LED-array-to-camera Communication

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ABSTRACT
In this paper, we describe the design and implementation of Visual Light Communications (VLC) via LED board as transmitter and camera from smartphone as receiver.

Keywords
Visual Light Communications, CamCom and Peggy2 LE

1. INTRODUCTION
Using Peggy2 LE as transmitter and camera from smartphone as receiver, we design a new CamCom method. Peggy2 LE, a 25x25 LED board, is controlled by laptop through the interface of Arduino, and dynamically output LED arrays as the transmitted messages. Similar to QR code but with a larger data rate, our design can approach 1080 bps for a 15 fps camera according to [1]. The receiver side uses DIP methods to decode the images. Different from QR code, we can use multiple frames to detect the LED board region, so the method of using fixed patterns on the three corners of transmitter pattern is abandoned. An alternative method is used to detect the region and fix the distortion. Finally, DIP method is applied to decode the messages. CRC may be used to correct errors.

2. DESIGN

2.1 Transmitter
Laptop transmit message strings to Peggy2 LE via serial port, the microcontroller convert the messages into sequential patterns and show them on the LED display.

2.2 Boundary detection and distortion fixer
Camera receives a series of images and decodes using DIP methods. Two-frame method from [2] is applied to detect the region of the LED display and fix the problem of image distortion. The method is described as follow. Four corners of the LED display is assign as anchor points, for each $2k_{th}$ and $2k+1_{th}$ frames, the $2k+1_{th}$ frames is serves as a reference frame. Auto-contrast over the grey scale of the difference frame is applied, so the upper-left, upper-right, lower-left and lower-right of white pixels of the result frame are found to locate the four corners of the LED display. Through this method, we can calculate the location of each individual LED. And therefore the problem of distortion of the LED display is fixed.

2.3 Decoder
After the acknowledgement of the location of individual LED in the image, we can access the pixel values and reconstruct the original messages.

3. REFERENCES
[1] http://en.wikipedia.org/wiki/QR_code

[2] W. Yuan, K. Dana, M. Varga, A. Ashok, M. Gruteser, and N. Mandayam, "Computer vision methods for visual MIMO optical system," in Proc. IEEE Comput. Soc. Conf. Comput. Vision Pattern Recog.Workshops, Colorado Springs, CO, USA, Jun. 2011, pp. 37–43.