Light based Positioning and Communication System.

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Abstract— The world is taking steady steps towards a more efficient communication technique i.e Light Communication. By making this project, it is our first step into the era of light. This paper proposes implementation of VLC (Visible Light Communication) enhancing VLP(Visible Light Positioning).In this paper we devised a technique to track the user's position and communicate with respect to the position and the digitization of data (text and sound) through LabVIEW software and communicating it employing 230V AC LED Bulb and a Photo-receptor at the user end. For User Positioning, Laser is used as a light source and LDR is used as a receiver.The interfacing circuitary is implemented using VIRTUAL INSTRUMENTATION, reducing physical circuitary and size of system, making it extremely portable and easy to use.For Data Communications, we will be using polarizing films on 230V LED and Photo-receptor The user terminal will have a Photo-receptor supported by an Application in the User Device such as Mobile. The Graphical User Interface is present in the Lab-VIEW software that we used in this project.

Keywords—*VLC, VLP, user's position, digitization of data* (text and sound), *Laser, LDR, 230V AC LED Bulb, VIRTUAL INSTRUMENTATION,* Photo-receptor, *Application, Graphical User Interface, LabVIEW.*

1 INTRODUCTION

The idea of using light as a communication medium was implemented by Alexander Graham Bell in 1880 with his invention of the photo phone, a device that transmitted a voice signal on a beam of light. Light Fidelity provides wireless communication with visible, infrared and near ultraviolet spectrum which carries abundant information, and solution tothe RF-bandwidth limitations.Optical Wireless Communication (OWC) generally works in the bandwidth of visible region. Therefore it can be referred to as Visible Light Communication (VLC). Bandwidth of Li-Fi technology can be enhanced by using the advanced version of Li-Fi involving the application of the phenomena of Lasers [2]. Lasers with high optical efficiency can be modulated at 10 times that of LED [3]. Hence, it is used for the User Positioning and Tracking. The digitization of data is done through Virtual Instrumentation software Lab-VIEW.

2 VIRTUAL INSTRUMENTATION

Laboratory for Virtual Instrument Engineering Workbench (LabVIEW) is a platform which deigns the system and it is developed for visual programming language from National Instruments [5].The programming language used in Lab-VIEW is a dataflow programming language. In Lab-VIEW, we can actually draw the program instead of writing a program. We can visualize the actual data flow through circuit GUI. Lab-VIEW programs-subroutines are termed Virtual Instruments (VIs). The use of this software has reduced our physical circuitry, thereby ensuring less noise interference and making it extremely portable. All the operations related to Positioning and Data Communication are performed. The Digitization of Data in terms of Text and Audio is being done with the help of this softwareFor audio communication first the sound file is converted to

„.wav" file.

The sound file is then digitized and LED Bulb is triggered w.r.t. logic pulses. In case of image transfer, the image is converted to pixels and then converted to binary.

3 SYSTEM SETUP FOR USER POSITIONING

The main objective is to track the exact position of the User and transmit the data. For that, we employed lazy Susan model which is a rotating table so that we get a 360^{O} view of room. For the table to rotate, we employed a SYNCHRONOUS MOTOR (220-240V AC) that was rotating the table in clockwise direction.Then we placed 3 LASER'S in such a way that each covers 120^{O} viewing angle [1]. The speed of the motor is so adjusted that the rotating table stops after user detection and the LASER points towards approximate user position. The user positon is detected when the user comes in between LASER and LDR.

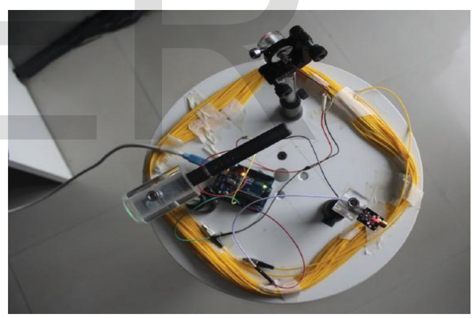

Figure1: 3 LASERS POSITIONED AT 120^{o} APART.

The Receiver section consisted of LDR interfaced with Arduino Uno. We used 3 LDR"s in the same arrangement to that of the LASER. LDR were placed at some distance in such a way that it was in vicinity of the LASER beam. Whenever the beam was interrupted or obstructed it accounted as the person is detected, elsewhere it displayed person is not detected. In the LabVIEW software; we used Boolean LEDs to display the detection; GREEN= True and RED=False. The above model has been employed for experimental purposes. In real scenario, a pair of Laser and 230V LED will be placed at 120^{o} and after User positioning the Data Communication will take place from the LED bulb of that zone.

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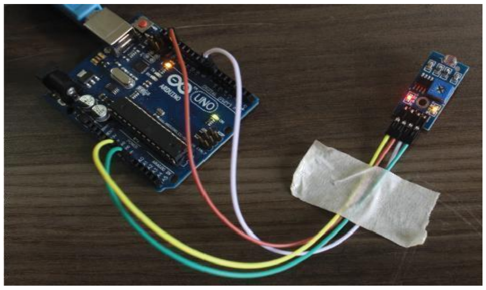

Figure2: 3 LDR'S POSITIONED WITH RESPECT TO LASERS.

4 DATA COMMUNICATION

We are using 230V LED Bulb for Data Communication. For this experiment a text message is inserted in string. This message is converted to its ASCII binary equivalent with Analog to digital converter. The digital stream generated triggers the 230V LED. The triggering of 230V LED is established with interfacing circuit Arduino UNO. A 230V LED is connected to WR pins of Arduino Uno wherein, it will be transmitting the data. The polarizing films play an important role in this. In parallel polarization, '0' is received and in perpendicular polarization, '1' is received. We transmitted and the reception was done using another PC. If we aim to receive it on the Mobile terminal, then an app will be enabling the user to access the text or audio files. The only noise interference will be through Additive White Gaussian Noise. The inter-symbol interference depends on the data rate and the Field of View of Transmitter and Receiver. For 200Mbps, Field of View should be 40-50 degrees and for 10Gbps, Field of View should be 5 degrees. The modulation scheme that is used is On-Off Keying (OOK) modulation scheme; light is transmitted (LED ON) to encode a '1' bit whereas no light is transmitted (LED OFF) to encode a '0' bit.

5 POWER AND CONTROL CIRCUIT.

We employed a power supply circuit to trigger the LED at higher switching speed for the data communication because we want to achieve an higher data rate making use of the Solid State Relay (SSR). But sooner we encountered with its side-effects. When the relay was closed, heat was generated due to its high resistance thereby causing an increase in electrical noise. When the relay was open, it exhibited lower resistance and it produced reverse leakage current (in µA).

We moved on to a more efficient power supply using Power MOSFET. In this circuit, we designed a power supply of 230V input through which we can trigger the LED. The power MOSFET circuit uses a single power MOSFET to drive a LED Bulb with optical isolation provided by TLP250 optocoupler IC. The power required at the gate of the MOSFET is from 9V-20V so we decided it to be 15V as the gate pulse. The MOSFET switching characteristics depends upon the Fall time, Rise time, Turn-On Delay time and Turn-Off Delay time. The MOSFET we used is 8NM50N.The below table shows the Switching characteristics of the MOSFET. The MOSFET switching time is fast with low rise time.

We burn the program into the microcontroller. it signals the Arduino board to trigger the LED bulb. Since the Arduino Uno board generates 5V at the output, we need to amplify it to 15V to trigger the gate of MOSFET and drive the LED. The 5V-15V conversion is done by the Optocoupler TLP250 IC which acts as the Level Shifter IC with optical isolation. It is then fed to gate terminal of MOSFET and then MOSFET triggers the corresponding LED bulb according to the output of microcontroller.

Symbol	Parameter	Typical	Unit
t_d (ON)	Turn-on delay time.	7	Ns
t_r	Rise time.	4.4	Ns
t_f	Fall time.	25	Ns
t_d (OFF)	Turn-off delay time.	8.8	Ns

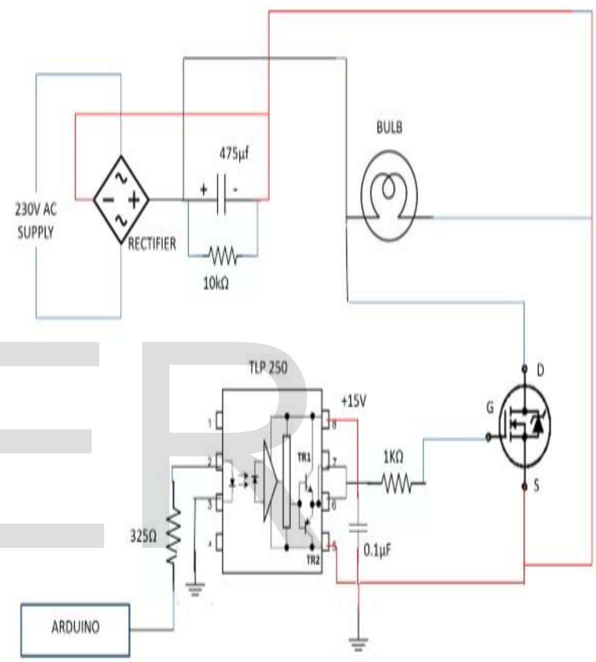

Figure 3: SCHEMATIC OF POWER CIRCUIT AND CONTROL CIRCUIT.

6 RESULTS & CONCLUSIONS

We first calibrated the voltage readings of the LDR when user was not present and when user was present and accordingly, we created some constants that were efficient to indicate us whether the user is present or absent in the room. The Voltage constant for Person not detected is 2.4V and the voltages equal to this or lesser than this indicates us the same.Similarly, Voltage constant for Person detected is 3V and the voltages equal to this or greater than this indicates us the presence of the user. The figure given below is the output of the same scenario.

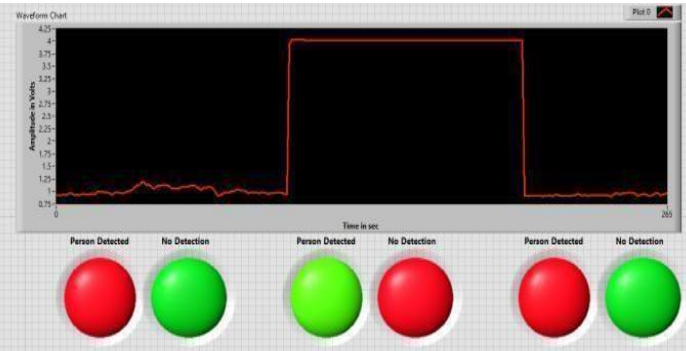

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Figure.3 PRACTICAL SCENARIO OF PERSON DETECTION IN THE ROOM.

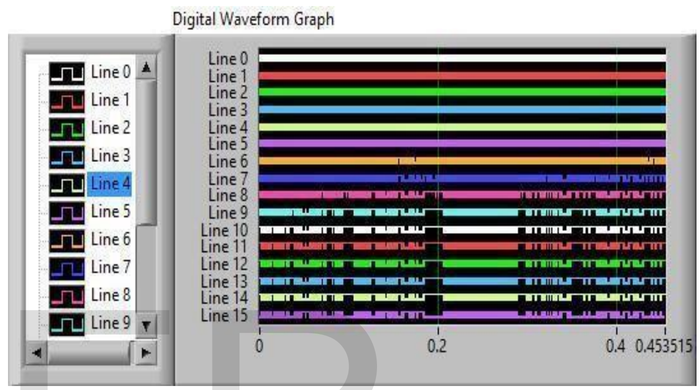


Figure.5 DIGITIZED AUDIO TRANSMISSION.

The above part was about positioning. Let's have a look on communication part. In this program, we have accepted a string from user. We have obtained ASCII equivalent of each character in the string. Then we converted these ASCII values into its binary equivalents. This result is in the form of stream of 1's and 0's. This digital data is given to Arduino Uno board which is an interfacing circuit used for triggering LED Bulb. It will be ON for bit 1 and OFF for bit 0. This optical signal is captured by photodiode which is connected at the same Arduino board. At the receiving side, this Boolean array will be produced which will be converted back into its corresponding ASCII values and then their equivalent characters. In this way we obtained same input string at receiving end given by the user. The digitization of audio is similar to text where sound input can be given either through Sound read block in Lab-VIEW. The audio can be .wav file or it can be microphone audio stored in system. This audio is analog audio waveform which is then converted to digital waveform which is then converted to Boolean array. This array is two dimensional, so it is converted into one dimensional array which is then serially transmitted through Arduino board. At the receiver side, the obtained 1D Boolean array is again converted into 2D Boolean array which is converted into digital waveform and then it is converted back into analog waveform and the audio is played at receiver side. The above process is for the Digitized Audio Transmission through Lab-VIEW software. If we want to transmit a stored audio, then the memory will be an issue for Arduino Uno. In that case, we will use Raspberry Pi-3 Model B to overcome the memory issue and we will get other additional on-board features such as sup-
port for Bluetooth, LAN port, CSI camera port and many other features.

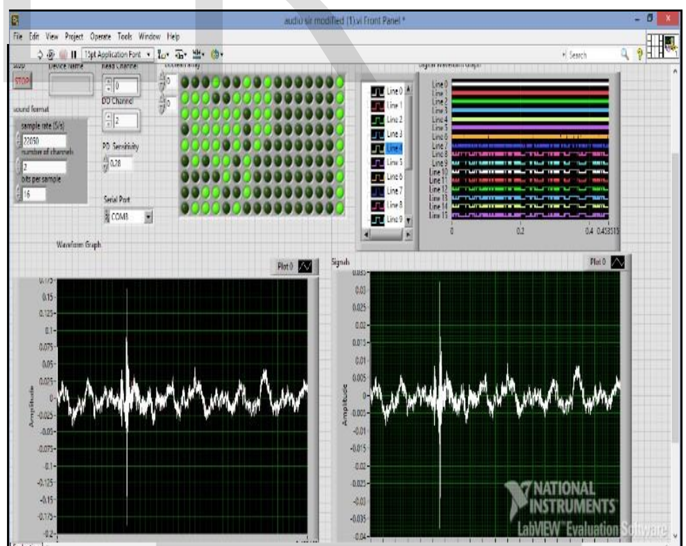
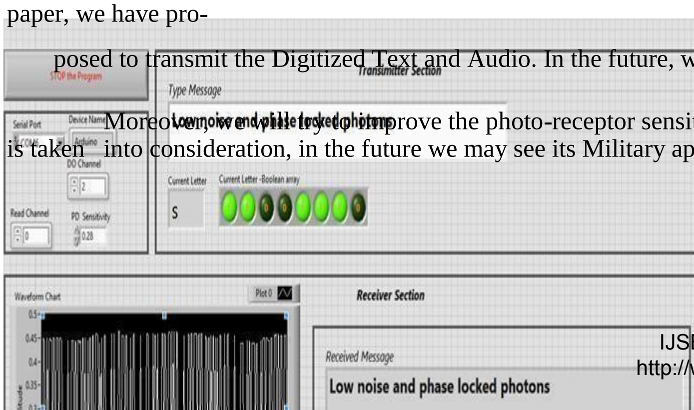


Figure 11: FRONT PANEL OF TRANSMITTED AUDIO

This model is used basically for the purpose of navigation and communication; but it can also be used for security purposes. This can be used for higher data rate transmission as laser is used .In the future, it can replace the existing Wi-Fi systems. In this paper, we have pro-

posed to transmit the Digitized Text and Audio. In the future, wbe experimenting the same transmitting Digitized image and video. e will

Moreover, we will try to improve the photo-receptor sensitivity so that the system becomes efficient. As the privacy of data is taken into consideration, in the future we may see its Military applications.



6 REFERENCES

[1]

Figure.4: DIGITIZED TEXT TRANSMISSION.

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