International Journal of Future Generation Communication and Networking
Vol. 13, No. 1, (2020), pp. 439-448

Image and Audio Transmission through Laser

Mrs. Varsha Patil[1], Revan Patil[2], Omkar Tingre[2], Kaushal Pathak[2], Aniket Jadhav[2], Someshwar Gavhave[2], Venkatesh Kapare[2]

[1] Assistant professor Department of Electronics& Telecommunication, AISSMS Institute of Information Technology
[2]Student Department of Electronics& Telecommunication, AISSMS Institute of Information Technology

Abstract

In this analysis we found that the data transmission using laser light is superior in many respects to the conventional communication system. Another motivation for exploring laser communications is the development of more efficient, cost effective space communications equipment. Because RF wavelengths are longer, the size of their transmission beam covers a wider area (about 100 miles); therefore, capture antennas for RF data transmissions must be very large. Laser wavelengths are 10,000 times shorter, allowing data to be transmitted across narrower, tighter beams. The smaller wavelengths of laser-based communications are more secure, delivering the same amount of signal power to much smaller collecting antennas

Keywords—*Raspberry Pi, Pi camera, LASER, Phototransistor, wavelength, Arduino Uno microcontroller, antenna, CSI protocol.*

I INTRODUCTION

Today, lasers have become one of the world's most important technologies, used in industries ranging from information technologies to telecommunication, medicine, consumer electronics, law enforcement, military equipment, entertainment and manufacturing.[3].Laser communication is much better than radio waves as light wavelength are packed much more tightly than radio and transmit more information per second with stronger signal. This work will help to increase range of space communication in future for image transmission.[4].

Laser communication through optical fiber moves large amount of data every second between cities and across oceans. Fiber optic link has transmission loss per unit length (0.15-5db/km) and is not susceptible to (EMI) electromagnetic interference. However, fiber optic link cannot be used in space communication.

Since in space-based communication we are mostly relay on radio frequency (RF) communication, which are slower in the moving data than optical fiber link, have issues related to antenna footprint, power requirement and limited available spectrum. The potential for the laser to overcome these issues in space was realized soon after its inventions, although its special properties introduced new issues, such as pointing and tracking of narrow beams over great distances while overcoming cloud cover, turbulence and other obstacles introduced by atmosphere. Free-space optical communication (FOSC) using laser is more efficient, cost-effective space communication equipment. This paper shows method of sending images and voice over Laser.

ISSN: 2233-7857 IJFGCN

I OVERVIEW OF THE SYSTEM

We have used raspberry pi processor to process the data and to transmit data such as image, audio using laser. Signal specifically image contains values in the form of matrix. These matrices can be used for serial communication. Thus In order to transmit color or gray image using laser, pixel values or intensity values are transmitted serially.

The Pi camera is interfaced to Camera serial interface (CSI) port of raspberry pi board. Laser module is connected to GPIO pins of raspberry pi. The laser we used is general purpose 650nm wavelength operated on 3V power supply. The audio signal is applied to the 3.5 mm audio jack present on raspberry pi board or present on SD card in WAV format. External SD card slot is available to extend the memory and to hold operating system and the processing codes. At receiver end phototransistor receives the light incident on it and transmits the data contained in light form in serial manner to the Arduino Uno controller to decode the data. Arduino Uno is interfaced with PC or laptop.

II LITURATURE SURVEY

[.1]" Data Transmission Using Laser Light" [Microcontroller based communication system using laser light to transmit data. The microcontroller is interfaced with PC for the purpose of giving input parameters such as audio, text and video to transmit with the help of laser medium. In this paper the data transmission using laser light is superior in many respects to the conventional communication system. Laser light has higher intensity, efficiency, as well as better visibility and performance quality.[1]

[.2] Appling Lidar -Based Obstacle Detection and Wireless Image Transmission System for Improving Safety at Level Crossings" in this paper Rail transportation is projected as the one of the safest modes of transport, although the interface between road and rail, named level crossings, represents a big potentiality of accidents for the railways. Railroad operations have long served as a convenient and effective transportation in Taiwan, especially with the efforts towards the expansion of railroad network and the increase of train speeds. However, the recent increase in the number of train accidents has brought serious concerns and anxiety regarding its safety.[2]

. [3]" Wireless Transmission of Audio Signal using Coherent Optical Signal "To demonstrate wireless transfer of an audio signal via a coherent optical signal in free space between two independent systems. The principle behind said communication is conversion of audio signal to light signal via the application of modulation and amplification into a high intensity laser source that is detected by a phototransistor or a photodiode and is then demodulated and amplified back to the audio signal.[3]

[4] Lunar Laser Communication Demonstration NASA's First Space Laser Communication System Demonstration: LLCD was the NASA first laser communication demonstration. LLCD has the capability to transfer data at a rate of up to 622 megabits per second (Mbps). It will demonstrate two-way, high-rate laser communications from lunar orbit aboard the Lunar Atmosphere Dust Environment Explorer (LADEE).[4]

ISSN: 2233-7857 IJFGCN

[5]"Laser Communications Relay Demonstration, The Next Step in Optical communication:" Laser Communication Relay demonstration (LCRD) mission proposes to revolutionize the way we send and receive data, video and other information, using lasers to encode and transmit data at rates 10 to 100 times faster than today's fastest radio-frequency systems, using significantly less mass and power.[5]

[5] Feb 2012, Ms. Disha Juriasinghani, Mr. Tanay Krishna Dev of MIT: describes an embedded system such a way that it acts as a bridge between the two devices enabling the transmission of data between the two devices.

III. SYSTEM ARCHITECTURE

The main purpose of this project is to realize a transmission-reception system to transfer image and audio via Laser without a guiding medium, using Intensity Modulation with little quality loss. It also results in faster transmission of data with minimum power consumption.

Figure 1 shows the block diagram for the image and audio transmission using laser. The system seems to be similar to that of optical fiber, communication system but the difference is that instead of using an expensive fiber Optic cable we are directly using the laser through air medium hence the system becomes less expensive.

Following main components are used

1 Raspberry pi

2 Raspberry pi Camera

3ARDINO Signal

4 Laser Modulator circuit

5 Laser Detector circuit

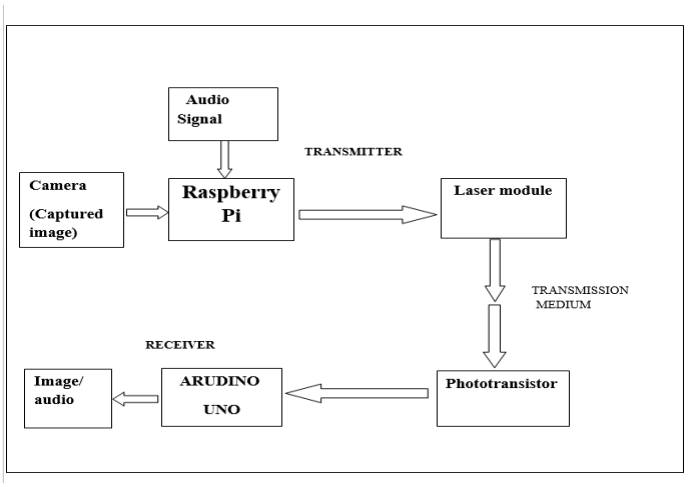


Figure 1: Block diagram of system

ISSN: 2233-7857 IJFGCN

Basis for journey of laser communication from microcontroller-based system [.1] to NASA s LLCD [4], LRCD [.5] projects.

IV. METHODLOGY

This paper is Realization of a transmission-reception system to transfer Image and audio via Laser without a guiding medium, using Intensity Modulation with little quality loss. It will also result in faster transmission of data with minimum power consumption with line of sight communication. And controlling between two processions will via raspberry pi and SOC s connected with WIFI modules. Hence line of sight space communications for Image and audio via Laser will possible.

Raspberry Pi uses NOOBs operating system. **NOOBS** (***New out Of the Box Software***) which will be used for the Imaging software

SD cards with preinstalled NOOBS OS are available from many distributors but in this project, we have downloaded the NOOBS from
website: raspberrypi.org/downloads.
At line of sight communication at several km. the signal will be received and image will be recreated using simple processors like Arduino. The flowchart can e visualized as:

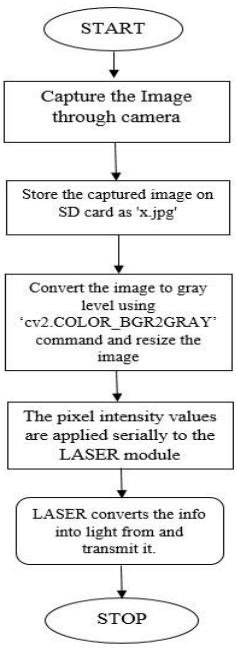


Figure 1**Flow chart for image transmission**

- ✓ **For Audio data the flowchart is:**

1. The WAV file present on the SD card is used for audio transmission.

ISSN: 2233-7857 IJFGCN

2. The wav file is read and is sampled using the required sampling frequency.
3. This sampled audio is digitized and is applied to the LASER module.
4. At the receiver this information is accepted by photo detector circuit and is applied to the µC.

A 5 mega pixel Pi camera having a resolution of 1080p with fixed focus is interfaced with a raspberry pi board which is been operated using the NOOBS operating system.

The camera is interfaced using 15 cm 15 way ribbon which works on CSI protocol. The image that is captured is processed in raspberry pi through a python code and is converted to binary form i.e. each intensity value representing a pixel of an image is applied to the laser serially.

.

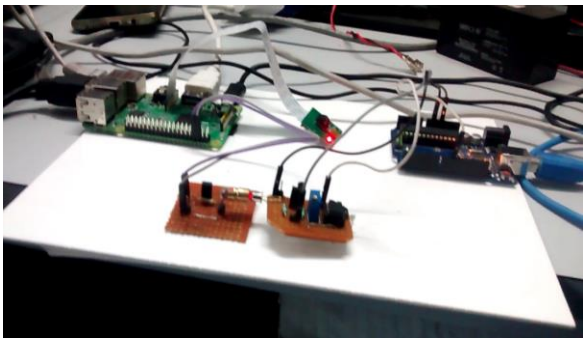


Figure 2. Working model using above technical approach

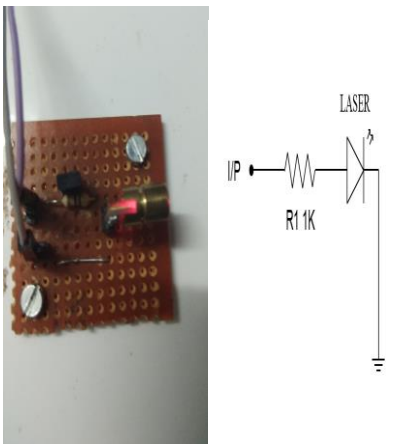
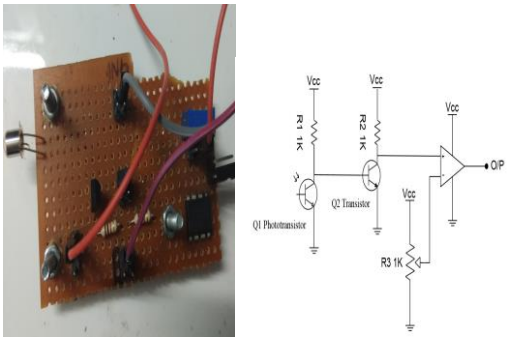


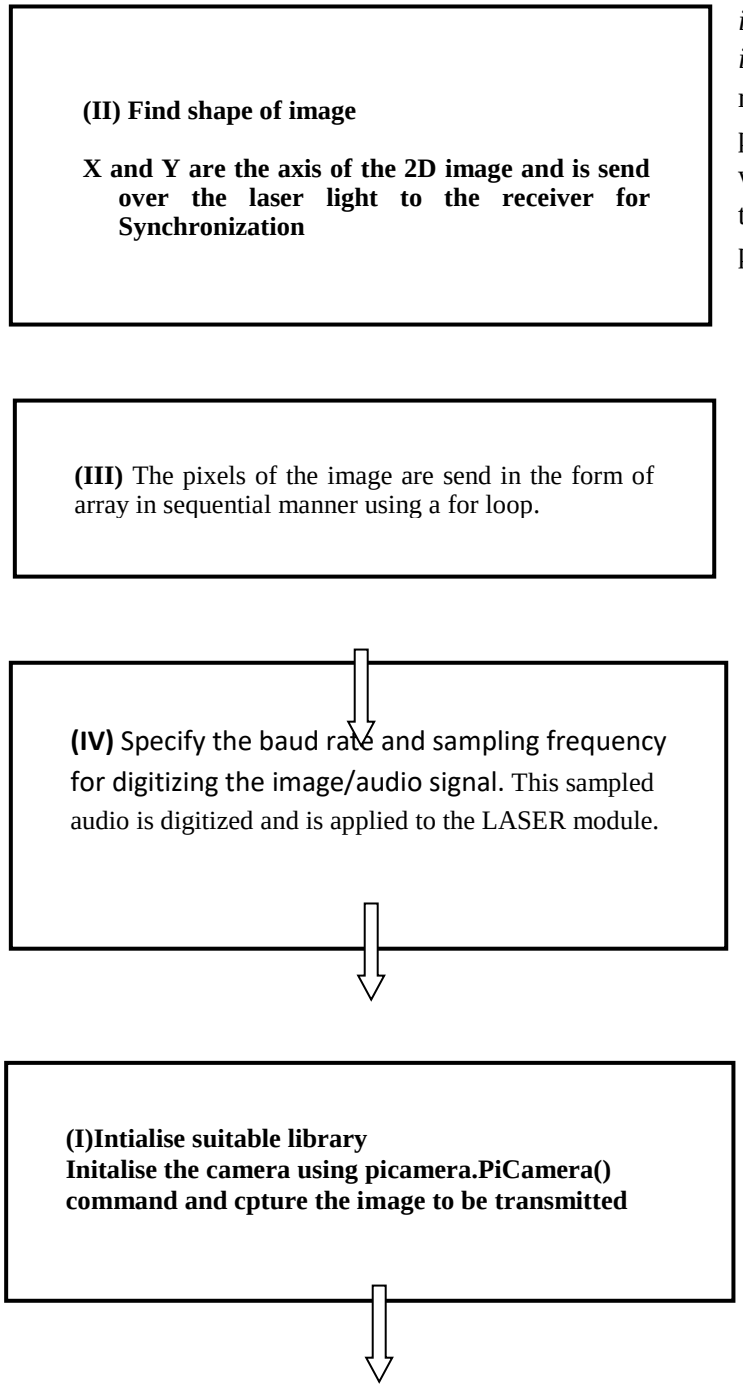
Figure 3. Laser circuit hardware



ISSN: 2233-7857 IJFGCN

Figure 4. Detector circuit hardware

This laser module converts the applied information into optical energy i.e. light. *that is conversion of analog information is done into information* . a general *optical* purpose red light laser operating on 3 V power supply having wavelength of 650 nm. It is connect to the GPIO pins of raspberry pi board.



ISSN: 2233-7857 IJFGCN

At the receiver the light emitted by laser is made incident on phototransistor. converts the light incident on it into electrical form i.e. voltage signal. The phototransistor used in the system is L14G1 operated on 5V and having the angle of deviation 10 degrees. The wavelengths that are acceptable are 450-1080 nm. This component converts the optical information into digital voltage form, the voltage levels for different pixel is decided using a threshold which is adjusted using a variable resistor.. The voltage is then amplified using a dual differential amplifier to bring the signal at adequate level.

The Raspberry Pi microprocessor is easily available and is the most convenient and easy to understand processor and is also called as a mini computer.. The NOOBS OS is stored in the micro SD card which enables the user to perform various processes on raspberry pi board. The pi camera is interfaced to board and the captured image is stored on the micro SD card. It is operated on 5V supply using an adaptor

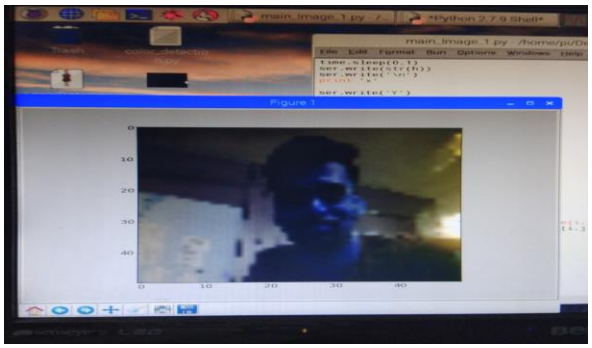
Lastly this 1's and 0's form of voltage is applied to the GPIO pins of the Arduino Uno board .*It is a microcontroller board based on AT mega 328. It has 14 GPIO pins out of which we are using 2 pins for serial communication used to receive (RX) and to transmit (TX) TTL serial data. This pins are connected to the laptop screen using USB-TTL serial chip i.e. AT mega 8U2. The information in voltage form at the output of phototransistor is applied to the serial RX pin of Arduino board, then using the mat lab program this voltage is quantized and converted to digital form and the intensity values for each pixel is regained and the image is produced using this voltage*.

The steps for transmission of image are as follows:

I. ALGORITHM AND CODES

A. Transimitter side:

Image transmission: According to our algorithm the image is captured and displayed on the screen using following commands in python language.
This image is stored on the micro SD card. The image is resized to lower resolution and converted to grayscale image using the following procedure
Transmitted Image after this process can be seen as in following figure

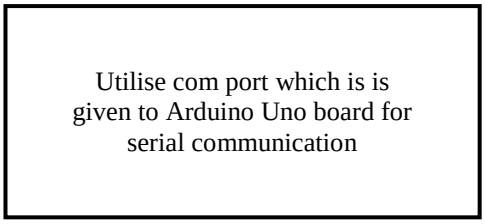


ISSN: 2233-7857 IJFGCN

Figure 9. Transmitted Image

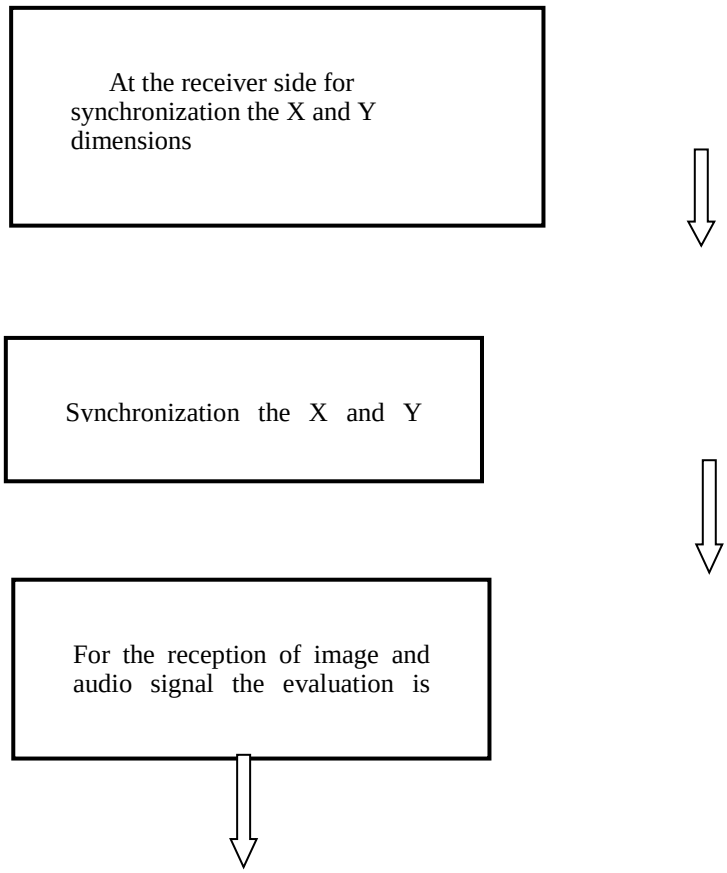
B. Receiver side:

At the receiver the com port is given to Arduino Uno board for serial communication. The following code describes how to initialize the com port.



The incoming pixel values are stored in array form after getting the X and Y dimensions using the following commands .

After system configration the recived image can be seen as follows:



ISSN: 2233-7857 IJFGCN

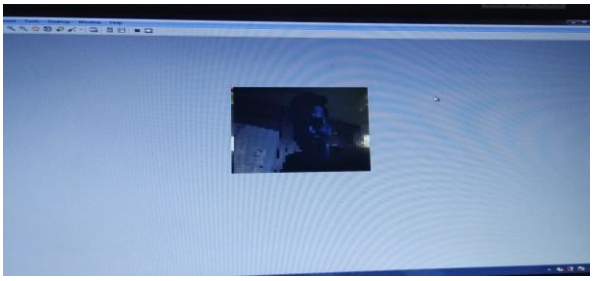


Figure 10. Received Image

A. For Audio Transmission

The output image that is reconstructed using the image information contained in voltage signal is shown on the screen using the following part of code.

```
imwrite(outImg,'x1.jpg','jpg')
   figure;colormap(gray(256));image(outImg);
elseif flag == 2
end
```

The audio sampples are recnstructed and stored in a array form and plotted on the screen .The output of recived audio samples is as follows.

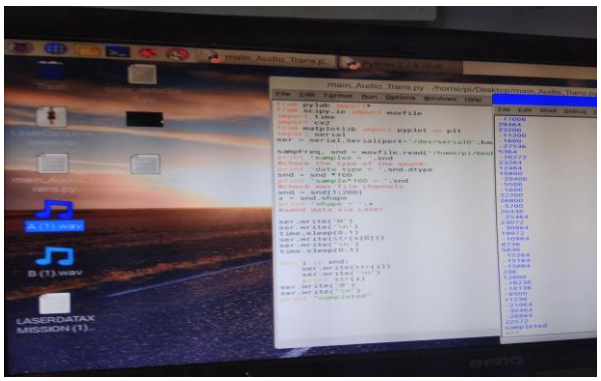


Figure 11. Audio Samples being transmitted

Figure 12. Received Audio signal

ISSN: 2233-7857 IJFGCN

II. CONCLUSION

The image captured by the camera or the audio send using the mobile should be stored and processed correctly using the method we proposed and it should be transmitted with less distortion and noise. At the receiver side the information should be decoded correctly and processed to get the original image or audio that was transmitted.

ISSN: 2233-7857 IJFGCN