Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Invisible-Watermarking Image Sensor Communication (IISC)
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Abstract: This is a proposal for Invisible-Watermarking Image Sensor Communication (IISC) Scheme based on the Intensity Modulation technique of a image pixel. The proposed scheme is asynchronous and supportive for frame rate variation. This scheme is feasible for different kind of digital signage application, smart advertising, device-to-device communication and so on.

Purpose: Call for Proposal Response

Invisible-Watermarking Image Sensor Communication (IISC)

Content

- Introduction
- Details of technologies
- System Topology
- Implementation

Introduction

Invisible-Watermarking Image Sensor Communication (IISC): Communication between any image senor such as camera and imaging device, for instance, display, monitor, digital signage etc. can be defined as IISC.

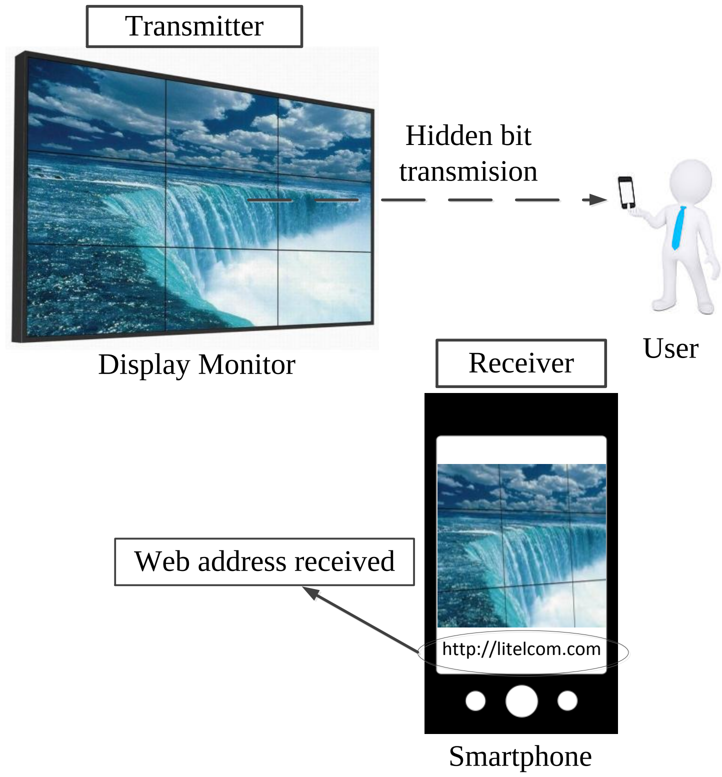


Figure 1: Illustration of Invisible-Watermarking Image Sensor Communication

Fields of Application:

1) Display to Camera Communication
2) Device-to-device communication
3) Display-User Interaction
4) Augmented Reality
5) Smart Advertising
6) Online payment
7) Online map viewing
8) Indoor navigation
9) Location based services

Advantages:

1) Dual use of display (Advertising and Communication simultaneously)
2) Electromagnetic interference free communication
3) No hardware modification
4) Supporting any image format
5) Feasible for static and video image
6) Distortion less data transmission
7) Dynamic real-time data transmission
8) Less computation
9) Less complexity

Disadvantages:

1) Perspective distortion
2) Motion blur
3) Illumination

Detail of technologies

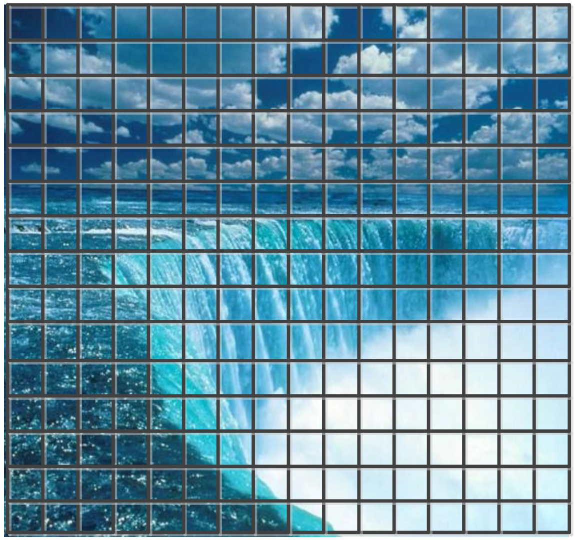
Working Principle

Steps:

1. **During video transmission, one image frame is made as reference image and the sequential image frame is modulated to transmit data i.e. the frame #*i* is the reference frame and the #(*i*+1) is the data frame.**
2. **The image is divided into NxM block where each block contains group of pixel. If the image frame contains PxQ pixel (P=row of pixel, Q= column of pixel), then every block will contain approximately (PxQ)/(NxM)= R pixels.**
3. **The data can be embedded real-time or prior to data transmission.**
4. **The data bit '1' interprets changing in the average intensity or less intensity elements of the pixel block; while the '0' indicates no variation in the intensity of the pixels in the block.**
5. **The reference image and the data image is compared to extract the data.**

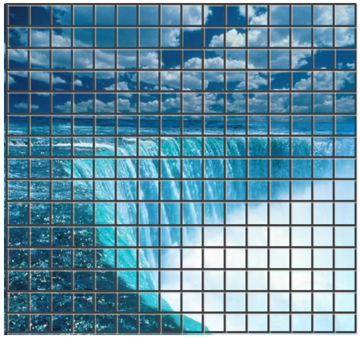
Image Frame

*N*x*M* pixel block



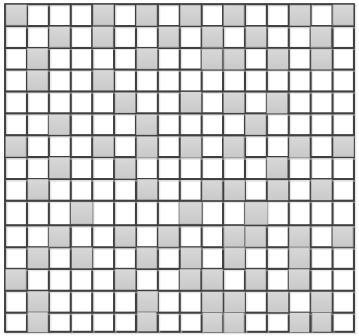
Data embedding Mechanism

16x16 pixel block

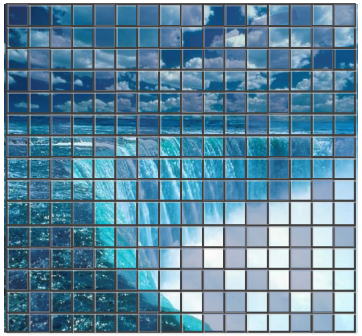


Reference Image Frame

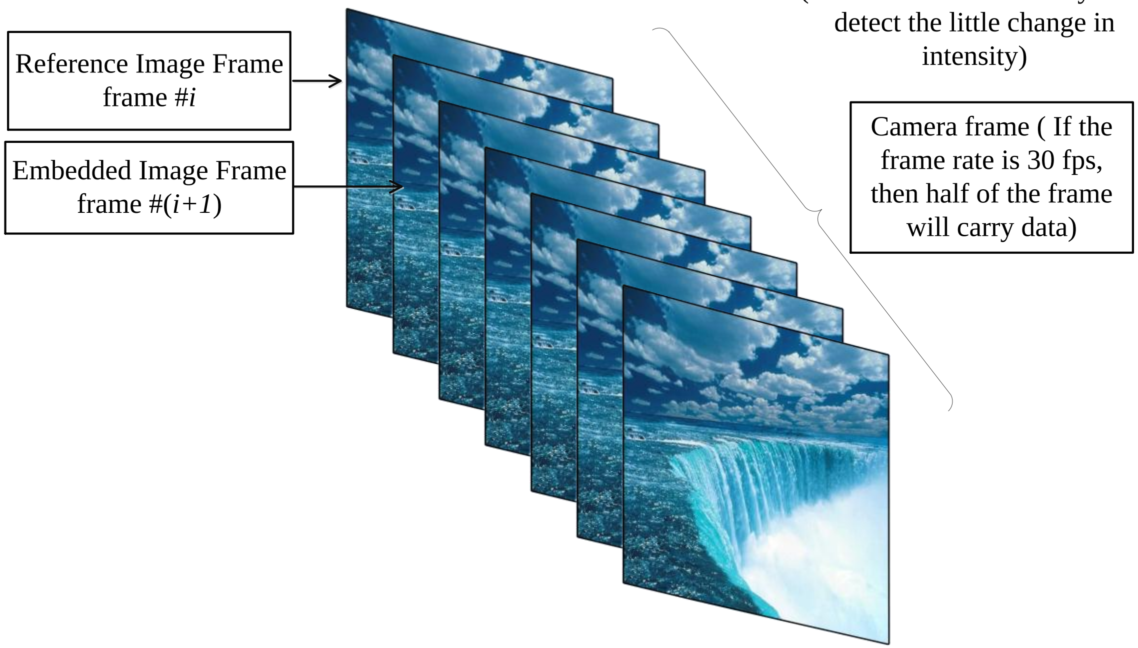
100111010101……..0100100011101001 (256 bit)



Data Image Frame



Embedded Image Frame
(**Camera view**-Human eye can detect the little change in intensity)



Implementation of Invisible-Watermarking ISC (Non-Flicker Mode)

Illustration of the Implementation work

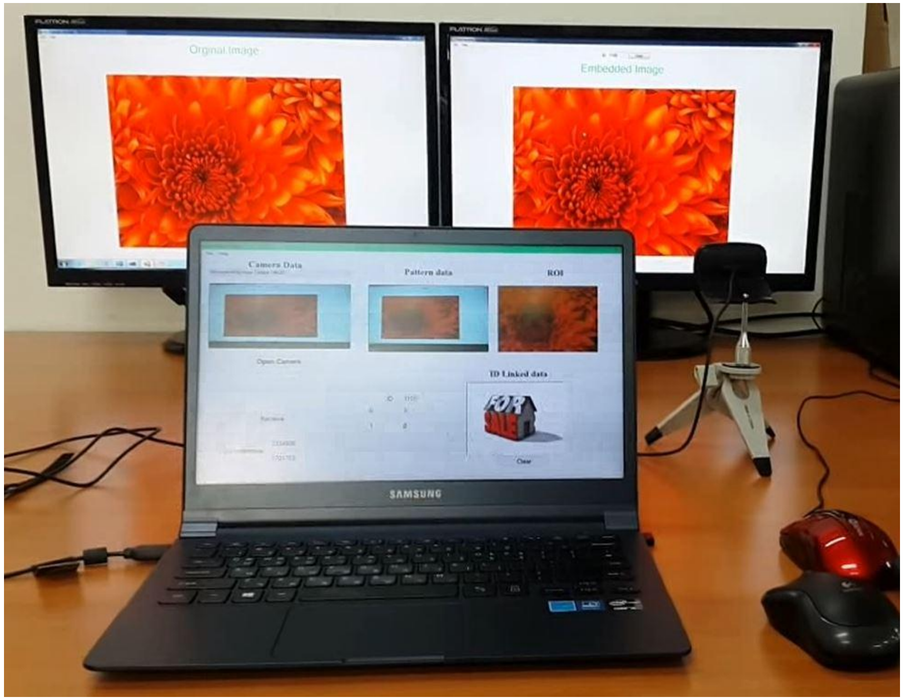


Figure: Demonstration of the implemented invisible embedded data for smart digital signage system. (Right side display contains an original video image while the left one includes the embedded data inside the image of the video)

Invisibility Analysis

Figure: Image used in implementation and histogram analysis.

(a) Original image and (b) Modified image

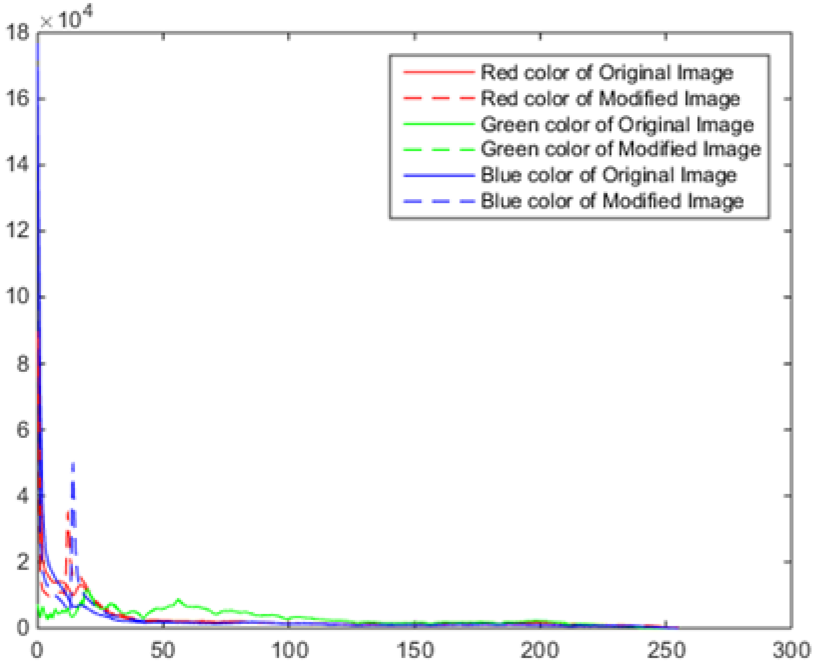


Figure: Histogram analysis of RGB part of the original image and the modified image.