ISSN: 0976-3104
SPECIAL ISSUE: Computer Science

ARTICLE

# VLC USING SINGLE INPUT SINGLE OUTPUT STRATEGIES AND MULTIPLE INPUT MULTIPLE OUTPUT ANTENNA STRATEGIES THROUGH OSDM

**M Anto Bennet[1*], G Vijayalakshmi[2], M Vijayalakshmi[3], P Shenbagavalli[4], S Saranya[5]**

*[1]Professor,[2]Asst. Professor,[3,4,5]UG Students,Department of ECE,VEL TECH ,Avadi,Chennai 600 062, Tamil Nadu, INDIA*

## ABSTRACT

*With increasing demands for faster and more secure wireless communications, there is a pressing need for a new medium of wireless communication as the radio spectrum is already crowded. Visible light is a medium that can address both of these needs. It is a relatively new technology with great potential. This work was completed to develop a working visible light communication system and demonstrate the transmission capabilities of such a system. This year's team set a goal to surpass the previous year's team in transmission speed, range, and size. Of these goals, transmission speed and range were both achieved, while the transmission of a large audio file was deemed not possible based off the difficulties the team encountered while processing large amounts of data.*

**KEY WORDS**
*forward voltage tracking (VFT), Pseudo-random binary sequences (PRBS),MIMO(multiple input multiple output).*

Received: 24 October 2016
Accepted: 20 December 2016
Published: 15 February 2017

***Corresponding Author**
Email:
bennetmab@gmail.com

## INTRODUCTION

Visible light communication is a viable technology to accommodate the need for faster and better wireless communications in the coming years. The basic idea, is that instead of using traditional methods of communication over cables or radio frequencies, VLC systems send data by turning light on (logic 1) and off (logic 0). This report describes and evaluates the visible light communication system design the team created. As visible light communication technology is relatively new, the team worked on creating a prototype to test out this technology and demonstrate its possible capabilities. Using last year's system design as a foundation, the team developed a successor with improved transmission specifications. The first part of the process is preparing a file or string of bytes for transmission [1,2,3]. In order to synchronize the transmitter and receiver, the system divides the data into units called "frames", each starting with a preamble to let the receiver know that a transmission has started. The transmitter takes a file, breaks into frames, and inserts preamble sequences before each frame. Then it sends the modified file to a microcontroller unit (MCU) over the serial port. The MCU controls the gate of a transistor based on the data it receives, switching an array of LEDs on when it sees a 1 and turning it off when it sees a 0. This light is picked up by an array of photodiodes on the receiver side. This signal is amplified and filtered to produce a clean signal as similar as possible to what was output by the transmitter MCU. This signal is then sampled by the MCU on the receiver end [4-7]. Each bit sent by the transmitter is sampled 16 times, and the receiver determines whether it's a 0 or 1 based on whichever bit appears more in that 16-bit section (i.e. 14 1s and 2 0s are interpreted as a 1). This data is sent to the computer through a serial connection to be processed by a MATLAB script. The script does the down-sampling and converts the bits into meaningful symbols, either text or audio. At this point, the transmission is complete. However, in our implementation, this success was only apparent on the transmission end of the system. The audio was transmitted flawlessly but the receiver was not able to convert the captured signal back into proper form due to problems in the ADC's of the microcontroller. Sampling errors accumulated to the point where they could not be filtered out by the down-sampling error correction, resulting in a meaningless output [8,9,10].

## MATERIALS AND METHODS

The proposed system explains about the transmission of data using two antenna strategies SISO(single input single output) and MIMO(multiple input multiple output) through OSDM. The block diagram describes process of visible light communication .First, The information source produces the data to the modulator where the signal is modulated and the modulated signal is produced to optical driver which has transmitting antennas and transmits the signal through LED and the unwanted signal is filtered and the signal received by the photo detector .the electrical band pass filter receives the signal and filters the electrical signal and the front end amplifier amplifies the signal and the signal produced to the demodulator . The demodulator demodulates the signal and produces to the output unit shown in [Fig. 1].

THE IIOAB JOURNAL

Editor: Dr. K. Sakthisudhan

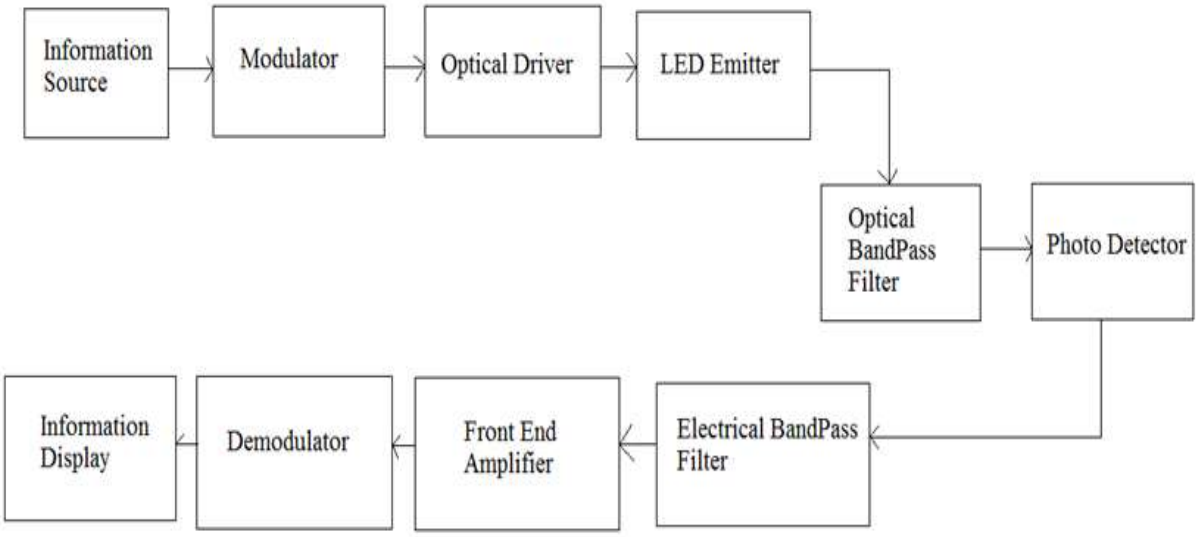


**Fig. 1:** Demodulator demodulates the signal and produces to the output

## Transformer

The purpose of a transmitter is to send data to the receiver so that the other side can process and interpret the data. In our analog design of the transmitter, we used LEDs to transmit light, which would be used to transmit data. As mentioned earlier in the work, the LEDs would modulate on and off to transmit 1s and 0s. The source of the data that would be sent to the LEDs would be the MCU of the transmitter circuit. During the preliminary rounds of building the analog transmitter circuit, it consisted of nothing more than just 20 LEDs and a MCU. While this design worked, it failed to meet one of our goals, which was to transmit at a distance of 1 meter apart to the receiver. The amount of power being sent to the LEDs from the MCU was miniscule. The current from the MCU to the LEDs is not adequate as it was approximately 23 mA of total current coming from the MCU to about 10 LEDs directly with zero resistance. This is approximately comes out to around 2-3 mA for each LED in our system which results in little light produced. In order to alleviate this issue, another power source was needed. We decided that some kind of relay or switch would be needed to handle the switching of the LEDs. We also decided to use the batteries from last year's team to be used as our external power source for the LEDs. In our third and current design as shown in [Fig. 2] below, we decided to change a few things. For the external power source, we decided that four AAA batteries was just not enough for the 10 LEDs so we decided to make use of eight AA batteries. The benefit of using AA batteries is that the power output would last much longer due to having a higher capacity for each battery. Furthermore, more batteries imply a higher voltage, which would lead to an increase in LED brightness as the amount of power for each LED increases. The voltage of our previous battery source is now effectively double in our current build. The resistors between the batteries and the LEDs also were changed as it used to be a higher resistance due to fear of damaging the LEDs with high current but later testing showed that the LEDs appeared to have no issues with a very low resistance. Therefore, the team ended up using two 10Ω resistors in parallel to have the current from the batteries travel through a 5Ω resistance pathway to the 10 LEDs. From our results, the current supplied from the batteries is approximately 360 mA. That would mean about 36 mA is supplied to each LED. The batteries voltage measured to be approximately 11V when the transmitter is off and when under load, the voltages drop down to 10.4V. The final power consumption for each white LED while being supplied with approximately 30 mA is estimated to be around 100 mW so for 10 LEDs, which would be 1.0 W overall shown in [Fig . 2].

THE IIOAB JOURNAL

Editor: Dr. K. Sakthisudhan

### Circuit Diagram

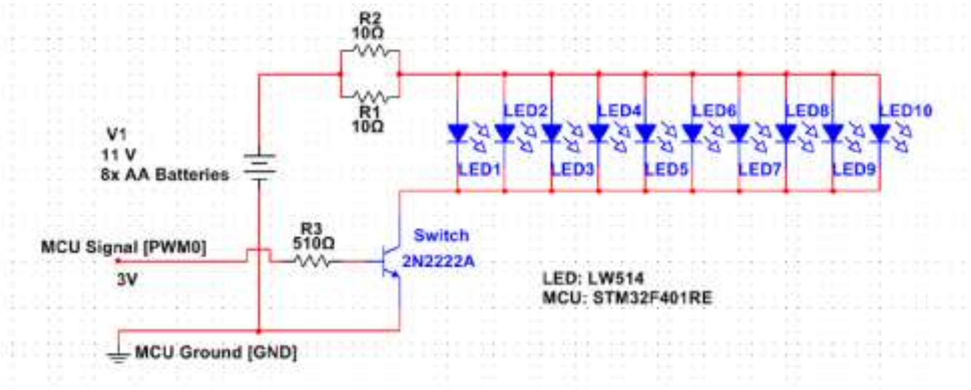


**Fig. 2:** Transmitter circuit diagram

The other major change to our current design is the transistor used. Originally, a MOSFET was used but was deemed to be unsuitable. This time, we decided to switch to using a BJT. During the testing of transistors, we briefly decided to use the 2N3906 BJT; however, as mentioned in previous sections, it was not adequate. We finally decided to use the 2N2222A BJT, which is very similar to the 2N3906 BJT but is made for slightly higher power usage circuits such as ours. The 2N2222A transistor turns itself on (the resistance between the collector and emitter essentially become 0Ω) when a 0.7 V or higher signal is at coming from the MCU PWM pin. This cutoff voltage is the main reason why we switched over from the IRF520 MOSFET to the 2N2222A BJT as the IRF520 needed 10 V to turn on completely (to lower the resistance between the drain and source to 0Ω). When the BJT turns on, the collector and emitter connect and the power from the batteries reach the LEDs. With the 2N2222A supporting high frequencies, we can turn the switch on and off quickly (up to 150 MHz) so there are no issues with the speed capability.

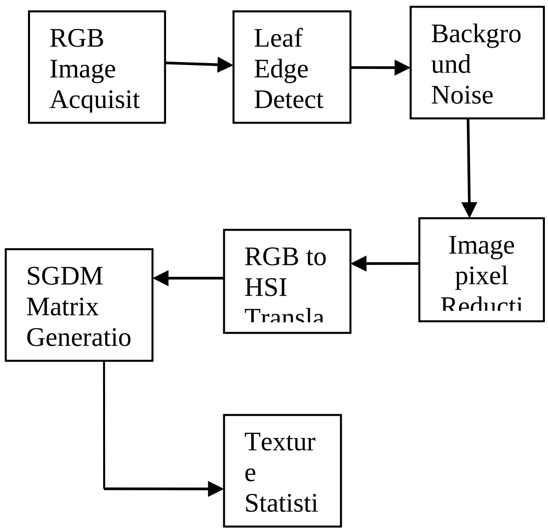


**Fig. 2:** Image acquisition and image Classification chart

### Receiver

The idea behind this circuit was to get a reasonably strong photo current that would only intake the signal from the transmitter LEDs and output that signal to the receiver MCU. To get a strong photo current at up to a foot away, we needed a sizable array of photo diodes. Matching the transmitter, the array had 10 photo diodes to capture the light. With the LEDs shining at 6 inches away, each photo diode produced 1.5 mA of photo current. 10 photo diodes produced 15 mA of photo current. Unlike the transmitter, which uses a resistor to pull a sizeable current from the voltage source through the BJT, the receiver needed a resistor to create a voltage difference with the photo diodes acting as a current source. This resulted in a square wave going from 150 mV to 300 mV, which was smaller than expected. Initially, the idea was to amplify the

Editor: Dr. K. Sakthisudhan

signal, and then we could set a voltage cutoff based on the output and there would not be a need for much analog processing beyond that. . We decided upon resistor values of R1 = 1 kΩ and R2 = 10 kΩ to give a gain of 10. This circuit did accomplish the goal of amplifying the input voltage to get a clearer difference between a logic 0 and logic 1, but the problem was that when the output was tied to the ADC input on the MCU, the voltage going in was at a range of about 2.5V to 5V. Not only was the AC component of the signal amplified, but the DC was amplified as well.To deal with this small voltage difference as well as the DC offset, we put this signal through an active high-pass filter. This would accomplish multiple things for our photo diode’s output. For one, it would amplify the photo current, making it less likely for the MCU to make a quantization error. Secondly, it would remove the DC offset and allow for more amplification while not running into the problem of hitting the MCU’s input ceiling of 3.3V. It is not very useful if the signal goes from 3V-7V if the MCU treats everything above 3.3V as the same.

Removing the offset makes the active range more compatible with the MCU. Third, a high pass filter would filter out all ambient light. Generally, ambient light in any indoor environment would be locked to 60Hz. This noise was actually initially quite apparent in the output and had a significant effect. A high-pass filter got rid of the noise caused by ambient as well as any general white noise. The feedback resistor, in relation to the series resister, determines the amplification of the system. The capacitor, combined with the series resistor, determines the cutoff frequency of the system. With the series resistor set to a value that would create a suitable input voltage (300 kΩ in this case), the capacitor and feedback resistor were chosen to match the desired amplification and cutoff frequency. We wanted to get a gain factor of ~3, and a cutoff frequency between 250 Hz and 500 Hz for the initial tests, where data would be transmitted at 1 kHz but without the 60 Hz ambient light frequencies. Thus, our feedback resistor was set to 1 MΩ and the capacitor was set to 15 nF. Theoretically, the gain should be approximately -3.33, and the frequency cutoff should be about 250 Hz. However, some problems were experienced with the previous design. There were a series of inconsistencies in the output of the previous circuit. At times, it would produce strange output signals. Through a series of tests, it was found that this problem was mostly eliminated by changing how power was supplied to the op-amp. Introducing a duel polarity power supply set up removed the inconsistencies in the output. This is likely because a power supply can more reliably supply power than the batteries could shown in [Fig. 3].

Rectifier Circuit Diagram

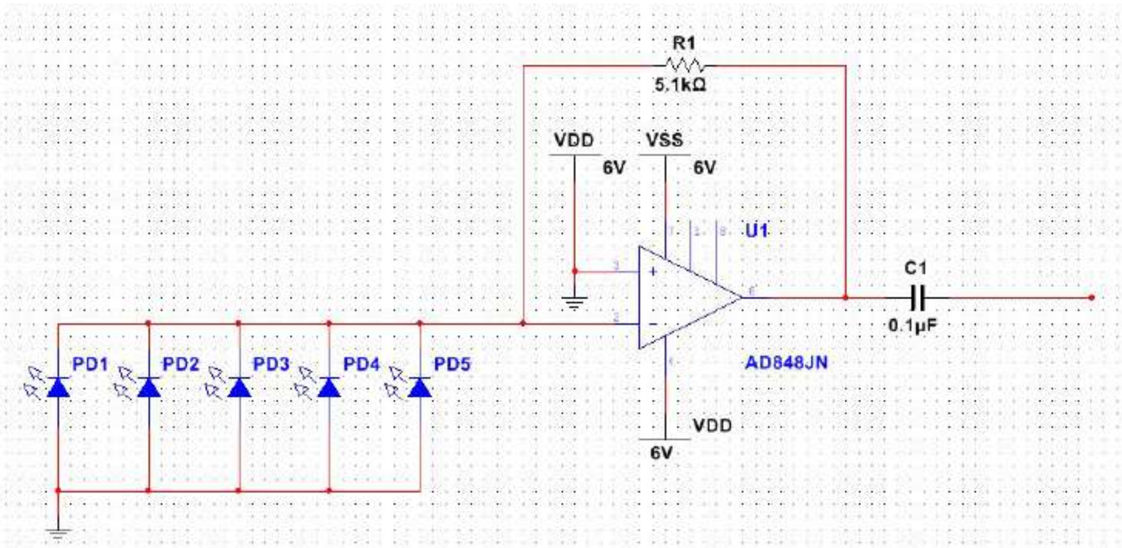


**Fig. 3:** circuit diagram

THE IIOAB JOURNAL

Editor: Dr. K. Sakthisudhan

## RESULTS

### Output For MIMO

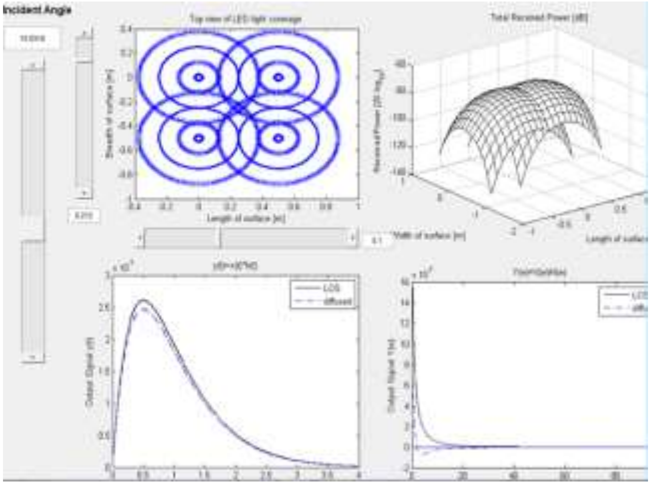


**Fig. 4:** MIMO Output

……………………………………………………………………………………………………………………………………

Multiple input is multiple output is a antenna strategy which has many inputs and produces many output .The above output describes the top view of LED coverage ,3 dimensional representation of total received power ,width of surface and length of surface. The third plot describes the variation in output signal due to line of sight. As the line of sight has some impact it will reduce the output signal shown in [Fig. 4].

### Output For SISO

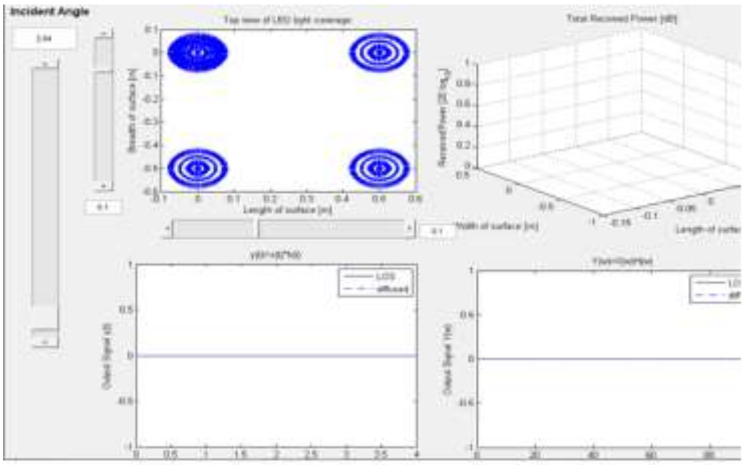


**Fig. 5:** Output for SISO

……………………………………………………………………………………………………………………………………

Single input is single output is a antenna strategy which has single inputs and produces single output .The above output describes the top view of LED coverage ,3 dimensional representation of total received power ,width of surface and length of surface. The third plot describes the output signal due to line of sight As the line of sight has some impact it will reduce the output signal. As it has single input it doesn't affected by line of sight shown in [Fig. 5].



Editor: Dr. K. Sakthisudhan

SNR VS BER(OSDM)

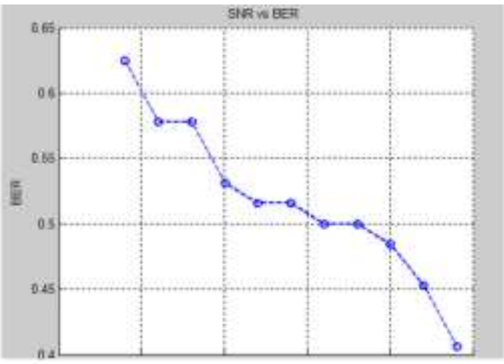


**Fig. 6:** output graph between SNR vs BER

The above plot describes the SNR VS BER reduced due to the implementation of OSDM shown in [Fig. 6].

## CONCLUSION

In VLC communication we used MIMO and SISO based strategies and through this we achieve the communication in indoorwise. In OSDM we have reduced the BER (bit error rate ) and increase the SNR (signal to noise ratio ). This project was used as a continuation and general improvement of the VLC project completed last year. Utilizing the knowledge the previous team gained through their experiences, a number of improvements could be made. The basic format of these circuit features was overall very similar to the previous year's design. The main difference came in component selection, particularly the photodiodes and the MCU's. The osdm and ofdm combinely used we can make the communication in outdoor also .The signal to noise ratio can be reduced in the future and the bit error rate is also reduced. the equipment cost can be more economical .It can be more commercialized. Loss due to obstacle should be overcome.

### CONFLICT OF INTEREST
There is no conflict of interest.

### ACKNOWLEDGEMENTS
None.

### FINANCIAL DISCLOSURE
None.

## REFERENCES

[1] Jun Hong Lee, Min Ho Jung, and Jong Ha Shin. [2012] Off-the-Line Primary Side Regulation LED Lamp Driver With Single-Stage PFC and TRIAC Dimming Using LED Forward Voltage and Duty Variation Tracking Control.12.

[2] Ali Mirvakili Department of Electrical and Computer Engineering Tufts University Medford, MA 02155. A Novel Multiple Modes PWM Controller for LEDs. -1-4244-3828-0/09/$25.00 ©2009 IEEE

[3] Krames MR, Shchekin OB, Mueller-Mach R, et al. [2014] Status and future of high-power light-emitting diodes for solid-state lighting [J]. *Journal of Display Technology*. 3(2): 160-175.

[4] Zhang, Member, IEEE, Hulong Zeng, and Ting Jiang. [2012]IEEE 802.15.7 Visible Light Communication: Modulation Schemes and Dimming Support.IEEE Communications Magazine.

[5] Min Ho Jung, and Jong Ha Shin A Primary-Side Control Scheme for High-Power-Factor LED Driver With TRIAC Dimming Capability. IEEE TRANSACTIONS ON POWER ELECTRONICS. 27(11). NOVEMBER 2

[6] AntoBennet M, Suresh R, Mohamed Sulaiman S. [2015] Performance &analysis of automated removal of head movement artifacts in EEG using brain computer interface", *Journal of Chemical and Pharmaceutical Research*. 07(08): 291-299.

[7] AntoBennet M. [2015] A Novel Effective Refined Histogram For Supervised Texure Classification", *International Journal of Computer & Modern Technology*. 01(02):67-73.

[8] AntoBennet M, Srinath R,Raisha Banu A. [2015] Development of Deblocking Architectures for block artifact reduction in videos, *International Journal of Applied Engineering Research*.10( 09): 6985-6991.

[9] AntoBennet M & JacobRaglend. [2012] Performance Analysis Of Filtering Schedule Using Deblocking Filter For The Reduction Of Block Artifacts From MPEQ Compressed Document Images", *Journal of Computer Science*. 8(9):1447-1454.

[10] AntoBennet M & JacobRaglend. [2011] Performance Analysis of Block Artifact Reduction Scheme Using Pseudo Random Noise Mask Filtering", *European Journal of Scientific Research*.66 (1):120-129,012.

Editor: Dr. K. Sakthisudhan