COMPUTER-AIDED DESIGN SYSTEMS

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COMPUTER-AIDED DESIGN SYSTEM FOR INTERNAL LED LIGHTNING

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Abstract. *The article describes the lighting equipment design. The algorithmic procedures at all design stages are developed.*

Keywords: design problem; computer-aided system, light-emitted diode systems (LED), calculation of light characteristics, radiator projection, calculation of transformer, optimization.

Introduction

Light-emitting technologies have a great potential for the future of the whole lightning industry. When comparing light-emitting diodes with traditional (gas-discharge and fluorescent) lighting, the following advantages of the first can be highlighted: lower power consumption, reliability, mechanical solidity, chatter stability, safety, low running costs, and the opportunity to control brightness and illumination levels.

By using light-emitted diode systems (LED) for lams production, its lifetime and durability can be increased for up to 50000–100000 hours (10–25 years of service), and this is without any changes in initial parameters of the quality of lightning. The above means that its exploitation period 100 times exceeds the conventional incandescent lamp exploitation period and by 12 times exceeds fluorescent lightning lamps. Moreover, light-emitting complexes enhanced with regulators, movement sensors and observation cameras transform into an intellectual lightning system, which allows regulate light fluxparameters, change its direction and operate LED blocks.

Among the disadvantages of LED we can name the following: low maximum temperature (which is why they require an external cooling radiator), high price in comparison with other artificial sources of light.

With the aim to minimize designing time constraints and create LED, which would have optimal lighting control, esthetic criteria, and cost – it would be beneficial to develop an automated projection process.

At present, such an automated projection system doesn't exist: you cannot design its external appearance or to have an optimal choice of its elements with the existing system. Also, with the current system it is not possible to conduct imitation modeling of the projected good. Currently, the following systems for designing exist, to name but a few: Dialux, Light-in-night, Relux (for lightning calculation and modeling); P-CAD Schematic, Altium Designer, KiCad, Proteus (for designing of the electric blocks).

Target setting for an CAD (computer-aided system) projection of LED

You can see the structure if the LED lamp on the fig. 1, it includes the following elements:

– source of light (LED);
– power source (driver);
– radiator (can be connected with the trunk);
– secondary optics and/ora shield;
– body.

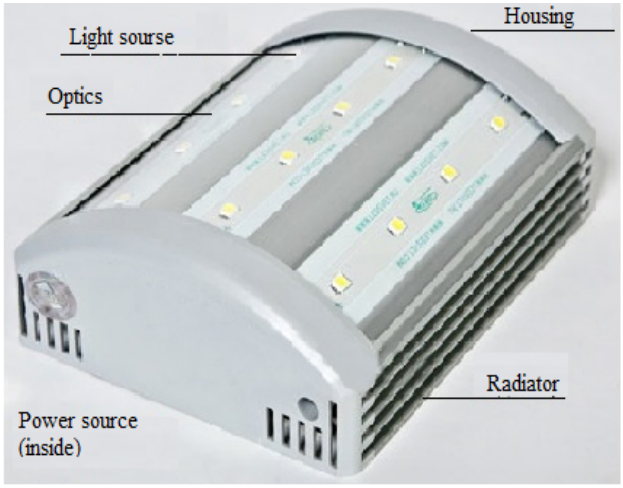

Fig. 1. The structure of an internal LED lightning device

The body of a lamp is made of aluminum alloy, which allows it to reach a protection degree of IP67, however, a glower absence gives it a high chatter stability. Furthermore, a lamp construction does not include harmful elements (such as mercury, argon, neon, krypton), this guarantees ecological and fire safety. Moreover, it does not require any special utilization processes. All the above makes LED more economically efficient and safe.

When designing a LED lamp, it is important to solve the following tasks:

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1) To calculate the amount of LEDs, to define their position within the body, in order to guarantee prescribed lighting characteristics; compute optics – lightning calculation.

2) To calculate a radiator in order to ensure the most effective conductive heat sink (choose the right type of the radiator and define its geometrical characteristics on the basis of mass optimization and its capacity (volume) – heat engineering estimation.

3) Power supply unit calculation, which includes an electric scheme development, printed circuit card, choice of electronic components – electro technical calculation.

4) To develop an external interface and its constructional elements – external appearance projection.

5) To optimize the LEDs elements choice by their reliability and cost (taking in account geometrical constraints) – optimization task.

6) To check correspondence with the imitation model characteristics of the finalized good – imitation modeling.

On the basis of the set tasks, a structural scheme of the automated system can be presented in the following way (Fig. 2).

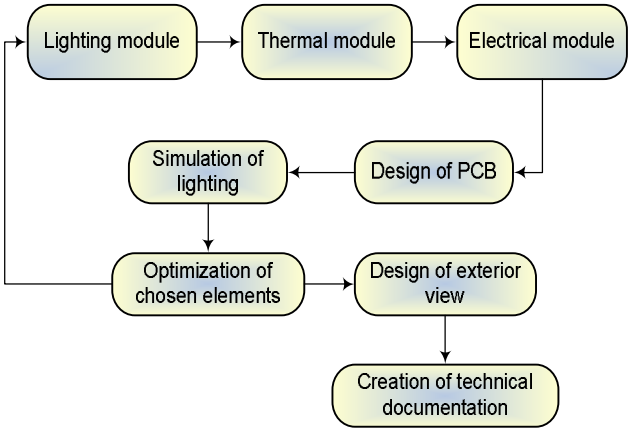


Fig. 2. Structural scheme of the CAD

Process of computer-aided system can be represented by a block diagram shown in Fig. 3.

The basic element of which is a block integrator. This block provides the result of system`s calculation (lighting, electrical and thermal calculations), which are converted into appropriate formats for software packages of Dialux, Altium Designer or Compas.

Dialux unit provides the ability to perform the simulation and evaluation of engineer and the resulting characteristics of spatial images isolux. The block Altium Designer, after the calculations submitted data to create models of the Spice transformer design concept and the power supply (PS). Assessment of the designquality is performed by simulation results of the developed scheme that runs in Altium Designer. In case of a positive result on the basis of information received from a database of geometric parameters of electronic components, printed circuit board design is performed by power supply unit (PSU).

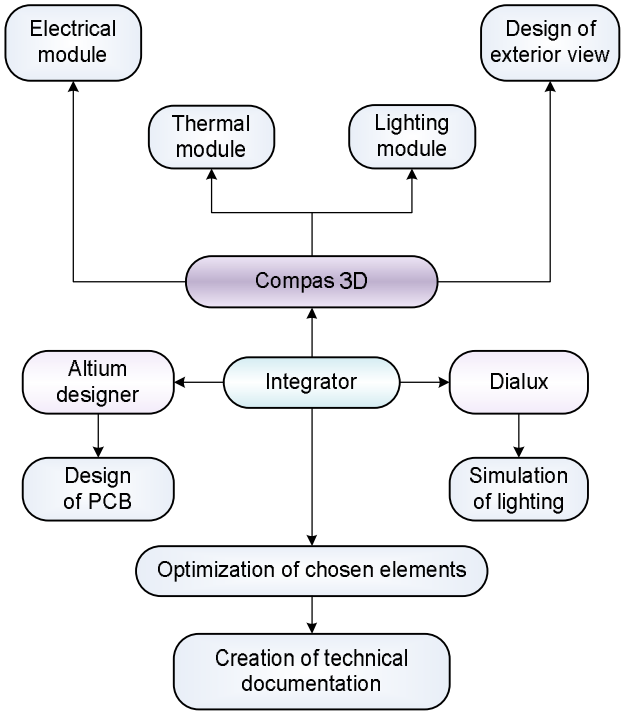


Fig. 3. The block diagramm of the CAD

In order to obtain an optimum lamp by cost optimization problem is solved. As a result, selects the optimum set of electronic components with repeatedly executed calculations of each set.

Design and exterior view is the final step in creating of a lamp. In the process of its implementation selects appearance, optimal in terms of aesthetic requirements, cost, and payment of components.

Figure 4 shows the CAD algorithm for LED lamp. Initial data for the program are: system requirements, luminous flux, type of light source, the number and arrangement of light sources, a single LED power, thermal resistance junction-case, case-radiator, radiator, environment, ambient temperature and the temperature of LED heating; input current and voltage on the system.

Work with the program can be divided into several stages. The first step is to select light sources, calculate the size of the diode module and simulate light distribution and optical system developed light unit. Just calculate the radiator fins and its area. At the end of the first phase of the designer develops the design concept and optimum schematic diagram and printed circuit board (PCB) for it, as well as the size of the simulated power supply. As seen from fig. 4 calculations are performed sequentially.

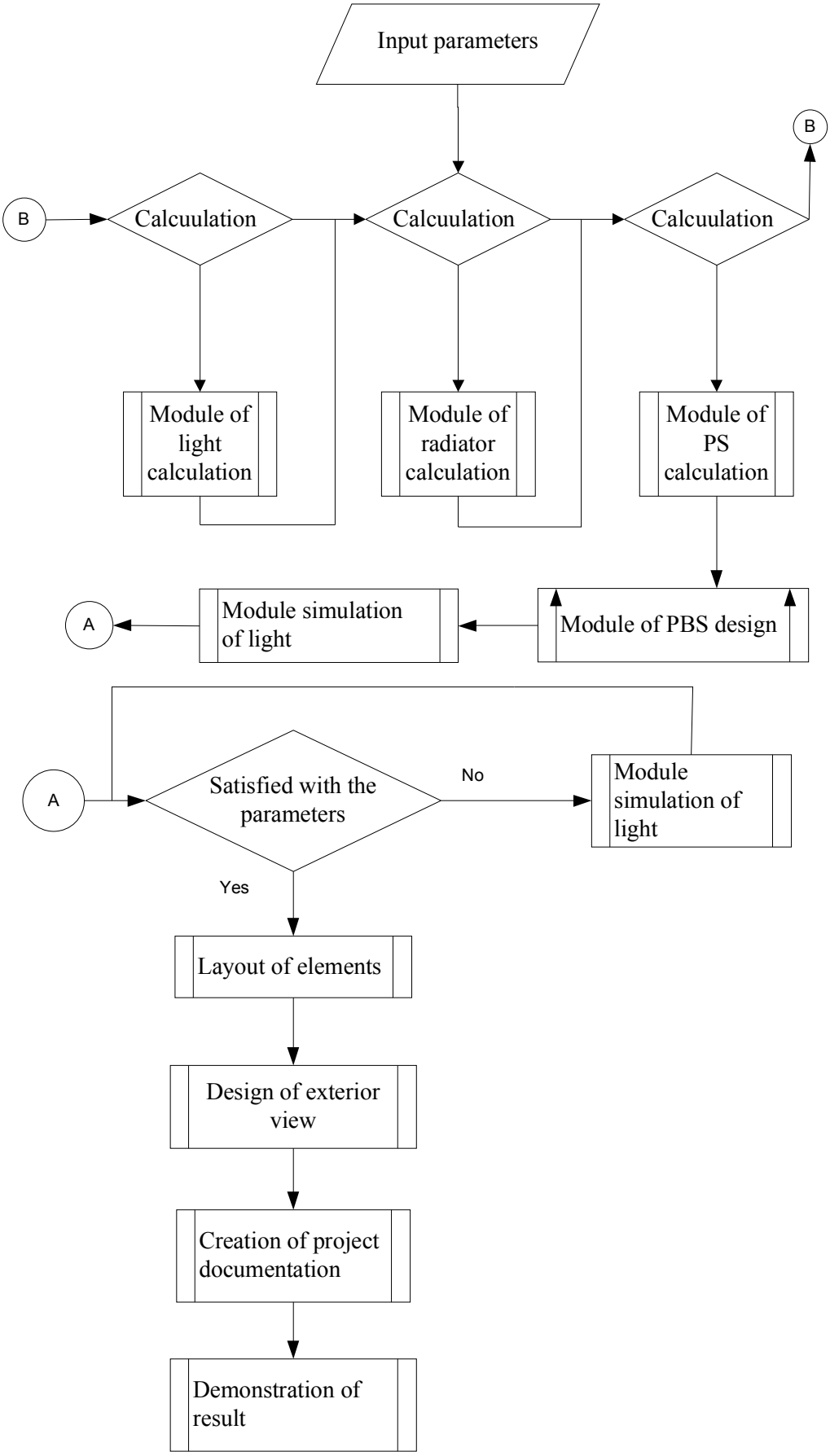
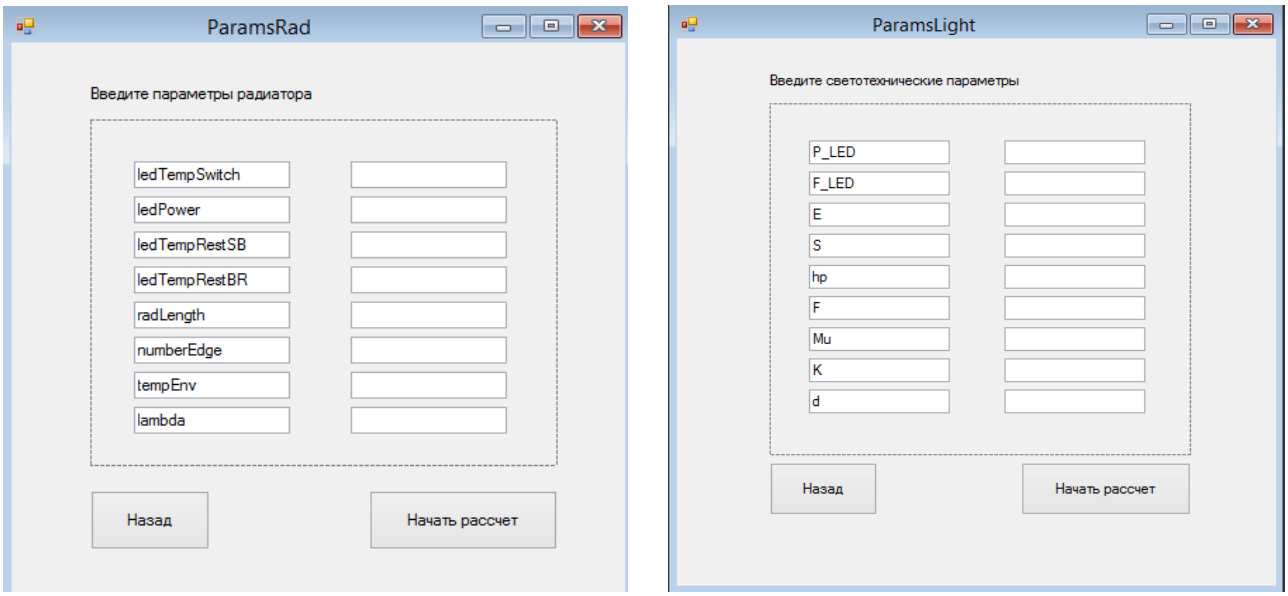


Fig. 4. CAD algorithm for LED lamp

At the second stage provided refinement, detailed study of the calculated data by qualitative assessment of light distribution, calibration of required parameters and the final construction of the light distribution, such as data passing through the optimization of the process module and depending on the completeness of the formalization of knowledge in a particular domain, the project design can be done automatically or interactively. Based on the findings and limitations (independent design parameters – requirements to the device) block can change variable parameters to obtain acceptable design solutions. If obtained data meet the set requirements, then composes elements for design appearance (exterior view).

Design results are displayed in a convenient form for human perception (Fig. 5), and contain information on which the designer could make a judgment about the designed system.

The most important function – initial data input for the design, evaluation and approval of the final design solutions remains engineer.



a *b*

Fig. 5. Exterior view of system`s forms : *a* is for lighting design; *b* is thermal engineering design

Conclusions

Substantiated the necessity of computer-aided design developing for LED lights, which will reduce design time and improve its quality, and thereby reduce the cost of the lamp.

Was proposed the structure of CAD, which is based on the integration of Dialux, Altium Designer and Compas package and includes the solution of problems such as: the calculation for lighting characteristics, thermal and electrical engineering, development and appearance of filling the candlestick modeling light control device; paperwork on lamp; finding several design solutions of the problem.

Developed CAD software package, one of the main advantages of which is to ensure maximum effectiveness of the program, in practice, due to ease of use and maximum visibility of results.

References

[1] Kudashkina, M. V. “Modern software tools for assessing lighting characteristics of lighting devices.” (in Russian). [E-resource] – Access mode: http://www.rusnauka.com/9_NND_2012/Informatica/2_105049.doc.htm

[2] Aisenberg, Y. B. “Reference book of illumination.” *Energoatomizdat*. 1983. 472 p. (in Russian). [E-resource] – Access mode: http://www.twirpx.com/fils/tek/illumination

[3] Skripnikov, Y. F. “Radiators for semiconductor devices.” Moscow. *Energiya*. 1973. 48 p. (in Russian).

[4] Knorring, G. M. “Reference book for the design of electric lighting.” Moscow. *Energiya*. 1976. 384 p. (in Russian).

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В. М. Синєглазов, К. І. Каленюк. Система автоматизованого проектування світлодіодних світильників внутрішнього освітлення

Описано основні розв'язувані завдання при проектуванні освітлювального приладу. Розглянуто принцип роботи з розробленим програмним забезпеченням для автоматизації процесу моделювання та проектування світлодіодного світильника.

Ключові слова: проблеми проектування; автоматизоване проектування, світлодіодні системи освітлення.

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В. М. Синеглазов, К. И. Каленюк. Система автоматизированного проектирования светодиодных светильников внутреннего освещения

Описаны основные решаемые задачи при проектировании осветительного прибора. Рассмотрен принцип работы с разработанным программным обеспечением для автоматизации процесса моделирования и проектирования светодиодного светильника.

Ключевые слова: проблемы проектирования; автоматизированное проектирование; светодиодные системы освещения.

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