An Automatic Calorie Estimation System of Food Images on a Smartphone

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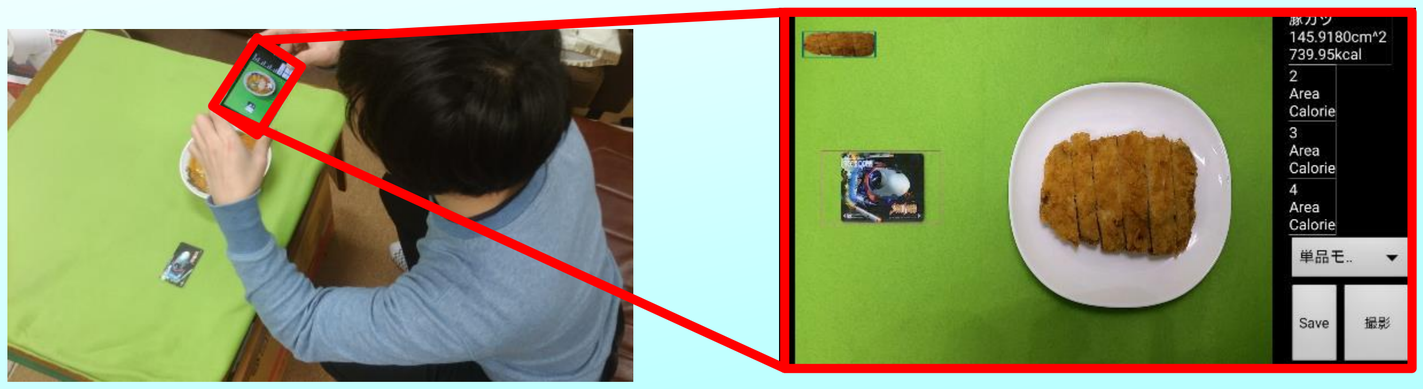
Proposed System: CalorieCam

- **How many calories ?**

Pork cutlet, rice, miso soup,…



CalorieCam (proposed system (Android app))

Introduction

- **Many recording meal apps**
  - ⇒ **Semi-automatic calorie estimation**
    - need to teach food amounts manually

FoodCam [Kawano et al. 2014]

Need to teach the amount of foods by the slider

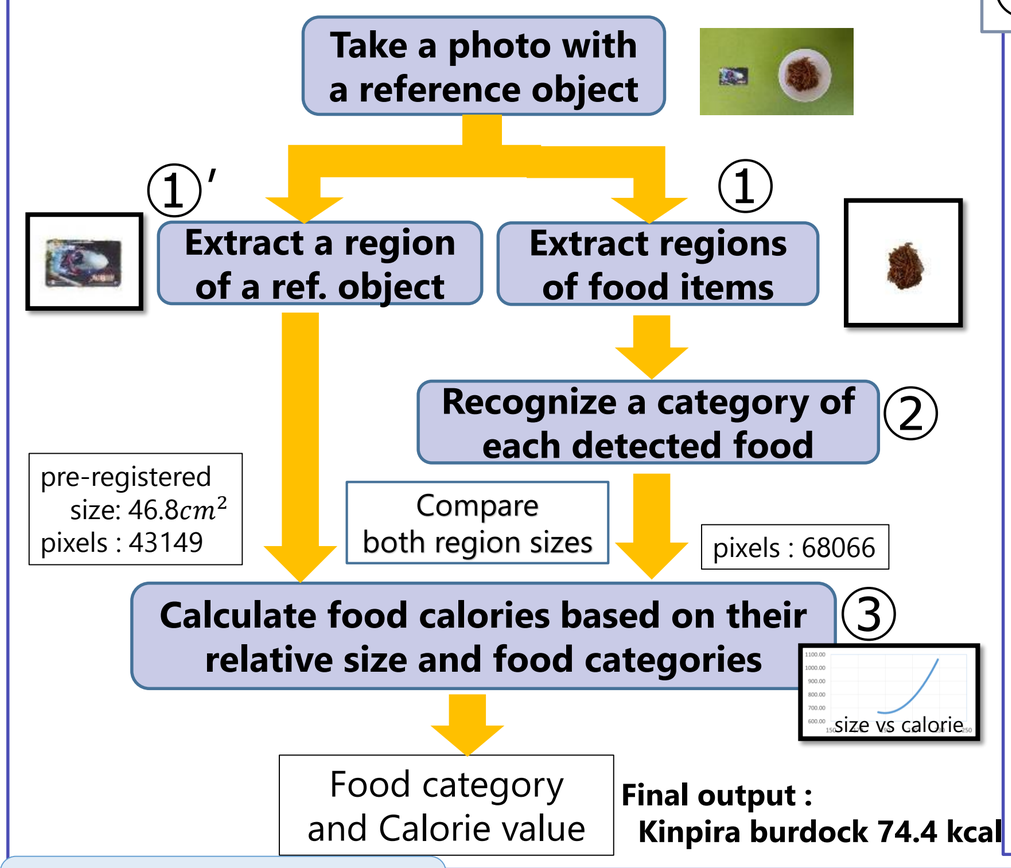
FoodLog
[foo.log inc.]

Need to teach the amount of foods by selecting items

New system: CalorieCam

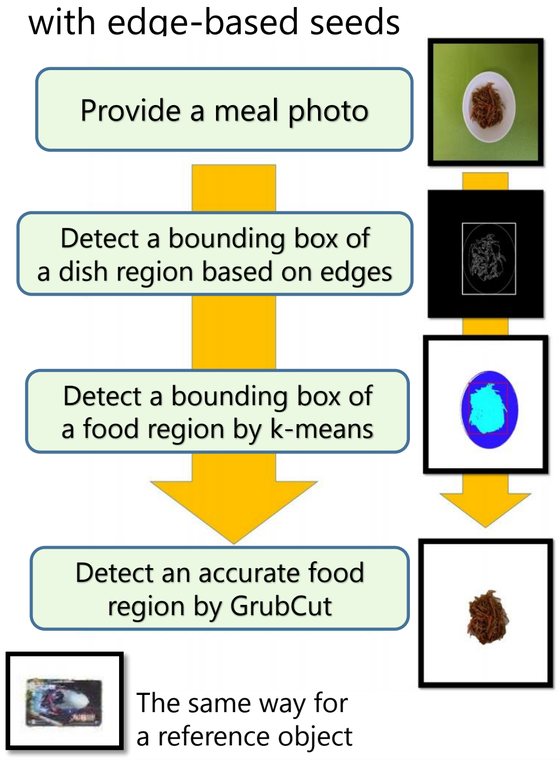
- Automatic calorie estimation
- Standalone system
  - no need of a recognition server
- Android app.

System Overview



① Extraction of regions

- GrubCut-based region extraction with edge-based seeds



② Food classification

- CNN-based mobile food recognition engines
  - "DeepFoodCam" engine
  - Standalone, no need of a recognition server
  - Network-in-network (NIN) based CNN
  - "Real" real-time recognition (27ms in iPhone7)

(Please see "DeepFoodCam" demo for detail !)

③ Size-based calorie estimation

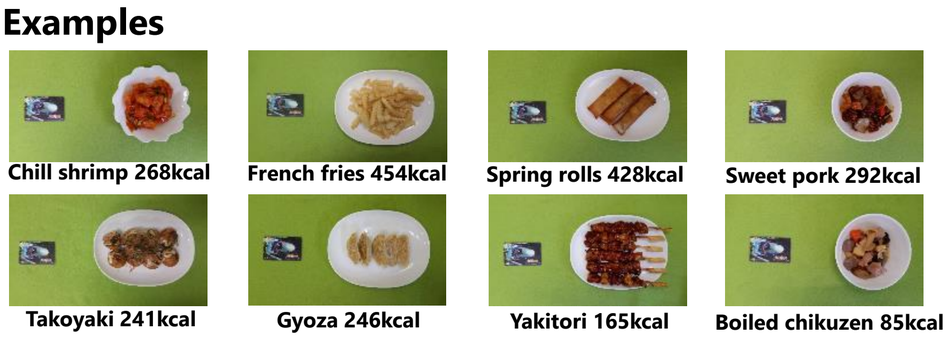
- Size-based estimation
  - Compare #pixels of a food region with #pixels of a reference object and estimate a real size
    $size_{food} = \#pix_{food} * \#pix_{ref}/size_{ref}$
  - Use quadratic curve based estimation from $size_{food}$ to a food calorie, cal.
    $cal = a_i * size_{food}^2 + b_i * size_{food} + c_i$
    where a_i, b_i, c_i are trained params for i-th categories.

Experiments

Datasets: calorie-annotated food photos
(20 kinds of dishes with 3 different sizes)

- Use for training of calorie estimation parameters (a_i, b_i, c_i)
- Prepare all the dishes and take photos in our lab.

Examples



Evaluation of automatic calorie estimation

Mean avg err.	Mean SD	Mean relative err.	Mean relative SD
52.2 kcal	±**40.4** kcal	**21.3%**	±**0.823**

Successful cases

Input image	regions	GT	Estimated	Error	Rel. err
	Pork cutlet	586 kcal	559 kcal	27 kcal	0.05
	Beef bowl	1322 kcal	1417 kcal	95 kcal	0.07

Failure cases

Input image	regions	GT	Estimated	Error	Rel. err
	Niku jaga	170 kcal	122 kcal	48 kcal	0.28
	Yaki soba	425 kcal	519 kcal	94 kcal	0.22

Comparison with FoodCam

- Ask five subjects to estimate food calories with FoodCam and CalorieCam

	Usability (5steps)
FoodCam	2.83 ± 0.80
CalorieCam	4.25 ± 0.72

		FoodCam		Proposed app	
Dish	GT	Avg. err	Avg.SD	Avg. err	Avg.SD
Beef bowl	**962**	**-53.25**	±**209.79**	**-242**	±**55.10**
Croquette	**552**	**-242**	±**91.26**	**-47.08**	±**52.52**
Salad	**14**	**54.83**	±**36.28**	**4.86**	±**11.87**

Conclusions

- Implement an image-based food calorie estimation app.
- average error: ±52kcal, relative error: ±20%

Future works

- CNN-based segmentation and calorie estimation
- Use calorie-annotated food images on the Web