Determination of Illuminance Level Using ANN Model

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Abstract. In this study, an illuminance determining method, using an artificial neural network (ANN) model, has been designed. The model was realized as an alternative to existing simulation programs to determine the illuminance of a working place. In the model, maintenance factor (MF), working plane (WP), suspension height (SH) of luminaries were selected as input parameters. average illuminance (Eav), minimum illuminance (Emin) and maximum illuminance (Emax) of working plane were selected as output parameters that are the effective parameters in establishment and maintenance of luminance. Comparison between the real time measurements, illuminance simulation program (ISP) and ANN model results has shown that designed ANN model is satisfied.

Keywords: Illuminance Level, ANN Model.

1 Introduction

Illumination affects the mood and motivation level of people. Its systemic effect on mood has been expressed through experimental studies [1]. In this context, many studies have been made to research suitable illumination conditions, particularly for working places. While some of these studies have used classical model approaches, the others have used artificial intelligence modeling approaches [2-10].

One of the most important criteria implemented in these studies is to ensure that the illuminance must be in desired level depending on the tasks in working places. For this aim, illuminance level can be determined either by real time measurements or illumination simulator programs (ISP).

An alternative illuminance determining method using an ANN model has been designed in this study. The ANN model has been implemented by ANN simulator developed by research team. Illuminance data related to a working plane has been obtained by designed ANN model as well as the real time measurements and a commercial ISP. The obtained illuminance results have been compared with real time measurements both for ISP results and ANN model results.

In the following sections, mathematical and ANN modeling of illuminance have been outlined and result of the studies have been explained.

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2 Mathematical Model

Illuminance (E) is defined in SI system as follows

$$E = \frac{\mathrm{d}\Phi}{\mathrm{d}A} \tag{1}$$

where, E is illuminance (lux), A is area receiving the flux (m2), Φ is luminous flux (lumen). It can be treated as a vector quantity. It can be calculated as at a specific point (point-by-point method) illuminance or in an average uniform horizontal illuminance (lumen method) across the working plane.Consider a point source illuminating a surface at an angle θ to the normal as in Fig. 1

$$E_{\mathrm{p}} = \frac{I_{\theta}.Cos\theta}{r^2} = E_{\max}.\cos\theta \tag{2}$$

where Ep is illuminance value at point P (lux) Emax is the maximum illuminance that the source could produce at point P, when θ=00 (lux), Iθ is the luminous intensity of the source in the direction of the illuminated point (Iθ =dΦ/dω) (candela [cd]), r is distance of the light source to the object (meter), θ is angle of light source as to normal.

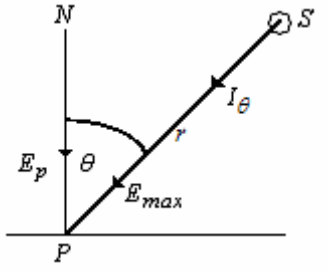

Fig. 1. A point source illuminating a surface at an angle θ to the normal

Specifications often require the lighting professional to know or design for average uniform horizontal illuminance. To do this with the Inverse Square Law for a large number of points would be both tedious and expensive. In addition, a second set of calculations would have to be made to determine the interreflected components. The lumen method is used to calculate the number of luminaries required for a uniform or general lighting layout. The lumen method calculates the average, uniform, horizontal maintained illuminance throughout a room. The average surface illuminance is calculated from the following equation

$$E_{av} = \frac{N \times \Phi_{in} \times n \times UF \times MF}{A} \tag{3}$$

where Eav is average illuminance(lux), N is the number of luminaries, Φin is initial luminous flux of the light source (lumen), n is number of lamps per luminaire, UF is utilisation factor. UF is the ratio of the total flux received by surface to the total lamp flux of the installation. It depends on the dimensions of room, the ceiling colour, the wall colour and the floor colour, A is area to be illuminated (m2), MF is the maintenance factor [11-12].