DEVELOPMENT OF NEW METHODOLOGY FOR DOSE CALCULATION IN PHOTOGRAPHIC DOSIMETRY

Teresinha F. L.Daltro, Leticia L. Campos, Homero E.B. Perez

Instituto de Pesquisas Energéticas e Nucleares
Comissão Nacional de Energia Nuclear
Caixa Postal 11049, Pinheiros
CEP 05499-970, São Paulo -BRAZIL

INTRODUCTION

The personal dosemeter system of IPEN is based on film dosimetry. Personal doses at IPEN are mainly due to X or gamma radiation.

The use of personal photographic dosemeters involves two steps: firstly, data acquisition including their evaluation with respect to the calibration quantity and secondly, the interpretation of the data in terms of effective dose .

The effective dose was calculated using artificial intelligence techniques by means of neural network. The learning of the neural network was performed by taking the readings of optical density as a function of incident energy and exposure from the calibration curve (1). The obtained output in the daily grind is the mean effective energy and the effective dose

MATERIALS AND METHODS

The photographic dosemeters used at IPEN are made up of two parts:

a) the Personal Monitoring 2/10 film (Agfa - Gevaert), consisting of two emulsions. b) the holder (badge) containing four filters (plastic, lead, copper and cadmium) and an open window. The area of the filters is sufficiently large to avoid edge effects.

The irradiations were performed using a ^{60}Co (1.0 GBq) ,^{137}Cs(53 TBq) and a X-ray machine Stabilipan model 250 Siemens.The quality control was carried out using a ^{14}C plane source.

The measurement of radiographic film density was performed using a transmission densitometer MacBeth TD 904.

The calibration curves (OD x Exposure) were ploted out as a function of the radiation energy for each filter of the badge. In this case , for each lecture **j** , due to a certain filter, it is possible to construct a family of response curves of OD (d_{ij}) as a function of Exposure (X_i) for each energy value (2).

NEURAL NETWORK STRUCTURE

Different structures of neural networks can be used, each one associated with one application. In this work it was used the backpropagation paradigma, were the neuronios are arranjed in layers: input, output and intermediate layers as shown in Fig. 1 In this work it was used the Neural Works Professional II/Plus software (3,4).

All values used for the network training are the average of five lectures.

For the training of the network the data were arranjed as a matrix as shown bellow . The matrix was presented to the network **10^6** times, during 30h in a PC-AT 486. The obtained average square error was less than 0.1%.

Different from the training, the use of the trained network is very fast, only a fraction of seconds (5).

In order to apply the trained network it was developed a software in Visual Basic Language for Windows.

$$\begin{bmatrix} DO-Cd_1 & DO-Ja_1 & DO-Cu_1 & DO-Pb_1 & DO-Pl_1 & E_1 & D_1 \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ DO-Cd_i & DO-Ja_i & DO-Cu_i & DO-Pb_i & DO-Pl_i & E_i & Di \end{bmatrix}, \quad i = 179$$

COLEÇÃO PTC
DEVOLVER AO BALCÃO DE EMPRÉSTIMO

h International Congress on RAdiation
rotection, Vienna, Austria, April 14-19,
996. V. 4

IPEN / CNEN - SP
BIBLIOTECA
Produção Científica

IPEN-DOC- 4576

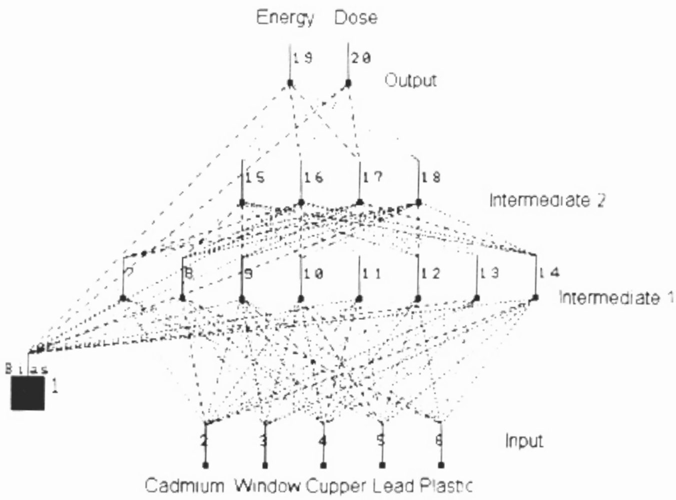

Figure 1 : Neural network topology

RESULTS

In order to check the developed system it was effected an intercomparison program with the IRD-CNEN/Rio. The badges were sent to the Laboratory, irradiated with different effective doses and effective energies and than brought back to IPEN. Table I shows the obtained values. It can be seen that in the worse case the standart deviation between the calculated dose and the real dose is only 6%.It is considered a good result for low energy and low dose when applied to personal monitoring.

Effective Energy [keV]	Effective Dose [mSv]	Calculated Effective Energy [keV]	Calculated Effective Dose [mSv]
45	2	62,4	2,0
45	5	54,8	5,3
45	10	51,2	10,5
58	2	61,8	2,2
58	6,5	52,3	6,6
58	10	68,6	9,3
79	3	59,4	3,1
79	8	88,1	8,3
79	10	98,6	10,6
134	2	126,5	2,0
134	5	147,1	6,0
134	10	107,7	10,0
661	2	647,1	1,7
661	6,5	678,4	6,5
661	10	664,7	10,1
1250	2	1256,3	1,9
1250	6,5	1261,4	6,6
1250	10	1259,1	10,1

Table I : Effective energy and effective dose calculated using neural network system

CONCLUSIONS

This method can be useful for dose calculations in personal monitoring services. It can be extended to mixed field, beta radiation field and neutrons.

REFERENCES

1. ISO Document 4037 (1979).
2. H. C. Mota, P. G. Cunha, et al., IRD - Publ. CNEN (1990).
3. J. J. Hopfield, "Parallel Distributed Processing" The MIT Press, Cambridge, London. V. 1, (1986).
4. L. Personaz, G. Dreyfus , I. Guyion , *La Recherche 204*, 19, 1362-1371, (1988).
5. G. Hadley, "Linear Programming", Adison Wesley (1962)