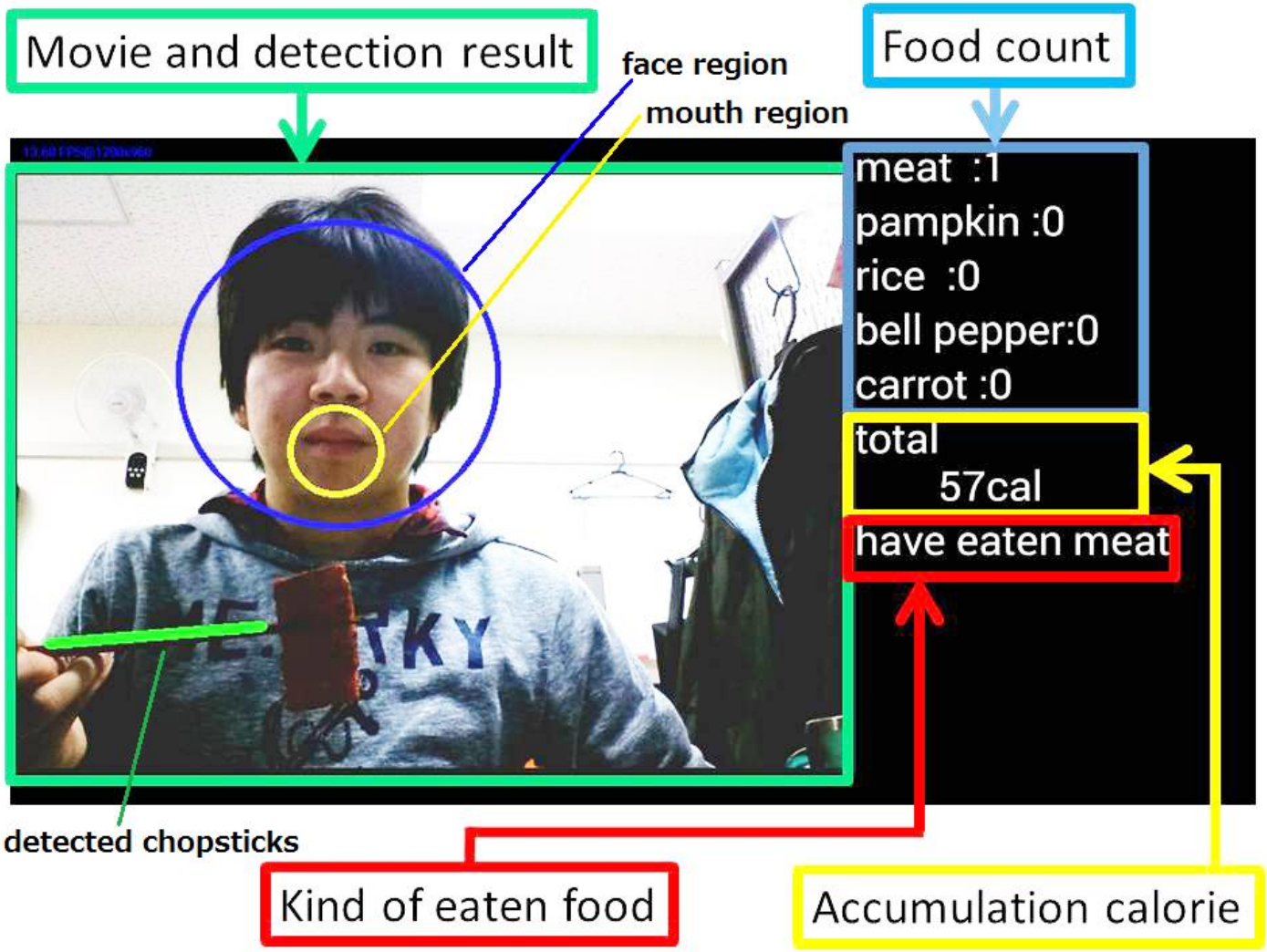
Record eating action



UI of GrillCam

Android App : Grill Cam

(In the current implemention, the target is a “Yakiniku” meal.)



Evaluation results

- Two kinds of evaluations

1. Classification accuracy (5-fold CV)

   → **74.4 %**

2. Simple user study (5 subjects)

   →Comparison with the baseline system which has no recognition in 5-steps

	baseline	GrillCam
usability	2.0	4.8

Much better than the no-recognition baseline

You can try GrillCam at the MM demo !!

You can experience a new type of meal with Grillcam !