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Hand Detection using AdaBoost

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Abstract: In this paper, we present hand database automatic generator and hand detection logic using AdaBoost. To generate hand database, we acquires videos using webcam on restrict conditions: posture, background, number of human and so on. After the video acquired, face is detected frame by frame on the videos. On the face region, color of face is analyzed to generate skin color model. Based on skin color model, hand candidate regions are detected. Only one region may exist except face region because of restricted condition. The region of hand is clipped and is saved. By this method, hand database is generated automatically. Once hand database is generated, none-hand database is also generated by randomly clipping the region. Using hand and none-hand database, Fist Look Up Table (FLUT) is generated by using AdaBoost training algorithm. Detecting hand is similar to the method of hand database generation.
Keywords: Hand Detection, AdaBoost, HRI

I. INTRODUCTION

Interacting human and robot is one of the active research topic. Keyboard, mouse, and joystick classically are used for Human Robot Interaction (HRI)[1]. In these methods, users need to carry external interface devices to control robots. So nowadays, many researchers try to do HRI using vision or voice[2]. In case of vision, to recognize human gestures is most important part. And most of gestures are made by hand and arm. Therefore, detecting hand is necessary for HRI. To detecting hand, there are two main methods: marker based and marker-less. Without marker, skin detection or pattern analysis are used. However, detecting hand is difficult and its detection ratio low because of various shapes of hand and illumination changes. We detect only fist to avoid difficulty of hand detection. In this paper, we propose fist detection system using AdaBoost. First of all, we made fist database and trained it by AdaBoost. FLUT is made by the result of training. Using FLUT, we should rapidly detect hand with high detection ratio.

II. AdaBoost

AdaBoost[3] is an aggressive mechanism for selecting a small set of good classification functions which nevertheless have significant variety. Drawing an analogy between weak classifiers and features, AdaBoost is an effective procedure for searching out a small number of good "features". A weak classifier ($h_j(x)$) consists of a feature ($f_j(x)$), a threshold (θ_j), and parity (p_j) indicating the directions of the inequality sign:

$$h_j(x) = \begin{cases} 1, & if \;\; p_j f_j(x) < p_j \theta_j \\ 0, & otherwise \end{cases}$$

In Table 1 shows the AdaBoost training procedure and right side value of the final strong classifier $\frac{1}{2}\sum_{t=1}^{T}\alpha_t$ is the threshold for detecting objects.

Table1. The AdaBoost Algorithm

- Given example images $(x_1, y_1), \ldots, (x_n, y_n)$ where $y_i = 0, 1$ for negative and positive examples respectively.
- Initialize weights $w_{1,i} = \frac{1}{2m}, \frac{1}{2l}$ for $y_i = 0, 1$ respectively, where m and l are the number of negatives and positives respectively.
- For $t = 1, \ldots, T$:
  1. Normalize the weights,
     $$w_{t,i} \leftarrow \frac{w_{t,i}}{\sum_{j=1}^{n} w_{t,j}}$$
     so that w_t is a probability distribution.
  2. For each feature, j, train a classifier h_j which is restricted to using a single feature. The error is evaluated with respect to w_t, $\epsilon_j = \sum_i w_i |h_j(x_i) - y_i|$.
  3. Choose the classifier, h_t, with the lowest error ϵ_t.
  4. Update the weights:
     $$w_{t+1,i} = w_{t,i}\beta_t^{1-e_i}$$
     where $e_i = 0$ if example x_i is classified correctly, $e_i = 1$ otherwise, and $\beta_t = \frac{\epsilon_t}{1-\epsilon_t}$.
- The final strong classifier is:
  $$h(x) = \begin{cases} 1 & \sum_{t=1}^{T} \alpha_t h_t(x) \geq \frac{1}{2}\sum_{t=1}^{T} \alpha_t \\ 0 & \text{otherwise} \end{cases}$$
  where $\alpha_t = \log \frac{1}{\beta_t}$

IV. Hand DataBase

We generate a hand database automatically. Before generating the hand database, we record a video clip with only one person who is forwarding a hand. And then, we execute our automatic hand database algorithm on this video clip. Fig1 shows a algorithm of automatic hand database generation. We detect a face on the gray image by MCT based face detector[4]. Skin color model based on YCbCr is generated by analyzing pixel of the face location. Using the skin color model, we detect hand candidate regions except face region. When we make video, we restrict the posture of the human and

background. Only one hand candidate region exists. To find boundary of the hand candidate region, we use corner detector. We extract hand image by boundary of the hand. The extracted images are resized to 20x20. The hands are stored to video clip. None-hand DB is generated randomly.

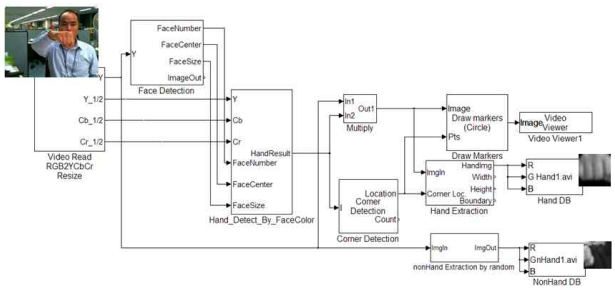

Fig.1 Automatic Hand Database Generation

V. Hand Detection

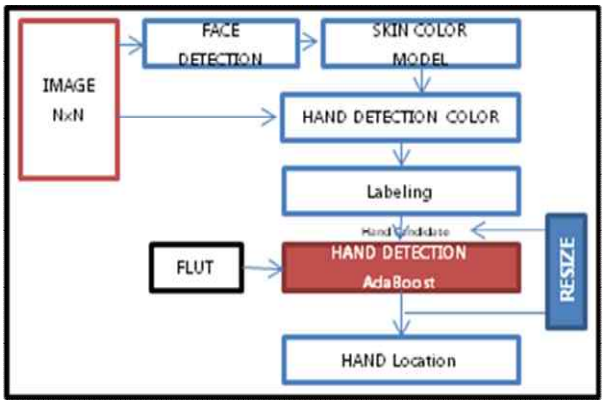

Fig.2 Hand Detection Method

Fig.2 describes hand detection method. Before detecting hand, we find face location to make skin color model. The skin color model is used to generate hand candidate regions. Among the hand candidate regions, face location is eliminated and hand is detected by AdaBoost. To detect various size of hand, hand candidate region is resized repeatedly until the size of image become 40x40 which is image resolution of hand data base.

VI. Experimental Result

To detect hand, we made hand train DB which is capture with 2 people by Microsoft VX-500. The training DB consists of 2427 hand image and 3450 non-hand. Fig.3 shows the train database. The size of image is 20x20. After making database, we trained hand DB by AdaBoost. Consequently, we generated FLUT. Fig.4 describes the result of hand detection.

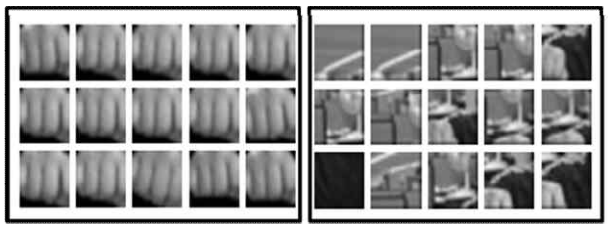

Fig.3 Hand and Non-Hand Data Base

Fig.4 Hand detection Result

VII. CONCLUSION

We presented hand detection by AdaBoost and generated hand database automatically. After that hand db was trained by AdaBoost with six haar features. The train result is FLUT whis is used to detect hand. To increase detection ratio, regions of hand candidates are generated by face detector and skin color model. In the future, we'll collect more hand and non-hand images, and apply the hand detection result to human computer interaction or human robot interaction.

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