Off-the-shelf bi-directional visible light communication module for IoT devices and smartphones

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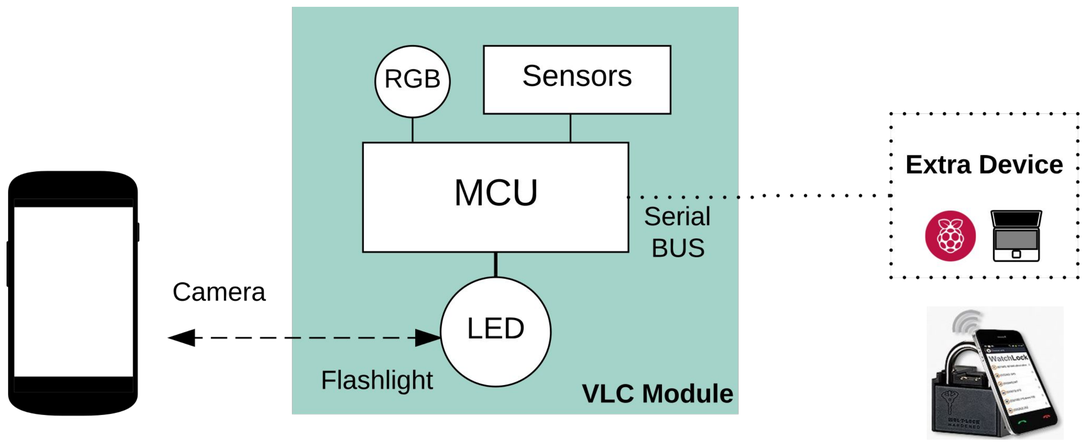
Context and goals

➔ Today consumers expect every **electronic products** to include **wireless connectivity**
➔ Manufacturing **costs** introduced by radio solutions are **non negligible**
➔ We propose **a low-cost alternative** using unmodified **hardware**: a cheap **LED** and a **smartphone**

Demo setup

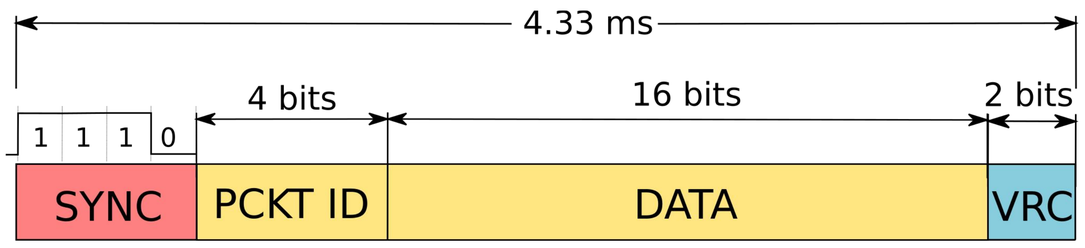


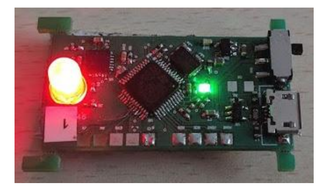
➔ **Hardware**
- Low Power Cortex M0+, LED, 6-axis sensor
- Raspberry Pi 3, Nexus 6P

➔ **Demo scenarios**
- Wake-up and configure the VLC module
- Get battery level and sensors values
- Authenticate through visible light

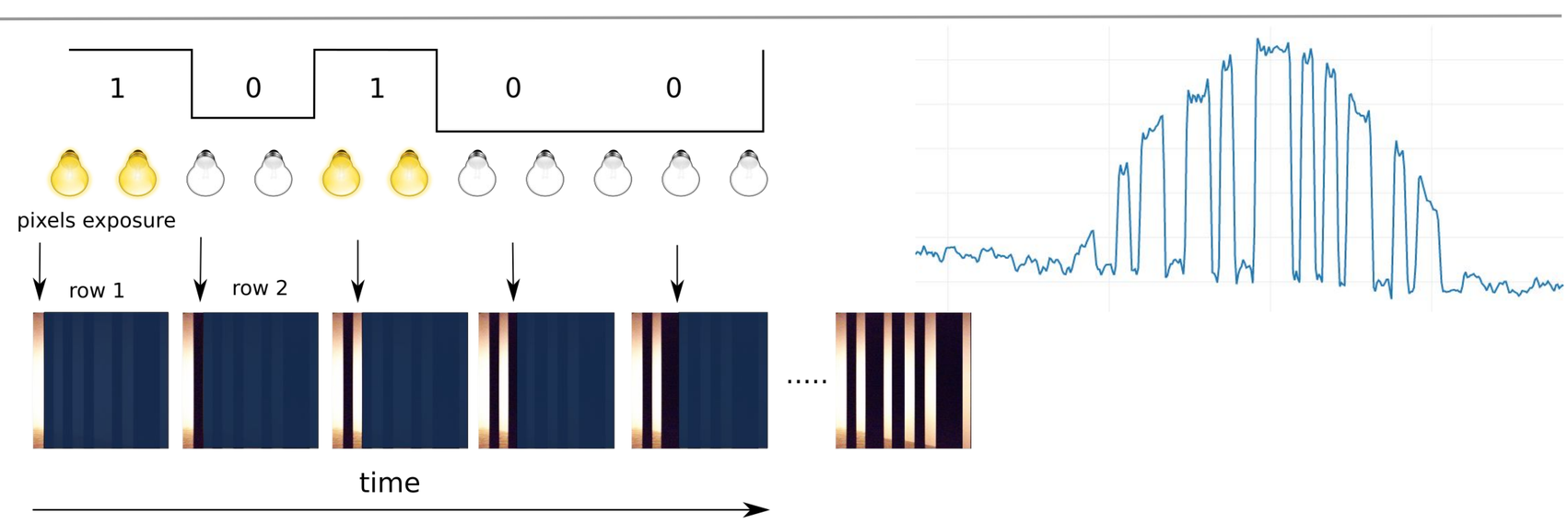
LED-to-camera

➔ **MCU** Emitter
➔ **PHY Layer**
- 6KHz On-Off Keying
- Manchester



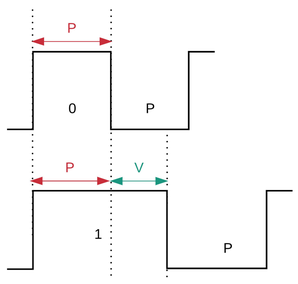


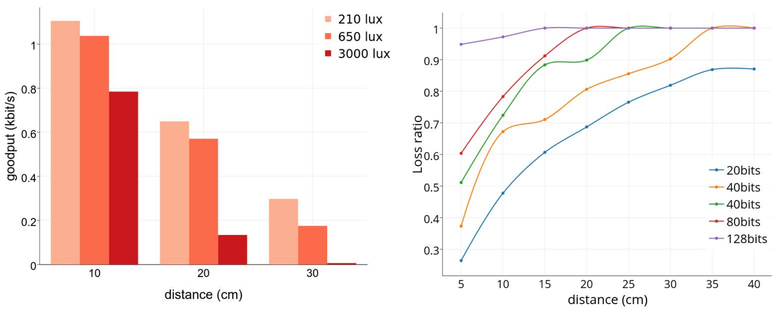
➔ Camera : **CMOS** Sensor
➔ Rolling Shutter Effect
➔ Real time computation



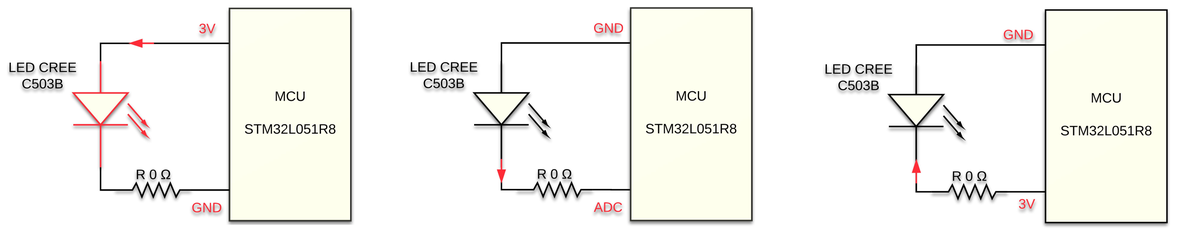
Flash-to-LED

➔ **V-PWM Modulation**
- Built-in flashlight
- 50-100Hz
- **ISI avoidance** mechanism





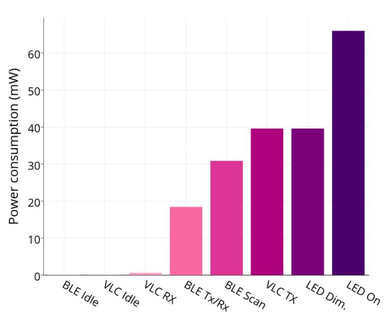
➔ **LED receives** and **sends at the same time**
- **Sampling** occurs when it transmits an **OFF symbol**
- Wired in **reverse-bias** to the MCU **ADC** pin
- Briefly charged, discharged, sense the residual tension
- **Fast** discharge : Flash ON - **Slow** discharge : Flash OFF

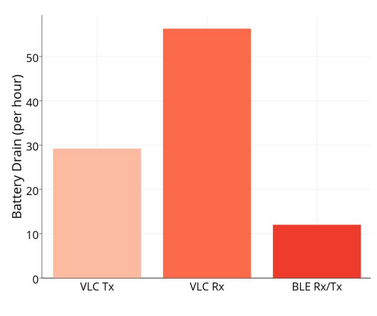


Evaluation

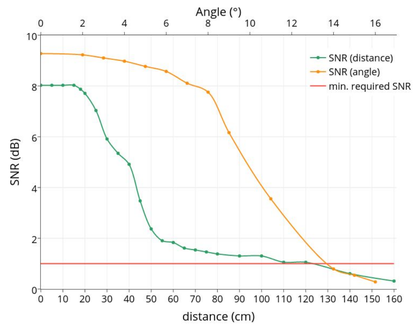
➔ **LED-to-camera** evaluation

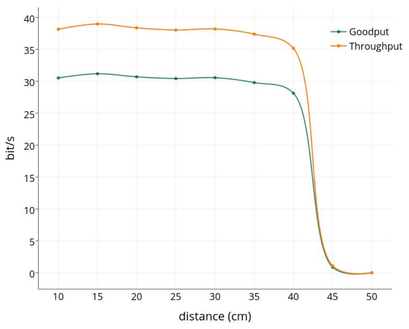
➔ **Power consumption**





➔ **Flash-to-LED** evaluation





Use Cases

➔ **Low cost** smart **consumer electronics** ➔ Wireless **smart lock** ➔ **Universal** alternative to **NFC**