International Journal of Internet, Broadcasting and Communication Vol.12 No.4 11-17 (2020)
http://dx.doi.org/10.7236/IJIBC.2020.12.4.11

IJIBC 20-4-2

A HMD VR data transmission solution by using strip LED attached Window Signage

Seung-Kyun Kim*, Deok-Gun Woo**, Young-Ki Park***, Sang-Il Im***, Khudaybergenov Timur***, Kyung-Hwan Ku****, Jae-Sang Cha*****

**Master Course, Department of Media IT Engineering, Seoul National University of Science and Technology, Korea*
E-mail : rlatmdrbs249@gmail.com
***Researcher, IoT Convergence Lab, Seoul National University of Science and Technology, Korea*
E-mail : itclabwoo@gmail.com
****Doctor Course, Department of Broadcasting Communication Fusion Program, Seoul National University of Science and Technology, Korea*
E-mail : ferrum.warchief@gmail.com, ykp@signtelecom.com, isi0418@gmail.com
*****Professor, Department of ICT Automotive engineering in Hoseo University, Korea*
E-mail : alarmkoo@hoseo.edu
******Professor, Department of Broadcasting Communication Fusion Program, Seoul National University of Science and Technology, Korea*
E-mail : chajaesang@gmail.com

Abstract

This paper proposed the design of a new window signage system architecture, which utilized a window of a building, with attached LED for visible light communication. In this paper, the proposed method using the LED strip to transmit light data and receive the data through a HMD with a smart device camera. The LED strip attached to the existing building window, as a part of semi-transparent signage. Semi-transparent signage based on a controllable LED strip-modules and attached to the window used to provide entertainment contents and the information service to people through optical camera communication (OCC) as well. Also, this work suggests using the camera supplied Head Mounted Device (HMD) as an OCC receiver. The LED attached window signage system structure described in this paper can be utilized in various buildings infrastructure like house, shopping areas, industrial building, etc.

Keywords: *LED, Digital Signage, Virtual Reality (VR), Head Mount Display (HMD), Optical Camera Communication*

1. Introduction

Manuscript Received: July. 28, 2020 / Revised: August. 6, 2020 / Accepted: August. 11, 2020
Corresponding Author: chajaesang@gmail.com
Tel: +82-10-4345-5985, Fax: +82-2-979-7903
Professor, Department of Broadcasting Communication Fusion Program, Seoul National University of Science and Technology, Korea

Implementation of the smart media system because of the development of ICT technology and the convergence of media and ICT nowadays become a main trend of entertainment. LED based Signage display, which is applied to inner space such as a museum and an apartment and public outdoor space such as a bus stop and a subway, become a common and widespread solution. However, using of the existing LED-based signage hardware which is installed on a fixed location such as a frame on the wall provides us monotonous content repeatedly. Furthermore, due difficulties in processing custom sized signage for existing transparent glass-based signage and transparent film based signage cost issues are increasing.

In order to solve these problems, in this paper, described an implementation of a light communication based smart signage. Which manufactured and implemented by using simple LED strip applied to the standard transparent glass window.

This paper organized as follows: in chapter 2, we explained the proposed system structure and operation principle; in chapter 3, the implementation of window signage and the method of transmission data description is given, chapter 4 – conclusion.

2. A study on LED attached window signage system

Recently, the signage market seems to grow continuously. Signage has smoothly changed from an existing outdoor billboard, which provides the only advertisement to citizens, to the digital signage, which making an advertisement effect maximize by providing real-time customized content through interaction with a user. Also, the development of display technology such as transparency display, curved display, and realistic content such as VR and AR, contributed to the signage market growth by making synergy with the digital signage industry. Nowadays the digital signage industry market is still growing by making various creative and experimental digital signage designs. Furthermore, the appearance of 5G communication which makes data transmission faster than 4G LTE. So we can expect to support streaming services such as YouTube or Netflix and even realistic content services such as VR, AR having more massive data through digital signage.

In this paper, we studied on new signage structure design to provide a content to the user through controlling LED strips attached to a building window.

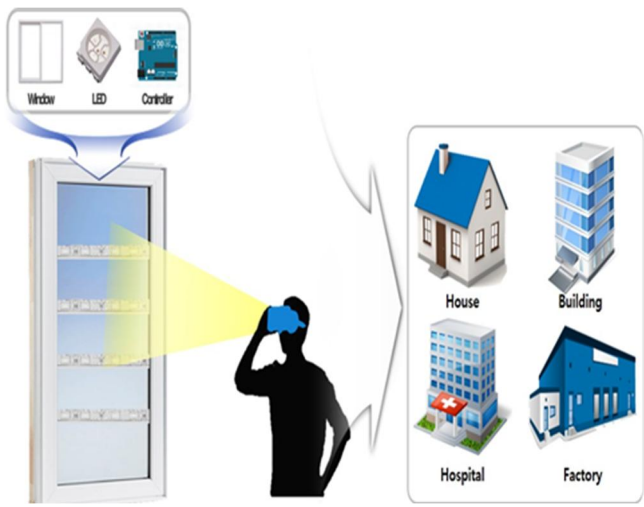

Figure 1. LED attached window signage

A new structure of designed signage shown in Fig. 1. The designed LED-based semi-transparent window signage created by attaching the LED strip to the window has high compatibility so that it can be applied to

the various buildings such as houses, apartments, offices, factories, etc. without the requirements to install additional infrastructure into the existing building`s elements.

The LED attached window signage can be utilized to control individual LED units, strips or pixels by using a micro-controller to display visual elements such as creating specific patterns or dynamic content. Based on the function, the designed window signage controller could receive media content from a remote server and display the receiving content through the LED frames. Content showing process can be provided by an application service in time when human is detected. By using an object detection sensor such as a motion sensor or an infrared sensor, the effectiveness of signage work could be increased.

In order to implement the data transmission method through the LED attached window signage, we selected OOK (On-Off Keying) modulation which is one of Optical Camera Communication modulation method. OOK modulated LED pattern recognition uses the smart device camera. Additionally, experiment were proceed by using HMD device to check availability of data receiving technique of OOK modulated data from the window signage by Google Card Board.

The data transmission method is organized as a specific On / Off pattern of the window signage LED. The data receiving proceeds by recognizing the pattern with the smart device camera. I.e., the window signage as a transmitter continuously changes the shape of the LED On / Off pattern due to the binary data, and the receiving side recognizes the LED pattern through the smart device camera and detects the data allocated for each pattern to receive the data.

In OOK modulation-based data transmission, communication proceeds in the form “LED ON” as logical “1” and “LED OFF” as logical “0”. In the window signage, the attached LED changing state continuously on/off form to transmit binary data, and in the smart device camera, which extracts data from the captured image.

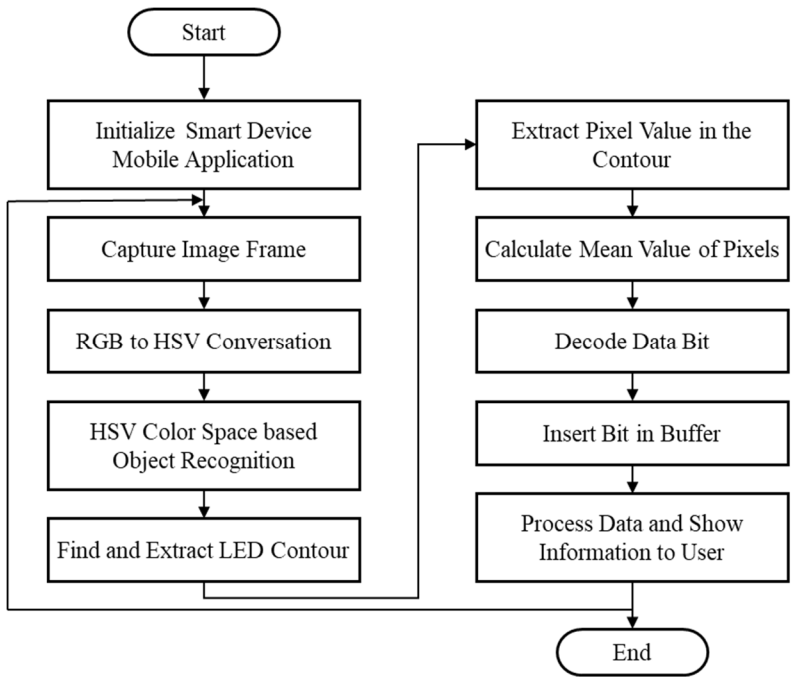

Figure 2. Light Data Receiving Algorithm

In Fig. 2 shows data receiving algorithm from the LED strip attached window signage to smart device camera. In order to receive optical data from LED, the smart device captures an image and convert color space

from RGB to HSV for improving recognizing LED intensity. Based on HSV color space image, the program starts to find a LED object and extract contour of it. Then pixels in contour of the frame is read one by one to recognize color of LED based on mean value of pixels. Finally, the data is decoded based on recognized LED status and stored it in a buffer, and user can check a information sending through LED attached window signage.

By applying the data transmission method using windows signage's LED and smart device camera, transmission of real-time media content such as VR and AR is available. This content receiving by signage from a remote server, and re-transmitted from LED pattern, however users can capture data through the camera of HMD smart devices. It is possible to provide application services in the form of enjoying content by receiving data same time, through a smart device camera.

This work consist studies of LED patterns expression and OOK modulation based data transmission method and describing ways to implement the data transmission method using LED attached window signage. Current project approved experimental by applying OOK based transmission method to window signage, and capturing correct data.

3. The implementation of LED attached window signage and method of data transmission

In order to implement the semi-transparent window signage structure, we attached LED strips and a controller to the building glass window, and experimented with generating patterns through micro-controller.

Figure 3. LED pattern attached window signage

The LED based window signage implemented by attaching the LED strips to the building window shown in Fig. 3. There used two types of LED strips for consisting of 10 lines to make a window signage. It is possible to implement various creative and unique window signage design depending on the way and the form LED pattern attaching design. LED strips could be controlled by using the micro-controller. It also provides a visual effect to the user by showing various pattern shapes and forms by controlling strip lines. Fig. 4 shows the connection circuit block diagram between the controller and the window signage for LED control.

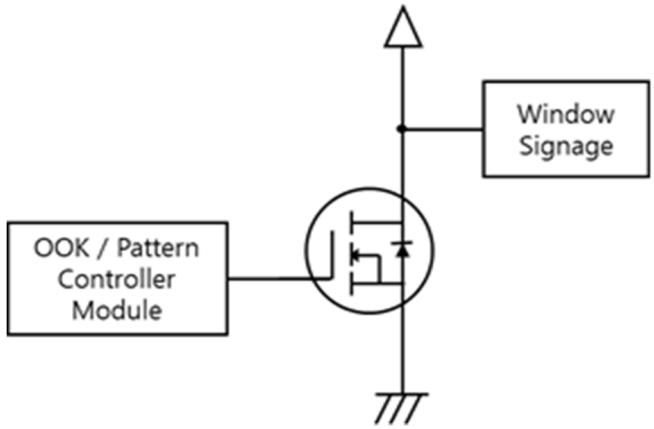

Figure 4. The circuit of between window signage and controller

A MOSFET acts as a switch not only OOK modulation but also controlling LED strip On/Off through the output pin of the microcontroller.

By using the implemented window signage controller, various patterns can be expressed through the color and pixel mapping control of the LED signage as shown in Fig. 5.

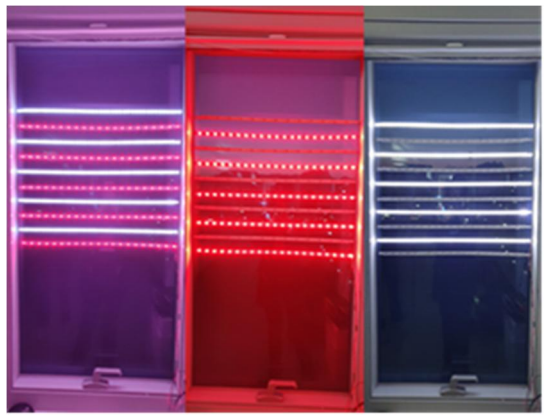

Figure 5. Controlling LED strip-lines

Also in order to implement the data transmission method using the LED attached window signage, we conducted the experiment applying the OOK modulation like Fig.6.

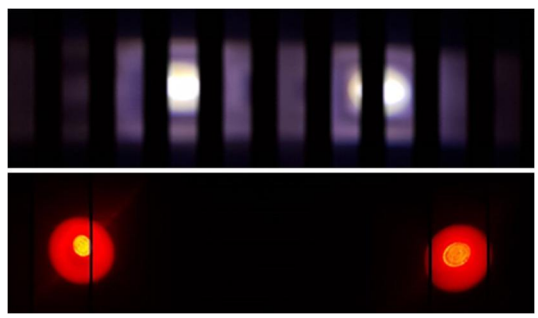

Figure 6. OOK modulation based data transmission

Controller organizing On/Off based data modulation makes LED strips On-Off flickering to send data. In

order to check the operation of the LED strip with OOK modulation applied through LED control, a VR HMD module, Google Card Board, were used. In this system, HMD module with a smart device receives data by utilizing a smart phone's camera.

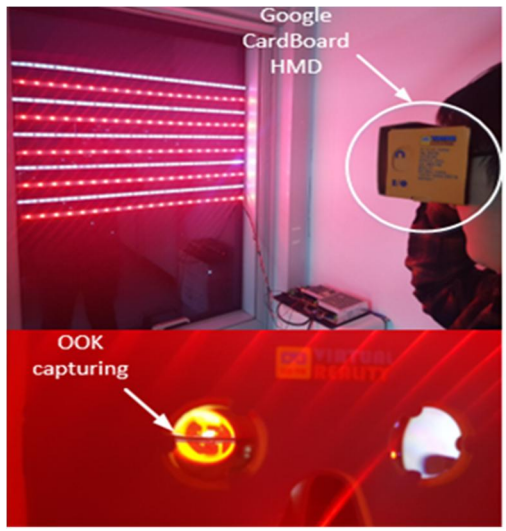

Figure 7. OOK data captured on HMD display

As shown in Fig. 7, Google cardboard HMD received the status of the LED through the installed smartphone`s camera. When the black line is captured through the smart device camera, it means the smart device camera recognizes the instant Off status of LED strip so that the application can decode data in captured frame.

In this system, we used different types of LED strips to check availability of using different light sources in combination, and possibility of data receiving. One type of LED strip is mono-colored lighting LED strip, another one is full controllable RGB LED strip. In this experiment, we could check LED pattern controlling and OOK modulation applying at the same time even if we used different types of LED strips. But during the experiments we find out one main limitation. The light intensity for both LED strips should be set respectively. In other words, the smart device`s camera should detect only one LED source. If you send one data set through a pattern, there is no problems. But if you sends different data sets by utilizing different LED strips, this could be a reason why capturing error happens.

In this experimental case, the distance between LED attached window signage and a user was 50 cm (Fig.8.).

Figure 8. Experimental distance

For this project, same data set were transmitted and received, through both LED strip types at the same time, and separately as well. For checking smart device`s camera data receiving ability we focused the camera lenses and also control the light intensity by changing LED dimming level. OOK modulation which was applied to the window signage was successfully constructed by micro-controller so HMD module received data.

4. Conclusion

Additional services by utilizing the windows of existing buildings and camera based data communication techniques related to the digital signage industry can propose new signage application service.

In this paper, we proposed the LED attached window signage structure that can provide visual effects and light data transmitting at the same time. The one of features of window signage is excellent compatibility that can be applied to various buildings without changing the infrastructure of the existing building, and can control LED through the controller to provide visual service to users. Also, the window signage supports optical camera communication technology that can utilize the smart device camera as a receiver. In this paper, we focused on progressing a study about pattern recognition and OOK modulation based data transmission technology capable of receiving data transmitted from the LED through the smart HMD device. So, it can provide a service of additional information supplement to the user through a smart device application approved.

Based on this study, we will do the advanced the research such as the various design of window signage and implementing data communication based on smart devices.

Acknowledgement

This work was supported by Institute for Information & Communications Technology Planning & Evaluation(IITP) grant funded by the Korea government(MSIT) in 2020(No. 2017-0-00217, Development of Immersive Signage Based on Variable Transparency and Multiple Layers)

References

[1] Lee Areum, Digital Signage Market and Industry Trends, Convergence Research Policy Center, vol.62, March, 2017

[2] Kim Tae-oh, Improving Regulation and Suggesting a Promotion Policy in the Digital Signage Market, KISDI, July, 2015

[3] Kwanghee Lee etc., Smart signage system using GIST'S flexible transparent electrodes, Gwangju Institute of Science and Technology, January, 2018
DOI: https://doi.org/10.23000/TRKO201800035664