ImageJ based segmentation, processing and evaluation of digital radiology phantom images

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Introduction:

In digital radiology it is state of the art to perform specialised procedures to estimate the image quality of the complete system on regular bases. This is done using dedicated phantoms.

In general the images taken with these phantoms have to be evaluated manually by a visual observer. This procedure is, depending on the test, very time consuming. To reduce the evaluation time the Open Source quality control tool for medical images - Optimage - was developed. The Optimage software package supports various modalities and phantoms [1,4].

This work describes the used image processing methods for the segmentation and evaluation of the projection radiography module based on the German DIN 6868-13 (Constancy testing of projection radiography systems with digital image receptors) standard [2].

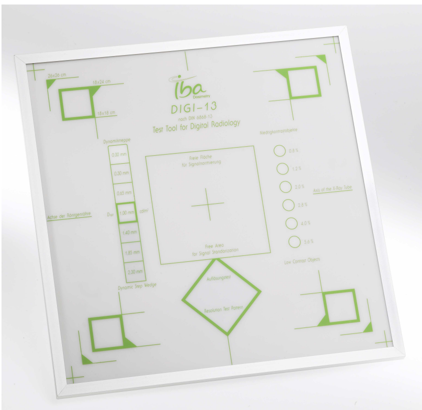


Figure 1: Phantom conform to the german DIN 6868-13. Used for Constancy testing in digital projection radiography

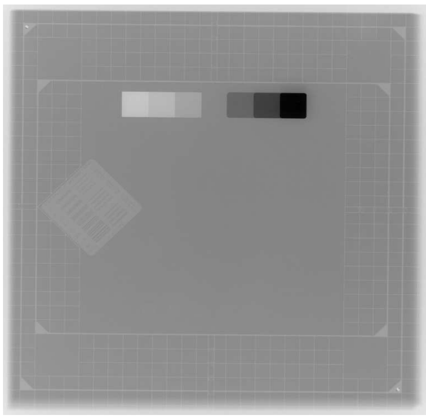


Figure 2: X-ray image of the phantom

Materials and Methods:

The phantom DIGI-13 from IBA Dosimetry was selected as test phantom, it contains a x-ray absorbing grid which will be used for segmentation. For the segmentation of the phantom features, an ImageJ plugin was written. This plugin is designed to deliver a polygon ROI containing the phantom features.

Therefore ImageJ embedded functionality and features of Thomas Boudiers snake plugin [3] are used.

To verify the function of the developed plugin a set of 50 images from 3 different x-ray unites with bracketing radiation settings was aquired. The images where taken for two voltages (70kV and 100kv) with exposure settings from 1mAs to 125mAs.

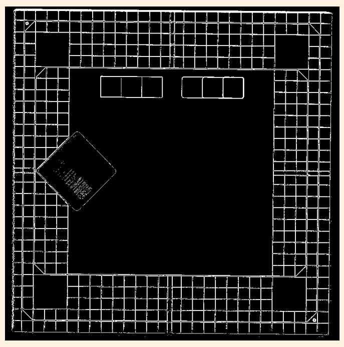
Results:

The workflow of the plugin is parted into three phases:

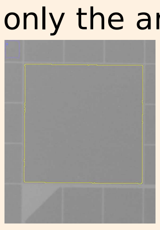
- image post processing
- segmentation of features
- classification of found features

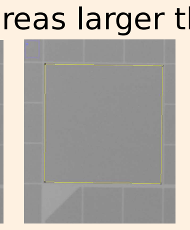
As return value of these steps a polygon ROI of the inner Light Field is displayed.

1. **Image Preparation**:
In this initial step potential existing noise is reduced. The grid lines of the phantom are accentuated to get a exact result during thresholding.



2. **Segmentation**:
The Segmentation process itself is realised by using the build-in Paricle Analyzer with parameters to get only the areas larger than the small squares inside the grid. The resulting ROI are converted to Polygon ROI by line fiting the borders.

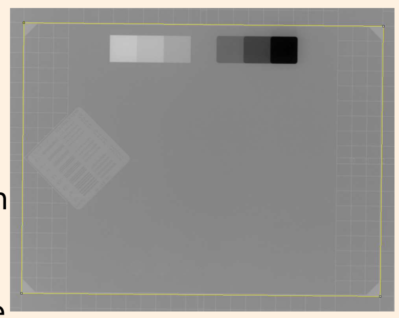




3. **Classification**:
The aquired set of ROI is now classifed. Therefore geometrical rules are used (number of corner point, angle between the points and the size are taken into account). Additionally the average grey values of the ROI is used to distinguish the white and black step of the step wedge. Due to the fact that the white and the following grey step are in cases with low doses not clearly differable, the snake plugin of Thomas Boudier is used to get exact seperated ROI. The orientation of the phantom image is checked by the location of the step with the lowest x-ray absorbtion. To get the final ROI which will be the basis for the following image evaluation. The approximately positions of the for the inner corner crossings (marked with triangles) is calculated using the already extracted features. To get the corners more accurate the area is analysed seperatly, using the build in edge detection and skeletonize functions of ImageJ.

Conclusion:

The plugin is tested with a set of 50 images from different digital radiology unites. With a detection rate of > 80%.
The not detected ~20% are images of very low and high dose.



References:

[1] Optimage central organised Image Quality Control including statistics and reporting: A. Jahnen, C. Schilz, F. Shannoun, A. Schreiner, J. Hermen, C. Moll; Radiation Protection Dosimetry, Oxford University Press (2008).
[2] DIN 6868-13 Constancy testing of projection radiography systems with digital image receptors: NAR; Deutsches Institut für Normung e.V. (2003-02).
[3] Snake plugin: Thomas Boudier; Université Pierre et Marie Curie, Paris, France; http://www.snv.jussieu.fr/~wboudier/softs.html
[4] Optimage homepage: http://www.santec.tudor.lu/projects/optimage

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