Demo: Achieving Simultaneous Screen-Human Viewing and Hidden Screen-Camera Communication

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ABSTRACT

We present and demonstrate INFRAME++, a novel system that enables concurrent, dual-mode, full-frame communication for both users and devices. It achieves unobtrusive screen-camera data communication without affecting the primary video-viewing experience for human users. It leverages the capability discrepancy and distinctive features of the human vision system and devices (modern display and camera). We have implemented INFRAME++ as a PC-phone application. Both communication will be realized through multiplexed videos frames which will be displayed on a modern monitor (120FPS) and captured by a smartphone camera for data decoding. In this demonstration (Figure 1), we will show that INFRAME++ can yield normal video-viewing experience for humans, and high-rate data communication for devices (up to 300 kbps). User participation will be welcome in this live demo.

Categories and Subject Descriptors

C.2.0 [**Computer-Communication Networks**]: General—*Data communications*; H.5.1 [**Information Interface and Presentation**]: Multimedia Information Systems—*Video*; H.5.2 [**Information Interface and Presentation**]: User Interfaces—*Screen design*

Keywords

Screen-camera communication; Hidden visible communication; Dual-mode visible communication; Full-frame video; InFrame++

1. INTRODUCTION

Recent efforts in screen-camera visible communication has exploited the display for data communication. Such practices, albeit convenient, have led to contention between space allocated for user-friendly content (*e.g.*, video, image) and content reserved for devices (*e.g.*, barcodes). This also causes unpleasant visual anti-aesthetics and distractedness. We propose INFRAME++, a novel system that enables concurrent, dual-mode, full-frame communication for both users and devices.

In essence, INFRAME++ leverages the capability discrepancy and distinctive features of the human vision system and devices

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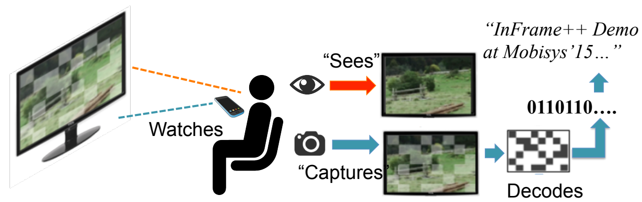

Figure 1: A typical use scenario of INFRAME++.

(display and camera), *e.g.*, screens can display content faster than human eyes perceive; cameras have shutter but human eyes do not, etc.. The key idea in INFRAME++ is to employ *Spatio-temporal complementary frame (STCF)*. Data are embedded into STCFs which consist of complementary pixels over consecutive frames and adopts spatially complementary patterns. When the resulting data frames are multiplexed with the original video frames under the superior display frame rate, human eyes can only perceive the average pixel values (thus data imperceptible) while the camera captures the artifacts to retrieve information bits. To further enhance unobtrusive viewing experience and data communication throughput, we propose and develop the following techniques in INFRAME++. We adopt *smoothing transitional frames* to alleviate flickers caused by STCF transitions and propose a novel *CDMA-like modulation* to boost the throughput. To handle the impact of primary video on screen-to-camera communication, we propose a hierarchical data frame structure and fast and accurate border localization. More technical details can be found in our paper [1].

2. DEMONSTRATION

In this demo, we will show the rationale, operations and performance of INFRAME++ (Figure 1). We will place a 23-inch LCD display which supports 120FPS frame rate as our sender. It is connected to a laptop, on which a user can select the video source and data source respectively. The video source can be a pure color, a static image, or an arbitrary video. The data source can be an a text file, or a randomly generated data stream. In the other side, we use a smartphone to capture the displayed multiplexed video and then decode the embedded data. We will show two settings. First, we show side-by-side comparison of original videos and multiplexed videos to illustrate that INFRAME++ ensures normal video-viewing experience. We then use one full-screen mode to play the multiplexed frames and decode the data bits embedded by INFRAME++.

3. REFERENCES

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