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あらまし

N-gram

N-gram

SVR (Support Vector Regression)

0.168 0.856 F

キーワード N-gram SVR

Cooking Operation Classification Based on Analysis of Eye Movement Patterns

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Abstract In this presentation, we propose a classification method of cooking operations by analyzing eye movement patterns. Since gaze information is important in understanding human behavior, we obtain it by a head–mounted device, and use it to classify cooking operations. We use the N-gram model known as effective in action recognition that focuses on gaze information. Conventionally, only relative movement from the previous frame was used as symbols for the N-gram. However, since in cooking, users pay attention to cooking ingredients and equipments, we consider fixation as a component of the N-gram. We also consider eye blinks which may reflect concentration. The proposed method estimates the likelihood of the cooking operations by Support Vector Regression (SVR) using frequency histograms of N-grams as explanatory variables. The effectiveness of the proposed method was confirmed through an experiment, which obtained the average F-score of 0.856, 0.168 higher than the conventional method.

Key words Classification of cooking behaviors, gaze analysis, eye movement pattern, fixation, blink, N-gram

1. は じ め に

[1]

[2]

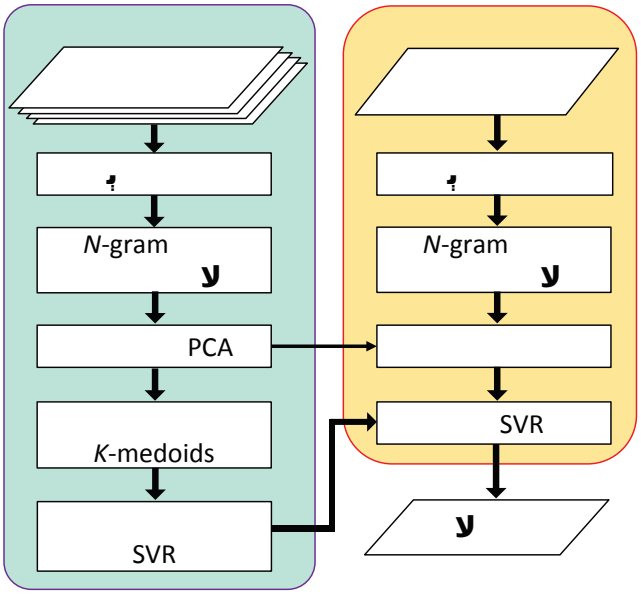
1

[3]

[4]

(a) Cut (b) Mix

1



2

[5]

Bulling

[6]

[7]

1

Optical flow

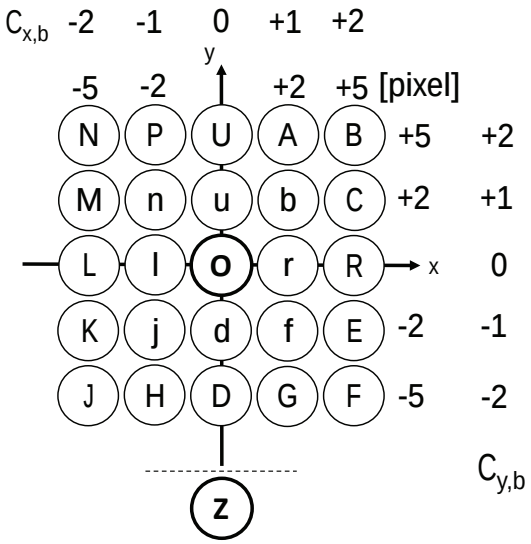
[8]

3

2.

3.

4.



4

2. 視線運動パターンの分析に基づく調理動作識別手法

2 N-gram 3

x y

$C = \{C_{x,b}, C_{y,b}\}_{b=1}^{T}$ [6]

(1), (2) α Haar (CWT-SD: Continuous Wavelet Transform for Saccade Detection)

$$C_{x,b} = \frac{1}{\sqrt{\alpha}} \int \psi\Big(\frac{t-b}{\alpha}\Big) x_t \, dt \tag{1}$$

$$\psi(\beta) = \begin{cases} 1 & (0 \leqq \beta < \frac{1}{2}) \\ -1 & (\frac{1}{2} \leqq \beta < 1) \end{cases} \tag{2}$$

$C_{x,b}$ b x x_t t x α 100 ms $\alpha = 6$

y 2 4 H L (3) 5 x y

$$\hat{C}_{x,b} = \begin{cases} 2 & (H \leqq C_{x,b}) \\ 1 & (L < C_{x,b} \leqq H) \\ 0 & (-L < C_{x,b} \leqq L) \\ -1 & (-H < C_{x,b} \leqq -L) \\ -2 & (C_{x,b} \leqq -H) \end{cases} \tag{3}$$

4 4

Cut Mix

[6] [6]

O

Cut Mix

[9]

Z 26

3 3

1 [6] 900 15 1 60 60

N-gram [6]

1-gram N-gram

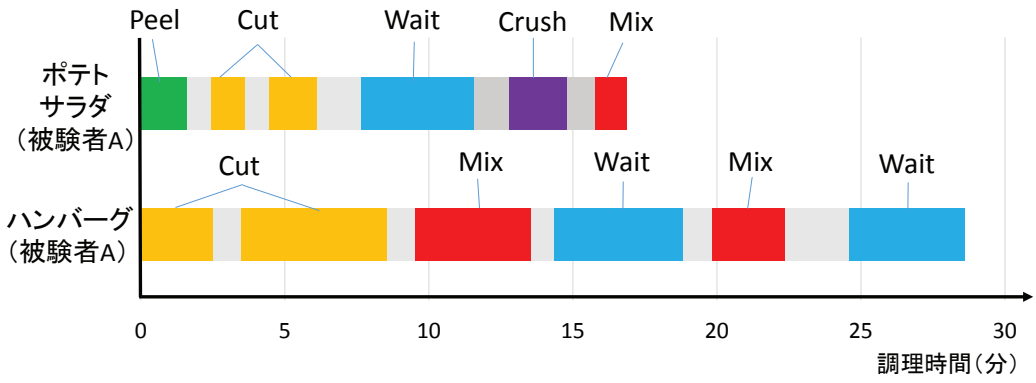
PCA: Principle Component Analysis

SVR [1] (Support Vector Regression) [10]

-1 1 one-against-all 0

2

1 lib-SVM epsilon-SVR



5

k-medoids [11]

k

3. 実　　験

7

4 3

Cut Mix Wait

Crush Peel 5 [2]

5

NAC EMR-9 [12]

$\pm 40^\circ$ $\pm 20^\circ$ 60 Hz

0.1° 1°

640 H 480(V) 2.

7,880

5

SVR

2

F F

precision

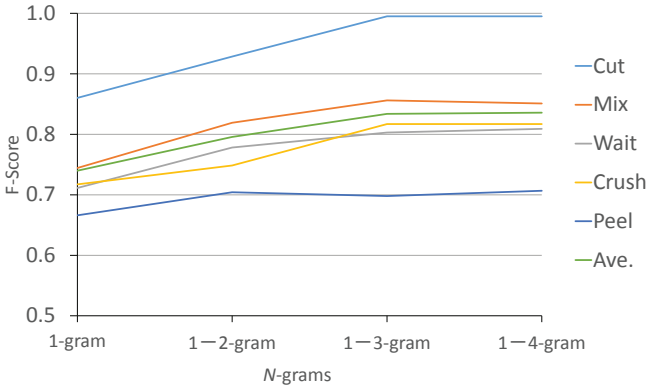
recall

$$F = \frac{2 \cdot \mathrm{precision} \cdot \mathrm{recall}}{\mathrm{precision} + \mathrm{recall}} \quad (4)$$

3.1 事 前 実 験

4

L [13]



6 N-gram

EMR-9 480 pixel 40°

1° 12 pixel

100 ms 1°

60 Hz 1

2 pixel

L 2 pixel H

$H = 5$ pixel

N-gram

N

6 N-gram F

$N = 3$ N-gram N

4-gram

4-gram

3-gram

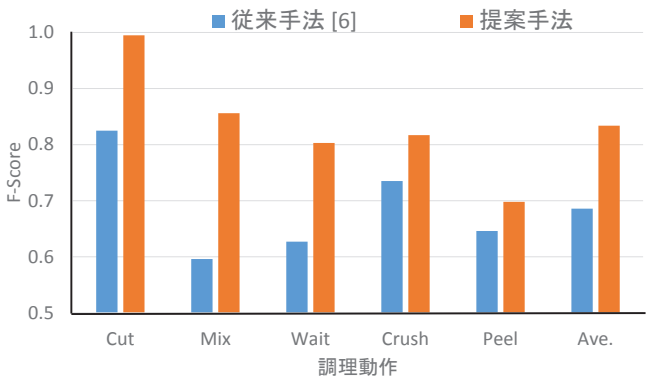
$N = 3$ N-gram

3.2 比 較 手 法

[6]

O Z

24 N-gram



7

8

1-gram 4-gram

4 Wordbook 5

(1) (2)

(3) (4) (5)

3.3 識 別 結 果

7

[6]

F [6]

0.168 0.854 Wait 9

9

3.4 特徴量間の比較

O Z

[6] O Z *N*-gram

O Z

8

Mix , Wait

Peel

3.5 多クラス分類による比較

2

Confusion Matrix

Cut , Mix , Wait

Crush , Peel

Mix recall

precision

Mix

4. む す び

5

2

N-gram

5. 謝　　辞

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