Li-Fi based Secure Programmable QR Code (LiQR)

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1. Introduction

The use of Quick Response (QR) code [1] has proliferated with growing number of mobile consumers and its use in a wide range of applications including advertisement, product labelling and tracking, access control, and mobile payments etc. However, being a static image, a QR code can be replicated or altered easily posing a security challenge while using it for sensitive applications, for instance, payments and access control. Visible light communication (VLC) or Li-Fi, which uses modulated LED light to transmit data that can be captured via the CMOS image sensor on a smartphone [2], presents an ideal opportunity to substitute traditional static QR code with an LED light based QR code. This type of light based QR code (LiQR) is secure and can be dynamically programmed for improved security as well as cover a wider range of applications.

2. LiQR Concept and System Design

Figure 1 shows a comparison of an image captured by an iPad mini 2 camera of a (a) QR code and a modulated LED light (b) & (c). Fig 1(a) and Fig 1 (b) are both captured using the same exposure settings and are showing what a normal human vision can perceive. However, Fig 1 (c) is captured with a very low exposure to highlight the continually moving rolling shutter pattern of the modulated LED light making the rest of the scene completely obscured. This demonstrates the fact that unlike a QR code, the information transmitted through an LED is not apparent and given the nature of hardware required to implement, neither it is straightforward to replicate.

The complete system consisting of an LED based transmitter and a smartphone based receiver is shown in Fig 2. The LiQR is transmitted as a light ID via a VLC enabled LED driver. The ID controller inside the LED driver allows for a reprogrammable QR code. The modulated LED signal is received by a smartphone camera as frames consisting of rolling shutter patterns. To decode the signal, each row of the pattern is translated into 1 and 0 based on the threshold level between dark and white pixel rows. The binary stream is combined to create a data frame consisting of a preamble, payload (ID) and error check sequence. The unique ID contained in the payload is then mapped to a uniform resource identifier (URI) database which can be eventually used by the application software. The experiment confirms that an iPad mini 2 can capture the LiQR from an 18 Watt light panel at a distance of ~3 meters.

Exposure 1/100 s ISO-40 (a) | Exposure 1/100 s ISO-40 (b) | Exposure 1/11494 s ISO-40 (c)

Fig. 1. The images captured with iPad mini 2 of (a) QR Code (b) & (c) Modulated LED light

3. Conclusions

LiQR, a LiFi based QR code, is proposed. It is demonstrated that in comparison to the traditional QR code LiQR can be more secure, visually unrecognizable and dynamically programmable.

References

[1] Denso-Wave Inc., "QR code standardization," 2003 [Online]. Available: http://www.qrcode.com/en/index.html
[2] C. Danakis et al., "Using a CMOS camera sensor for visible light communication", Proc. IEEE Globecom Workshops, 2012.

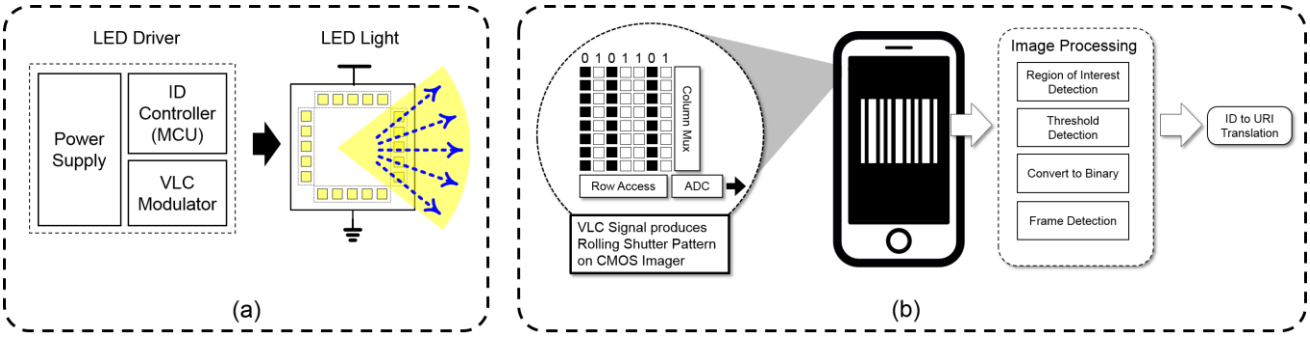

Fig. 2. Block diagram of the LiQR system showing (a) Transmitter side (b) Receiver side