Fogging Based Street Light Management System for Smart City

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Abstract--Smart cities deliver great advantages both in terms of protection and energy efficiency. The city street lamp is connected to both energy conservation and protection. The street light is therefore a critical part of intelligent cities. However, today's street lamps lack intelligent features that increase both danger and energy consumption. A Street Light Management System (SLMS) focused on fog computing for smarter cities is suggested in this paper to resolve these issues. The benefits of the proposed SLMS include: 1) fine control as each street lamp can be controlled independently; 2) dynamic luminosity adjustment; dynamic adjustment, all street lamps can be adjusted; and 3) an independent warning in the abnormal state. Results from studies have shown SLMS can increase energy efficiency and mitigate hazards.

Key words-- Smart street lamps, smart cities, sustainable energy, fogging, security.

1.INTRODUCTION

The main objective of the intelligent city is to improve the protection, convenience and convenience of operations and to conserve resources. To foster intelligent cities, an urban infrastructure is also more intelligent. As an integral part of the city's urban infrastructure, the street lamp is closely related to protection and energy conservation. Today, without street lights it is difficult to imagine how the city looks like. But in such a situation, theft and robbery are likely to seriously increase. it is easy to predict. In addition, the existing street lamp management needs to be streamlined due to its high energy level on day-by-day usage.

Today, the key drawbacks of the street lamps are manual administration or the light perception controls:

1) Long cycle of servicing. Both manual management and monitoring of light perception take manual patrols to control broken street lamps. The maintenance cycle is therefore too long and it can be much longer than a few months, particularly for the suburban street lamps. However the risk increases only after the street light is disabled, so more accidents, robbery and theft may occur.

2) Hard management of fine grain. Manual management is clearly not intelligent enough and can be managed with difficulty in real time. In addition, one switch is used to control several street lamps at the same time in order to simplify manual management. The versatility is nearly restricted for light perception control. Real-time controls and remote controls are not included in the latest management systems.

3) High use of energy. There are only two states nowadays street lights, off and on. Furthermore, their brightness cannot be changed. Therefore, excess energy is consumed. The street lamps may often be dim in order to conserve energy.

4) Easy robbery. No efficient way to avoid street lamps from being stealed exists. There are a large number of street lamps, so all of them cannot be regulated at all times. To

stop robbing, street lamps have the ability to track themselves.

A new generation of street lamps must boost their efficiency by incorporating the following features in order to optimize the above-mentioned drawbacks in developing smart cities:

1) Minimize service life. One of the most significant maintenance cycles is major smart city criteria. The maintenance cycle must therefore be minimized to the extent possible. A mechanism must be given to verify in real time broken lamps.

2) Complement the management of fine grain. There are few parts to fine grain controls: first each street lamp requires its own identity to differentiate between it; secondly, each street lamp should be controlled independently; third, all street lamps should be tested continuously.

3) Reduce the consumption of electricity. The luminous the street lamp, the more energy is used. However, energy consumption can decrease by changing the dynamic light intensity according to current demands.

4) A self-sufficient warning to deter robbery. Each street lamp must have the capacity to protect itself. If robbed, it can give a warning autonomously. This will prevent the theft of the street lamp.

In this article we propose to satisfy all of the above four skills a street lamp management system (SLMS) based on fog computing. The proposed SLMS consists of three main parts: an intelligent street lamp that can change light brightness, an independent warning that reports on suspicious activity, and an effective network used to communicate in real time between managers and bulky street lamps; and finally, a simple and highly automated, scalable management platform.

In the proposed SLMS, the key contributions are:

1) the hybrid network will be implemented and the Narrow Band Internet of Things (NB-IoT) will be used for the real-time communication between servers and broad street lamps.

2) A versatile management platform is in place to alert managers of the broken street lamps in real time and to restore broken street lamps automatically by the maintenance personnel;

3) The states can be mapped in real-time for all street lamps.

2. RELATED WORKS

S. Kamoji et al. (2020). [1] The method implemented is standardized, with modules: LED module and PIR, LDR, Emission Detector and the camera. The framework is a modular design. In the lack of motion and if the ambient light is sufficient, the brightness of the lights is decreased. The machine driver assistance module recognises the expelled cars by recognising the number plate. The recognition number plate was carried out with RCNN and some techniques for the analysis of images. Pollution levels can be detected and registered by the pollution sensor around the street lamps. These data allow us to generate a city heat map of pollution and to identify areas that congested high frequency. A docking point for charging electric cars, which is a prepayment facility, is provided on a light pole.

Y. Xue et al. (2020). [2] A smart dimming model based on the neural network is drawn up in this paper. The system will analyse road information submitted by the sensor layer, and output the dimming signal, enhancing the effectiveness of a flow control and a nerve network. The test results showed that the model is more environmentally friendly and compatible with naked eye in contrast to the conventional approach.

H.Ibrahim et al. (2020). [3] The study explores efforts to focus on the idea of using

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load pressure from the transport route junction by means of mobile vehicles to peat lands and transform it into electric energy using a ramp coupled with piston-spring pressure control and Piezoelectric equipment.

Junjian He et al. (2019). [4] This study analyses the Wireless Sensor Network(WSN) intelligent road lighting system and the useless decision-making process. this paper. The system captures metrics of the traffic conditions through WSN and implements versatile rules to smartly change the light on the road. The evidence shows that this paper's sophisticated street lamp management system can intelligently control and light street lights on-demand, dramatically reduce energy usage and increase street lamp support and storage quality.

M. Durgun et al. (2019). [5] The suggested street lighting offers special lighting depending on the region of illumination. The bulb can be tracked for the amount of light, location and fault conditions. For different illumination situations, variable structure techniques have been suggested. The proposed device, because of its practicality and effectiveness, is expected to provide a revolutionary solution for current lighting problems.

Sunhuang Chi et al. (2019). [6] This report contains and implements a highly tuned access control mechanism (includes high competitiveness, high availability and high scalability) for urban street lamp IoT. And the test findings support the methodology reported in this article, which has enhanced stability and access to thousands or even millions of street lighting systems.

Y. Sarr et al. (2019). [7] This paper provides a practical deployment of a vast intelligent street lighting platform that provides solar light stations to control street lamps dynamically. When only one access point is implemented due to collisions, simulation findings indicate a high rate of packet loss. The results show that multiple LoRa network gateways obtain a higher packet distribution ratio and low consumption of energy.

W. A. Jabbar et al. (2019). [8] The work has proposed an intelligent environmentally green street light system for the efficient use of renewable energy sources and energy conservation (SGStreet-LS). The proposed system creates powerful concepts and concepts that allow street lights to function safely and quickly depending on the availability of illumination and movement detection by using RF wireless connectivity controls based in Arduino.

N. T. Tung et al. (2019). [9] This review deals with both the formulation and management of an intelligent street lighting system dependent on LED light and wireless Lora interaction.

D. Tukymbekov et al. (2019). [10] This article deals with an automated public lighting device with an energy-efficient predictive algorithm. The work is connected to the control of the device using algorithms which can supply each lamp during the night.

M. Hossain et al. (2019). [11] This article contains and shows a unique Led Street Lighting Device for Bangladesh regulated Smart Autonomous Power and Turn.

S. Bruno et al. (2019). [12] This work provides preliminary findings of a continuing architecture research project to incorporate public road light strategies based on LEDs into other intelligent urban infrastructure and services. The article outlines the overall smart grid design of many devices, including renewable power generation, energy storage, charging stations and lights based on LEDs.

A. Jha (2019). [13] This report outlines the major features of an 80W smart LED carrier that functions in 6LoWPAN connectivity.

M. Cimdins (2019). [14] This article describes us with a network comprising of an 868MHz ISM band transportation system and a 2.4GHz ISM sensor network. Our test bed and simulation first results demonstrate how the device is functional. To maintain the platform's interoperability, automation and further testing are important in the future.

3. PROPOSED SYSTEM

The proposed smart street lamp (SLMS) consists primarily of three parts: 1) intelligent street lamp sensing, street lamp brightness can be changed, and irregular activity will be identified by an autonomous alarm; 2) powerful infrastructure, the infrastructure can be used for real-time communication, NB-IoT is adopted for server-to-massive street lamp communication, and Internet infrastructure, such as Wi-Fi and 4G, is adopted for server-to-managers communication; 3) The communication strategy can optimize resource planning for simple and highly advanced management through a versatile management system. The structure of the SLMS can be seen in the Fig. 1.

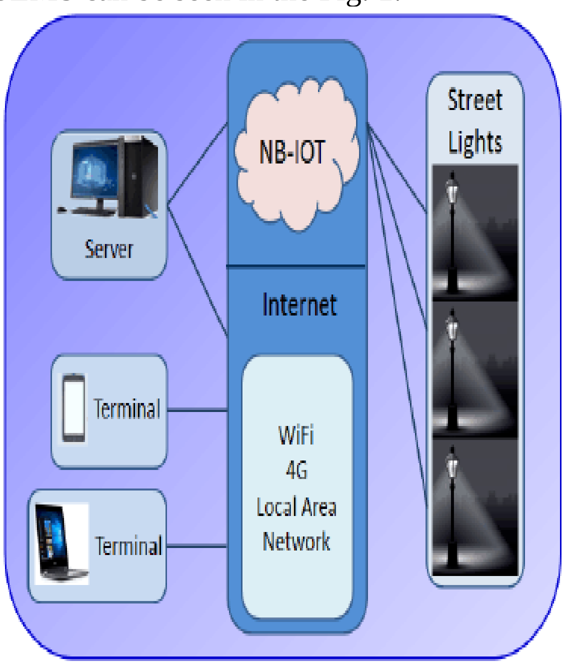

Fig. 1. SLMS architecture

A. Street Light of Intellectual Sensor

In order to shape an intelligent sensing street lamp, the street lamp is fitted with several sensors, such as a position sensor, an infrared sensor and a light sensor. Consequently, street lamp luminosity can be changed.

The street lamp will communicate with the server via the network using these sensors. In this paper, the street lamp sends reports on its current and voltage values regularly. The server will calculate the state of the street lamp based on the street lamp's current and voltage values. If the street lamp current is zero, but the voltage is not zero, then the server may infer that there might be a break in the light bulb.

The server can be told, by the location sensors in the street lamp, if the street lamp is stolen. In addition, when the street lamp is lost, the street lamp may be marked. In addition, when the server learns that street lamp light bulbs are broken, the server can send the precise location to the serviceman for repair, so that the serviceman can precisely locate the broken street lamp, which increases efficiency.

In a street lamp, the infrared sensor makes the street lamp more intelligent. Street lamps may differentiate between the criteria for brightness. That is, the brightness should be turned down for street lamps in the unmanned area, and the brightness needs to be turned up for the street lamps in the crowded area. Protection in crowded areas can also be assured, and shutting down unmanned street lamps satisfies the criteria for energy conservation. The street lamp's light sensor makes the street lamp feel alert to the external world. In addition, the sensors make street lamps smarter.

As a consequence, the street lamp will connect with the server and collect its instructions. In other words, different commands can be sent by the server, such as turning on, turning off, turning up, turning down and testing states, etc.
When streetlights acquire these instructions adjust their settings as per the instructions.

B. Powerful Infrastructure

Many problems may occur while street lamps interact with server. Owing to its excellent of wide coverage, good stability, good protection, low latency, power efficiency, and so on the suggested SL MS implements the NB-IoT to solve these issues, all of which try to reduce all the limitations. Nevertheless, NB-IoT communication between street lights and servers is a major issue: the NB-IoT bandwidth is small. When street lamps send messages to servers, the problem can be solved by time sharing. But when servers send messages to street lamps, that's serious. Therefore as large commands are sent from the server to multiple street lamps concurrently, a certain latency occurs. In order to overcome the latency, the big data analysis was utilized in the SLMS.

The street lamps regularly send the external ambient luminosity data to the server. It is easy to get the relationship between the brightness of the exterior atmosphere and time and season for each street lamp based on this data and big data analysis technology. For two street lamps at different places, the relationship between the brightness of the external environment and time and season is presented in Fig. 2. The SLMS will decide the priority for each street lamp according to that relationship. The darker the external setting is the greater the priority would be. In addition, the higher the street lamp priority is the faster the command is sent.

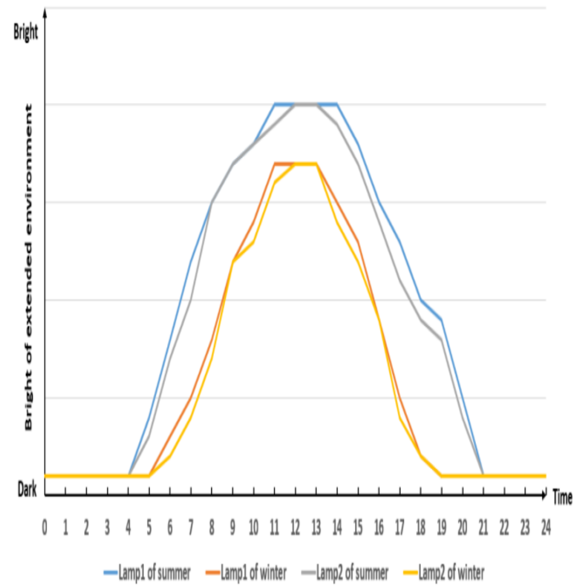

Fig. 2. The correlation between both the light of the outside setting and duration and climate for two street lamps at numerous places.

4. SLMS AUTHENTICATION

Figure 3 provides a graphical demonstration of SSL applications in Xiasha. In the district, we arranged 10 movable street lamps, each of which has 5 states: open, denoting that the street lamp is turned on with the highest brightness; save, denoting that the street lamp is turned off, near, close, Offline denotes that the street lamp is switched off which denotes that the street lamp does not interact with the server, and fault denotes that the bulb is damaged or power failure has occurred. The offline and fault states are distinct and are separated by the data collected. For example, if no data from one street lamp is received, then the street lamp is offline; otherwise if zero electric current and non-zero voltage of one street lamp are received, then the street lamp is defective. Different colors are used to represent various states in Figure3.

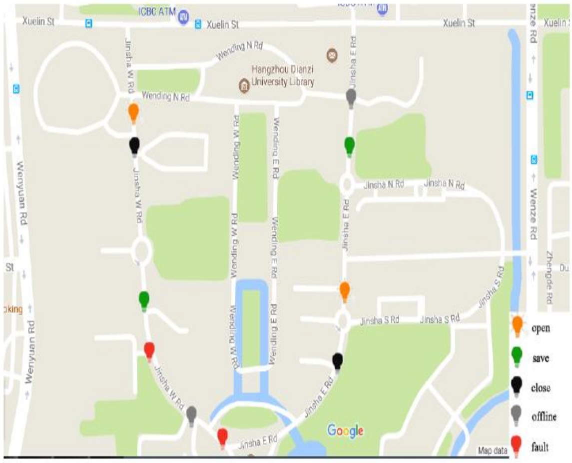

Fig. 3. Pictorial illustration of Xiasha's SLMS programme.

Each lighting fixture in Figure 3 includes real-time data about its ID, position (longitude, latitude), and present state. For each street light on the map, this data can be instantly seen in the layout shown in Figure 4. Its position on the map changes concurrently after the street lamp is relocated.

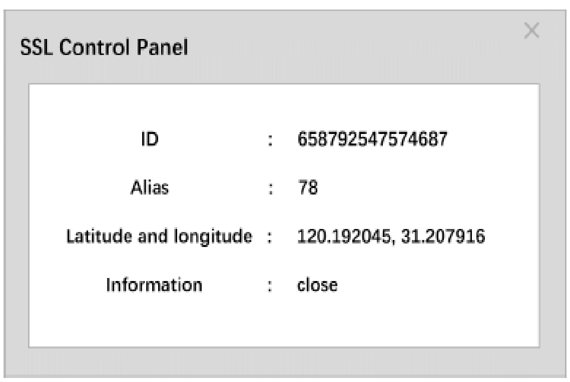

Fig. 4. Real-time states for each street lamp.

5. RESULTS AND DISCUSSION

We test the efficacy of the proposed SLMS in this section by simulating irregular street lamp states. First, we introduce the configuration of the framework based on the fog computing server that implements a scalable platform for management. Secondly, we examine the regular checks of street lamps' irregular states. Thirdly, we present the findings of SLMS reliability; and finally, we discuss the conservation of electricity.

A. System Settings

We developed a management framework with a server focused on fog computing. The configurations for the device are given in Table 1. Dynamic information about its ID, location (longitude, latitude) and state is stored in the server database for each street lamp.

TABLE I: system configuration

Processor	Intel(R) Core(TM) i5-3470 3.20GHz
Memory	4.0 GB
OS	Windows 7
Database	Oracle
Disk	1 TB with 7200 r/s

B. Analysis of Regular Checks

The mechanism of dropping into an irregular state to be fixed must be understood in order to determine the average maintenance time of the SSL. Figure 5 presents this phase, in which it can be seen that it consists of three parts:

1) Depending on the statistics from its sensors, the street lamp checks its own condition, position, current and voltage. This consciousness is regularly sent over the NB-IoT link to the server. In this article, the sending time is set to 20 minutes. This portion can be split up into two processes: each street lamp transmits its status to the access point, and every street lamp transmits statements to the server.

2) Once the server receives street lamp data these data will be saved to the server database immediately and the server begins checking whether some suspicious state occurs in the database. The search period is also 20 minutes. The check period is set.

3) The information is sent to the manager and the nearest servant if the server discovers the abnormal status.

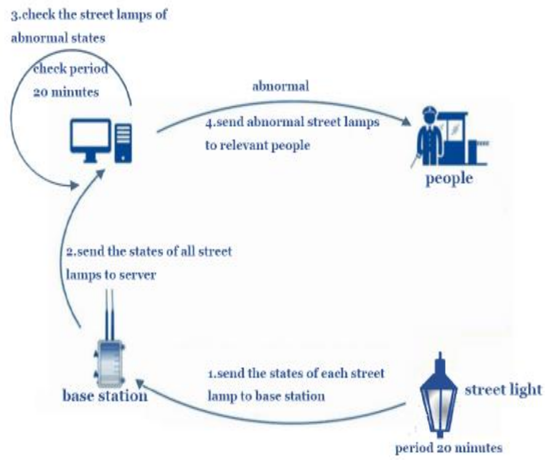

Fig. 5. The mechanism to be restored from dropping into an irregular state.

In simulation it was based on theoretical study that the total maintenance time of SLMS was 20 minutes. In the first half of the time the contact between lamp and server was spent, while the remaining half periodically checked the Server for irregular conditions. The maintenance cycle was therefore considerably shorter than in conventional management systems.

The results showed that 10 road lamps were abnormal 100 x 10 times, that is, 100 x 100 times in every street lamp. We have reported maintenance data during the simulation and are provided with the recorded data for a broken bulb in Figure 6. Figure 6 shows the L1-1 on x-axis, showing the first Lamp 1, L10-100 report, indicates the 100th Lamp 10 report. The repair time is shown on the y-axis. The total maintenance cycle was 21.6 minutes, a little over 20 minutes, mostly due to a lack of time to simulate. However the findings were approximately 20 minutes to check the maintenance time.

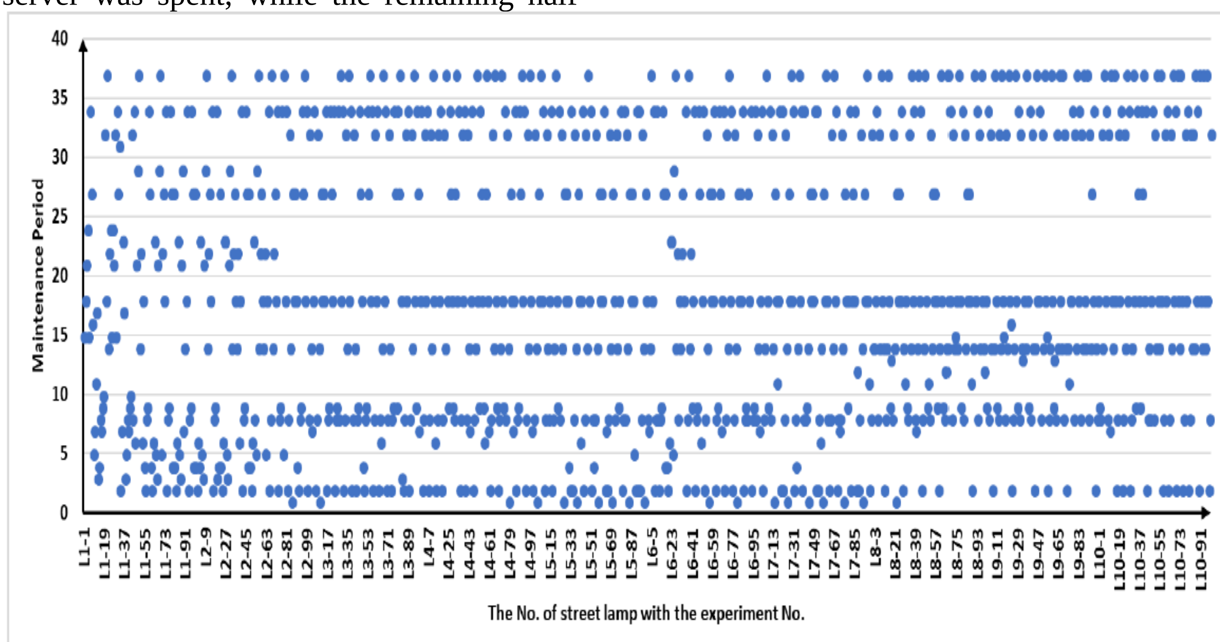

Fig. 6. Broken bulb's regular checks case

6. CONCLUSION

This paper proposes a smart streets lamp (SLMS) based on fog computing to meet the requirements of smart cities. SLMS consists primarily of the following three parts: 1) intelligent sensor lamp (street lamp brightness can be changed and autonomous alerts about lamp abnormality); 2) effective network (real time communication is achieved; NBIoT is used for communication between servers and bulk street lamps. and highly automated street lamp device management).

REFERENCES

[1] S. Kamoji, D. Koshti, J. Noronha,E.Arulraj and E. Clement, "DeepLearning-based Smart Street Lamps – A Solution to Urban Pollution," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 478-482, doi:10.1109/ICIRCA48905.2020.9182980.

[2] Y. Xue, Y. Zhang and P. Shuxue, "An Intelligent Dimming Algorithm of Streetlight Based on Fuzzy Neural Network," 2020 International Wireless Communications and Mobile Computing (IWCMC), Limassol, Cyprus, 2020, pp. 1964-1967, doi: 10.1109/IWCMC48107.2020.9148128.

[3] H. Ibrahim, B. F. Ikotoni and I. Y. Jatto, "Smart Traffic Roads Junction Energy Exploration for Electrical Energy Generation," 2020 IEEE PES/IAS PowerAfrica, Nairobi, Kenya, 2020, pp. 1-5, doi: 10.1109/PowerAfrica49420.2020.9219928.

[4] J. He, Z. Zhu, F. Wang and J. Li, "Illumination Control of Intelligent Street Lamps Based on Fuzzy Decision," 2019 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS), Changsha, China, 2019, pp. 513-516, doi: 10.1109/ICITBS.2019.00129.

[5] M. Durgun and L. Gökrem, "Cloud-Based Adjustable and Section Led Pattern Controlled Street Light," 2019 3rd International Conference on Advanced Information and Communications Technologies (AICT), Lviv, Ukraine, 2019, pp. 308-310, doi: 10.1109/AIACT.2019.8847902.

[6] S. Chi, S. Bi, M. Dong, B. Sun and C. Xie, "A High-Performance Access Control Model for Urban Street Lamp Internet of Things," 2019 IEEE International Conference on Real-time Computing and Robotics (RCAR), Irkutsk, Russia, 2019, pp. 632-637, doi: 10.1109/RCAR47638.2019.9043936.

[7] Y. Sarr, B. Gueye And C. Sarr, "Performance Analysis of a Smart Street Lighting Application Using LoRa Wan," 2019 International Conference on Advanced Communication Technologies and Networking (CommNet), Rabat, Morocco, 2019, pp. 1-6, doi: 10.1109/COMMNET.2019.8742356.

[8] W. A. Jabbar, M. A. B. Yuzaidi, K. Q. Yan, U. S. B. M. Bustaman, Y. Hashim and H. T. AlAriqi, "Smart and Green Street Lighting System Based on Arduino and RF Wireless Module," 2019 8th International Conference on Modeling Simulation and Applied Optimization (ICMSAO), Manama, Bahrain, 2019, pp. 1-6, doi: 10.1109/ICMSAO.2019.8880451.

[9] N. T. Tung, L. M. Phuong, N. M. Huy, N. Hoai Phong, T. L. Dinh Huy and N. Dinh Tuyen, "Development and Implementation of Smart Street Lighting System based on Lora Technology," 2019 International Symposium on Electrical and Electronics Engineering (ISEE), Ho Chi Minh, Vietnam, 2019, pp. 328-333, doi: 10.1109/ISEE2.2019.8921028.

[10] D. Tukymbekov, A. Saymbetov, M. Nurgaliyev, N. Kuttybay, Y. Nalibayev and G. Dosymbetova, "Intelligent energy efficient street lighting system

with predictive energy consumption," 2019 International Conference on Smart Energy Systems and Technologies (SEST), Porto, Portugal, 2019, pp. 1-5, doi: 10.1109/SEST.2019.8849023.

[11] M. Hossain, M. T. Islam Opu, M. Islam and N. R. Nadi, "Design of a Cost Effective Smart Autonomous Power and Switch Controlled Led Street Light," 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), Dhaka, Bangladesh, 2019, pp. 1-6, doi: 10.1109/ICASERT.2019.8934533.

[12] S. Bruno, G. Giannoccaro, M. La Scala, G. Lopopolo and C. Rodio, "A Microgrid Architecture for Integrating EV Charging System and Public Street Lighting," 2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), Genova, Italy, 2019, pp. 1-5, doi: 10.1109/EEEIC.2019.8783640.

[13] A. Jha, "Smart LED Streetlighting System with Improved Power Quality and Low Standby Consumption," 2019 3rd International Conference on Recent Developments in Control, Automation & Power Engineering (RDCAPE), NOIDA, India, 2019, pp. 131-136, doi: 10.1109/RDCAPE47089.2019.8979119.

[14] M. Cimdins, W. Arlt and Horst Hellbrueck, "IoTiSS: Internet of Things in Smart Streetlighting," Mobile Communication - Technologies and Applications; 24. ITG-Symposium, Osnabrueck, Germany, 2019, pp. 1-6.