SDMA Based Multi User VLC System for Indoor Office Environment

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Abstract - Visible light communication is an upcoming high speed wireless data transmission technique which uses a beam of light in the frequency range of 400-800 THz for signal transmission. Meanwhile, space division multiple access is an emerging multiple access technique in mobile communication systems which uses the same frequency. In this study we propose a space division multiple access based multi user visible light communication system for indoor office environment with the use of an array of light emitting diodes. Here, multiple users are assigned with light emitting diodes with spatial diversity which are placed with a specific distance from each other. The performance of the system is measured with the use of light source diversity.

Keywords: ***Space division multiple access, Visible light communication, Light emitting diodes***

I. INTRODUCTION

Visible light communication system (VLC) technology has emerged as a complementary alternative to current radio frequency (RF) techniques. Light emitting diodes (LEDs) are commonly used as light sources for an eco-friendly world due to their advantages over conventional wireless communication systems. In a general VLC system, an LED could be served as a transmitting element and a photodiode could be served as a receiving element. Thus a communication system can be proposed to be implemented with the placement of multiple LEDs as an array which can serve multiple users simultaneously.

Multiple access techniques are created to allow a large number of mobile users to share the allocated spectrum in the most efficient manner. Many studies have shown that conventional multiple access (MA) methods such as frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), orthogonal frequency division multiple access (OFDMA), and the new multiple access method which is non-orthogonal multiple access (NOMA) can also be used for multi-user VLC systems. Frequency division multiple access uses different frequencies to transmit multiple data streams at the same time. In coinciding FDMA with a VLC system with LEDs, multiple LEDs with different colours have to be used to conduct such a simultaneous data transmission. In an indoor work environment, it is not very suited to use multi coulored LEDs blinking or transmitting data around the premises. Therefore, a multiple access system should be proposed to use the same frequency band without any hindrance for the users to be accessed by mitigating the inter user interference. Therefore, we propose a space division multiple access based indoor communication system by assigning different LEDs for different users. This technique uses the same frequency band throughout the process, where we need to use only one-colour LEDs for the transmission.

We proposed an interference free environment for the users. That is users cannot be placed too close. But we cannot consider our system like that. So we need to consider all the possible situation in this system. So we have to upgrade our LED allocating algorithm which is suitable for every possible ways that multiple users are to be accessed to the network. We can create a SDMA-based VLC system [1][2][3] to transmit data from server to multiple users simultaneously.

II. METHODOLOGY

There are two main phases in the proposed system for data transmission as selection of LEDs and transmission of data. Initially, the user sends a signal to the server that the user is ready to establish a communication. For that, we use a multiplexer, which has a connection with two users and the server. First, user send a request to the server with that user is ready for the transmission. Next, the server starts to “ON" the LEDs with certain time period. When the first LED is on, the receiver photodiode receives a power, then we feedback that power to the server. Then server store the power values. Same process is used to save the voltage values of eight LEDs and a maximum of n values within is selected and we allocate those corresponding three LEDs to user 1.

After the allocation of LEDs to user 1 the selected/allocated n LEDs want to send the specific data to user 1 by establishing a communication channel. Therefore, the connection with user 1 and the multiplexer is disconnected while a new connection is oriented with user 2. A similar process is conducted for user 2 for the selection of LEDs. After the allocation of LEDs, the system starts to send data from the server to two users simultaneously. This process doesn’t need a key code for the transmission. In any case if the photodiode did not detect any light beam from the transmitter, the system is reset until the receiver detects any light signal. Moreover, ‘T’ seconds are allocated for the initial LED selection for the users.

Here we proposed maximum power deliverable methods to allocate LEDs to users. But if there is an interference between 2 users, we need to add another algorithm method with LED accessibility. So even if 2 users are close, LEDs will be allocated for the 2 users morally. The data flow diagram of the system is presented in Fig,1.

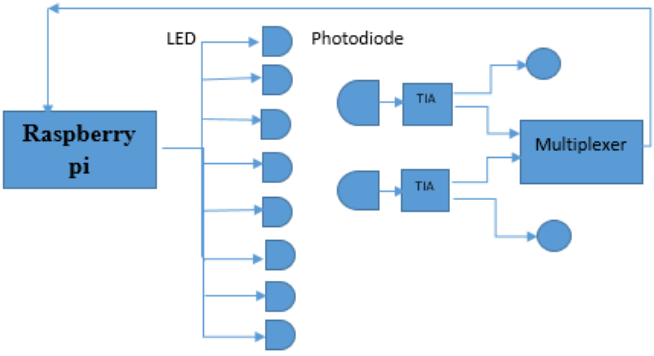

Fig. 1 Methodology data flow Diagram

The proposed methodology is illustrated further in the flow chart as in Fig. 2.

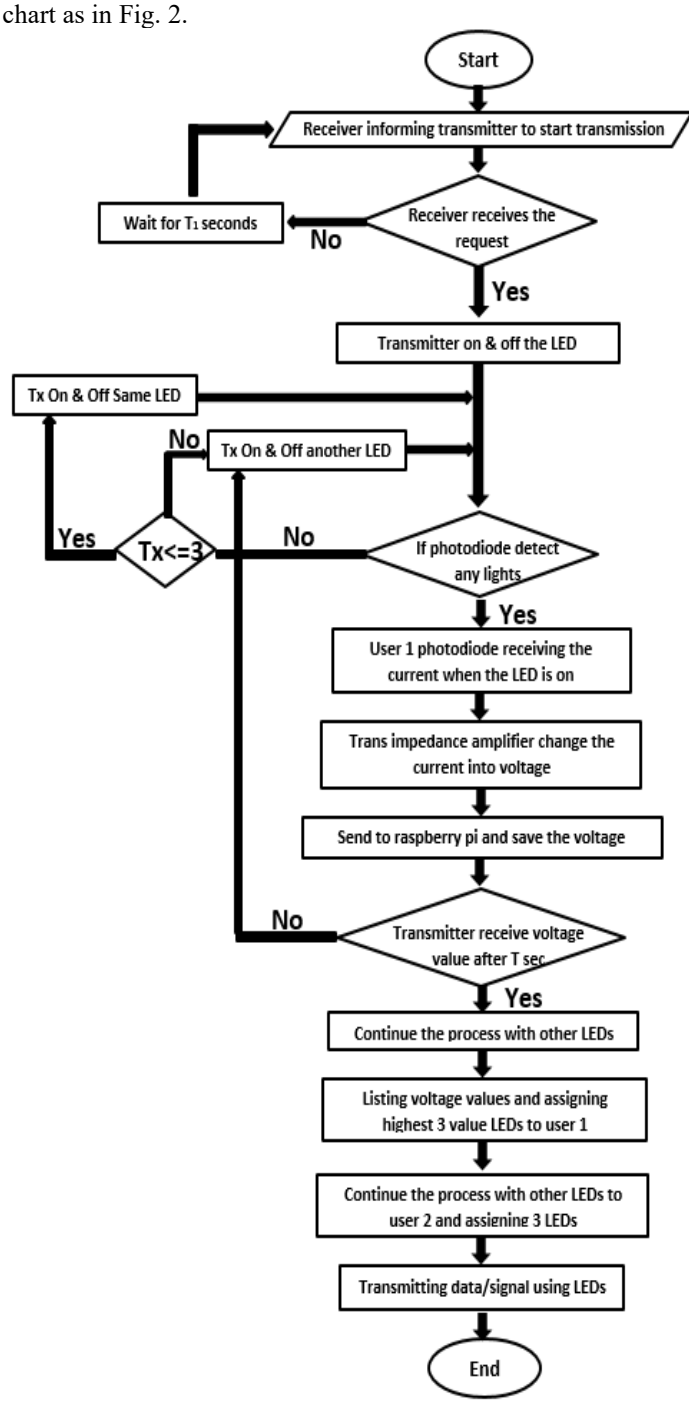

Fig. 2 Methodology Flowchart

III. RESULTS AND DISCUSSION

With the initial data analysis, a general comparison in between the proposed SDMA data transmission and CDMA data transmission is compared in Table 1. It is clearly observed that with the gathered data, the data transmission time for SDMA-VLC system is 9 seconds lower than CDMA-VLC system, where the proposed system could transmit a higher data capacity within an allocated time period. Additionally, the signal processing time is also much lesser in the proposed SDMA system where it could be an advantage in terms of latency of the data transmission. This SDMA-VLC processing time is calculated using the system which we have done until now. A comprehensive comparison of overall data transmission time (LED allocation time plus data transmission time) with TDMA and CDMA is to be done in future with the system implementation.

Table 1. Processing time comparison between CDMA & SDMA with visible light communication
D1 – Data for user 1 C1 – Code for user 1
D2 – Data for user 2 C2 – Code for user 2

Processing time for CDMA-VLC	**Processing time for SDMA-VLC**
D1 x C1 = 8 seconds	Assigning LEDs to receivers = 30 seconds
D2 x C2 = 8 seconds	Data transmission = 5 seconds
Tx Data addition = 8 seconds	-
Decode Rx1 signal = 10 seconds	-
Decode Rx2 signal = 10 seconds	-

IV. CONCLUSION

In this paper, a SDMA based VLC system is proposed for data transmission which is suitable for an indoor office environment. The maximum power deliverable methodology is used to allocate the LED to the specific users and multiple users are to be served simultaneously with the same frequency band. Though the initial system is proposed to transmit data among two neighbouring nodes the system can be adequately extended for multiple users with the limitation of the LED allocation processing time which is used prior to the data transmission. In our future works we hope design a (SDMA + CDMA) based multi user VLC system.

References

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