Improved Design for an Optical Communication System

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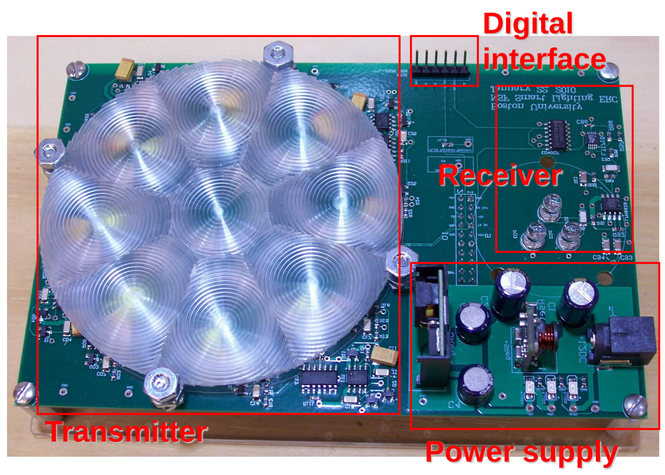
Introduction

Several projects within this Engineering Research Center (ERC), which develop upon free-space optical (FSO) and visible light communications (VLC), require FSO transceivers for empirical testing.

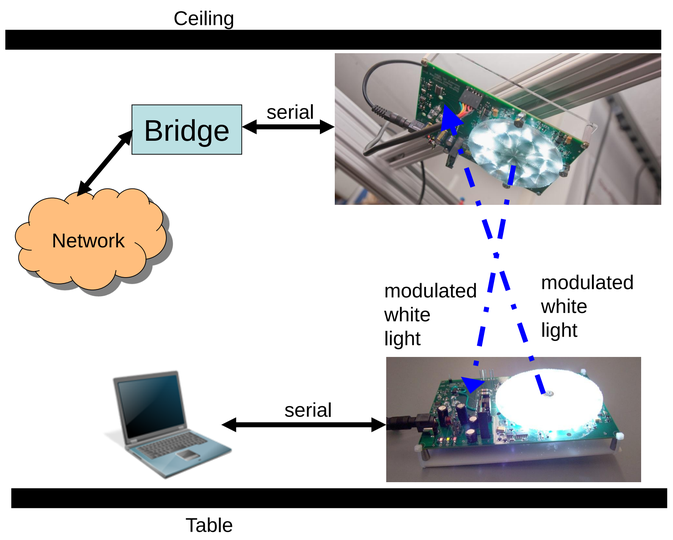
To facilitate this testing, two new transmitters and one new receiver have been designed and fabricated to address problems in and to improve upon existing FSO transceivers.

Previous Version



- 1MHz (2Mb/s OOK) digital transmitter
  - Cannot transmit steady high
  - Eight 1W white LEDs
    - (with 8 LED drivers)
- Integrated digital receiver and power supply
- Up to 1MHz (2Mb/s OOK) digital interface
  - Cannot support steady high
- Expensive (~$300 each)

Old System

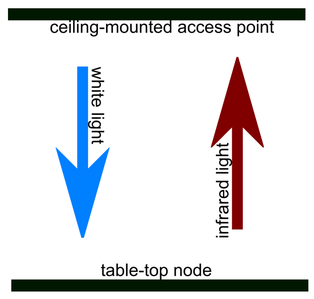


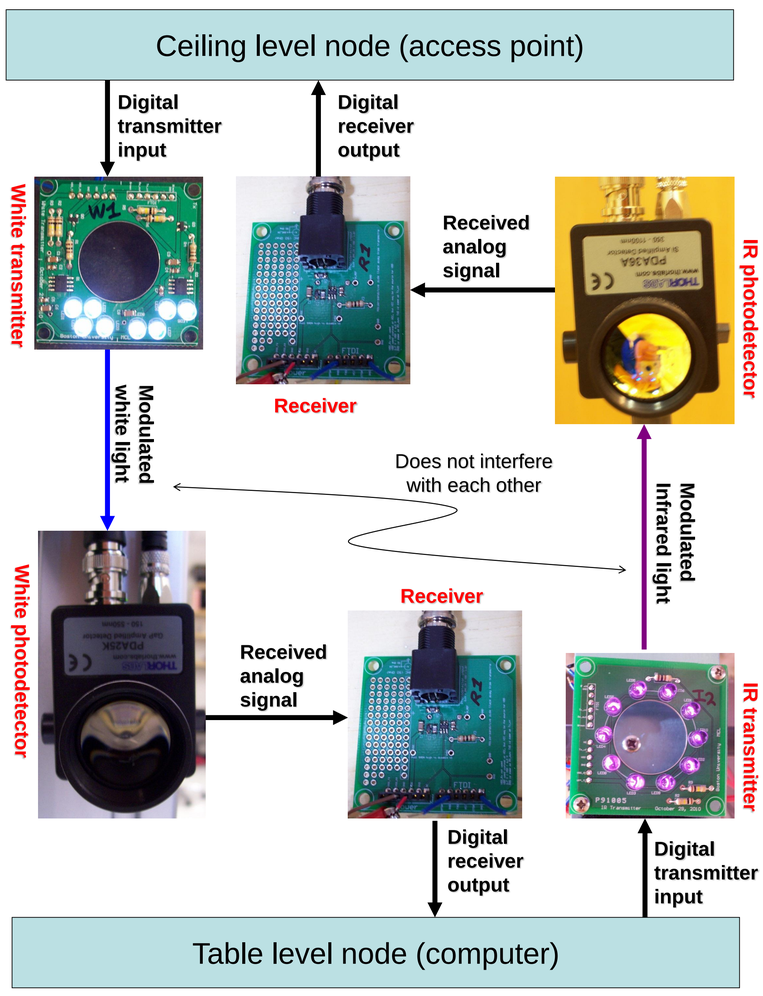
- Cross-talk
  - Optical (white light both ways)
  - Electrical (on same board with same power supply)
- Uncomfortable bright light at table level
- Serial connection defaults to high when idle
- Expensive

New System

To resolve these problems:

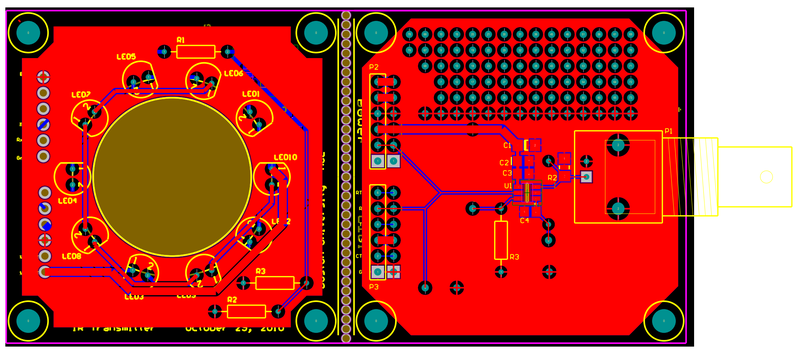
- Replace white uplink with infrared (IR) uplink
- Modularize
- Use off-the-shelf photo-detectors





New Transmitters and Receiver

- Simplified designs
  - For reduced costs (less than $30 each)
  - Eliminates hard-to-find parts
  - Facilitates analysis and optimization
- Easy construction
  - All parts can be hand soldered
- Designed to reduce electrical interference



Transmitter

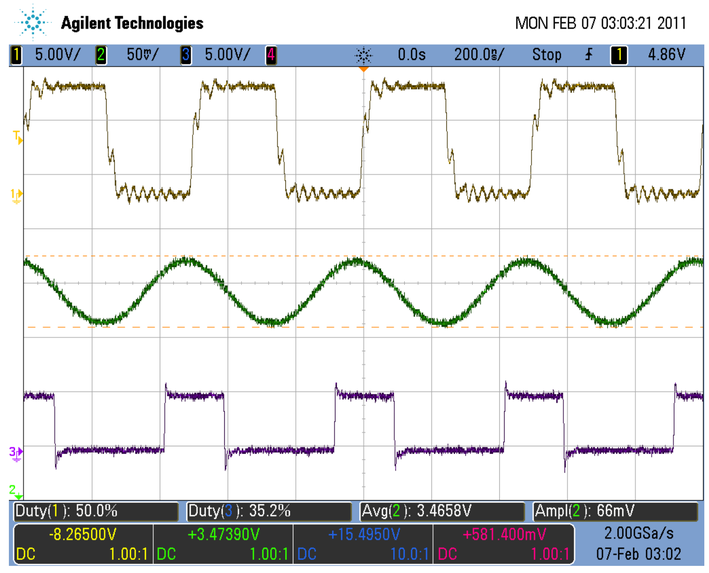
- Improved current-control through current-mirror LED driver
  - Supports 8 IR LEDs or 4 white LEDs each
- DC to 4MHz operation
- Digital high-impedance 3.3V or 5V input

Receiver (excluding off-the-shelf photo-detector)

- Digital 5V output
- Tested 30Hz to 30MHz
  - (Shrinks with reduced input signal strength)

Performance

Transmitter input (1), receiver input (2), and receiver output (3) shown for a 2MHz signal transmitted 1.9 meters using the new IR backchannel with the photo-detector gain at 50dB.

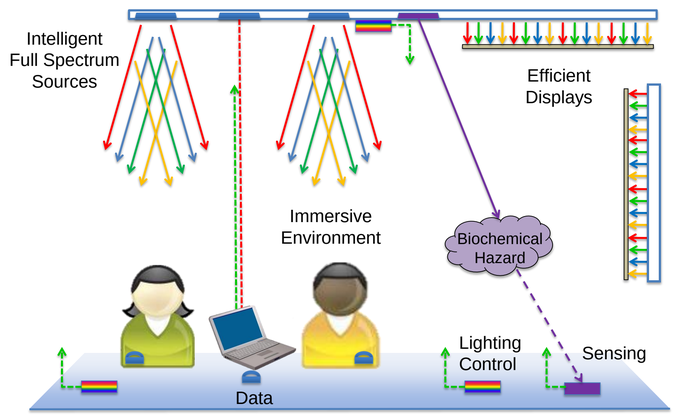


Limitations & future improvements:

- Receiver loses reference if signal remains high for long time
- Computer serial port is high when idle but receiver is low if signal absent
- Receive duty-cycle is smaller than transmit duty-cycle
- Further amplify photo-detector signal

Smart Lighting Vision

- Enables empirical evaluation of VLC- or FSO-based systems (until better transceivers are ready)
- Allows prototyping of systems that include FSO-transceivers



Acknowledgements

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