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Digital recording of photometric data for multisource luminaires

Abstract: *On the ground of the overview of multisource luminaire constructions, with the emphasis on LED solutions, the need to formulate the recording of photometric properties of the luminaires, of considerable size and non-uniform distribution of the field of luminous beam generation, was perceived. The alternative method of photometric file organisation, including diverse luminous flux distribution for each point of a luminaire, was introduced.*

Streszczenie. *W oparciu o przegląd konstrukcji opraw wielośródłowych, ze szczególnym uwzględnieniem rozwiązań z diodami elektroluminescencyjnymi została sformułowana potrzeba zapisu właściwości świetlnych opraw o znacznych rozmiarach i nierównomiernym rozkładzie pola generowania promieniowania świetlnego. Zaproponowana została alternatywna metoda organizacji pliku fotometrycznego uwzględniająca zróżnicowany rozsył strumienia z poszczególnych punktów oprawy.* (***Cyfrowy zapis danych fotometrycznych opraw wielośródłowych***)

Keywords: fotometric file, lighting calculation, luminaire.
Słowa kluczowe: plik fotometryczny, obliczenia oświetlenia, oprawa oświetleniowa.

Introduction

History of the digital calculation has barely a few dozen years and nowadays we are not able to imagine that we could design anything without a computer aid. New generations of calculating machines arise continually with stronger processors, more memory, working with larger speeds allowing to accelerate calculation processes significantly.

On these computers there are new applications running, which analyse more and more elements and simulate larger and more complicated structures with more accuracy. Recently, there have been analysed models of physical phenomena that were neglected before. All this is done in the name of progress and with hope of obtaining the greatest possible compliance with the experience. In all calculation processes, a very important factor is data exchange between the various programs. The results of calculations for one application become the input data of the others and must be properly understood.

In addition, in the world of computer science there is pluralism and competition. The same calculations, should and in most cases are carried out by different programs written by competing software suppliers. They should be able to work on the same data. The results of these programs should be consistent, and form of their output should allow their direct comparison. To do this, there was introduced certain standards for data entry. However, these standards are maturing at the same pace as the whole computational technology. It is necessary to their periodic replenishment and when progress is too quick – replacing outdated standards by new ones. However, by the revision of the standard should allow the ability to use data stored / recorded in accordance with the previous format.

Standards of photometric data

In the lighting technology for a long time photometric solids of luminaires have been recorded in the same unchanged manner. Lighting point located in the optical center of luminaire is assigned a digitalized photometric solid i.e. the intensity value of the luminaire in the selected directions. This form of writing had been amended several times, but the changes were cosmetic. The idea has been remaining unchanged for years.

Ignoring photometric data collected in closed databases supported by special programs created by the few luminaire producers, all photometric data are stored in one of two basic formats: * ies and *.ldt. Often manufacturers tried to get their product to a broad group of customers provide their data in both formats.

The first one is created by the Illuminating Engineering Society of North America (IESNA), periodically updated [1], and in 2002 version was set up as an American National Standard ANSI [2]. Second, proposed by Axel Stockmar, since its launching in 1990 was not updated [3]. There are formats proposed by CIE [4] and the European Union, however, do not differ significantly from the mentioned above and have no practical significance. All the listed formats are text ones files containing alphanumeric savings of luminaires luminous intensity values. They begin with the information about the luminaire manufacturer, luminaire name and type, the light source. Then they include the characteristics of the way of photometric in one of the most common systems, Aα Bβ or Cγ [5] and a set of directions for luminous intensity values. It should be noted that there is the only ability to regular measurement of luminaire, in the same set of directions in each photometrical plane. The file closes the most important part, contained all values of the intensity luminaires sorted in order of photometrical planes and order lines on the planes.

Capabilities of modern computers allow to perform much more accurate calculations than the result of the treatment luminaire as a point of light. Most programs that help lighting calculations slightly improves the accuracy of the calculations by dividing luminaires into pieces and each of them assigning the same portion of a whole luminaire photometric solid. In some cases, such treatment gives good results. In others, and this number will be growing, the errors are visible. As a result of expanding users disappointment it will be good idea to avoid it. At this moment technological progress forces to achieve new quality in lighting calculations.

Luminance photometric data of luminaire, relied on giving luminance distributions of luminaire viewed from different angles, is the target for data entry of photometric calculation programs. However, it seems that it is too early to find its practical and universal application. Although the technique of CCD-based luminance measurement enables to acquire appropriate data resource and computer equipment is able to collect and process [6] but society of lighting engineers makes the impression that is not prepared for such changes.

First of all, there is too small saturation of photometric laboratories with measuring equipment and knowledge about the CCD-based luminance measurement is poorly grounded. Therefore, it is necessary to establish a

transitional format which allows for significant improvement in the quality of the lighting simulation with modern lighting equipment maintaining the existing systems of collection and storing of data.

Modern luminaire design

To create a new format for photometric data files it should be analyzed the structure of modern luminaires. Luminaires with discharge lamps are supported with high polished aluminium reflectors with facet structure. They consist of a set of flat or parabolic surfaces located appropriately in relation to the light source.

Each facet reflects light in a certain, characteristic for its range directions in space. Solid photometric luminaire arises from the gathering solid of light with various facets solids. Watching such luminaire of variables angles you can see that the luminous area varies with the angle. The figure of bright points significantly moves on the hole output surface of luminaire. Taking into account, not small dimensions of such luminaire, it is easy to deduct that it will be quite often used to illuminate the surface from the distances below the minimum photometric distance.

The minimum photometric distance is not very often reached in the point illumination method using the more traditional lighting equipment. For example in building illumination the distance between luminaire and a facade is comparable with the dimension of light-emitting surface, so even when applying the diffuse luminaires it would not be considered as a point.

In some applications, to increase the reliability of illumination luminaires with two sources are used, in which only one source is working, while the second one is the backup source in the event of extinction of the first one. The current photometric data supplied by the manufacturers of these luminaires do not take into account changes in the characteristics of distribution in switching power between sources. Relatively significant dimensions of the source, cause, that the movement the middle of light is significant. Taking into account the modern solutions of high polished reflectors following noticeable change in the characteristics of the luminary lighting. This change should be included in the project and exposed /shown in the calculation.

Table 1. The proposed format of a single photometric file

Line	Contents	Meaning
01	Multi 2011	Format Identifier
02	<Keyword 1>	Key words: [DATE], [MANUFAC],[LUMINAIRE],[LAMP], [OTHER]. Preceding data: date of creation manufacturer, symbol of luminaire, symbol of source, optional description
03	<Keyword 2>	
04	<Keyword 3>	
…	<Keyword 4>	
N	[FLUX] f	Luminous flux of whole luminaire
N+1	[PHSYSEM] Chr	Photometric system Chr= A: system Aα; B: system Bβ; C: system Cγ.
N+2	[DIM] l; w; h	Dimensions of luminaire: length, width, high
N+3	[PART] p	Number of parts
N+4	<Keyword 5> j; x; y; z; f_j	Key words: [PART1] … [PARTp] index of part, coordinates to center of luminaire, partial flux
…	<Keyword 6> j; x; y; z; f_j	
M	[ANGLES] va; ha	Number on direction on photometrical plane, number of planes
M+1	[VERTICAL] v_1; …; v_{va}	Value of angles of directions
M+2	[HORIZONTAL] a_1; …; a_{ha}	Values of angles of planes
M+3	<Keyword 7> $i_{1,1}$ …$i_{1,va}$	Key words: [LIGHT1] … [LIGHTp] luminous intensity in following directions in following planes
…	$i_{ha,1}$ …$i_{ha,va}$	
M+3+ha	<Keyword 8> $i_{1,1}$ …$i_{1,va}$	
…	$i_{ha,1}$ …$i_{ha,va}$	

LED luminaires flow to us in wider stream. There will be used more commonly, especially, that the effectiveness of the latest generation of LEDs are already comparable with effectiveness of discharge lamps. LED luminaires are carried out in replication, complementation or mixed methods [7]. In the first of them dividing photometrical solid into same parts is used quite well because on the whole surface of luminaire the light emitting elements with identical characteristic of light distribution are spread evenly. In other methods light distribution in various parts of luminaire may vary significantly. In such situation it may be significant deviation in lighting calculations [8].

Ways of taking into account luminaires length

Solution for described above problem may be the introduction of dividing luminaire into parts/ fragments with different characteristics of the angular intensity distribution. Leaving the problem of putting separate parts of luminaire into calculation program to designer will not meet his approve, because since this would require too deep involvement in the knowledge of the construction of luminaire. It would be time consuming and labour work.

This can lead to errors resulting from common mistakes. Such a set of lighting subpoints must be entered as a whole, with one click of a mouse in the corresponding dialog box. To do this it is need to establish new data format for photometric matrix luminaires. Each part is assigned a different photometric solid coupled to its center point and all the information saved in one file. Thus, by simple calculation, will arise matrix of luminous elements. Each tile can be enabled, disabled or adjustable individually.

It is possible to move two alternative and equivalent ways. The first is through the creation of new file formats data for the whole of the luminaire, the second by creating a file merging multiple component files in a single luminaire.

Multi-IES, Multi-EULUMDAT (*.mies, *.mldt)

For creation of a format matrix source file the schemes already existed such as: IES, LDT, CIE, EU or completely new one may be use., there was created sample format file based on the IES system. Its structure is presented in table 1.

The multisource file of luminaire must contain information on the number of parts, on which the luminaire was divided, their location and the photometric data of each of them. It should start with the standard data about luminaire name, its manufacturer, photometric system and method, the applied light source and its total nominal flux. Then there should be contained information on the number of fragments, on which luminaire was divided, the position of the lighting points relative to a common luminaire middle / centre, a flux that is assigned to the individual elements.

All parts must have identical system and way of measurement, so the set of planes and directions should be the same (common) to all. Successively it should be given luminous intensity each of the pieces of the luminaire in the order of their mention in the list. The sum of the partial flux

Table 2. The proposed multi source luminaire file format

Line	Contents	Meaning
01	Matrix 2011	Format Identifier
02	<Keyword 1>	Key words: [DATE], [MANUFAC],[LUMINAIRE],[LAMP], [OTHER] itp. Preceding data: date of creation manufacturer, symbol of luminaire, symbol of source, optional description
03	<Keyword 2>	
04	<Keyword 3>	
…	<Keyword 4>	
N	[FLUX] f	Luminous flux of whole luminaire
N+1	[DIM] l; w; h	Dimensions of luminaire: length, width, high
N+2	[PART] p	Number of komponent luminaires
N+3	<Keyword 5> j; x; y; z; path	Key words: [PART1] … [PARTp] coordinates to center of luminaire rotation angles, path to photometrical file
…	<Keyword 6> j; x; y; z; path	

should be equal to the flux the entire source. Giving flux offering a greater sum shall indicate that in the luminaire exist sources of light interchangeably. The sum of the photometric solid of individual parts should be, responding to above, equal to the total luminaire solid measured in the far field.

Multi Source Luminaire File Format (*.msl)

Luminaire can be trated as a constant and invariant collection of any number of lighting parts. Each of them corresponds to the specified luminaire part. The photometric data of each of those elements are stored in a traditional file-format *.ies or *.ldt. These files must be gathered in one place, preferably in a separate directory and accompanied with a matrix, which will contain information on the number and position of each partial luminaire relative to a common matrix centre and the names of the individual files from their photometric data.

This file will organize and simplify data entry process, and will not take part in the simulation calculations. Luminaire will be treated by the computing algorithms as a set of completely independent light points. An example structure of such a file is presented in table 2.

Advantages and disadvantages of systems

Proposed ways of introducing photometric data of luminaires are solving some problems resulting from development in lighting equipment area. Improvement of the accuracy of the lighting calculation realized mainly by implemented LED luminaires. They allow to avoid some of clearly visible calculating errors existing in simulations, in which lighting equipment work in near distances.

Long time of calculation resulting from the multiplication in the number of luminaires for user is slightly not noticed, as it rises only milliseconds. File photometric size also increases several times, but it is not intended for the manual treatment, and the remaining volume less than 1 MB for the modern media is almost unnoticed.

The proposed solution is not free from defects. It requires greater effort of work during measuring and preparing data of luminaires. Reasonable division of luminaires on parts requires knowledge of its structure and physiology of the operation as well as taking thoughtful decisions.

Execution of photometric measurements needed to create the file forces partial measurements, which require screening all but the measured luminaire part or measuring, using the CCD-based luminance meter, and integrating the designated areas.

The proposed ways of data recording shouldn't be treated as final solution, rather as a transitional one aiming at the luminance recording of photometric files. The introduction of the proposed format does not exclude the use of existing formats for luminaires, which have simpler structure.

REFERENCES

[1] IES LM-63-95 Standard File Format for Electronic Transfer of Photometric Data and Related Information

[2] ANSI/IES LM-63-02 ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information

[3] Stockmar AW. EULUMDAT, ein leuchtendatenformat fur den europaischen beleuchtungplaner in Tagungsband Licht, 1990

[4] CIEPublication 102-1993: Recommended File Format for Electronic Transfer of Luminaire Photometric Data

[5] Żagan W. Podstawy techniki świetlnej, OWPW Warszawa 2005

[6] Słomiński S., „Mapowanie luminancji na modelu obliczeniowym źródła światła – możliwości wykorzystania matrycowych mierników luminancji w technice świetlnej ", Przegląd Elektrotechniczny, ISSN 0033-2097, R. 87 NR 4/2011, 87 – 89.

[7] Zalewski S. Application of LEDs In Road lighting, Przegląd Elektrotechniczny ISSN 0033-2097 R. 85 Nr 11'2009280 - 282.

[8] Zalewski S., Zapis właściwości świetlnych LEDowej oprawy oświetlenia drogowego, Przegląd Elektrotechniczny, ISSN 0033-2097, R. 87 NR 4/2011, str. 93 – 95.

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