Under Water Light Encryption Scheme Using LED and Camera Image Sensor

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Abstract: ***Visible light communication (VLC) is relatively secure communication when it compared with other wireless communications using radio frequency (RF). Visible light communication systems provide another to the current standards of wireless transfer of information, It is done by using light from LEDs it act as a communication medium for illumination as well as low cost, high speed, high power efficiency and secure data communication. It can use as underwater light because LED operate at lower temperatures, use less energy, better vibration, work with DC voltages, and last far longer than conventional incandescent bulbs. Here a light encryption scheme using devices having light-emitting diode (LED) and a camera image sensor which is used under water. The original visible signal sending from the lamp can be first received by the proposed light encrypter, The information is encrypted and then emitted. In optical domain the light encrypter acts as an encryption gateway for the signals. The rolling shutter effect of the complementary metal–oxide semiconductor (CMOS) camera can be used; the data information can be obtained by demodulating the rolling shutter pattern. To define the data logic in the rolling shutter pattern we use Otsu thresholding scheme.***

Keywords: VLC, LED, UVLC, CMOS, OSTU

1. Introduction

Visible light communication (VLC) examined as one of the promising solutions for future fifth-generation (5G) wireless networks since it is license-free, and it uses the extra electromagnetic spectrum (the visible light spectrum) instead of the congested traditional radio- frequency (RF) spectrum for communications works well for under-water communication and future data-center networks. VLC is regarded as. Besides, VLC is very directional; hence, the communication zone can be confined to a small area. A high density and high capacity wireless communication can be achieved. VLC also a relatively secure communication when compared with other wireless communications using RF [1, 5], since VLC is directional and does not penetrate walls [1]. Therefore, people outside the luminance zone cannot receive the information. The visible light communication has attracted the attention due to the characteristics of green, ubiquitous, license free, and potential high bandwidth [2].Many observations are done for the demonstration for indoor high speed communications. In the meantime, outdoor VLC applications are utilized in several areas, such as lighthouses broadcastings, intelligent transportation systems and underwater communications [2]. Compared with laser diode used in the free space optical (FSO) communications, the light-emitting diode (LED) has much lower thermal resistance and thus, can emit much higher optical power light communication (VLC) has attracted increasing attention. Many experiments have been demonstrated for indoor high speed communications. In the meantime, outdoor

VLC applications are utilized in several areas, such as lighthouses broadcastings, intelligent transportation systems and underwater communications [2]. Compared with laser diode used in the free space optical (FSO) communications, the light-emitting diode (LED) has much lower thermal resistance and thus, can emit much higher optical power. Nowadays, underwater wireless information transmission is of great interest to the military, industry, and the scientific community. Although the progress has been made in the field of underwater acoustic communication, its performance is limited by low bandwidth, high transmission losses, time varying multi-path propagation, high latency, and Doppler spread. In an underwater environment, light propagation is wavelength sensitive with relative less attenuation in the blue/green wavelength range. Furthermore, the data rate of VLC is much higher than acoustic transmission in the water [5]. Visible light communication (VLC) between LED light bulbs and smart-phone cameras or image sensor cameras has already started to obtain transaction for detection and indoor localization applications. The frequencies and data rates are typically limited to below 1kHz and tens of bytes per second (Bps) for supporting the detection by camera [4].

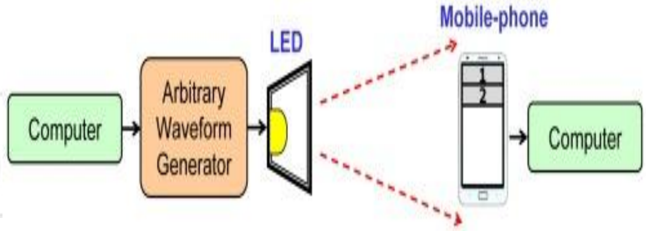

Figure 1: The VLC using mobile-phone camera as Rx.

2. Proposed System

Here the paper proposes underwater visible light communication, light encryption scheme using devices having light-emitting diode (LED) and a camera image sensor receiver (Rx) such as waterproof mobile phone and camera [1]. The VLC signal sending from a LED can be received by the light encrypter, which could be any device having optical Rx, or an camera image sensor, and having a visible LED for the optical transmitter (Tx) which can be used under water. Here, we use waterproof mobile phone ore camera as the light encrypter since it has a camera and a white-light LED. After the visible light signal is received in the light encrypter, the information can be encrypted using different encryption algorithms. In the data encryption side we use encryption key and perform xor operation [1]. For decryption the same key used to perform xor operation with the encrypted signal for retrieving the decrypted signal. In the symmetric-key scheme, besides the xor operation other schemes such as shift-cipher (i.e., shifting the bits forward or backward) can be used. Public key cryptography used for more advanced encryption schemes. Anyone can have the public key can encrypt the message in public key schemes but only the private key holder can decrypt it. The private key can be send through RF (Radio Frequency) instead of via visible light to increase the level of security. Underwater visible light communication (UVLC) is of great interest to the military, industry, and the scientific community [2].

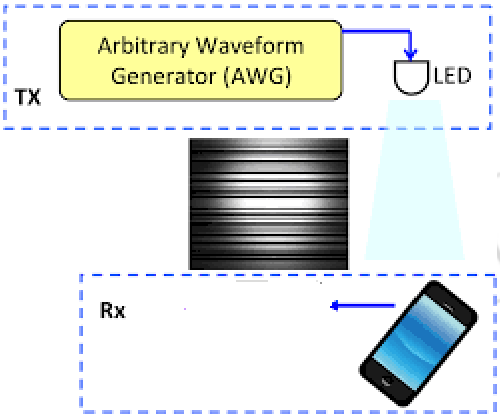

Figure 2: Data or Message Transmission

3. Literature Survey

The original visible light signal sending from the lamp can be first received by the proposed light encrypter; then, the information can be encrypted using private key or other advanced encryption algorithms [1]. Then, the encrypted signal can be emitted as visible light by this light encrypter. The light encrypter acts as an encryption gateway for signals in optical domain. The Rx in this light encrypter can be a positive- intrinsic-negative (PIN) photodiode (PD), an avalanche photodiode (APD), or a camera image sensor in the mobile phone. As mobile phone plays an important role in our daily lives, in the proof-of-concept demonstration, we use the mobile phone camera image sensor as the VLC light encrypter Rx. Rolling shutter effect of the complementary metal–oxide semiconductor (CMOS) camera can be used to enhance the transmission data rate higher than the frame rate of the camera. Then, by demodulating the rolling shutter pattern (bright and dark fringes received by the camera), the data information can be obtained [1-3]. However, requires complicated histogram together with Sobel edge detection for the bright and dark fringes extinction ratio (ER) enhancement. Here, we propose and demonstrate using the Otsu thresholding scheme for the first time up to our knowledge to define the data logic in the rolling shutter pattern. The Otsu method is very popular for segmenting a picture in image processing. Here, we show that the Otsu scheme is also effective to define the data logic in the rolling shutter pattern for estimating the bit-error-rate (BER). We also apply the smoothing scheme to reduce the data pattern fluctuation.

Signals sent from the row address decoder (row-reset and row -select), after a row-reset signal each The background related to rolling shutter, the exposure in CMOS image sensors is controlled by the row become photosensitive and after a row-select signal it stops collecting photons and starts reading out data [6]. There is only one row of readout circuits, thread out timings for different rows cannot overlap. In rolling shutter, the readout timings are moved sequentially from top to bottom. The reset time, readout time and exposure time for a row is denoted by Δts, Δtr and Δte respectively. For typical CMOS sensors Δts is around1~5s and Δtr is around15\~40s. An image sensor with M rows here we denote the reset timing (arising edge of row-reset signals) and y-th row ($1 \leq y \leq M$) with ts (y) and tr (y) respectively for the readout timing. For rolling shutter tr (y) = y Δtr and ts (y) = tr (y) - Δte - Δtr -Δts [1, 6].The geometric distortion caused by rolling shutter and proposed methods to compensate for skew due to planar motion demonstrated the high-speed photography by the use of rolling shutter with a camera array. For specific applications the components of CMOS image sensors have also been improved such as HDR imaging and multi-resolution readout. These ideas are giving rise to a new breed of image sensors mentioned toas "smart" CMOS sensors [6]. The CMOS image sensor as VLC Rx is challenging since the VLC data rate will be significantly limited by the image sensor frame rate. Besides, signal data loss will occur due to the relatively long processing time gap in frame-to-frame proposed using the rolling shutter effect of the CMOS image sensor to increase the VLC data rate; however, our work provides detail discussion of the features of CMOS sensors, The pixels of each row frame to frame is the overlapping of exposure time processing time gap and also the image sensor "blooming" effect [6]. Besides, in our proposed scheme, a column matrix of gray scale will be selected just away from the center of the blooming. This can provide distinguishable gray scale value even at very high blooming effect. Bit-error-rate (BER) analysis is also provided demonstrated a special image sensor with specific pixels for imaging and specific pixels for high speed VLC; however, this sensor requires relatively complicated fabrication process, and may not be available as embedded device in mobile-phone [3].

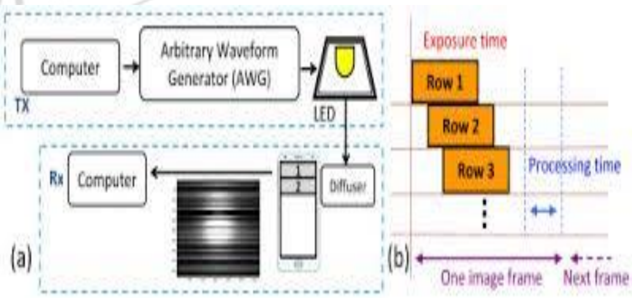

Figure 3: Message Encryption and Decryption.

4. Conclusion

VLC is regarded as a relatively securer communication when compared with other wireless communications using RF. And also we can do the VLC underwater for better communication. Underwater visible light communication (UVLC) is useful for the military, industry, and the scientific community. However, the VLC signals are still pointed to eavesdropping when they are emitted by the light source due to the visual nature. Here, we proposed a light encryption scheme underwater. The original visible light signal sending from the lamp can be first received by our proposed light encrypter then the information can be encrypted, which can then be emitted as visible light by this light encrypter under water. There are keys for encryption and decryption (public and private key) encryption is done by using public key and decryption is done by using private key, only the receiver and sender knows about the private key without the private key no one can decrypt the message sent in this system the rolling shutter pattern is used as the decryption key. In this work, the Otsu thresholding scheme is used to define the data logic in the rolling shutter pattern. We analyzed that at high illuminance using 16 Otsu-intervals was better. Processing time was also studied. Besides, the proposed smoothing scheme can significantly enhance the BER with up to 2 orders of magnitude at high illuminance due to the reduction of ER fluctuation.

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