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Influence of X-Radiation in Receiver System on Reconstruction Performance of Projection Tomography

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Abstract—It is investigated tomogram recovery accuracy dependences on radiation redistribution layer between receiver system parts. Developed model of multi-unit receiving system allows to change its characteristics. We have calculated boundary redistribution characteristics, that provides one-valuedness of tomogram restoration.

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Many recent applied scientific investigations are directed to development and improvement image reconstruction methods in computed tomography, that can give an opportunity to reduce an influence of different artifacts on tomogram reconstruction performance. The basis of tomogram construction is representation of reconstructed two-dimension distribution of absorption factor X-radiation by tissue. Reconstruction accuracy depends on account level of radiation propagation character in a source-detectors system. Since mentioned above applied problem is urgent we propose new optimized methods of reducing an artifacts influence in projection tomography.

Problems of development and optimizing of reconstruction methods are considered and compared in paper [1]. Authors of paper [2] consider the methods of elimination of artifacts of high density presence in bone tissue for computed tomography reconstruction. In the paper [3] they attend new methods of artifacts influence minimization in tomography image reconstruction using minimal amount of data. In following paper they consider characteristics and methods of reduce an influence of limit and superposition artifacts [4]. For noise abatement it is used a photon count detector. Such detectors assign weight of every received photon, the weight factor is a value, proportional to photon energy. They conducted reconstruction estimation using water cylinder with diameters 14 and 20 cm, including bone tissue and low-contrasting particles. Here X-ray tubes with quantum energy 120 and 90 kV are used. It is defined, that using such detectors enables to overcome partially the artifact [5].

Now we consider a tomogram reconstruction using mathematical modeling, taking into consideration radiation redistribution between detectors, uniformity of distribution is defined by Gaussian curve. An aggregate radiation intensity can be specified as $I_0 = \sum_i a_i I_{0i}$. Radiation redistribution in source-detectors system is described using weight factors of radiation influence on detectors. Reconstruction goes using calculated projection data. Obtained reconstructed tomograms with taking into account radiation redistribution and without it, comparison histograms are represented in Figs. 1, 2. The investigations were carried out for different weight factor sets (Table 1).

To estimate obtained reconstructed images we calculate quantitative parameters of image identity, defining different aspects of quality, D is a normalized mean-square measure of comparison. A great spread in values of small region leads to great value of parameter D:

$$D = \left[\left\{ \sum_{i=1}^{M} \sum_{j=1}^{N} (F_{i,j} - Z_{i,j})^2 \right\} \Big/ \left\{ \sum_{i=1}^{M} \sum_{j=1}^{N} (F_{i,j} - \bar{F})^2 \right\} \right]^{1/2},$$

r is a correlation factor: