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Determination of Radiation Shielding Properties of Fabrics using Image Processing Method

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It is extremely important to protect the human body from radioactive rays. Protective clothing can be used to absorb radiation because it is preferable to avoid the natural and artificial radiation exposure in our daily lives. There are many different types of fabric, used for clothes. In this study radiation absorbing properties of fabrics, which are widely used in the daily life, such as alpaca-type fabric, cotton fabric, cotton polyester blend fabric, woven dyed fabric and knitted fabric were examined using the image processing method.

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1. Introduction

In the world, more than three-hundred nuclear facilities have been used to fulfill the needs in the fields of scientific research, energetics, agriculture and industry. In addition to this, in medical centres radiation has been used for treatment and diagnosis. It has been known for a long time that high-doses of radiation lead to cancer [1]. It has been known that there is a relation between the cancer cases and the radiation sources used in the fields of technology, health and industry.

All organisms are exposed to radiation in a variety of ways, from cosmic rays, coming from the space and Sun, radioisotopes from the Earth's crust and natural sources, such as water and food, to artificial sources [2]. The most important thing for radiation protection is to know limits of tolerance for radiation and to prevent people from working in radiated environments [3]. The aim of radiation protection is to prevent tissue damage effect or to maintain the possibility of occurrence of this effect at an acceptable level. Therefore, the level of exposure to radiation must be as low as possible. All precautions should be taken, because of biological effect of radiation on human health [4].

2. Materials and methods

2.1. Materials

In this study fabrics, which are widely used in the daily life, such as alpaca-type fabric, cotton fabric, cotton polyester blend fabric, woven dyed fabric and knitted fabric, were used. Radiograms of cloths were obtained at Private Şifa Central Hospital, at 55 keV, 130 mA, 3.5 MAS energy, in order to determine radiation absorbance property of the materials. Image on a radiogram is a result of X-ray beam, which has reached the film held by body [5]. Very small part of the X-ray beam, passing through tissues, having high atomic density, reaches the film. It is seen on the film as light grey and white regions [6]. Almost the entire beam, passing through air gaps, without being blocked, reaches the film. Such beam will be seen on the film as dark grey and white. Shading of the film changes from white and grey scale to black, depending on the X-ray permeation through the materials. The adsorbed amount of X-ray beam can be determined using the distribution of shading. This process can be carried out computationally by image processing methods.

2.2. Processing

Shading value, corresponding to cloth with stronger absorption of X-ray radiation, is closer to white, while shading value, corresponding to cloth with little absorption, is close to black. This variation of shading can be distinguished computationally by an image processing method. Digital images of obtained Rontgen films were subjected to pre-treatment and then their sizes were changed to 2350×2350 pixels. Images were converted from RGB colour to 8-bit grey scale format. An image has 256 different colour tones. Zero colour tone corresponds to black and colour tone of 255 corresponds to white. Horizontal and vertical axes represent the ton value and number of pixels, having this color, respectively.

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Radiation Keeping Image Processing Value (RKIPV) can be calculated by dividing sum ($\sum ab$) of multiplication of horizontal excess values a and vertical axes pixel numbers b, by total colour tone value ($\sum a$)

$$\text{RKIPV} = \frac{\sum ab}{\sum a}. \quad (1)$$

If this value is high, radiation absorbance will be high as well. There is a relationship between RKIPV and radiation absorbance [7].

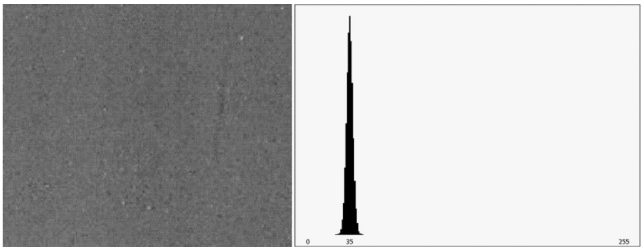

Fig. 1. Digital image transection and digital image histogram of fabric.

Digital Rontgen images of fabrics, taken under 70 keV, were converted to histograms by using a commercial program. Figure 1 shows Rontgen images of fabrics and histograms.

3. Results and discussion

X-ray images, produced for five different types of fabric, used in the daily life, were processed using mentioned program. Three measurements for each sample were made and the average values were taken. Results are given in Table I.

TABLE I

Image processing numerical value.

Type of fabrics	1. meas.	2. meas.	3. meas.	Average
Knitted	0.78	0.77	0.77	0.77
Alpaca	0.74	0.75	0.73	0.74
Dyed woven	0.74	0.73	0.73	0.73
Cotton	0.68	0.68	0.69	0.69
Cotton polyester blend	0.67	0.66	0.67	0.66

4. Conclusions

Radiation Keeping Image Processing Value was calculated using Eq. (1), using data obtained from analysis results of image processing. Radiation absorbing property of fabrics, which are widely used in daily life, such as alpaca-type fabric, cotton fabric, cotton polyester blend fabric, woven dyed fabric and knitted fabric, were examined using image processing method. For the analysed fabrics, the radiation shielding quantities were determined. While the best result was obtained for knitted fabric, the minimum value was obtained for cotton polyester blend. Absorption values of alpaca, dyed woven and cotton fabrics, listed in the decreasing absorbance order, were found to be in between.

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References

[1] N. Petoussi-Henss, W.E. Bolch, K.F. Eckerman, A. Endo, N. Hertel, J. Hunt, M. Pelliccioni, H. Schlattl, M. Zankl, *Ann. ICRP* **40**, 1 (2010).

[2] *Ann. ICRP* **21**, 60 (1991).

[3] D. Saravanan, *AUTEX Res. J.* **7**, 53 (2007).

[4] K. Alexander, B. Dietrich, *Radiological Protection*, Springer, 2005.

[5] I. Akkurt, B. Comak, S. Kılıncarslan, C. Basyigit, *Digit. Signal Proc.* **20**, 1592 (2010).

[6] I. Akkurt, S. Emıkönel, F. Akarslan, K. Günoğlu, Ş. Kilinçarslan, İ.S. Üncü, *Acta Phys. Pol. A* **128**, B-53 (2015).

[7] F. Akarslan, T. Molla, I. Akkurt, S. Kilinçarslan, I.S. Üncü, *Acta Phys. Pol. A* **125**, 316 (2014).