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BEZPRZEWODOWY AUTOMATYCZNY SYSTEM DO STEROWANIA ORAZ MONITOROWANIA ŚWIATEŁ ULICZNYCH

Streszczenie: W artykule przedstawiono wyniki badań inżynierów z Ukrainy oraz praktyczną implementację uzyskanych wyników polegającą na redukcji poboru energii elektrycznej. Badania odnoszą się do systemów oświetlenia instalowanych na wolnym powietrzu. Stosowano wysokiej jakości lampy LED-we. Opracowano system bezprzewodowego automatycznego sterowania oraz monitorowania oświetlenia. Ten system został całościowo opisany w pracy.

Słowa kluczowe: oszczędność energii, typy świateł na otwartym powietrzu, diody, system monitorowania

WIRELESS AUTOMATIC STREET LIGHTING CONTROL AND MONITORING SYSTEM

Abstract: The article presents the results of Ukrainian engineers research and their practical implementation aimed at reducing electricity consumption for outdoor lighting by using high-quality LED lamps and the developed wireless automatic system of illumination monitoring and control is presented.

Key words: energy saving, outdoor light sources, LED, monitoring system

1. Formulation of the problem

One of the main priorities of Ukraine's energy policy is energy efficiency and savings. Reducing energy consumption directly affects the reduction of fuel resources imports which is important for economic development. Electricity consumption for lighting reaches up to 30% of the total. Decreasing this indicator will positively affect the overall dynamics of the energy market.

Reduction of electricity consumption used for street roads and adjoining territories illumination is the purpose of the theoretical research and practical development

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complex carried out by the Thermophysical Processes Monitoring and Optimization Department Institute of Engineering Thermophysics NAS of Ukraine.

The overall analysis has highlighted the main aspects of this task, such as using the high quality lamps with minimal energy consumption and maximum light flux and implementation of lighting monitoring and automation systems.

2. Lamp type selection

It is known from many sources [1, 2] that only some of the electricity consumed by any lamp is converted to light, the rest of the power is transformed into thermal infrared and other types of radiation. Due to their low efficiency incandescent lamps are no longer used in modern street lighting. Discharge light sources (gas-discharge lamps) replaced the incandescent lamps, however, the linear spectrum of radiation, fatigue from flickering light, noise from ballasts, the harmfulness of mercury vapour when the bulb is destroyed, the shortcomings for re-ignition for high pressure lamps remain the disadvantages. Despite the drawbacks discharge lamps were preferable to incandescent lamps in many lighting applications prior to improvements in LED lamp technology [3].

Globally street lighting fixtures must meet many criteria. Key features to consider are power saving, colour rendering, structural strength and environmental protection.

Street luminaires illuminate large areas and it is especially important that most of the light emitted is directed to the illuminated surface. LED devices most satisfy these requirements in versions of direct light and can save energy even in comparison with similar high-pressure discharge lamps and sodium lamps [1, 2].

LED lighting sources mostly have the best colour rendering characteristics. In addition, the colour tone and colour rendering index can be selected when choosing a lamp for a specific application.

The worklife of LED lamps is significantly longer than the life of traditional street light sources. However, LED light sources are sensitive to elevated temperatures and under the poor heat dissipation conditions the service life may be significantly reduced.

The negative fact may be that the price of an LED luminaire is often significantly higher than similar traditional lighting devices. But, since the replacement of lamps in traditional outdoor lighting devices is associated with significant costs, requires special equipment, the use of LED devices in some cases gives tangible savings in the short term.

3. Street lighting source designing

LED luminaires for streets, parks, roads and architectural lighting must be made in a casing protected from moisture and dust, in addition, their casing usually acts as a heat sink and is made of highly heat-conducting materials.

The body of the device should be designed so that debris, bird stool and water do not accumulate on the surface of the lamp and do not impair its cooling ability, transparency of the protective glass, thereby preserving characteristics throughout the entire service life. Also the uniformity of lighting depends on the design of the luminaire and in most cases provides the necessary radiation pattern for direct light fixtures. The developed luminaire is a console LED street lamp (Fig. 1).



Figure 1. Console LED street lamp

It has a standard EFA 35W body, a LED module and a power supply unit produced by the Korean company Seoul Semiconductor [4]. The selection of LEDs from this manufacturer was made according to the analysis of the Ukrainian market [3]. Its use allows to increase the luminous flux by almost 2 times in comparison with similar lamps created on the basis of components from China.

The main characteristics of the developed luminaire are presented in Table 1.

Table 1. The console LED street lamp main characteristics

Power, W	35
Luminous flux, Lm	5250
Colour temperature, K	4000...6500
Input voltage, V	198...242
Size, mm	500×215×75
Weight, kg	3
Case Material	Aluminium
Ingress Protection Rating	IP65

4. Wireless automatic control system developing

As mentioned above, LED lamps are quite expensive in terms of their maintenance. Their overheating will reduce the warranty working period. In addition, in order to energy saving, it is advisable to maintain a low-light mode depending on the season of year or time of day, for example, to switch off or dimming the lamps partially at deep night. Modern IT technologies allows to create any algorithms of control and monitoring, and communication facilities – to carry out remote control of process providing the high-quality illumination.

A wireless automatic control and monitoring system of street lighting networks was developed within the stated tasks for operative control of lighting without additional wired communications between lamps. System allows to control the luminance of LED lamps both individually (in manual mode) and in automatic mode, depending on the external illumination and the specified working algorithm.

The main components of the developed system are the PC, the main chip with the built-in algorithm, the router and GSM-modules which the required number of luminaires are equipped. The block diagram of the system is presented in Fig. 2.

The system is managed and adjusted from a PC with the ability to create custom GUIs. It does not require any additional communication lines through providing remote control of the system via the Internet.

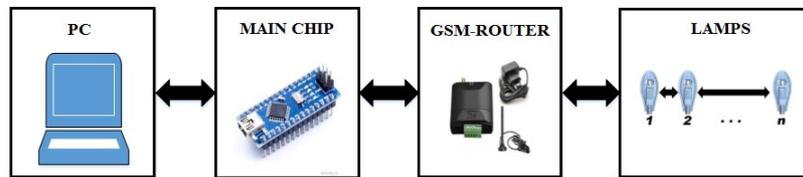


Figure 2. A wireless automatic control system block diagram

Developed wireless automatic control system can implement:

1. Automatic or manual control:
 - a separate lamp;
 - luminaire groups (for example, streets, street side, through one for economical use).
2. Control depending on the external lighting, season or day time.
3. Monitoring the temperature of the lamp (matrix and power supply unit) which will prevent the timely failure of the lamp.
4. Monitoring the light flux of the matrix which will allow timely automatic detection of a decrease in light flux or failure of the lamp.
5. Completely disconnecting the lamp from the power supply during the non-working period.

Conclusions

The result of the research and practical development of Ukrainian engineers aimed at reducing electricity consumption for outdoors territories illumination is street lighting source designing based on high quality LED lamps with minimum energy consumption and maximum light flux, the development and implementation of wireless lighting monitoring and automation systems.

The monitoring system implementation ensures:

- high efficiency and low power consumption due to the use of modern LEDs and power supplies as light sources;
- reduction of electricity consumption for lighting several times;
- increasing the worklife of lamps;
- compliance with all environmental requirements.

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