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A development of Automotive recognition streetlight lighting control with sound recognition technology

Wonchul Choi[1], Choongchae Woo[2]

[1] Hanseo University, Dept. of Electronic Engineering, Seosan, Korea
[2] Hanseo University, Dept. of Electronic Engineering, Seosan, Korea (corresponding author)
[1]comling2497@gmail.com, [2]woo9@hanseo.ac.kr

Abstract. In this paper, proposed a new lighting control system which can reduce power consumption compared to conventional street lamps and intelligently control the light efficiently depending on whether there is a vehicle on the street. The new lighting control system proposed by this paper detects the presence of cars by collecting and analyzing sounds generated by the movement of cars. Then, the system controls lighting of street lamps based on the above car detection information, and turns on the street lamps sequentially by transmitting the car detection information. Experimental results showed that lightings were controlled based on the presence of cars and that operations of the lamps were made by turning on the lights sequentially by determining the moving direction of cars. This system is considered a technology that can reduce energies by applying to local roads with a few cars moving or national highways where lights are always turned on with low energy efficiency.

Keywords: automotive recognition, lighting control, sound recognition, streetlight.

1 Introduction

Under the conventional streetlight control system, a streetlight controller installed in each street lamp receives the control signal through the PLC (Power Line Communication) or RF (Radio Frequency) communication method from a distribution box to control turning on/off of the street lamp; monitors the short circuit, power consumption and possible failure and sends the data to the distribution box [1-5].

Such system of controlling the streetlight through the distribution box is applied to most street lamps, and such system is an example of energy waste as the street lamps are turned on or off only by time regardless of brightness of the road.

Although the illumination of the road is measured using an optical sensor to such problem, the sensor has the problem of creating error caused by foreign substances such as snow or dust as time passes. A more advanced system detects the vehicle on the road with an IR sensor, but the system turns on the street lamp when it detects a vehicle, and thus it is an inefficient system for securing visibility which is the main purpose of streetlight [6].

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In this paper, we propose and develop an advanced streetlight management system which uses a sound recognition function to detect the sound generated when a vehicle moves and turn on a street lamp then sequentially turns on the next street lamp in the direction of the vehicle movement.

The rest of this paper is organized as follows. In Section 2, we introduce the organization of the developed system and computer simulation test. Section 3 describes the theory applied to the developed system and design of the system. Section 4 shows the result of test. Finally, we present the conclusion in Section 5.

2 Paper Preparation

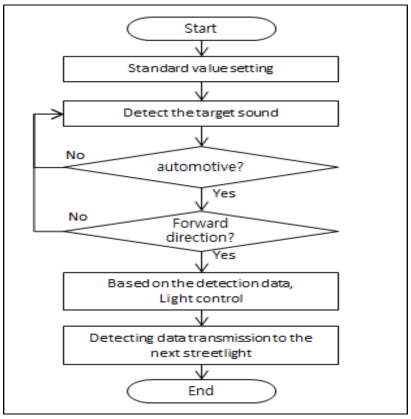

Fig. 1. System flowchart

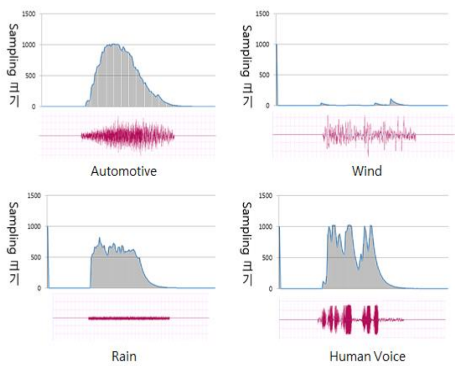

Fig. 2. Sound sampling data

The developed system consists of a detection unit to detect the sound generated by a moving vehicle, an integrated controller to analyze the existence of a vehicle and its moving direction based on the data from the detection unit, a lighting control unit to control lighting according to the control signal from the integrated controller, and a wireless communication unit to send the vehicle detection data to the next street lamp in the vehicle moving direction. The developed system can detect the vehicle on the road and its moving direction and control the streetlight to reduce the energy consumed by the street lamps.

Fig. 1 shows the work flow of the developed system. The developed system detects a sound and compares the acquired sound data with the predefined reference data to determine the if the sound is generated by a moving vehicle. It also analyze the acquired sound data to determines the moving direction and send the data to the next street lamp in the vehicle moving direction to control it. To correctly extract the sound generated by a moving vehicle, the sound generated by moving vehicle as well as the noise on the road such as wind sound, sound of rain, sound of wind and human voice were also collected. The standardization size and frequency of the sounds were analyzed through a computer simulation test.

Fig. 2 shows the standardization size and spectrum data of the actual sound of a vehicle moving on a road as well as the noise on the road such as wind sound, sound of rain, sound of wind and human voice. The analysis of the standardization size and frequency of the acquired data with Cool edit pro (simulation program) by Syntrillium Software indicated that application of a band-pass filter which only passes the frequency of 1kHz ~ 5kHz can minimize the noise when extracting the vehicle sound. Figure 3 shows the band-pass filter developed with the simulation program.

3 Result

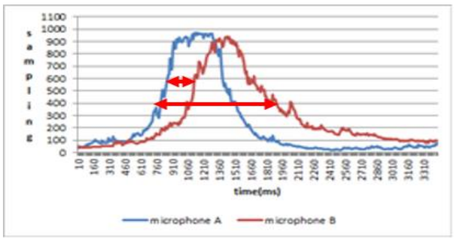

Fig. 3. One automotive forward direction

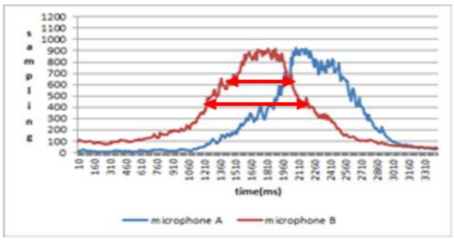

Fig. 4. One automotive reverse direction

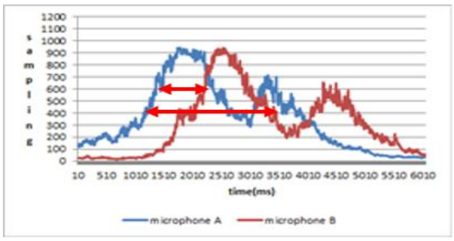

Fig. 5. two automotive forward direction

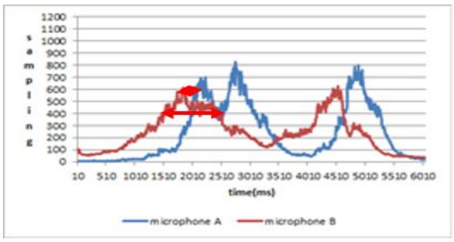

Fig. 6. two automotive reverse direction

The developed system was designed for a microphone installed on both sides of the case to determine the existence of a vehicle and its moving distance. Because of limited time and cost, the developed system was not tested with actual street lamps but installed on the model street lamps in similar environment as shown in Figure 12 and appled on an actual road. Its operation was checked when a vehicle moves, and the sound data were acquired at the same time to check if the fabricated system operates normally.

Figures 3 and 4 show the data sampling the size of the sound generated when a vehicle moved forward and backward on an actual road with 10ms time delay.

Figures 5 and 6 show the data sampling the size of the sound generated when two vehicles moved forward and backward on an actual road with 10ms time delay.

4 Conclusion

The sound recognizing streetlight control system described in this paper has following benefits. First, it not only reduces the energy but also saves the cost by intelligently controlling the street lamps which normally remains lighted continuously. Second, the applied sound recognition has less risk of error than the conventional system of turning on a street lamp by measuring the brightness. Third, sharing of control data among the street lamps enables efficient management of many street lamps and efficient control of each street lamp. Fourth, the system can be easily installed in the existing street lamps thus can reduce the initial replacement cost or installation cost.

As such, the sound recognizing streetlight control system proposed in this paper can be applied to the street lamps which are always lighted inefficiently on the remote roads where there is relatively less traffic and efficiently save the energy.

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