High-Speed Near-Infrared Indoor Communication System

Students

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Definition of Task:

Dynavisual AG develops special caps with integrated internet-of-things (IoT) capability and a matrix of RGB LEDs, as shown in Fig. 1. Currently, the caps can be remotely controlled via Bluetooth or WLAN to display any image or series of images on the LED matrix. For a new application, Dynavisual AG considers to utilize the caps at indoor events with thousands of spectators (e.g., in a stadium) to form a single giant screen that is able to display impressive visual effects.
At these indoor events, especially the 2.4GHz ISM radio band is often heavily occupied by WLAN or other systems. In this thesis, a dedicated communication system is developed, which uses exclusively infrared light to transmit the data to the individual caps.

Approach / Technology:

The implemented system consists of several near-infrared (NIR) transmitters used to cover different areas as well as a large number of caps with integrated infrared receivers and RGB-LED matrices, as can be seen in Fig. 2.

As shown in Fig. 3, the transmitter part obtains the colour information for each cap by an external computer and transmits the data by modulating the infrared LEDs with on-off keying. The modulated signal is generated with the aid of a special feature of the RP2040 microcontroller, the so-called programmable input/output (PIO). An elaborated data protocol can be defined with a dedicated PIO software to achieve the synchronization and the addressing of the caps. This way, the use of an expensive FPGA or a complex electrical circuit can be avoided.

On the receiver side, the cost of the electronic components and the required space has to be minimized. The transmitted infrared signal is detected with a photodiode, which is a light-sensitive diode and produces a small current when light reaches its surface area. The amplified signal is then converted to a binary signal, which is further demodulated with a PIO. The colour information for that specific cap is then displayed on the RGB-LED matrix.

Conclusion:

Our system can transmit the colour information at a rate of at least 40 times per second to 512 individual caps. The current prototype can transmit up to a distance of 26 meters and shows the feasibility of the desired communication system. Further improvements can be implemented to increase the achievable distance and the total number of caps required in a large stadium.

Figure 1: Cap with LED Matrix
Own presentment

Figure 2: Aim of the Task
Own presentment

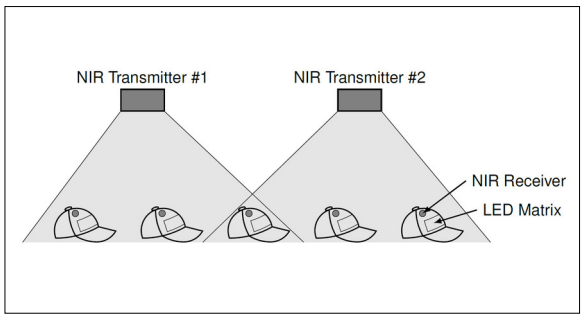
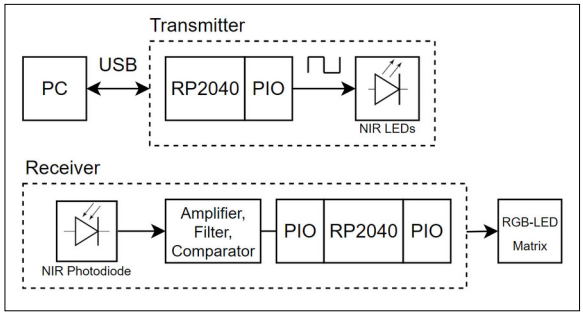


Figure 3: Components of the Communication System
Own presentment



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Subject Area
Wireless Communications

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