

# Camera Based Optical Wireless : A Visual MIMO approach to V2V communication

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<http://winlab.rutgers.edu/~aashok/visualmimo/Home.html>

## 1. MOTIVATION

- The inherent limitations in RF spectrum availability and susceptibility to interference make it difficult to meet the reliability required for vehicular safety applications

- Optical Wireless for V2V :

- highly directional communication
- limited range (10s of meters) – limited power, high background noise
- mechanically steering transmitter and/or receiver is very costly
- single photodiode receiver may not work in such a mobile setting

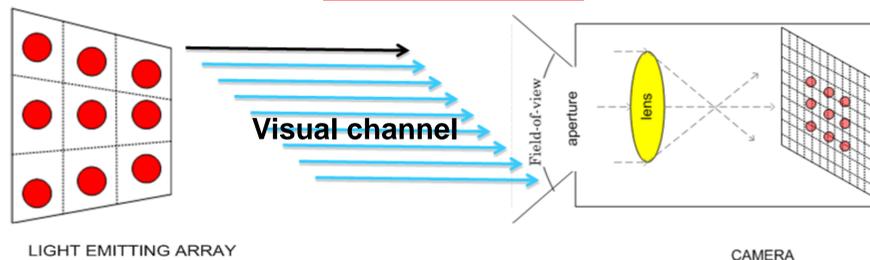
- LEDs for rear and head-lights and Cameras (e.g. parking assistance, rear-view cameras) are getting common in cars



Why not use them for communication?

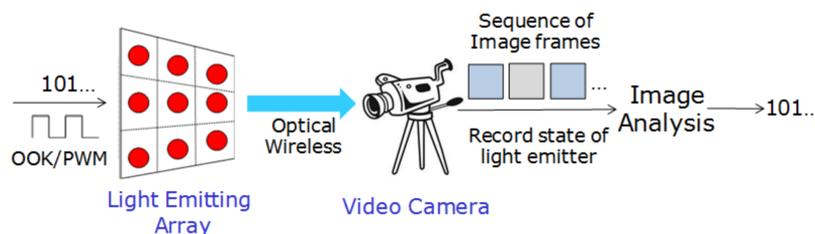
## 2. Light Emitting Array – Camera Communication

### Visual MIMO [1]



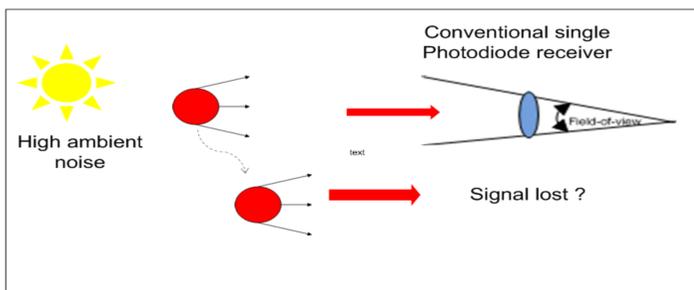
Optical Array transmitter + Camera receiver = **VISUAL MIMO**

### How does it work?

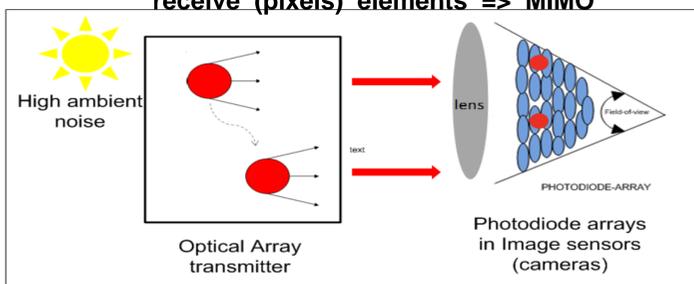


### What's new..

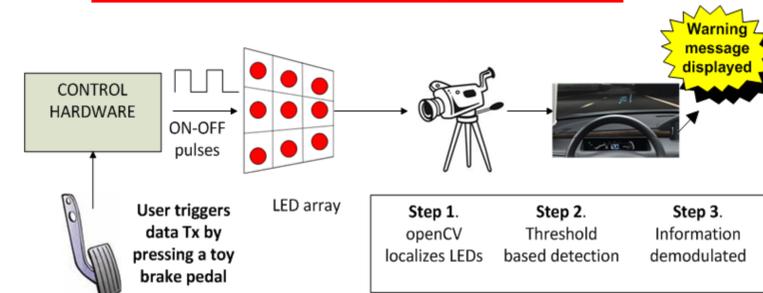
- Computer vision based image analysis techniques can be used to spatially separate signals and remove interferences from distracters such as traffic lights
- Conventional approaches use photodiode receivers [3] or complex hardware processing [4]



Energy detection is done over multiple receive (pixels) elements => MIMO



## 3. Visual MIMO prototype for V2V



- An LED array transmits the brake pedal intensity information (0-255) in the form of ON-OFF pulses (ON = bit 1, OFF = bit 0) when triggered by an user

- Retrieved data is displayed on a receiver computer screen as colors (not-pressed = green, half-pressed = yellow, fully pressed = red)

- Template matching tracking algorithm implemented in OpenCV based on a binary template of the LED array

## 4. Visual MIMO V2V Demo [2]



## 5. REFERENCES

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- M. Varga, A. Ashok, M. Gruteser, N. Mandayam, W. Yuan, K. Dana, **Demo: Visual MIMO-based LED-Camera Communication Applied to Automobile Safety**, Proceedings of ACM/USENIX International Conference on Mobile Systems, Applications, and Services (*MobiSys*), to appear 2011
- S. Kitano, S. Haruyama, and M. Nakagawa, **Led Road Illumination Communications System**, VTC, IEEE 58th, volume 5, pages 3346) U3350, Oct. 2003.
- T. Saito, S. Haruyama, and M. Nakagawa, **Inter-vehicle Communication and Ranging Method Using LED Rear-Lights**, Proceedings of Conference on Communication Systems and Networks, 5:278(283, Aug 2006