Contours Identification in Modelling Facial Silicone Epistasis

SERBAN ROSU1*, NICUSOR ALIN SIRBU2, ROMULUS FABIAN TATU3
2SIM Timisoara, 30 Mihai Viteazu Blv., 300222, Timisoara, Romania
3University of Medicine and Pharmacy “Victor Babes” Timisoara, 2 Eftimie Murgu Sq., 300041, Timisoara, Romania

To achieve a modeling of the epithesis as close as possible to the lost organ, information on its size and shape can be registered by using computed tomography and 3D reconstruction. This paper aims to investigate to what extent the recording geometry of facial regions using computed tomography and identify on the sections of computed tomography the contour of the region to be reconstructed for virtual modeling of future silicone epithelium can be achieved. The results were obtained by applying the algorithm described in C++ program and contour detection in computed tomography images recorded preoperatively in patients who were to receive resection surgery of a facial region followed by reconstruction of the defect by facial epithesis.

Keywords: acrilic resins, contour detection

Experimental part

The main steps in making silicone epithesis are: patient examination and treatment plan development, imprinting the prosthetic field, casting the working model, achieving the wax layout of epithesis, layout trial in in practice, preparing silicone color, packing the layout and carrying out the stencil/pattern, tamping the silicone in the printer, cooking, unpacking and finishing denture and adaptation of the epithesis to the patient (fig 1).

We can intervene in the stage of preparing the layout by preoperative registration of the geometry of the region to be resected and transferring the data through 3D printing in order to make the model. Registration of the spatial geometry is done according to two-dimensional computed tomography sections. The first step in image processing of tomography is to identify the contours of the various components that make up the image.

A contour detection method is to calculate the grayscale gradient of the image section at each point [3, 6]

\[
\vec{G} = (G_x, G_y) \quad G_x = \frac{\partial I}{\partial x}(x, y) \quad G_y = \frac{\partial I}{\partial y}(x, y)
\]

Contour direction can be determined considering that the gradient is perpendicular to the contour at each point. Different contour points will be determined by comparing the gradient with a chosen value.

The digital image is composed of points with different gray values \(g(i, j)\) located at unitary distances. These correspond to different brightness \(I(x, y)\). It can be written as following:

\[
G = \sqrt{(g(i, j) - g(i + 1, j))^2 + (g(i, j) - g(i, j + 1))^2}
\]

or:

Fig 1. Steps to achieve a nasal wing epistasis
Fig 3 a. Identification of the bone contour on computed tomography section, b. Outer surface of a 3D reconstruction based on CT sections

Silicones can be used successfully in epithesis of patients with large defects resulting from resection surgery of various facial tumors. In the modeling of silicone epithesis the tridimensional digital methods play an important role because of the opportunities they offer in copying original facial geometry of the patient.

References
6. HADAR A., BORDEASU I., MITELEA I., VLASCEANU D., Mat. Plast., 43, no.1, 2006, p.70

Fig 2. Quick method for calculating the gradient contour direction when taking into account formula signs and relative independence of the threshold in relation to the type of image.

Roberts approximation that uses cross differences (fig 2) improves contour detection in situations where the gradient varies very little [4]. It can be written:

\[
|G| = |g(i, j) - g(i+1, j+1)| + |g(i+1, j) - g(i, j +1)|
\]

By comparing \( |G| \) with a threshold value \( T \) we can obtain: \( |G| \geq T \), situation where the point is on the contour, or \( |G| < T \), situation where the specific point is not included in the contour[3].

Results and discussions
The results were obtained by applying the algorithm described in C++ program and contour detection in computed tomography images recorded preoperative in patients who were to receive resection surgery of a facial region followed by reconstruction of the defect by facial epithesis. By 3D integration of contours we were able to achieve 3D model of the region and therefore the virtual model of epithesis (fig 3).

The 3D surface of the model represents the union of all contours determined from the section images. Therefore, the determination of individual contour for each section depends not only on precise determination, but also on the possibility of achieving spatial continuity of several contours. A very useful tool for spatial linking of contours is Hough transformation [5].

Conclusions
This paper presents the contour shaping of the various elements of an image based on the transformation principles envisaged by Hough. The algorithm shows the possibility to improve silicone epithesis modeling skills based on the three-dimensional model of facial extremity registered with CT. The advantages obtained in this case are: relatively low volume of calculation, obtaining the contour direction when taking into account formula signs and relative independence of the threshold in relation to the type of image.

Silicones can be used successfully in epithesis of patients with large defects resulting from resection surgery of various facial tumors. In the modeling of silicone epithesis the tridimensional digital methods play an important role because of the opportunities they offer in copying original facial geometry of the patient.