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INFORMATIVENESS OF X-RAY IMAGES OF HUMAN BODY

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ABSTRACT

"Cleaning" the image from the imperfectness of the imaging system, should be the main preprocessing task before any further enhancement and processing. Carefully estimate of the quality of the imaging devices, i.e., knowing the apparatus function, together with estimation the sort and magnitude of noise in the image would improve spatial resolution significantlyю It is found that in the both restored images, the spatial resolution is improved, although the best result is depicted, where a frequency dependant estimate of the noise/signal power ratio is done via respective autocorrelation functions.

Keywords: *human body, X-ray*

The Physical theories allow us to make predictions: given a complete description of a physical system, we can predict outcome of some measurements. This problem of predicting the result of measurements is called the forward problem. The inverse problem consists of using the actual result of some measurements to conclude the values of parameters that characterize the system. While forward problem has (in deterministic physics) a unique solution, the inverse problem does not. Because of it, in the inverse problem, one needs to make explicit or implicit any available *a priori* information on the model parameters. One also needs to be careful in the representation of the data uncertainties.

Transmission X-ray radiography, which has been used for over 100 years, is based on the partial absorption of X-rays in material, which depends on thickness (x) and the material-dependent absorption length (λ) through D'Alember's Law,

$$I(x) = I(0)\exp(-x/\lambda) \tag{1}$$

which describes the exponential decrease of beam intensity with thickness [1]. An image in medicine represents the spatial distribution of the patient tissue components within the field of view. Visualization of important details requires separation of the "structures of interest" against the "background" (e.g. in mammography (a special kind of breast radiography), micro-calcifications in the breast glandular tissue) [2]. The quality of the various components of the imaging chain (focal spot, imaging geometry, image receptor, video camera and amplifier, image processing software, image display) has also influence on the image signal, obtained at the viewing station.

Extracting useful information from such image is an inverse problem with a typical property, the so-called ill posedness. The ill-posed problem means that little non-avoidable errors in the measured values can lead to significant changes in the solution [3]. This problem has been understood and methods for overcoming difficulties due to this property have been developed [4]. Computer-supported techniques play an important role in the feature extractions from an image [5, 6].

In this paper, the Wiener filter is applied to images in mammography to get rid off of imperfectness of imaging devices [7, 8]. Matlab software was used for the image processing. Typical results are depicted below.

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The blurred, noisy image is depicted in Fig. 1. This is the raw image of the bar-pattern, estimated to be convolved with Gaussian as a model of imperfectness of the image devices (standard deviation 2), and added white noise (zero mean and standard deviation approx. 10% of mean signal). The bar-pattern was used, instead of a real breast, due to better visualization of the results. Namely, restoration process should increase spatial resolution and this case can be seen easily.

Restored images are depicted in Fig2. a), using methodology with scalar estimate of the noise/signal power ratio (NSR). In other words, only the total amounts of power in the noise and in the image is provided and their frequency dependence is not supplied 1, and b) using methodology 2, with frequency dependant estimate of the noise/power ratio.

It is found that in the both restored images, the spatial resolution is improved, although the best result is depicted in 2b) where a frequency dependant estimate of the noise/signal power ratio is done via respective autocorrelation functions.

"Cleaning" the image from the imperfectness of the imaging system (x-ray mammography unit), should be the main preprocessing task before any further enhancement and processing. Carefully estimate of the quality of the imaging devices, i.e., knowing the apparatus function, together with estimation the sort and magnitude of noise in the image would improve spatial resolution significantly. Artefacts created by Wiener filter, as a most objective, would be negligible.

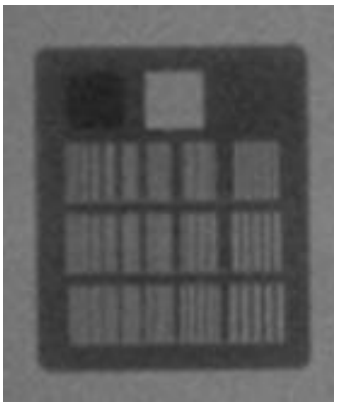
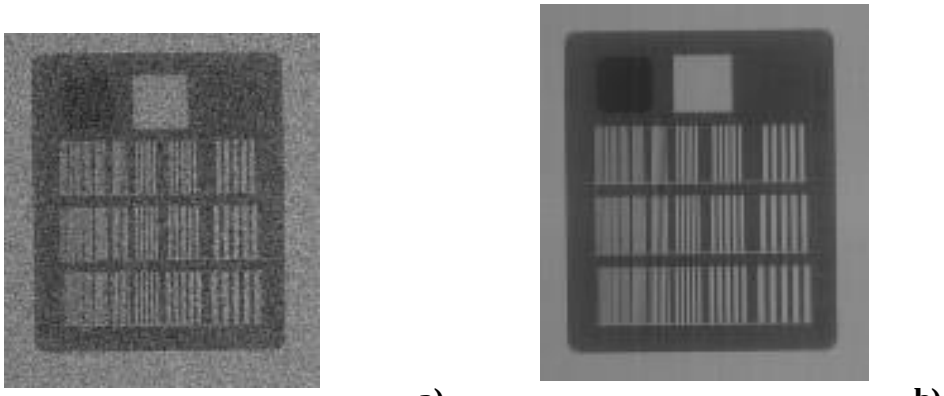


FIGURE 1. The blurred and noisy image of the bar pattern



a) **b)**

FIGURE 2. The restored images by using methodology 1 a) and methodology 2 b) Further investigation is needed, for the cases where the apparatus function and noise is overestimated or underestimated. That could be closer to the realistic cases.

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