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Design and implementation of a multi element visible light bi-directional communication system

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Power Light Emitting Diodes (LED) exhibit high efficiency and high frequency capabilities. As such in addition to interior lighting systems, they can be used for communication purposes. In visible light communication (VLC) systems, data transmission is performed by modulating one or several LEDs according to data signal through a switching circuit. At the re receiver, light power received on a photo diode is demodulated to recover the data. Recently, VLC is used for indoor data communication, underwater communication, traffic control systems, and indoor positioning systems etc. Most important usage is using VLC for indoor data communication since it can achieve high data rates, less interference from other electromagnetic signals, energy efficiency, and high security.

However, implementing a VLC communication system has many challenges due to undesirable ambient light conditions and need of high speed electronics circuits. There are many research to solve such issues. Moreover, since practical communication systems require both downlink and uplink transmission, enabling bi-directional capability in VLC systems is important. Some research has presented bi-directional solutions using visible light for downlink and infrared for uplink transmission. In addition, to communicate data in a room such as between two access points, visible light can be efficiently used in both directions.

In this work, we have designed a VLC bi-directional communication system with 3 LED transmitters and a photodiode. By analyzing the mathematical models of LED and Photodiode, geometric design of the transceiver is introduced to reduce the self-interference of the bi-directional link. Using this method bi-directional VLC system can be identified as two separate links which has minimum self-interference. Pulse Position Modulation (PPM) is used in transmitter for dimming controlling of LED lighting. By changing and measuring the bit error rate, the optimum geometry for transceiver was determined. Varying ambient light condition affects the performance of VLC. By using moving average filter ambient light effect can be removed to a negligible level. Measurement results clearly show that our VLC system is capable of superior performance in addition to increasing the operating distance.