Visible Light Communication

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ABSTRACT

Software Defined Radio (SDR) has proven to be an effective and practical tool in the area of RF communication systems, essentially allowing flexible and rapid exploration of signal processing techniques. The software defined concept can also be adapted to other physical communication media; we consider an optical channel. Visible Light Communication (VLC) uses the visible light spectrum as a medium for data transfer. This topic has gained recent interest due to the ubiquity of emerging solid-state lighting provided by “white” LEDs.

BACKGROUND

Light Emitting Diodes (LEDs) are used in consumer electronics, toys, light bulbs, cars, and monitors. With LEDs, it is possible to control light brightness at a frequency much higher than conventional light bulbs: LEDs can be switched on and off at very high rates. As result, LED-based lighting can be used for wireless communication services by modulating the intensity of the emitted light. Further, LEDs can also be used as receivers just like photodiodes. We call this concept Visible Light Communication (VLC) with LED-to-LED networking. Significant research contributions have been achieved by Disney Research in the area of networked systems for VLC. VLC creates opportunities for low-cost, safe, and environmentally friendly wireless communication solutions. We focus on connected toys and light bulb networks. Our work targets a full system design that spans from hardware prototypes to communication protocols, and applications.

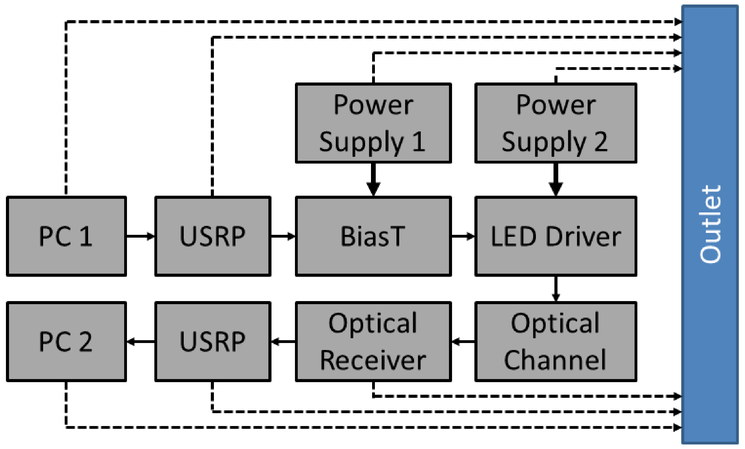
OBJECTIVE

We demonstrate a Software Defined VLC (SDVLC) solution implementing an illumination quality optical front end to adapt an SDR platform to the VLC channel. Utilization of such a system allows for quick implementation of new testing scenarios in order to facilitate research in VLC.

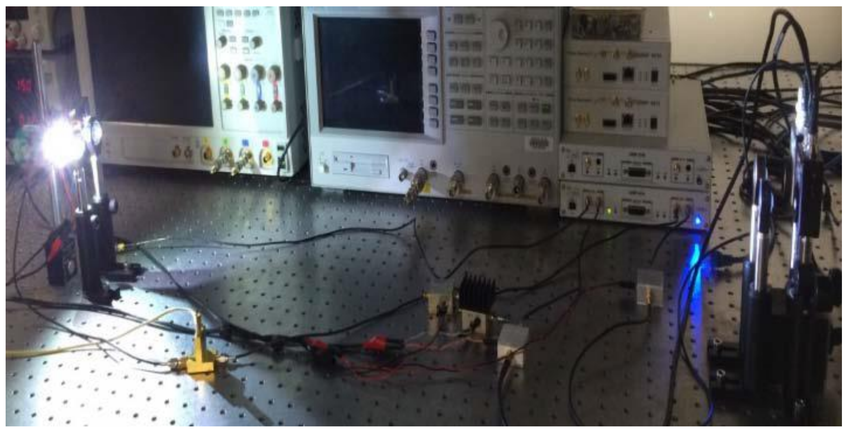
DEMONSTRATION DESCRIPTION

Our SDVLC system implements the GNU Radio platform with a VLC front-end. GNU Radio is a free software development toolkit for runtime signal processing that interacts with external hardware typically used for transmitting RF signals. We utilize this hardware, namely the Universal Software Radio Peripheral (USRP) with low frequency transmitter and receiver (LFTX / LFRX), as an interface to an optical front end in order to create a point to point VLC link. The demonstration shows the use of illumination quality lighting to provide a 1Mb/s real time video stream over a distance of 3 meters. Raw data from a UVC compatible webcam is first converted to steaming media via a Gstreamer application. This video stream is then passed through GNU radio to the USRP in order generate the low frequency modulation schemes presented to our optical transmitter.

THEORETICAL ANALYSIS



RESULTS



CONCLUSION

The experimental results show that spatial diversity MIMO VLC improves error performance at the cost of spectral efficiency that spatial multiplexing should enhance. The results will demonstrate tradeoffs among various modulation schemas and MIMO schemes in a real-time combined lighting and communication system such as lumens, transmission power distribution, beam divergence and focusing, transmitter and receiver pointing, environmental optical properties, data rate, 5A3-9 communication range, detection performance, and system complexity.