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ORGANIZATION OF CHARACTER DATA TRANSMISSION WITH THE HELP OF WHITE LIGHTING LEDS

АҚ ЖАРЫҚ ДИОДТАРЫ АРҚЫЛЫ СИМВОЛДЫҚ ДЕРЕКТЕРДІ БЕРУДІ ҰЙЫМДАСТЫРУ

ОРГАНИЗАЦИЯ ПЕРЕДАЧИ СИМВОЛЬНЫХ ДАННЫХ С ПОМОЩЬЮ БЕЛЫХ ОСВЕТИТЕЛЬНЫХ СВЕТОДИОДОВ

Abstract. The article proposes a data transmission system based on VLC technology using a new physical coding. The transfer of character data from one personal computer to another was realized using a white illuminating LED. When transferring data, a driver was used to control the LED. Instead of the standard physical coding approach, where one clock corresponds to a value of 0 and one clock to a value of 1, expressed in the maximum power of the LED, a new coding was implemented. This approach in two clock cycles at 0 voltage determines 0 in binary coding, and at a voltage that provides the maximum power ofthe LED, identifies 1 in binary. Although the baud rate is reduced, the reliability is improved by using two bits.
Keywords: optical wireless communication, VLC, LED, microcontroller.

Аңдатпа. Мақалада жаңа физикалық кодтауды қолдана отырып, VLC технологиясы бойынша дерек- терді беру жүйесі ұсынылған. Символдық деректерді бір жеке компьютерден екіншісіне ақ жарық диоды арқылы беру жүзеге асырылды. Деректерді беру кезінде жарықдиодты басқару үшін драйвер қолданылды. Бір сағаттың мәні 0-ге және бір сағат 1-ге, жарық диодтың максималды қуатында көрсетілген физикалық кодтау тәсілінің орнына жаңа кодтау енгізілді. Бұл тәсіл 0 кернеудегі екі циклде екілік кодтауда 0-ді анықтайды, ал жарық диодының максималды қуатын қамтамасыз ететін кернеу кезінде екілік сандық жүйеде 1-ді анықтайды. Деректерді беру жыл- дамдығы төмендегеніне қарамастан, екі битті қолдану арқылы сенімділік артады.
Түйін сөздер: оптикалық сымсыз, VLC, жарық диоды, микроконтроллер.

Аннотация. В статье предложена система передачи данных по технологии VLC с использованием нового физического кодирования. Была реализована передача символьных данных с одного персонального компьютера на другой с помощью белого осветительного светодиода. При передаче данных использовался драйвер для управления светодиодом. Вместо стандартного подхода физического кодирования, где одному такту соответствует значение 0 и одному такту значение 1, выраженное в максимальной мощности светодиода, было реализовано новое кодирование. Данный подход за два такта при 0 напряжении определяет 0 в двоичном кодировании, а при напряжении, обеспечивающем максимальную мощность светодиода, идентифицирует 1 в двоичной системе счисления. Несмотря на то, что скорость передачи данных уменьшается, надежность за счет использования двух битов повышается.
Ключевые слова: оптическая беспроводная связь, VLC, светодиод, микроконтроллер.

The article proposes a data transmission system based on VLC technology using a new physical encoding. The transfer of symbolic data from one personal computer to another was carried out using a white glowing LED. When transmitting data, a driver was used to control the LED. Instead of the standard approach of physical coding, where one clock cycle corresponds to the value 0, and one clock cycle corresponds to the value 1, expressed in the maximum power of the LED, a new coding was implemented. This approach determines 0 in binary coding in two cycles at a voltage of 0, and at a voltage that provides the maximum power of the LED, determines 1 in binary code. Although the baud rate is reduced, reliability is improved by using two bits.

The widespread introduction of devices into the intelligent environment represents a serious challenge for communication service providers in order to ensure an economical and high-quality wireless connection. To date, the radio frequency in the range of 1-3 GHz optimal for use is already overloaded [1, 2]. Therefore, the spectrum deficit, called the spectral crisis, must be solved by appropriate countermeasures in wireless communication systems.

To meet the growing demand for a wireless network, either an increase in bandwidth or an increase in spectral efficiency should be used. However, the increase in spectral efficiency is slow and cannot meet the rapidly growing demand. Using the new spectrum becomes a unique solution. In parallel with the development of technologies in the radio frequency domain, there is an additional potential for the use of optical wireless communication (Optical wireless communication, OWC) as a new generation of communication systems. The technologies have a number of unique advantages of VNK, such as a wide spectrum, high data transfer rate, low latency, high security, low cost and low power consumption [3-5].

In the VNC, ultraviolet or infrared spectra, as well as visible light, can be used as a transmitting medium. Within the last two bands, communication via visible light (Communication with visible light, VLC), wireless optics (Free space optics, FSO), communication via an optical camera (Communication with an optical camera, OCC) are possible. Figure 1 shows the general data transmission schemes of these technologies, which have individual distinct features and limitations in application [6-9].

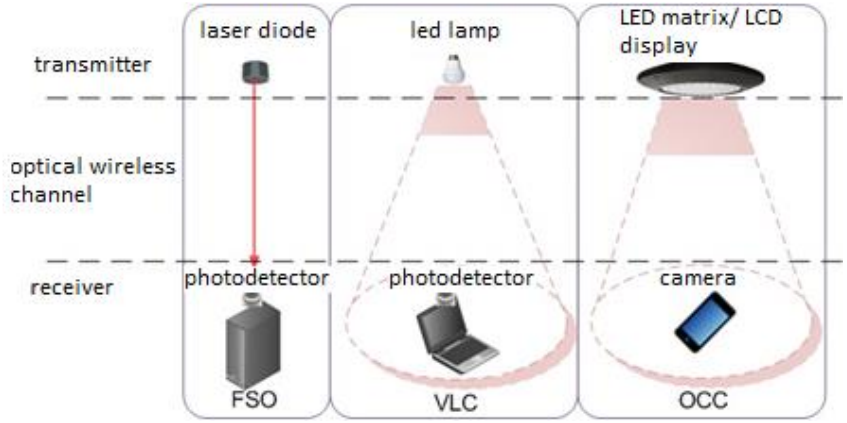

Figure 1. Data transmission schemes for optical wireless communication.

VLC technology is the most promising for organizing a data transmission system via optical wireless communication in a room. An LED lighting device acts as a transmitter, which performs its main function – lighting the room. Conducting a large amount of research and promoting this technology is associated with the introduction of LED lighting in the last ten years, since, unlike traditional lighting infrastructure, semiconductor lighting technology has higher technical and economic indicators, operational parameters, as well as the ability to create a dynamic comfortable lighting environment [10]. Inertia-free switching on of LED devices and high switching speed made it possible to consider LEDs as a means of transmitting information. Separately, it is necessary to

highlight the possibility of regulating the luminous flux of a light diode in the range of 400-800 THz, which is 10,000 times more than the radio frequency bandwidth [6, 7].

Thus, due to the qualities of the LED and its wide use in lighting of buildings, buildings and other objects, their use in data transmission is possible. Data transmission using VLC c technology is carried out by quickly turning off/on the light source, which simultaneously performs the function of a lighting device, which is not perceived by the human eye. The flickering of light, which occurs with a high frequency, allows you to transmit information without changing the level of illumination in the room. In addition, the VLC player technology has the security of information transmission at the physical level, resistance to radio frequency electromagnetic interference and free licensing.

Previously, we developed an audio signal transmission system using VLC technology. The experiments carried out on the system's operability showed that when using conventional LED lighting devices, it is possible to transmit audio signals in rooms with no more than 20% illumination from sunlight [11]. Such systems are convenient in rooms without natural lighting (basements, tunnels, mines, etc.).

This article discusses the system developed by the authors for transferring symbolic data from one personal computer to another using a white LED lighting using VLC technology.

In VLC systems, methods used for radio frequency communication can be applied, as well as specific modulation methods are implemented. The main modulation methods are based on two types of modulation – the modulation of one and several carriers [12-14].

When solving the task, the modulation of a single carrier was used to transmit information. At the same time, since data was transmitted from the computer port to the microcontroller in the form of a binary code, when physically encoded, the signal from the microcontroller had the form of a two-level unipolar NRZ code (Non-return to zero). The difference between the NRZ code and the standard protocol was as follows: the value of bit 0 occupied two – the absence of a signal, and the value of bit 1 also occupied two, but the presence of a signal (Fig. 2). The physical encoding used is due to the fact that when transmitting data (0, 1), the influence of both external and internal distortions decreases. In two cycles, the distortions occurring during this time are averaged, and the influence is correspondingly reduced. The presented method of data transmission is planned to be used in the future for control systems in which the reliability of information is more important than the speed of data transmission.

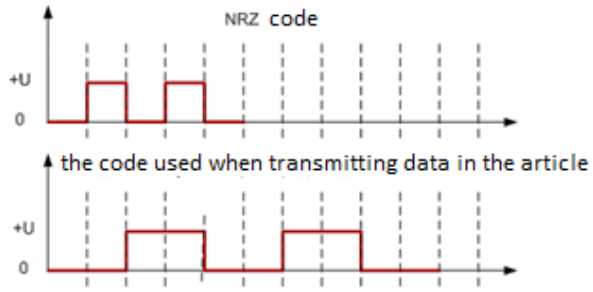

Figure 2. Graphical representation of physical coding.

Figure 3 shows the general scheme of data transmission over VLC, which uses physical encoding. From a personal computer, character data in accordance with the ASCII table (the American standard code for information exchange) is transmitted to the microcontroller in the form of a binary code. Discrete signals transmitted from the microcontroller to the LED driver are represented as physical encoding and transmitted over a digital communication channel over a distance. In the receiving part of the system, the digital signal from the photodetector is amplified using an amplifier and fed to the microcontroller. After the microcontroller, the signal in the form of binary numbers is sent to a personal computer, where, in accordance with the ASCII table, it is converted into characters.

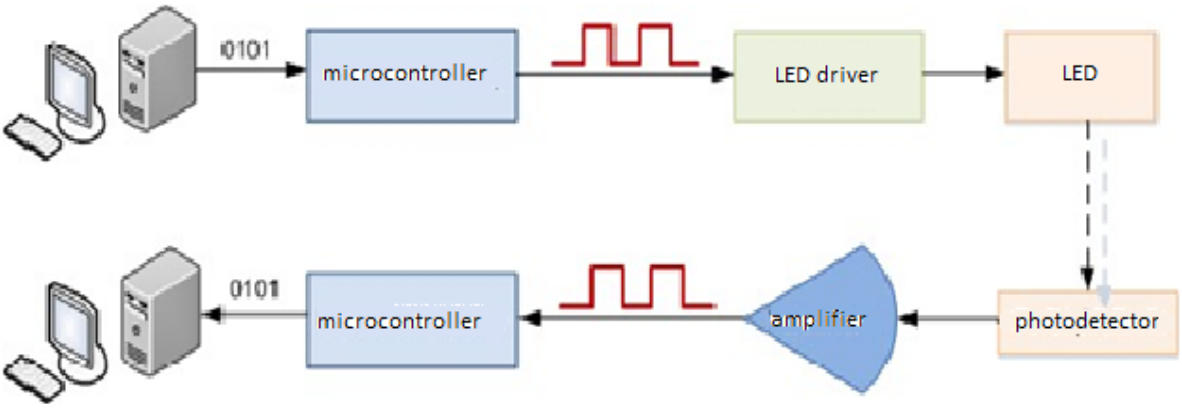

Figure 3. General scheme of data transmission using VLC technology.

The appearance of the developed symbolic data transmission system is shown in Fig. 4.

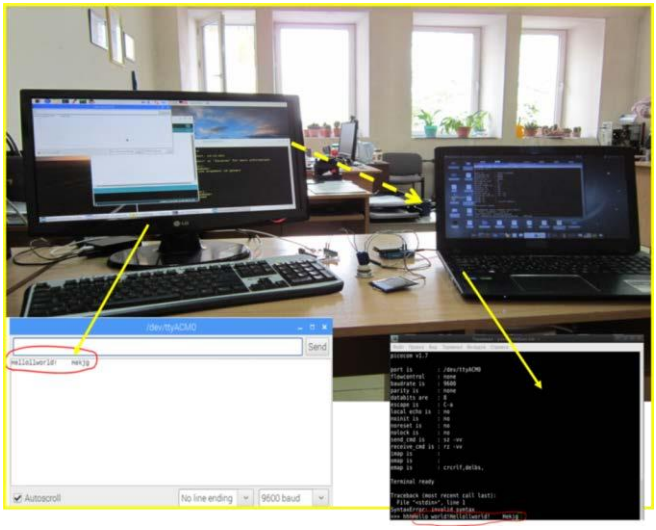

Figure 4. Appearance of the developed data transmission system.

A single-watt Nichiya LED was used as a light source. A solar photocell was used to receive the signal. The STM32 microcontroller was used to convert the signal (for transmission and reception).

To date, radio frequency systems cannot meet the high demands of future communication networks. Optical wireless communication technologies are the best additional solution for the implementation of intelligent and cost-effective environments. As a result, a data transmission system using LED lighting has been developed. A new method of physical encoding has been implemented, which made it possible to reliably transmit characters in ASCII format. Character data transmission using the-

The coding with a frequency of 2 kHz showed sufficiently stable characteristics with weak signal distortions. This suggests that there is a possibility of a significant increase in frequency when using microcontrollers with a higher clock frequency. Testing of the system showed high quality of data transmission. The results obtained allow us to conclude that this approach can be used in control systems.

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