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Application of intelligent systems for specification of automotive equipments using LEDs

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Abstract

The advantages offered by the electronic component light emitting diode (LED) have caused a quick and wide application of this device in replacement of incandescent lights. However, in its combined application, the relationship between the design variables and the desired effect or result is very complex and it becomes difficult to model by conventional techniques. This work consists of the development of a technique, through artificial neural networks, to make possible to obtain the luminous intensity values of brake lights using LEDs from design data.

Keywords: Artificial neural networks; Intelligent systems; Brake light; LED; Automobile industry

1. Introduction

The LED device is an electronic semiconductor component that emits light. At present time, it has been used in replacement of incandescent lights because of its advantages, such as longer useful life (around 100,000 h), larger mechanic resistance to vibrations, lesser heating, lower electric current consumption and high fidelity of the emitted light color [1].

However, in designs where incandescent lights are replaced by LEDs, some of their important characteristics must be considered, such as direct current, reverse current, vision angle and luminous intensity.

In automobile industry, incandescent lights have been replaced by LEDs in the brake lights, which are a third light of brakes [2]. In these brake lights are used sets of LEDs usually organized in a straight line. The approval of brake lights prototypes is made through measurements of luminous intensity in different angles, and the minimum value of luminous intensity for each angle is defined according to the application [3].

The main difficulty found in the development of brake lights is in finding the existent relationship between the following parameters: luminous intensity (I_V) of the LED, distance between LEDs (d) and number of LEDs (n), with the desired effect or result,

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i.e., there is a complexity in making a model by conventional techniques of modeling, which are capable to identify properly the relationship between such variables. The prototype designs of brake lights have been made through trials and errors, causing increasing costs of implementation due to time spent in this stage. Moreover, the prototype approved from this system can sometimes not represent the best relationship cost/benefit, since few variations are obtained from configurations of approved prototypes. The artificial neural networks are applied in cases like this one, where the traditional mathematic modeling becomes complex due to nonlinear characteristic of the system. These networks are able to learn from their environment and to generalize solutions, making them attractive to this type of application.

2. Overview of automotive applications using LEDs

Modern automotive vehicles have still used incandescent lamps for parking, turning and brake lights. These red and yellow lights commonly use a standard clear incandescent bulb behind a colored lens. Incandescent bulbs consume a large amount of energy for the amount of colored light projected from the vehicle's lighting fixture.

Recently, the automotive industries have supported the development of schemes that replace the inefficient incandescent lights described above with more efficient lights, such as light emitting diodes (LED). Because LEDs produce light at the needed wavelength for automotive use, less energy is consumed by the lighting fixture when compared to the white light generated by incandescent bulbs. Moreover, LEDs exhibit long lifetimes, on the order of 100,000 h [1]. Coupled with the ruggedness inherent in solid-state devices, this indicates usefulness for low maintenance applications. Fast response times also make them ideal for some automotive equipments.

In [3] has been demonstrated that the conversion of a turn signal from an incandescent light to LED is possible with the latest advancement in LED designs. In [1] is proposed a system based on LEDs for vehicle traffic control applications. From geometric considerations, the system requires a cluster of some 200 LEDs each of red, amber and green for a single three-light system, or 200 multicolor LEDs. In [9] is presented a vehicle that uses LEDs in its headlights. To get white light out of an LED, it was put a blue LED behind a phosphor that emits yellow light when stimulated by the blue. Together, the blue and yellow rays make white. In [6] is described a light emitting diode brake-light messaging (LEDBM) system, which can be used to avoid forward collisions. The LEDBM is comprised of modulated LED brake lights that communicate information about a vehicle's state to any following vehicle that is equipped with an LEDBM receiver. In [11] is presented an alternative and convenient procedure using artificial neural networks for estimating the impact of weaving vehicles on the capacity of freeway segments. In [12] has been also proposed an intelligent system using Kalman filtering and Takagi–Sugeno fuzzy models for applications in vehicle tracking problems.

This paper shows an industrial application using artificial neural networks to estimate values of brake lights luminous intensity from the design data. Although this work is aimed to the application of LEDs in brake lights, methods hereby developed and described can also be used in other applications, such as traffic lights, electronic panels of messages or any other application where LEDs are used in groups.

3. LEDs applied in brake lights

LED is an electronic device composed by a chip of semiconductor junction that when traversed by an electric current provides a recombination of electrons and holes. Fig. 1 shows the representation of a junction being polarized.

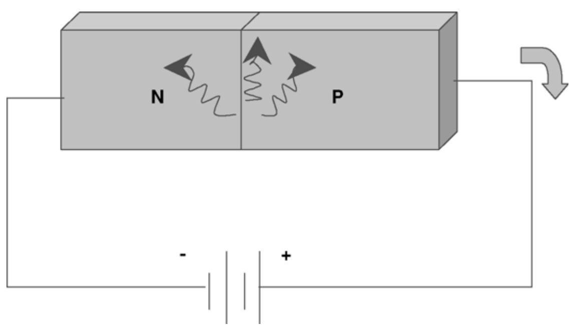

Fig. 1. Junction PN being polarized.