IVC: Imperceptible Video Communication*

Roberto Carvalho, Ching-Hsiang Chu and and Ling-Jyh Chen
Institute of Information Science, Academia Sinica
{roberpaulo, kingchc, cclljj}@iis.sinica.edu.tw

1. INTRODUCTION

Visible light communication (VLC) has received significant attention recently because it facilitates data communication in scenarios with high user density, where conventional wired and wireless technologies cannot work well due to user mobility and channel contention. However, the existing VLC techniques require specialized hardware for communication to take place, and therefore they are considered impractical for end users yet. Given the abundance of cameras and LCD screens in today's environment, it makes sense the use of these devices for wireless communication. Specifically, cameras can be used for shooting nearby LCD screens and use them for network access. A couple of works provided feasible solutions to video channel communication, however their works did not overcome at least one of the challenges: low data throughput, reliance on additional infrastructure (Digimarc Technology [1]) and unreadable video (PixNet [2] or COBRA [3]). This demo explores this novel communication medium and presents Imperceptible Video Communication (IVC). A system that takes advantage of both off-the-shelf cameras and LCD displays, and it transfers imperceptible data over a normal video and without the reliance on additional infrastructure.

2. SYSTEM OVERVIEW

We adopt the concept of LCD screen-camera communication and propose the IVC system, a channel to communicate wirelessly through transmission and reception of a binary data over video stream. Specifically, messages are embedded into selected video frames via watermarking that are not perceptible to naked eyes, then played at high frame rate video for communication. There are two components in the proposed IVC scheme:

Embedder: The process of embedding watermark into an image using IVC is summarized as follow. First, we retrieve all the frames of a normal frame rate video and duplicate each of the frame to form a high frame rate video. Each duplicated frame is placed immediately after the original frame. Then, we embed information into the duplicated frames by increasing or decreasing the brightness of blocks of pixels. The change of brightness represents '0' and '1' that are the digital information within the frame. The brightness of pixels is changed smoothly so that the changes are imperceptible to human eyes but readable for cameras. Finally, the resulting video are played on the LCD screen.

Reader: The reader starts by watching the video on the LCD screen, and it retrieves the information by performing the reverse of the embedder.

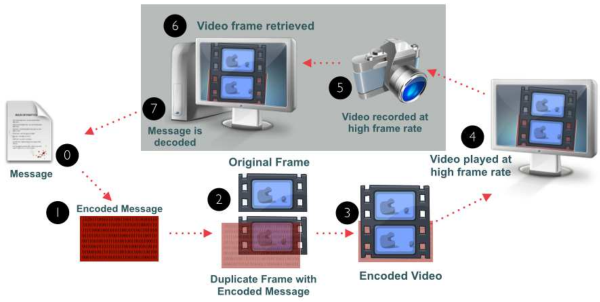

Figure 1: IVC process

3. DEMO

In this demo, we show how IVC system achieves wireless file transfer with a throughput of 5 Mbps when the block size is set to 5 pixels[1]. We use the setup as shown in Fig. 1, in which after message being encoded in the video, a camera as the receiver captures the video frames displayed on the LCD screen; and a computer download the captured video then decode it into files. Note that steps 5, 6 and 7 in Fig. 1 can be performed by most of the smartphones that we use nowadays. Thus, IVC is simple, effective, and instantly ready to be deployed.

4. REFERENCES

[1] Digimarc. *http://www.digimarc.com/*
[2] S. D. Perli, N. Ahmed, and D. Katabi. PixNet: Interference-free Wireless Links using LCD-camera pairs. *ACM MobiCom, 2010.*
[3] T. Hao, R. Zhou, and G. Xing. COBRA: Color Barcode Streaming for Smartphone Systems. *ACM MobiSys, 2012.*

*This research was supported by the National Science Council of Taiwan and Academia Sinica under Grants: NSC 101-2628-E-001-004-MY3, NSC 101-2219-E-001-002, and AS-102-TP-A06.

[1] The maximum theoretical data throughput can achieve 26 Mbps when the video is played at 60fps, the frame resolution is 1280x720, and the block size is 1 pixel.