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COMPARATIVE ANALYSIS OF 3D-FILTERS EFFICIENCY IN THE NI LabVIEW

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Abstract. *Many applications in biomedical engineering currently require the use of 3D filters. This is connected with production of prototypes of prostheses based on 3D - reconstruction of series of CT or MRI images, and with diagnostics based on 3D comparisons of paired or symmetrical organs. At the same time, such a situation has arisen that if there are a developed toolkits of 1D and 2D filters, they are lacking in 3D case. The work offers options for implementing such filters in the software environment NI LabVIEW and comparative analysis of their effectiveness for biomedical applications.*

Key words: *3D filter, 3D reconstructions, prototypes of prostheses, NI LabVIEW.*

Introduction.

Recently, in the field of biomedical engineering, there has been a need to use 3D filters of various types and in various software environments. This is related to the actual tasks of prostheses prototypes manufacturing based on 3D - reconstruction of CT or MRI image series, and to diagnostics based on 3D comparisons of paired or symmetrical organs. The fact is that the direct 3D reconstruction of a series of CT or MRI images has a very uneven surface, which makes it difficult to manufacture prototypes of prostheses based on them. And when diagnosing paired or symmetrical organs by comparing their 3D reconstructions, too fine detailing at the voxel level prevents the detection of larger diagnostic signs.

The purpose of the work is a comparative analysis and optimization of proposed implementations of 3D filters in the NI LabVIEW for biomedical applications.

Main text.

The proposed 3D filters are created in the NI LabVIEW software environment [1], but the general algorithms and results of comparing their efficiency can be generalized for other implementation options in other software environments.

An example of a block diagram of one of those proposed and implemented in the NI LabVIEW filters (median filter) is shown in Figure. 1.

In a similar way (but using other algorithms), other 3D filters are built: arithmetic mean averaging filter and Gaussian.

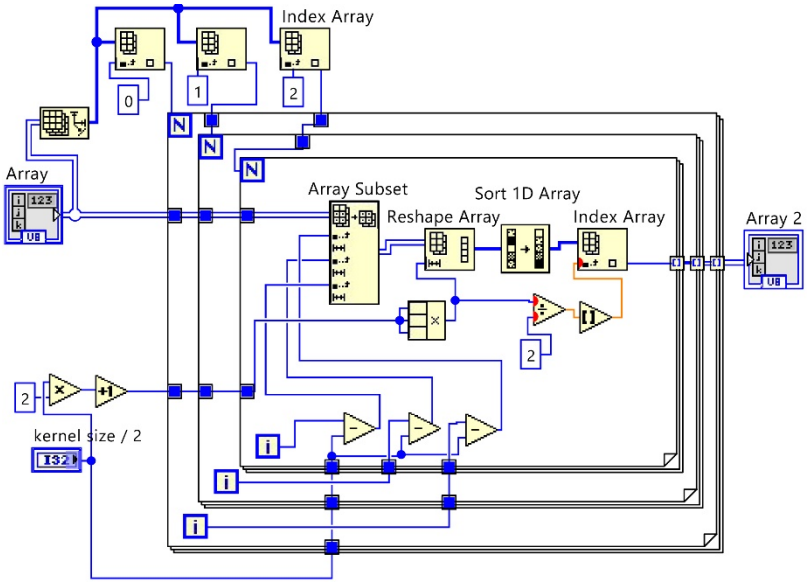

Figure 1 – Block diagram of median 3D-filter

Illustration of 3D reconstruction is done using the library function of the NI LabVIEW environment "3D Image Reconstructor" [2, 3]. A set of layer-by-layer CT images of the knee part of patient's legs, which without preliminary processing have a rather complex spatial structure, was chosen as the object sample for comparing the efficiency of 3D reconstruction.

The essence of the proposed procedure consists in preliminary filtering of a 3D array of voxels created from a set of layer-by-layer CT scans. After that, a 3D reconstruction of the object takes place using "3D Image Reconstructor" and display results on the standard NI LabVIEW environment screen.

For convenience of comparing the results of filtering with proposed 3D filters and their combination, the obtained images are collected together (Figure 2).

Summary and conclusions.

The paper proposes and implements variants of 3-dimensional filters in the NI LabVIEW software environment for preprocessing of objects 3D reconstruction and a comparative analysis of their effectiveness for biomedical applications.

As can be seen from above results, the double Gaussian and median 3D filter has the most effective smoothing property, the result of Gaussian 3D filter looks a little worse. Other options are significantly worse.

References:

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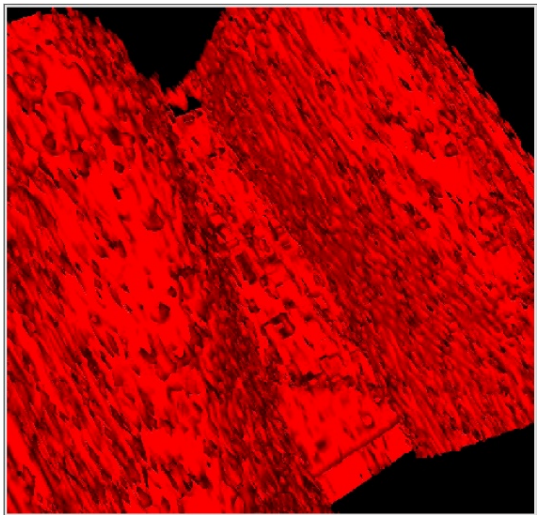
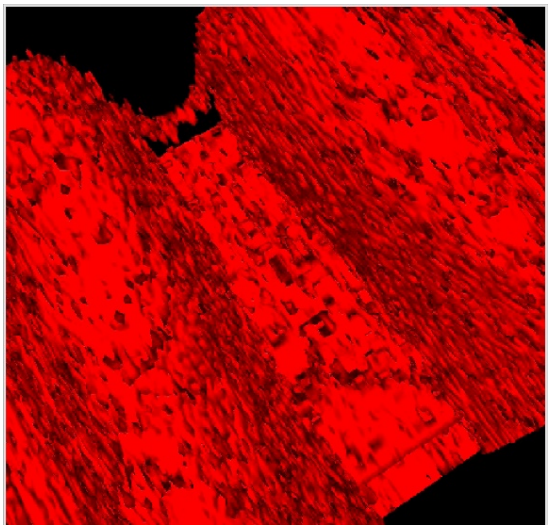
2. Alliez, P., Ucelli, G., Gotsman, C., & Attene, M. (2008). Recent advances in remeshing of surfaces. In Mathematics and Visualization (9783540332640 ed., pp. 53-82). (Mathematics and Visualization; Vol. 0, No. 9783540332640). Springer Heidelberg. https://doi.org/10.1007/978-3-540-33265-7_2

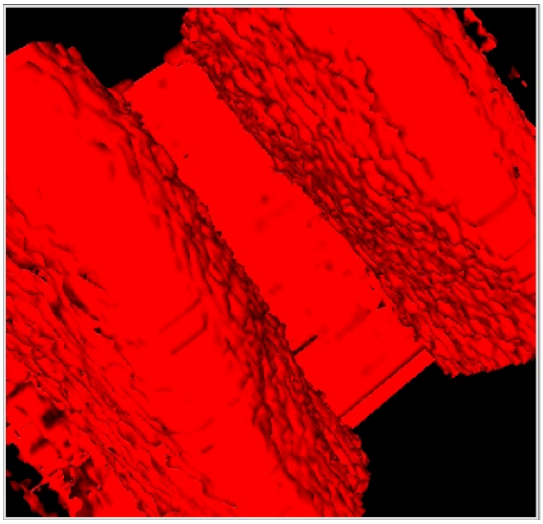
3. Official site National Instruments (NI) [Electronic resource] // – Resource access mode: https://www.ni.com/docs/en-US/bundle/labview-biomedical-toolkit-api-ref/page/lvbiomed/bio_med_image.html



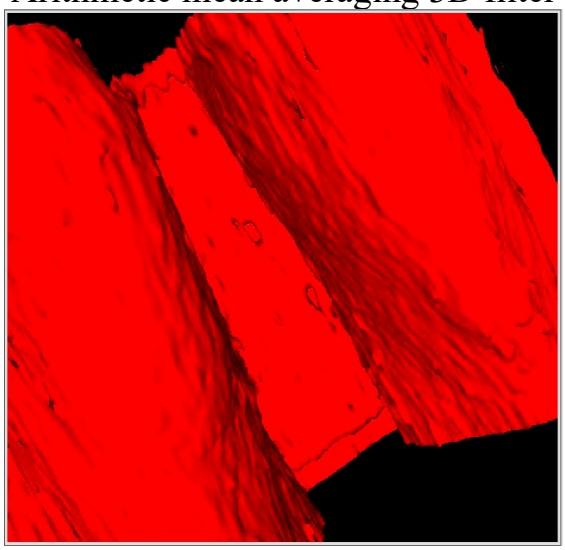
Without filters



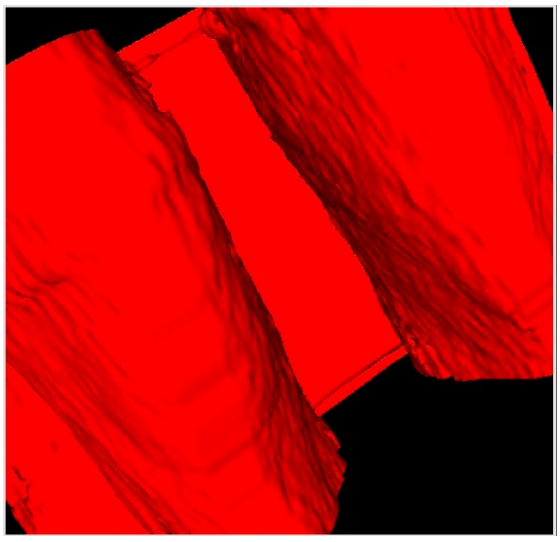
Arithmetic mean averaging 3D filter



Median 3D filter



Gaussian 3D filter



Gaussian and median 3D filter

Figure 2 – Comparison of processing results with different types of 3D-filters

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