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Neural Estimator Automatic Fluorescent Daylight Control System

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Abstract

The daylight control system represents an electric light system used in office or design laboratory applications. The system tries to maintains constant the illuminance level on the working plane even the daylight contribution is variable. From other point of view the daylight control system is the lighting system that compensates the daylight variation in a room (office, design laboratory). The importance of this type of lighting system is that it satisfies the following requirements: user visual comfort and electrical energy savings. Considering these requirements the lighting system has to be implemented such an automatic control system with negative feedback. The behavior of the automatic lighting system will depend mainly on the controller behavior. In the present paper, a feed-forward artificial neural network (FANN) was chosen to control the lighting process using the Control by Estimation Iterative Algorithm. Due to the control strategy for a stable behavior of the automatic lighting control system without or with acceptable overshoot (regarding the control system step response) the learning rate of the FANN needs to have very small values and in a short range. To remove this shortcoming in present paper is proposed a modified learning error which allows the learning rate to have a wider range of values for which the automatic lighting control system has a good behavior. Also, is proposed a new way that the user can modify the speed reaction of the automatic control system regarding the daylight changes.

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Keywords: artificial neural network; estimation; automatic daylight control system; fluorescent lamp.

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1. Introduction

Since Rosenblatt proposed the Perceptron model, the first artificial neural network (ANN) which can learn from example, the ANNs reach the attention of the researcher and engineers. Nowadays, due to their learning and approximation capabilities, the ANNs became a comfortable choice regarding the process identification and control. In [10] the authors used as the on-line system identifier a NARX model based on a kind of feedforward artificial neural network (based on wavelet analysis) known as recurrent wavelet neural network. The identification results are used in a predictive ship course control simulation to shows the effectiveness of the proposed identification method and control strategy. The authors from [6] use the neural network predictive control strategy to control a continuous stirred tank reactor. For process identification it was used two types of a FANN (Multi-Layer Perceptron – MLP, Radial Basis Function – RBF) and an Adaptive Neuro-Fuzzy Inference System (ANFIS). Yang and Wu propose in [9] an adaptive control scheme (based on artificial neural network nonlinear identification) for an induction motor and show the better adaptability and stronger stability of this control system over the PID control system. In [7] the authors simulate via the Matlab Simulink models, the control of an Unmanned Aerial Vehicle using the model reference control strategy based on two ANNs: first ANN is used for process identification and the second is used as controller. The plant model is identified first, and then the controller is trained so that the plant output follows the reference model output. Tran and Tan use in [8] a FANN to model the nonlinear relation between dimming levels of LED luminaires and illuminance tables in case of a networked LED-lighting system. The obtained neural model is used, in simulation, in a sensorless illumination control. The experimental results show the energy saving functionality of the proposed approach.

2. The automatic lighting control system

The used experimental stand is the same one used in [3] and is presented in Fig. 1a and is composed by the following components: the computer (1), the technological installation (2), the lighting sensor (3), data acquisition board (4) and the working plane (5). The computer represents the calculation machine on which will run the code machine source of the used artificial neural network. The technological installation is composed by the lighting process (accomplished with two 36W warm white fluorescent lamps) and the execution element (accomplished with the following modules produced by Tridonic: a DSIA/D converter and a digital ballast PCA 2/36 EXCEL). The lighting sensor represents a multifunctional LRI 8133/10 sensor produced by Phillips. The data acquisition board has two 1 byte conversion channels: one A/D channel used for the acquiring of the data from lighting sensor and the other channel a D/A channel used to send the command from computer to the execution element. The working plane represents the surface of the desk on which the user of the automatic lighting control system executes different office tasks.

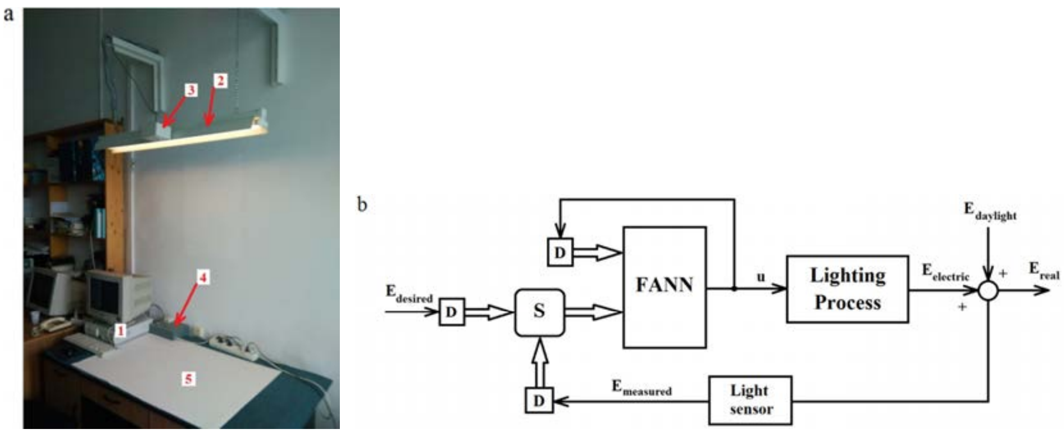

Fig. 1. The ALCS: (a) The experimental stand; (b) block diagram