PC to PC File Transmission using Li-Fi Technology

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Abstract: The efficiency, durability, and lifetime of light-emitting diodes (LEDs) have lead to their use in a variety of applications, including general illumination, vehicle lights, sign age, and displays. The designed prototype is based on visible communication system, which is to transfer data as well as text files from one PC to other PC. The basic idea is to send data and files as serial data using serial communication. To transmit the data, light emitting diodes are used at the transmitting end and for reception photodiodes are used at the receiver end. LED carries the data in the form of 1's and 0's by switching on and off the light at faster rates. The microcontrollers are used at both the ends for controlling the transmission and reception process, and also it does the data conversion from ASCII to binary at transmitter end and from binary to ASCII at the receiver end, to make data into a suitable file to be recognized by the PC software. In order to access the file and to transmit it serially Lab VIEW programming is used. Thus the transmission of text file from one PC to other PC is carried out with the Li-Fi technology using LEDs and photodiodes, with the data rate of 1.136 kbps over the distance of 15cm successfully using light as the transmission medium.

Keywords: Microcontroller, USB to serial TTL, LabVIEW, LCD.

Introduction

Visible Light Communications is essentially communication by means of optical light. It falls under the category of free-space optical communications. Transmitting data via light is achieved by having the light source flicker on and off to represent a logic high and logic low signal respectively. A receiver (photodiodes) will detect the light coming from the transmitter and will interpret the signal. When the receiver detects light, it is represented as a logic high and when it detects no light at all from the transmitter, it is represented as a logic low. By turning the light on and off, the transmitter can transmit 0s and 1s. This is the simplest method that visual light can be used for digital communication. Varying levels of light between on and off could allow for the transfer of more than one bit of information.

Any light technically could be used to transfer data but what matters the most is the brightness and the frequency of the light at which it modulates. The data rate of the transmission will depend on how fast the lights can turn on and off. LEDs are a popular choice for VLC communication as they can be switched on and off at a very high speed. Fluorescent lights used in indoors can also be used as they flicker at a speed that is fast enough that the human eye cannot see. There is one issue with fluorescent lights however. While they could be used for communications, they can only do so at relatively low frequencies, due to the fact that fluorescent bulbs cannot be turned on and off at high speed.

Currently, one major VLC system is operating within a few countries. Named the RONJA (Reasonable Optical Near Joint Access) system, it can transmit at speeds of 10 Mbps while transmitting light to the receiver at a distance of nearly 1 mile apart. It makes use of a high brightness LED and shines it through loupe lens to increase the brightness. This allows for a longer transmitting distance. The RONJA system is a free technology project and was developed by Twibright Labs. The purpose of this system is to network neighboring houses with cross-street Ethernet access, extend the internet connection to houses close by that are not covered by ISPs by the last mile, or just provide a link layer for fast neighborhood mesh networks. With VLC technology improving and becoming more prominent in the world, Li-Fi, a subset of VLC is becoming more of a reality. Li-Fi is built upon VLC and is a high-speed bidirectional wireless network similar to Wi-Fi. This is achieved by having a transmitter and receiver built in each device where it transmit light and receives incoming light from another device.

Block diagram

Fig. 1 shows the block diagram of PC to PC file transmission using Li-Fi technology, the basic idea behind this communication scheme is transmission of 'Data through illumination'. The on-off activity of LED enables a kind of data transmission which transmits binary codes, however the switching on a LED is a logical '1' and switching off is a logical '0'. A light sensitive device photo diode receives the signal and converts it back into original data. This method of using rapid pulses of light to human eye will not be able to perceive this changes and the LED appear to have a constant intensity.

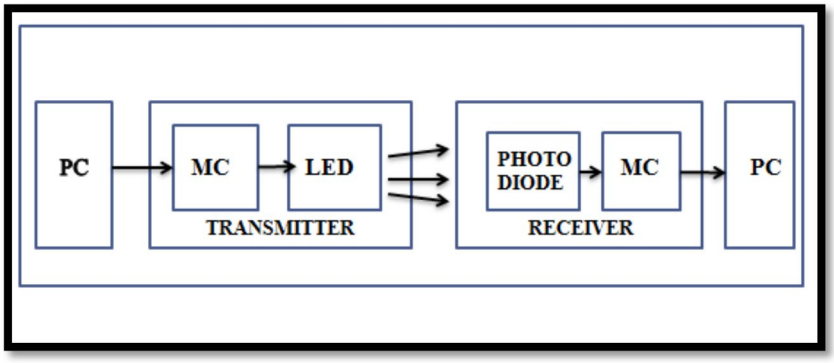

Fig.1 Block diagram of proposed methodology

The system architecture consists of a transmitting section and a receiving section. The transmitter section consists of LED as the main source to transmit the data. The data from PC is transmitted serially via USB to TTL serial drive to the microcontroller, where the microcontroller converts the ASCII data to its equivalent binary form. These binary form of data is transmitted through the LED by controlling its intensity, where its voltage reaches 3.3v it transmits binary 1, if it is 0.2v it transmits binary 0. These transmitted data is received by the photo diode receives the data and demodulates the incoming received signal based on the sequence of 1s and 0s and then sends the signal to the microcontroller, where again it converts the binary data to the ASCII and transmits the data to PC via USB to TTL serial drive. Thus it transmits the data from one PC to the other PC wirelessly using LED. Replacements for other technologies as compare with other wireless technology Li-Fi have great features.

USB to TTL Serial Drive
The USB to serial TTL takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, other UART re-assembles the bits into completely bytes.

Microcontroller
The main usage of microcontroller is to control the transmission and reception process accordingly, and to convert the ASCII code to binary and vice versa.

LED (Light Emitting Diode)
The LED used is of 1Watt which has a power dissipation of 1365mW and a DC forward current of 350mA. A 1 watt LED is used so that a large area is illuminated and the photo detector or photodiode can detect the light at a considerable distance.

Photo diode
A photodiode is one type of light detector, used to convert the light into current or voltage based on the mode of operation of the device and These diodes have a slow response time when the surface area of the photodiode increases.

LabVIEW Software
LabVIEW is a highly productive development environment for creating custom applications that interact with real-world data or signals in fields such as science and engineering.
It itself a software development environment that contains numerous components, several of which are required for any type of test, measurement, or control application.

Implementation

Fig.2 shows the hardware implementation of the project. It has the following components: Transmitting PC, USB to TTL serial drive, Microcontroller, LED, Photo diode, receiving PC. Transmitting PC has LabVIEW programming, where the file which is to be send is accessed. The content of the file is sent to microcontroller from the USB to TTL serial drive through serial communication. The microcontroller converts ASCII to binary and sends the data to the LED for transmission. LED transmits the data by switching on and off at faster rates. The transmitted data from LED is received by the photodiode. Then the received data is given to the microcontroller, where again the binary data gets converted back to ASCII. These converted data is again reaches the receiving PC from the USB to TTL drive. At the PC the received file can be opened and saved by using the LabVIEW.

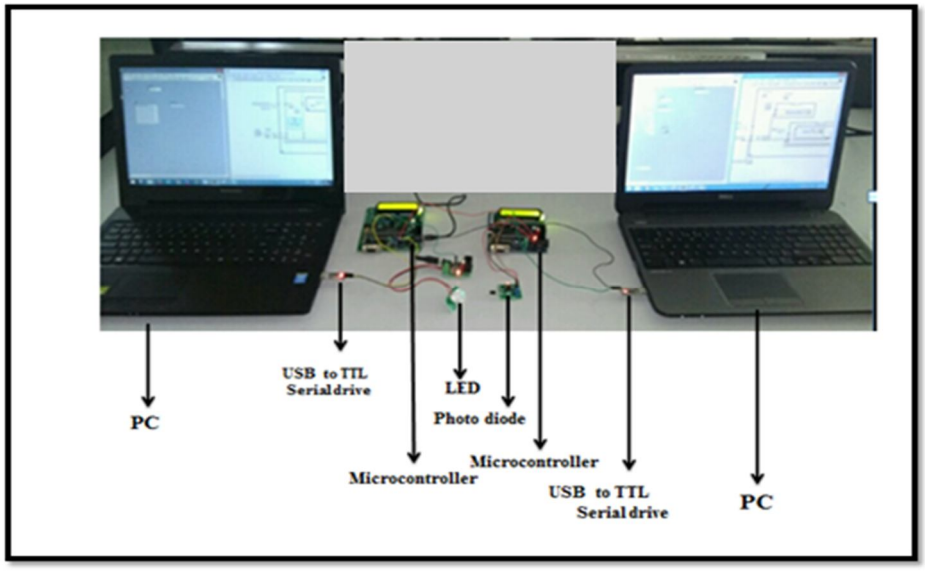

Fig.2 shows the hardware implementation

LABVIEW block diagram and its description

Transmitter block diagram

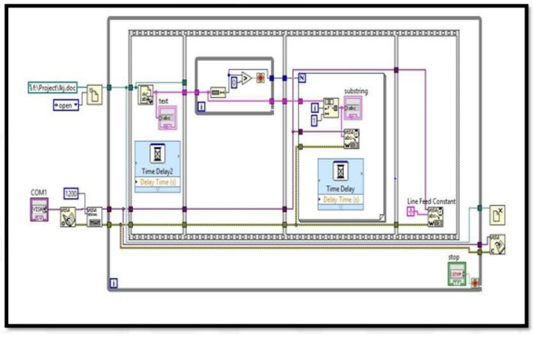

Fig. 3 Transmitter Block diagram

The Fig.3 shows block diagram of transmitter to transmit the text file from one PC to other using LabVIEW, in this diagram consists of create text file, read from text file, subset string, VISA com port, close file. First create the file in the respective drive, then open file as to open the respective file in the folder and then the read from text file function has to read the contents of the file in the respective folder. The string length can be used to find the length of the file, greater than function can be used to compare the string length and the zero, if the string length is less than zero to stop the operation, otherwise it will continue to transmit the text message. The for loop can be used to execute the sub diagram in N times, where *n* is the value wired to the count (**N**) terminal. The iteration (**i**) terminal provides the current loop iteration count, which ranges from 0 to *n*-1.Substring of the input string beginning at offset and containing length number of characters. Then the offset is at the starting position and it must be numeric. The offset of the first character in string is 0. Substring is empty if offset is greater than the length of the string or if the length is less than or equal to 0. If length is greater than or equal to the length of string minus offset**,** substring is the remainder of string beginning at offset.

The flat sequence consists of one or more sub diagrams, or frames, that execute sequentially. Use the Flat Sequence structure to ensure that a sub diagram executes before or after another sub diagram. Data flow for the Flat Sequence structure differs from data flow for other structures. Frames in a Flat Sequence structure execute from left to right and when all data values wired to a frame are available. The data leaves each frame as the frame finishes executing. This means the input of one frame can depend on the output of another frame.

Time delay Specifies how many seconds to delay running the calling VI. The default is 0. The VISA open, write, serial, and close function can be used to transfer the text messages serially at the 1200 baud rate.

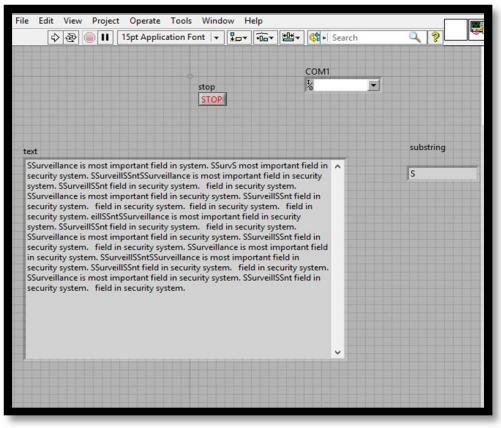

Fig. 4 Transmitter Front panel

The Fig.4 shows the front panel of LabVIEW to transfer the text message serially, then first select the COM port to start the transmission. Click on Run button to execute the program, once it starts execution the contents will be displayed on text box, each bits will be displayed on substring box.

Receiver block diagram

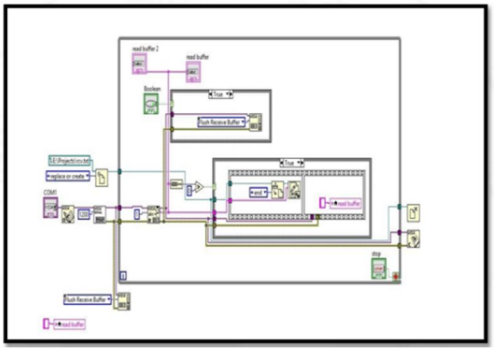

Fig. 5 Receiver block diagram

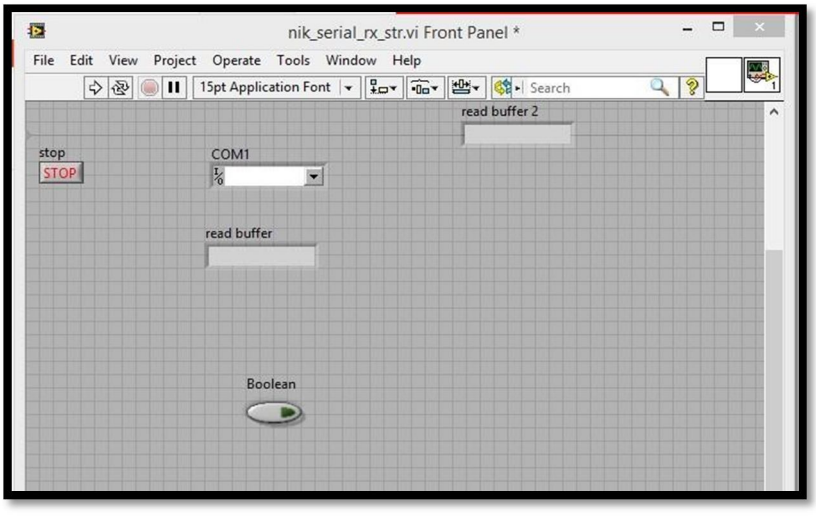

Fig.6 Receiver front panel

Fig. 5 and 6 shows the block diagram and front panel of the receiver respectively, it is same as the transmission process, but it will use the case structure which contains one or more sub diagrams, or cases, exactly one of which executes when the structure executes. The value given to the selector terminal determines which case to be execute. VISA flush buffer function

consists of VISA resource name, mask, error in and out. It Flushes the I/O buffer specified by mask .Then the set file function moves the position of the current file mark of the file identified by reference number to the position indicated by offset (in bytes) according to the mode in from.

Results

The PC to PC file transmission using Li-fi technology implemented. Fig.7 shows the interface developed for the communication, which has two set of microcontrollers one at transmitter and other at receiver side.

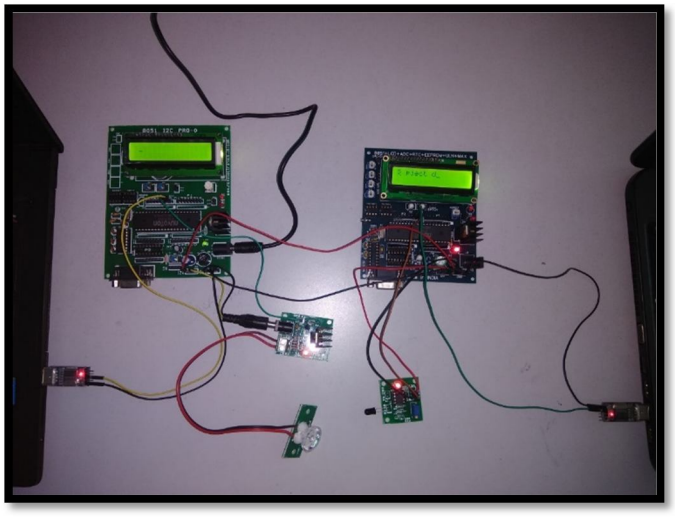

Fig.7 shows the interface developed for the communication

The Proposed system was tested and obtained the following results

Table 1 Test results

Data Size	Time taken to send
1.136Kbits	1sec
1KB	7sec
10KB	1.10min
100KB	11min

Table 1 shows the results which was obtained by testing the model. The time required to send the data of 1KB is 7 sec and 10KB and 100KB respectively is 1.10 min and 11 min.

Conclusions

Li-Fi is an emerging technology and it has vast potential to look for numerous possibilities to explore. This project gives a new dimension to use a normal LED's used for lightings to transmit the data from one place to other efficiently. It can be viewed as a bigger replacement to a RF communication over shorter ranges. This technology will become one of the major technologies in the near future. It will be cleaner and greener and the future of mankind will be safe. As the amount of available bandwidth is limited, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. It has great potential in the field of wireless data transmission and also a promising replacement to conventional methods of wireless communications. It can be used for the high speed data transmission from one place to other, which has no radio interference. This technology can solve issues such the radio frequency, bandwidth and also allow internet where the traditional radio based wireless is not allowed such as aircraft or hospitals. It is one of the upcoming technology, however is that it only work in direct line of sight. Thus the increasing research in this technology will provide a promising and best communication technology for future.

The project was successfully completed with a model to transmit the text file from one PC to other by using Li-Fi technology, according to the initial goal. The data rate and the distance was the main concern and problem, which was approximately over came by varying the baud rates and reducing the delay in the programs. To transfer the text file from one PC to other

reliably and efficiently LED's were used as the light source. Thus it transmits the data at the rate of 1.136kbps with 1200 baud rate over the distance ranging from 1- 15cm successfully without any errors.

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