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Audio Transmission through Free Space Optics using Visible Light

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ABSTRACT

With FSO communication, maximum data transfer rates up to 2.5 Gbps is possible, unlike the maximum data transfer rates of 622Mbps offered by RF communication systems. Using air as a medium FSO technology can transmit voice, video and data. Transmission using FSO technology is relatively simple. In this paper, we propose a prototype of audio transmission system using inexpensive commercially available LASER. Experimental result shows that high quality audio can be transmitted with maximum distance of 6 m. Careful considerations can make it an attractive alternative to introduce in the market for applications like communication among buildings within a large campus and other indoor and short distance outdoor places without the complexities of cables.

Keywords: Visible Light Communication, LASER, Audio Broadcasting System, Attractive Alternative Communication

I. INTRODUCTION

FSO provides point to point and point to multipoint transmission of communication information by using air as medium and optical signal as it carrier. It has drawn attention in telecommunication industry, due to its cost effectiveness – easy installation, quick establishment of communication link. The range of frequencies where it operates makes FSO communication free from licensing. G. Anandhi et al [1] first analyzes various issues with current wireless communication systems, and discusses how visible light communications can resolve these issues. G. Subba Rao et al [2] has theoretically investigated the transmission performance of the FSO system. It is shown that the system can be used for providing high speed data rate and for free space optical communication networks, extending broadband connectivity to remote areas. Luanxia Yang et al [3] has proposed FSO communication systems using OOK and source information transformation. It was shown that such systems can achieve good BER performance without the need for knowledge of the instantaneous CSI and PDF of the turbulence model. They have derived an analytical expression for the PDF of the detection threshold and developed a tight upper bound on the average BER. Manish Sharma et al [4] have evaluated the performance of a ground-to ground FSO. The average bit error rate of their configured architectures is also evaluated under different turbulence conditions. The performance of these reconfigured architectures slightly degrades in comparison to the basic architecture.

M. J. Lok et al [5] - theoretical and numerical analyses have been carried out to study the capability of FSO communication system under atmospheric turbulent channel. It possesses advantages over RF technology such as lower power consumption. It also reveals the relationship between the scintillation index and the strength of turbulence. Modulation and signaling formats have been verified to FSO system

performance by measuring the BER during the propagating along FSO channel under atmospheric turbulence. Under weak turbulence, PSK modulation format offers the best performance by obtaining the lowest BER at the lowest. Thus FSO technology facilitates an optimal solution, bandwidth scalability, speed of deployment (hours versus weeks or months), re-deployment and portability, and cost- effectiveness (on average, one-fifth the cost of installing fiber-optic cable).

II. FSO OPERATION

A Free Space Optical transmission system is one form of wireless communication system designed for the interconnection of two points which have a direct line of sight. The carrier that is used for the transmission of this signal is Infrared and it can be generated by either high power LED or laser diode. The basic principles for the transmission of a signal along a fiber are the same as for transmission through free space.

III. FSO OVER OTHER MODES OF COMMUNICATION

The increasing demand for high bandwidth in metro networks and service providers' pursuit of a range of applications, including metro network extension, firm LAN-to-LAN connectivity, wireless backhaul and many more are relentless. This imbalance is often referred to as the "last mile bottleneck." Service providers are put in the situation where they have to provide services quickly and cost-effectively. But the last mile bottleneck is only part of a larger problem. Similar issues exist in other parts of the metro networks. The connectivity bottleneck is everywhere in metro networks.

Parameters	FSO	Optical Fiber	Microwave Radio	Coaxial Cable
Installation	Moderate	Difficult	Difficult	Moderate
Data Rate	Gbps	Independent	Mbps	Mbps
Security	Good	Very Good	Poor	Good
Connectivity	P2P, P2MP Short And Long Reach	P2P, P2MP Short And Long Reach	P2P Short Reach	Multidrop Short Reach
Maintenance	Low	Low	Low	Moderate
Spectrum License	Not Required	Required	Required	Required

Table 1 represents comparison of FSO over other modes of Communication. Firstly, the most obvious choice is fiber-optic cable. Without a doubt, fiber is the most reliable means of providing optical communications. But the digging for laying fiber and associated costs to lay fiber to establish connection often make it economically prohibitive.

Second option is the radio frequency (RF) technology. Though RF based communication for long distance communication, RF-based networks require large capital investments to acquire spectrum license. RF technologies cannot scale and the bandwidth is limited to 622 megabits.

The third alternative is wire and copper based technologies. The biggest hurdle is bandwidth scalability. Copper technologies may ease some short-term pain, but the bandwidth limitations of 2 to 3 Megabits, which makes them a marginal solution.

Fourth and finally, the most viable-alternative is FSO. The technology facilitates an optimal solution, bandwidth scalability, speed of deployment and cost-effectiveness (on average, one-fifth the cost of installing fiber-optic cable).

IV. WORKING OF FSO

The Figure 1 represent general block diagram of FSO. The transmitter consists of electrical input, which is the input from the user, followed by modulator; the modulation scheme is selected by the user based on the

application. Now the signal is converted from electrical to optical and is transmitted by using light source (i.e.) LED or Laser. The receiver consists of photo detector which detects the transmitted signal and converted the received optical signal into electrical signal for processing. The converted electrical signal is given to demodulator to get back the original signal that is transmitted.

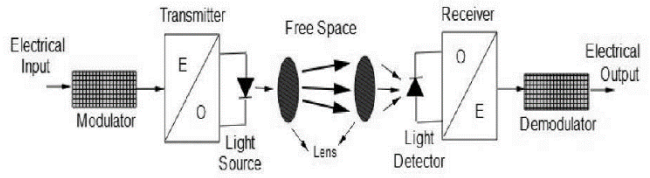

Figure 1. FSO Block Diagram

[Reference article : Loss Calculation in Free Space Optical Communications , Mr.G.Subba Rao et al. Int. Journal of Engineering Research and Application, Vol. 6, Issue 6, (Part -4) June 2016, pp.49-51]

V. DESIGN AND IMPLEMENTATION

Figure 2 represents the block diagram of FSO audio transmitter and receiver. The voice input from the mobile is given to 2N3904, the output of the previous section is amplitude modulated and converted into optical signal using optical source.

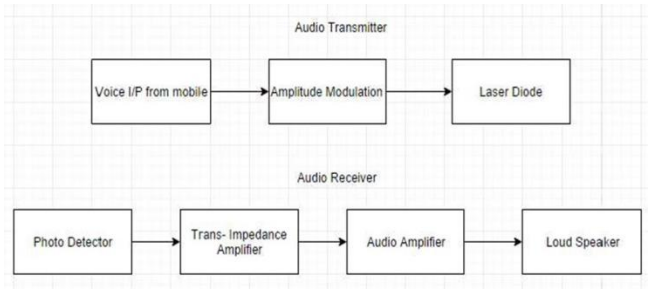

Figure 2. Block diagram of FSO Audio Transmitter and Receiver

The optical source used in this work is a laser diode that emits optical radiation at 635nm. Thus Amplitude Modulation technique is been applied to modulate the instantaneous power of the optical signal. We can even use a plano - convex lens after the Laser for better performance and mostly for low power Lasers with conventional beam divergence of 0.6 mrad. The modulated optical signal then passes through the atmosphere as a coherent beam. Figure 3 shows the Audio Transmitter circuit.

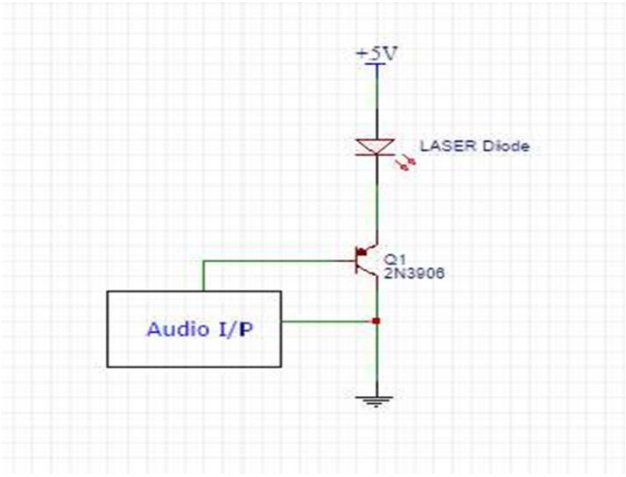

Figure 3. Audio Transmitter Circuit

The optical receiver, which is responsible for converting the optical signal into electrical equivalent and removing the effects of different noise sources through transmission and obtaining an exact replica of the transmitted signal, contains a photo detector. Figure 4 represents audio receiver circuit. The output from the optical detector should be amplified by a pre-amplifier. LM 741 is used for this purpose. The output of the previous section is given to LM386 an audio amplifier, and then this amplified signal is given to the loud Speaker.

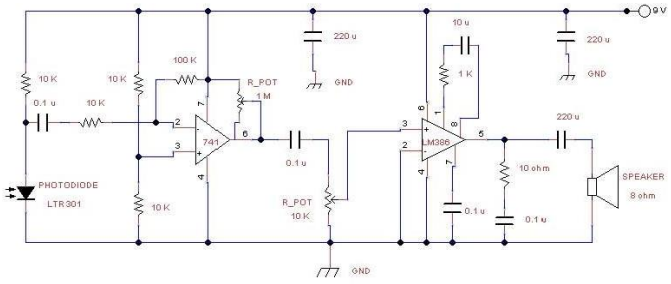

Figure 4. Audio Receiver Circuit

VI. HARDWARE IMPLEMENTATION

Figure 5 shows the hardware setup of FSO Audio Transmission System. It has to be noted that laser diode used has wavelength of 635 nm. In the setup shown above the transmitter uses simple BJT2N3904 which modulates the input voice signal from the mobile fed through the audio jack. The receiver

consists of a photodiode (LTR301); one of the common features of this photodiode is high sensitivity and wide range of collector current. Thus the received optical signal from the transmitter through air interface is converted from optical signal to its equivalent current signal. This is then given to IC741 which acts as a trans-impedance amplifier (current to voltage converter). The IC741 also boost the signal to certain level and it is given to the Audio amplifier - LM386 which further boosts the signal and the audio is played by the Loud speaker. The 10K potentiometer is connected between the output of IC741 and non-inverting input of LM386, by tuning this potentiometer we can able to vary the gain of the audio amplifier which in turn controls the volume of the Loud speaker.

VII. CONCLUSION AND FUTURE WORK

The proposed wireless technology which transmits data or sound signals from one point to another through a laser beam will be used in many applications in the near future. The system is safe since no hazardous radiation is emitted. The possibility of transmitting audio is presented in this work using simple, cheap and available elements. The (FSO) distance (range) between a working transmitter and receiver is 6 meters indoor, thus the designed system acts as a demonstration system which uses the benefits of the wireless laser communication. To increase the range of communication system, one can use beam expander, more powerful lasers and/or more sensitive detectors. The produced picture wasn't obvious because of the noise sources (internal noise and external noise).

Thus FSO can be used in:

Outdoor wireless access: it can be used by wireless service providers for communication and it requires no license to use the FSO as it is required in case of microwave bands.

Fiber backup: FSO can also be used as a backup link in case of failure of transmission through fiber link

Service acceleration: it can also be used to provide instant service to customers when their fiber infrastructure is being deployed in the meantime.

Military access: Since FSO System is a secure and undetectable system it can connect large areas safely with minimal planning and deployment time and is hence suitable for military applications. It can be used to communicate between point-to-point links and point to multipoint links.

VIII. REFERENCES

[1] G. Anandhi, J. Meera , I. Irudhayasuji , P. Anandhi, "Design of an intelligent data transmission technique over free space optics" in *International Journal of Advanced Research in Electronics and Communication Engineering* (IJARECE), vol. 4, Issue 4, Apr. 2015.

[2] G. Subba Rao, Hinsermu Alemayehu, Temesgen Bailie, Hari Hara P Kumar, "Loss calculation in free space optical communications" in *International Journal of Engineering Research and Application*, ISSN : 2248-9622, vol. 6, Issue 6, part 4, pp. 49-51, Jun. 2016.

[3] Luanxia Yang, Bingcheng Zhu, Julian Cheng, and Jonathan F. Holzman, "Free-space optical communications using on–off keying and source information transformation" in *Journal of Lightwave Technology*, vol. 34, no. 11, Jun. 1, 2016.

[4] Manish Sharma, D. Chadha, and Vinod Chandra, "High-altitude platform for free-space optical communication: performance evaluation and reliability analysis" in *Journal of Optical Communication Network*, vol. 8, no. 8, Aug. 2016.

[5] M. J. Lok, I. E. Lee, Z. Ghassemloo, and G. C. Chung, "Investigation on the error performance of modulation formats in free-space optical communication links with turbulences" in *10th International Symposium on Communication Systems, Networks and Digital Signal Processing* (CSNDSP), Apr. 2016.