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FEATURES OF DEVELOPMENT OF SIGN LANGUAGE RECOGNITION METHODS

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One of the main tasks of hand recognition is to identify the shown static gesture in the presence of a set of reference hand configurations.

Here are the problems that hand gesture recognition systems may face [1, 2]:

– The need for real-time gesture recognition;
– Differences in palm / hand size for different people;
– Features of gestures inherent for different people;
– Noises present in the images of the hand.

Getting a hand image from a range image is considered as a set of two subtasks:

– calculating the position of an arbitrary point of the palm of the hand in the distance image [3];
– getting the image of the hand at the position of the point of the palm.

Consider in more detail the second subtask.

Denote by *dist*(*a*, *b*) distance between points $a, b \in R^n$.

Let there be a recognized point of the palm (x_c, y_c) in the range image *d*(*x*, *y*). Consider the model of the observed object in the form of a set of spatial points {(*x*, *y*, *d*(*x*, *y*))}.

Step 1. A sphere is created around a point $(x_{c,}y_c, d(x_{c,}y_c))$ with radius:

$$\lambda = \left[\frac{C}{d(x_{c,}y_c)}\right],$$

where *C* – some constant that depends on the characteristics of a particular sensor.

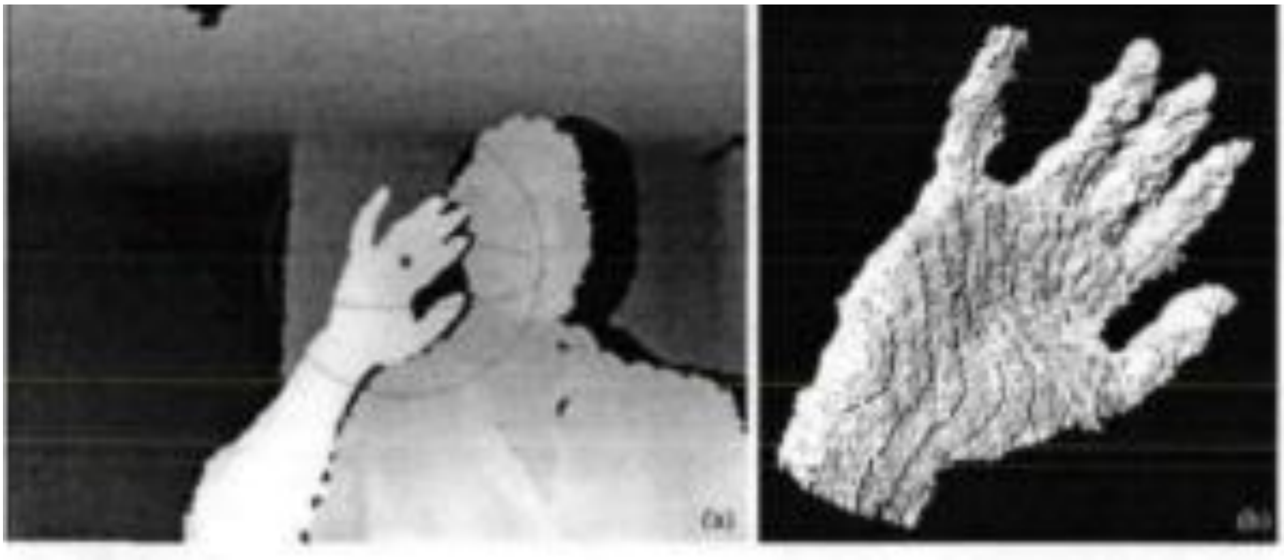
Step 2. All points of the range image are marked (*x*, *y*), for which (*x*, *y*, *d*(*x*, *y*)) are not included in the constructed sphere, i.e. those that meet the condition *dist*(*x*, *y*, *d*(*x*, *y*)), $\left(x_{c,}y_c, d\left(x_{c,}y_c\right)\right) > \lambda$.

Step 3. All points of the range image are marked (*x*, *y*), which are not r_0 -associated with the recognized point of the palm $\left(x_{c,}\ y_c\right)$ in a set of unmarked points.

Step 4. Based on the original image, a new range image with size is created $(2\lambda + 1) \times (2\lambda + 1)$, good to note, that the marked points are defined *d*(*x*, *y*) = *0*.

Processing (extraction) of the image of the hand is carried out for the estimated time *O*(*n*), where *n* – the number of points of the original image [4, 5].

In the Figure 1(a) is shown a range image of a person in the form of a halftone image, the recognized point of the palm and the sphere around this point [6]. In the Figure 1(b) the selected hand image is shown.



(a) (b)

Figure 1 – The image of a man in the form of a halftone image:
(a) – distance image of a person, the recognized point of the palm and the sphere around the found point; (b) – getting of hand image

Note that in the above image, the hand is close enough to the person's face and covers the part of the face that is not an obstacle to obtaining an image of the hand [7].

Theorem. Set of points $\{(x, y) \mid d(x, y) > 0\}$, obtained by the algorithm for extracting the image of the hand, is a discrete figure in the elongated long-range image.

Argument. Note $A = \{(x, y) \mid d(x, y) > 0\}$. To prove the theorem it is necessary and sufficient to prove that the set A is r_0-associated and quantity A is not a subset of another r_0-associated quantity [8].

Let be $\forall (x_0, y_0), (x'_0, y'_0) \in A \Rightarrow (x_0, y_0)$ та (x'_0, y'_0) is a r_0-associated with point $(\lambda + 1, \lambda + 1)$. It follows that $\exists (x_0, y_0), (x_1, y_1), \dots$, (x_n, y_n) and $(x'_0, y'_0), (x'_1, y'_1)$,…, $(x'_m, y'_m) \in A$, such, that (x_{i-1}, y_{i-1}) та (x_i, y_i), (x'_{j-1}, y'_{j-1}) та (x'_j, y'_j) is a r_0-associated neighbors for all values $i \in \{1,2, \dots, n\}$, $j \in \{1,2, \dots, m\}, (x_n, y_n) = (x'_m, y'_m) = (\lambda + 1, \lambda + 1)$.

Consider a sequence of points (x_0, y_0), (x_1, y_1), …, (x_n, y_n), (x'_{m-1}, y'_{m-1}), (x'_{m-2}, y'_{m-2}), …, (x'_0, y'_0). According to the definition of the point (x_0, y_0) and (x'_0, y'_0) is a r_0-associated, that, in turn, means, that quantity A is a r_0-associated.

Theorem proved. It is further considered, that an elongated long-range image of the hand is received.

Recognition of the components of the brush can be reproduced using a static method [6], which is based on recognizing the geometry of the hand (which is a unique biometric characteristic of a person) using special devices that allow you to get a three-dimensional image of the hand (some manufacturers scan the shape of several fingers) [9, 10].

The received data are used to obtain a unique convolution that uniquely identifies a person [11].

There are two main approaches to using the geometric characteristics of the hand. The first of them is based on the geometric characteristics of the hand. The second also introduces the figurative characteristics of the hand (images at the joints between the phalanges of the fingers and patterns of blood vessels).

In the Figure 2 the pattern on the palm is shown, consisting of five main lines (left) and control points and 17 geometric features of the hand (right).

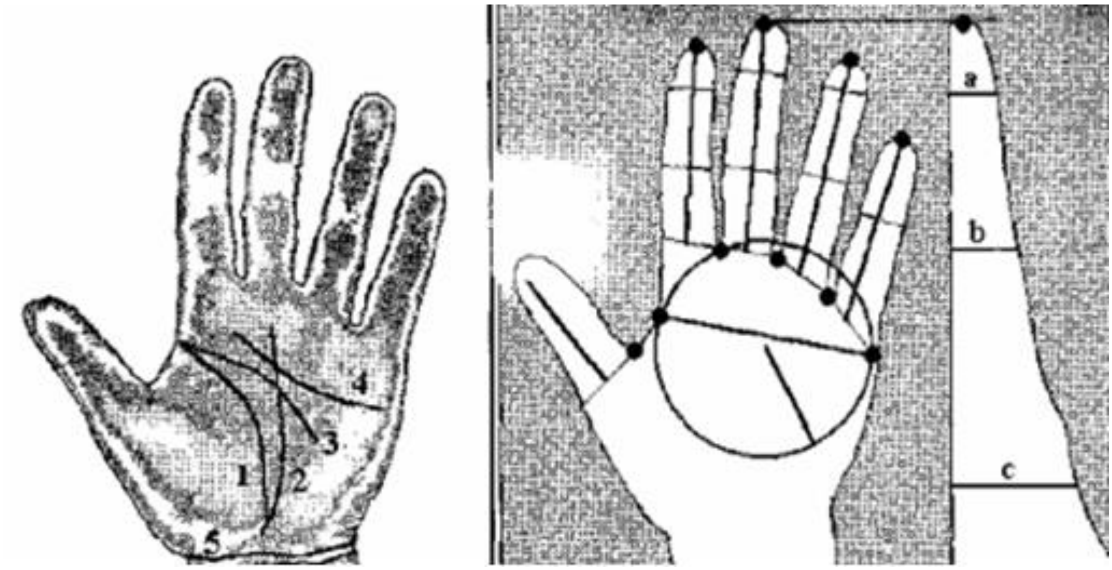


Figure 2 – Image of a human palm

The main geometric features are:

– Palm width;

– The radius of the circle inscribed in the palm;

– Finger length;

– Finger width;

– Hand height in three places.

All these features are combined into a single vector of values [12].

The method of identification by vector of values is quite simple.

First, the user is removed from several projections of his hand. Each of these projections forms its own vector of values. A special class is created based on several value vectors. Then all the features in the class are averaged, the features of the reference image are formed (the center of the class is located) [1, 2, 4].

In the process, the original images can be modified. If you successfully compare the new image with the standard, it can be included in the class of initial features.

You can compare the two images according to several criteria. The most obvious is the smallest distance from the studied image to the standard.

A more complex method involves the analysis of the removal of four characteristics, three of which are characteristic dimensions, and the fourth is a halftone image of skin folds at the bend between the phalanges. This method virtually eliminates the error of the device.

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