

A Study for Vision Based Data Glove with Back Image of Hand

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Abstract

In this paper, we propose new Vision Based Data-Glove with back image of the hand. Although we have proposed Vision Based Data-Glove with palm image of a hand in our previous research, some fingers often are hidden over the palm in back image of the hand. It can estimate hidden finger joint angles by using aspect ratio of hand image, hand area in 2D-image and length of convex hull outline.

Categories and Subject Descriptors (according to ACM CCS): Human-centered computing [Computer Graphics]: Interaction paradigms—Virtual reality

1. Introduction

Researches to recognize hand posture from images is called Vision Based Data Glove (VBDG). They are classified into two groups. One uses database of hand postures [WP], but the problem is that database is so large because of human hand flexibility. Another detects fingertips from an input image [CFAR07]. However, it cannot estimate hand posture when a fingertip is hidden with self-occlusion. In our previous research we have proposed VBDG with palm image of a hand [YFI12]. We assume that fingertips (and a tip of the thumb) can usually be detected from 2D image by using computer vision technology. Then each joint angle is calculated by Inverse Kinematics (IK). When a fingertip is undetectable with self-occlusion, we have assumed that the finger motion is continued for a while, then estimate the fingertip position and calculate angles. In this paper we propose VBDG with back image of the hand. Although we also use CV technique to detect fingertips, they often are hidden over the palm. First the tip of the thumb is obtained by aspect ratio of hand image and thumb's angles are obtained when it is hidden. Then each angle of fingers is obtained by hand area in 2D-image and length of convex hull outline.

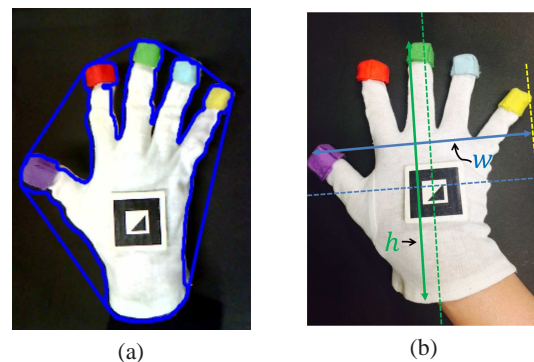


Figure 1: (a) Hand area and length of convex hull outline, (b) aspect ratio h/w .

2. VBDG System

When all fingertips are detected from 2D image, all joint angles are calculated by IK same as a palm image VBDG. Otherwise the system tries to calculate the total angle of thumb's joints. If a tip of the thumb is hidden, it obtains total angle of thumb's joints first by using hand area in 2D-image, length of convex hull outline and aspect ratio of hand image (Fig. 1). Before using it, three dimensional table which has the total angle of thumb's joints as an element has been made (Fig. 2). In addition each thumb's joint angle is estimated from the total value, space did not permit us to insert

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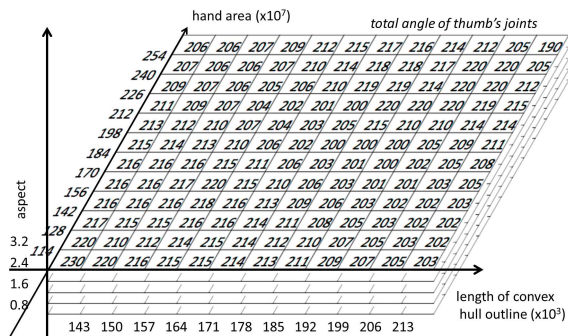


Figure 2: Example of 3D table for total angle of thumb's joint.

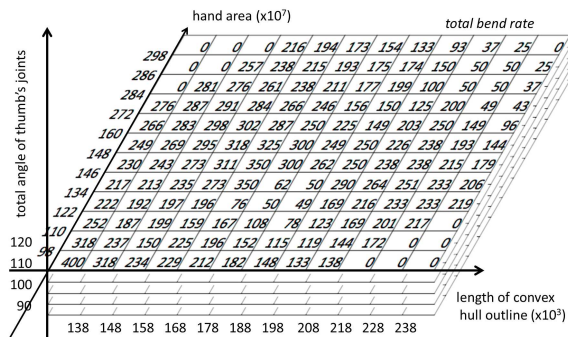


Figure 3: Example of 3D table for total bend rate.

the details.

Then it obtains a total bend rate of four fingers using hand area, length of convex hull outline and total angle of thumb's joints. Another three dimensional table which has a total bend rate as an element has also been made (Fig. 3). Total bend rate is represented from 0 to 400 points, and each bend rate is represented from 0 to 100 percent for each finger (Fig. 4). Finally a part of detectable fingers is taken from the total bend rate, and other finger's angles are estimated like dividing it for the fingers equally. We have to omit the details for want of space.

3. Experiment and Conclusion

We constructed an experiment system to confirm the effectiveness of the method described above. The pilot system detects fingertips using color markers attached on the fingertips, and measures the hand position as 6 degrees of freedom with an ARToolKit marker. Besides the image is assumed as the just at the back of the hand. Fig. 5 shows an experimental result. The left is input image and CG generated with estimated angles. The right is palm side image and CG for confirmation. The hand posture (finger joint angles) can be estimated when the finger is hidden.

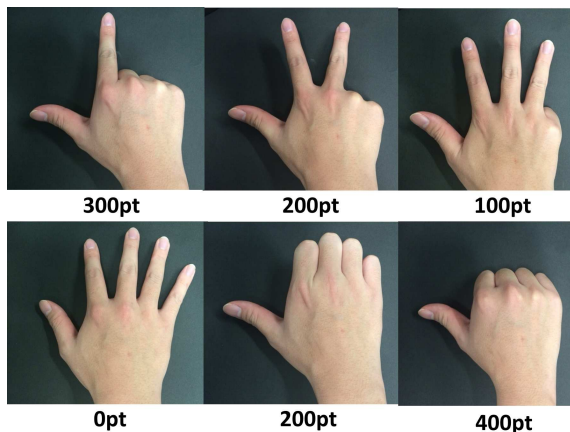


Figure 4: Example of total bend rate.

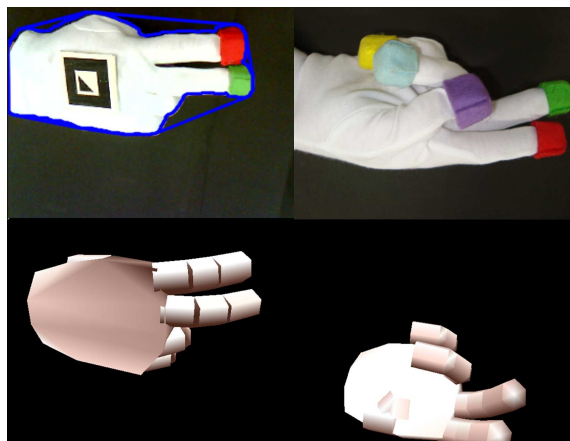


Figure 5: Experimental result.

In this paper, we proposed a new VBDG with back image of the hand. It can estimate hidden finger joint angles by using aspect ratio of hand image, hand area in 2D-image and length of convex hull outline. In the future, we would like to consider the hand position and direction, it means, we should treat multi dimensional table with pitch and roll of a hand.

References

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