Development the Hand Color Detection System for Hand Gesture Front of the Face

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Abstract. In recent years, Intuitive style operations and the user-friendly operations are necessary for the future computer interaction. HMD and camera devices are usually used on those style systems and research. For beginner operators, HMD is easy devices at anywhere and anytime. But there are some problems. Especially, the hand detection is difficult. The hand area has specific dynamic colors. It is not robust for illumination change and individual difference of flesh color. For those problems, our research selects the color distribution of hand area for the gesture operations. Our method renews color distributions dynamically about hand areas by the characteristic tracking. This method has robustness at illumination change and individual difference of flesh color. In addition, this method runs only processing of tracking area. It cuts calculation cost. The implementing the proposal method has an advantage at real time.

Keywords: HMD, User interface, Cognitive exercise therapy, Hand color detection.

1 Introduction

Intuitive style operations and the user-friendly operations are necessary operations for the future computer interaction as UI. Because these techniques are possible to work the hand gesture using the hand detection techniques. HMD and camera devices are usually used on those style systems and research. Our proposed system has the same approach. For beginner operators, HMD is easy devices at anywhere and anytime. But there are some problems. Especially, the extracting hand area is not robust. The hand area has specific dynamic colors. It is not robust for illumination change and individual difference of flesh color. This problem has been solved by many approaches. Muto's method used the brightness gradient [1][2]. This method is learning a specific area and SVM makes clusters by the brightness gradient. Higashiyama's method uses the pattern matching processing for the 3-D model [3]. Muto's method is robust to illumination change of use of brightness gradient. Higashiyama's method has a low calculation cost. This method detects to pattern matching process. But there are some problems

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about those methods. Mutou's method needs big calculation costs. Because the brightness gradient is the local characteristic values, there are complex calculations on many tiny areas. The Higashiyama's method cannot recognize many hand figures. Because the template sample can not support all hand figures. Our proposal is supporting those problems and doesn’t use color templates and/or figure templates. Our research selects the color distribution of hand area at gesture operations [4]. The method dynamically renews color distributions about hand areas by the characteristic tracking. This method has robustness at illumination change and individual difference of flesh color. In addition, this method runs only processing of tracking area. It cuts calculation cost. The implementing the proposal method has an advantage at real time.

2 The proposed method

We describe the state of the operation target at the beginning. The next, we explain the proposed hand detection method. Left of Fig.1 representing the state of the target operation. Fig.2 shows the hand detection algorithm for the hand gesture interface.

Fig. 1. Operating target (left) and Hand detection (right)

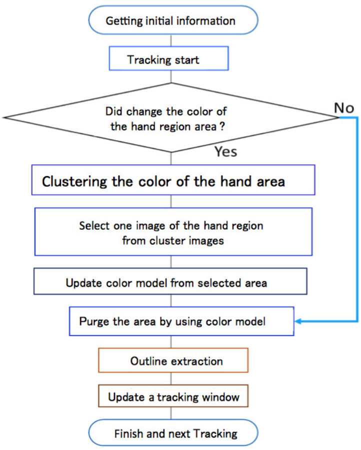

Fig. 2. The hand detection algorithm

2.1 Getting Initial Information

The first step, we set a getting window area and shot one image. The color information is gotten as the initial information. Initial information is different by skin color extraction environment. Therefore, a proposal algorithm always takes first. This method makes it possible to follow with change in skin color caused by individual differences. Also, this method will be robust to the dynamics of the illumination light. The screen is shown in Fig.3.

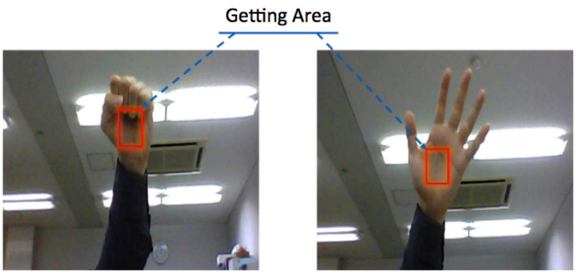

Fig. 3. Getting initial information

2.2 Color Changing of the Hand Region Area

This section describes the determination of the color change of the hand area. If system algorithm wants to track robustly the hand region, then the hand region must keep a color information density above a certain level in the follow-up window. At this time, a change in the color distribution is generated about the hand region of the palm or back of the hand by the Camera's dynamic range. There are same cases lots. When this case, the color information density of the hand region is altered to rough as shown in Fig.4. So the tracking window area has low density in this case.

For the algorithm, the focus point is this nature. If the density of the hand area of the window in the tracking becomes below a certain value, then the algorithm to update the color model. This algorithm was about 0.4 density threshold.

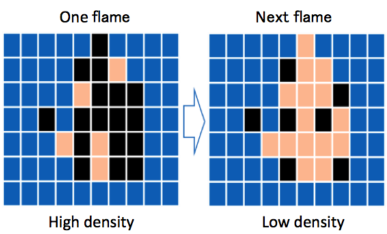

Fig. 4. The color information density on 1st and 2nd flames

2.3 Changing the Color of the Hand Region Area

The hand region is made up of a number of colors among orange, flesh color, yellow, red, and white. Those are depending on a changing illumination. Thus, the algorithm system encloses in a rectangular hand area. The system makes clusters with the color distribution in that rectangle.

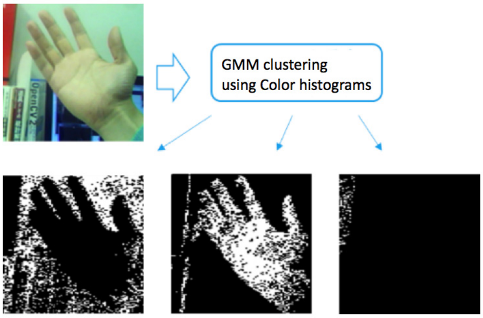

Fig. 5. Result of GMM clustering

Dynamic clustering execution gives the region extraction robust to "individual differences", "illumination changes" and "color disturbances". We have set three-classes as a number of hand region classes. The reason is that area of the hand is a small area. Clustering the subject is a two-dimensional UV histogram of the YUV color space. Gaussian Mixture Model (GMM) was used as the clustering algorithm.

2.4 Following Up the Hand Area

The mean-Shift method was used to hand region tracking technique. The system algorithm sets the initial position and is taken the initial color and position information. After that, tracking is started using your mean-Shift method from that position. Color and Motion likelihood estimation's map is used to mean-Shift method. Tracking density distribution must correspond to the dynamic motion. The likelihood estimation's map is the most effective as tracking density distribution. However, the basic mean-Shift are using the spatial probability density distribution. We do not use the color likelihood directly but also used the cumulative likelihood of colors. This is the color likelihood accumulated by the sampling time. The system also must prevent many tracking other small objects. The first step is to track other objects that exist in the around of the hand region. Next step, the algorithm calculates the collision detection of the hand area of the original. If it's not already collision, this object is not tracked the original object. This process prevents the many wrong tracking. The hand area is included to arm area, is considered. So, the system algorithm successively updates to the shape of the hand region-tracking window of mean-Shift. Tracking is a process the list below.

1. Getting Initial position
2. Createing Various likelihood map
3. Execution of Mean-Shift
4. Collision detection
5. Update Tracking window

2.5 Update of tracking window

Tracking using a mean-Shift Method is enabled. Space probability distribution by dense likelihood map that has been synthesized plays a major role. However, there are other problems in the follow-up of the hand area. If short-sleeved image, distribution is widespread. In the next frame, local value of the density is uniform or 0. Distribution is multimodal. Distribution of part of the elbow and the palm becomes multimodal. Angle of the elbow is changed after this extreme. Distribution of a peak is disappearing in this case. The reason for this is due to the characteristics of the likelihood map, which is combined with the characteristics of the mean-Shift Method.

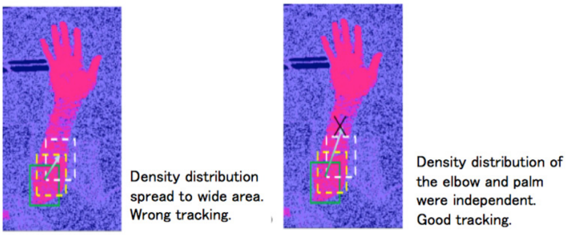

Fig. 6. the untraceable case by mean-Shift method

A basic Mean-Shift method uses a spatial probability density of the tracking window to track objects. However, our likelihood contains the color and movement. That is using the spatial probability density distribution due to the likelihood map. Therefore, it is a problem that the motion likelihoods cause. See Fig.5 In addition, we solved this problem by changing the shape hand region window of mean-Shift method. See.Fig.6.

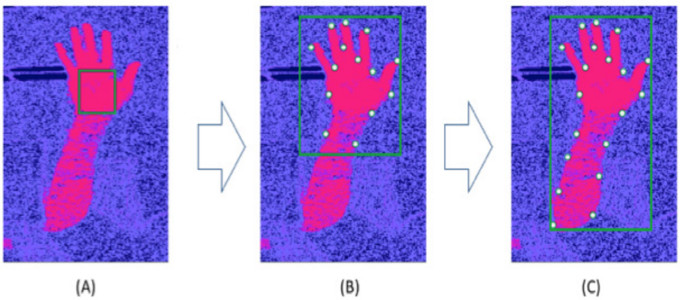

Fig. 7. changing the shape hand region window

2.6 Segmentation

Our algorithm uses a binary region segmentation using Graph Cut method finally. As a result, the system will merge each class. And segmentation of the perfect hand region is established. This study uses color likelihood in that hand region window, which created from the color information in Graph Cut.

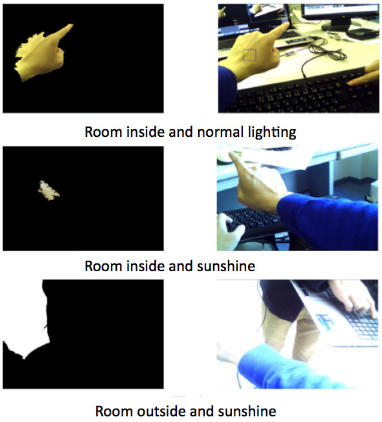

Fig. 8. Experimental and results

2.7 Experimental and Results

We use Intel Corporation CoreTMi5, PC of the experiment. Memory size is 8GB. Moving point camera was used front of the eyes of the camera Wrap920 of Vuzix Corporation. Language is C++ and OpenCV.

3 Conclusion

Algorithms in this study depend on the clustering results of GMM. Processing speed was average 56fps. This delay is a little big. In the experiment, calculating cost of the other regions is large. So the detection was unstable. Further, the influence of the re-sampling is propagated to a subsequent frame. There is a danger that the color model generated as wrong model. It is necessary in order to obtain a robust result that we are considered for a new re-sampling method.

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