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FACE RECOGNITION BASED ON BINOCULAR STEREO RECONSTRUCTION

Three-dimensional modeling is widespread in medicine [1-5]. This allows you to increase the reliability of diagnosis and rehabilitation.

Images of people's faces are used for plastic and reconstructive operations.

Plastic surgery is a surgical specialty involving the restoration, reconstruction, or alteration of the human body. It can be divided into two main categories: reconstructive surgery and cosmetic surgery. Reconstructive surgery includes craniofacial surgery, hand surgery, microsurgery, and the treatment of burns.

While reconstructive surgery aims to reconstruct a part of the body or improve its functioning, cosmetic (or aesthetic) surgery aims at improving the appearance of it. Both of these techniques are used throughout the world.

Implementing the 3-D facial recognition method is a complex task. To solve this problem, we used binocular stereo vision. This method is because the points on the object's surface give images whose relative position depends on the distance to the observation point.

For the implementation of this approach requires two pre-calibrated ca-meras. Since the camera viewpoints in the stereo pair overlap, you can find matches to the same parts of the scene in the stereo pair images. The volume effect occurs because parts of the scene located at different distances from the observer when viewed from different points have different angular displacement, called parallax [1].

One of the main stages of stereo reconstruction is the correct positioning of the cameras. They must be fixed at the same level and rotated to reflect the stereo base. If too small a distance between the points of removal of the left and right frame will significantly decrease the accuracy of determining the depth of pixels in the image, at too big – complicated the problem of finding correspondences.

The essence of reducing to an epipolar stereo pair is to modify it in such a way that for a certain coordinate system, the epipolar lines become parallel to one of its axes and the disparity appears only along this axis.

To achieve this goal, select several well-defined control points on the face and then align the images on the y-axis. At this stage, you can study the images, and if there are points that violate epipolarity, draw a conclusion about the wrong positioning of the cameras or a high level of interference.

The difference between conjugate points on the x-axis will be a disparity. The distance to an object is inversely proportional to the disparity, and the distance to nearby objects can be measured more accurately than to distant ones. Note also that the disparity is proportional to the distance between the centers of the lenses, so with a fixed error in measuring the disparity, the accuracy of determining the depth will increase with the increase in the stereo base — the distance between the centers of camera objects. A depth map is constructed based on the disparity at the control points at a pre-selected scale.

For a calibrated stereo pair we have two projective matrices [2]:

$$\begin{pmatrix} u_i s_i \\ v_i s_i \\ s_i \end{pmatrix} = M_i \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix} \tag{1}$$

where *X, Y, Z* are the three-dimensional coordinates of the point; ui and vi is their projections on the image i; si is the scale factor. Stereo pair: *I = (u, v)* – point of the image plane; *P= (x, y, z)* – point of the world coordinate system.

An area-based algorithm with correlation of image intensity levels (grey levels) is used [1].

$$s = \frac{\sum_{i,j}\Big((I1(x+i,y+j)-\vec{I}1)-(I2(x+dx+i,y+dy+j)-\vec{I}2)\Big)^2}{\sqrt{\left(\sum_{i,j}(I1(x+i,y+j)-\vec{I}1)^2)(\sum_{i,j}(I2(x+dx+i,y+dy+j)-\vec{I}2)^2\right)}} \tag{2}$$

Where I1, I2 are the intensities of the left and right images (stereo), their average correlation values; dx, dy are the offsets along the epipolar line; *S=max (0.1-c)* is the correlation score.

Using the depth buffer data, surfaces are constructed. The result is a three-dimensional three-dimensional impression of the front part. After combining the casts, parts are cut off with a clipping plane to align the volumes. After the set-theoretic subtraction operation, the number of three-dimensional points (voxels) belonging to the object is determined.

$$F(x,y,z) = F_1(x,y,z) \setminus F_2(x,y,z) \tag{3}$$

The fewer voxels that remain, the greater the similarity of the objects being tested.

The method of identification of a person based on the face geometry obtained by binocular stereo reconstruction is considered. The paper presents the principles of camera positioning that allow calculating the disparity, with preliminary reduction of the stereo pair to epipolarity, and identification based on the obtained data.

References

1. Vyatkin S.I., Romanyuk S.A., Pavlov S.V., Necheporyk M.L. Face identification algorithms and its using . *Modern engineering and innovative technologies. Technical sciences. International periodic scientific journal.* 2018. Issue 5. Part 1. (Germany). P. 111-115. *DOI: 10.30890/2567-5273.2018-05-01-078*

2. Sergey Vyatkin, Alexander Romanyuk, Sergey Pavlov and Oksana Romanyuk. Identification of persons using stereo image pairs and perturbation functions. *BIT-MDMM2019: Biometric Identification Technologies Based on Modern Data Mining Methods, EasyChair Preprint*, № 1688, October 16, 2019, P. 1-18 Springer

3. S.I. Vyatkin, S.V. Pavlov, S.A. Romanyuk 3D Face Recognition Using Quadrics With Perturbations . *Наукові праці Донецького національного технічного університету. Серія : Інформатика, кібернетика та обчислювальна техніка. - 2016.* - Вип. 1. - С. 142-145.

4. С. О. Романюк Підвищення реалістичності відтворення зображень людських облич для задач пластичної хірургії, на Міжнарод. наук.-практ. конференції *Електронні інформаційні ресурси: створення, використання*, доступ, м. Вінниця, с. 210–213, 2017.

5. С. О. Романюк, "Діагностичні ознаки для морфологічного аналізу зображень обличчя людини для проведення пластичних і реконструктивних операцій", на Міжнарод. наук.-техн. конф. *Комп'ютерна графіка та розпізнавання зображень,* Вінниця, 2018, с. 211–215.