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"SMART STREET" MANAGEMENT SYSTEM PROTOTYPE BASED ON THE LORAWAN PROTOCOL

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Прототип системи управління "Smart Street" на основі протоколу LoRaWAN

Актуальною і важливою задачею місцевої влади є зменшення використання енергетичних і людських ресурсів у сфері обслуговування вулиць. Вирішення даної задачі потребує розробки прототипу системи управління, яка дозволить автоматизувати процес керування вуличним освітленням, моніторингом вільних місць для парковки і своєчасним вивозом сміття. Для кожного з виділених завдань було розроблено прийомопередавачі із власним набором сенсорів. У роботі запропоновано використання протоколу LoRaWAN для передачі даних від спроектованих сенсорів до центру обробки. За результатами розробки представлено прототип додатку для управління "Smart Street".

Today an urgent and important task is to reduce the use of energy, time and human resources. Proper planning of sequence of certain system tasks execution is one of the possible solutions to this problem. However, at a certain point, the exclusively rational resources usage ceases to be effective. Automation based on the concept of the Internet of Things (IoT) can be a modern solution to the problem.

According to Cisco's research, 500 billion devices connected to the Internet are expected by 2030 [1]. Each such device combines certain sensors that interact with the internal and external environment. As data generators, these devices have access to the global network. Connecting such devices into a single structure is called the Internet of Things. IoT devices not only become a source of information, but also automate processes that can affect the state of the environment.

A growing trend to solve the problem of excessive resources usage is the introduction of the Internet of Things technologies in an urban environment. Municipal authorities thus exercise cheaper control over various industries such as water supply, timely garbage collection, road traffic control and parking lots. And besides, effectively used weather data, lighting management, atmosphere quality control and early earthquake detection. In addition to the obvious financial and social benefits, officials receive an increase in the public confidence rating. A useful bonus of implementing the Internet of Things is the collection of all kinds of depersonalized helpful data, so that authorities, mobile operators and client-oriented companies better understand the audience by offering high-quality demanded services.

A possible scenario for the development of the "Kiev Smart City" concept is to design an automated elements management system prototype for the "Smart Street". Introduction of the following controlled spheres are proposed:

- street lightining maintence based on the illumination parameter;
- checking of parking spaces congestion degree;
- scheduling of garbage containers cleaning.

This choice is due to the following practical factors: in Barcelona smart lighting technology can save up to $ 37 million a year, parking spaces booking applications allow the city to earn 50 million euros a year. In addition, it simplifies the search for electric vehicles charging station, and it is easier for municipal authorities to control traffic congestion [2]. In Chicago, the sensors installed in garbage containers allowed reducing the number of garbage ignition by 32%.

For the “Smart Street” management system implementation the following steps are proposed:

- selection of data transfer protocol;
- creation of three necessary sensors types;
- setting up the base station and Network server;
- development of an Application server.

One of the popular urban-oriented data transfer protocols is LoRaWAN (Long Range Wide Area Network). It allows devices to exchange small information volumes (up to 254 bytes per message) at a very low (0.3-50 kbit/s) speed. Collecting information from scanners is safe for human health since the transmitter power reaches only 25mW [3]. The communication nodes hierarchy consists of an end device (sensor), a data exchange gateway, a Network server, and an Application server [4]. The trade-off between message transmission range and speed allows using the end device with an internal power source up to 10 years. The frequency standard for Europe (including Ukraine) is 868 MHz, which is not licensed under the laws of Ukraine, and the bandwidth is 125-500 kHz. The LoRaWAN protocol provides mandatory two-level encryption with the AES-128 standard (CMAC) to ensure message integrity. One base station coverage ranges up to 5 kilometers in an urban environment.

An imporant objective of this work is to develop transmitter capable to work on the LoRaWAN protocol basis. This decision is due to the cheaper production of future integrated systems, as well as the personal transmitter settings possibility. As a computing unit, the use of Arduino Nano microcontroller is proposed. Its main advantages are the availability of non-volatile memory (EEPROM) and support for SPI (Serial Peripheral Interface).

To work on the LoRaWAN protocol basis, a modem, receiver and signal transmitter are required. The modem is responsible for using the desired type of modulation, as well as encoding and decoding information. In addition, the modem provides synchronous and asynchronous operation modes. In view of modern integration trends, the modem, receiver and transmitter are made in the single chip form. For compatibility with Arduino Nano, the RFM95W chip manufactured by HopeRF was chosen. Its choice is due to the presence of the ready-to-use open library LMIC (LoRaWAN-in-C), which is compatible with Arduino Nano, as well as the lack of the need to use power regulators, as the microcontroller and chip have the same supply voltage.

The developed transmitter needs to be registered in the LoRaWAN network. Therefore, it is necessary to configure precisely two main system topology components: the gateway and the Network server. The gateway is configured by installing special software - Packet Forwarder (PF). Every Network server provides its own PF for downloading, so there is a need in choosing a reliable one. The popular and convenient Actility service was chosen as the Network server, the team of which took part in the LoRaWAN protocol creation. After installing the software, the base station has to be registered to Actility. The last configuration step is to register the created transmitter, after which it will be possible to observe incoming data packets in Actility Wireless Logger.

The last stage in the control system development is the selection of an Application server for decrypting messages and interpreting monitoring results. The most convenient option to satisfy all the system needs is to create processing program. It is proposed to use an application written in the LabVIEW development environment as a prototype (Fig. 1). As the main functionality, it is worth highlighting: the presence of a message decoder, the ability to save the readings history in a MySQL database or as a Word format report, alarm signals flexible configuration and a graphical information representation.

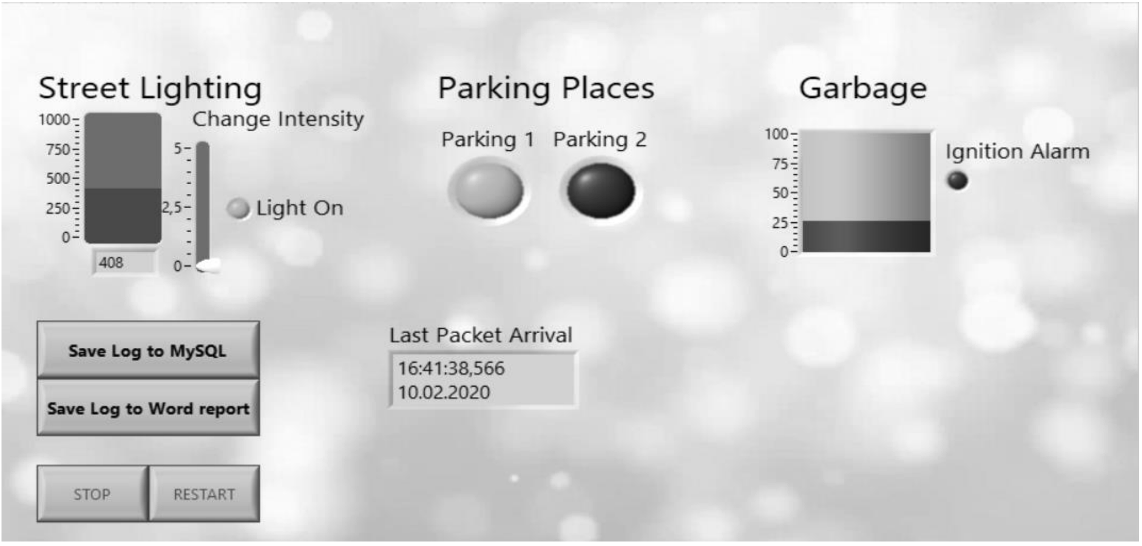

Figure 1. The NI LabVIEW developed application

Conclusion: As a result of the development of the “Smart Street” management system prototype, the following goal was achieved: the transmitters creation as well as the gateway and the Network server configuration, which together made it possible to establish the network based on the LoRaWAN protocol. In addition, in the work an Application server prototype is presented, that allows automated monitoring and control of the created system parameters. Future work will be devoted to expanding the devices range, creating a physical street prototype as the the sensors implementation form, as well as improving the processing program.

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