

Wireless Data Transfer Using Light Fidelity

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Abstract: There are around 1.4 million cellular mast radio waves base stations deployed, with over 5 billion mobile phones. Mobile phones transmit over 600TB of data. Presently wireless communication uses radio waves. Spectrum is the one of the most essential requirement for wireless communication. With the advancement in technology and the number of users, the existing radio-wave spectrum fails to cater to this need. To resolve the issues of scalability, availability and security, we have come up with the concept of transmitting data wirelessly through light using LED's. An indoor visible data transmission system utilizing LEDs is proposed. In this system, these devices are used not only for illuminating rooms, but also for an optical wireless communication system.

Keywords: Light Fidelity, Data through Illumination, Wireless communication, VLC.

1. Introduction

Presently, wireless communication uses radio waves. The demand for voice and mainly high end data services like VOIP, video calling, instant messaging by the users is rapidly increasing as the consumer needs better and efficient ways of transferring data which are large and often need a high level of encryption. The existing Radio Spectrum fails to cater this burgeoning need and faces various other issues like scalability and availability. [1] It's time to explore the potential of other available spectrums, a new medium which can best serve our needs. An indoor visible data transmission system utilizing LED lights is proposed. This system of communication using Light-Fidelity can be used in critical environments, such as aircrafts or hospitals, where radio frequency (RF) based transmissions are usually prohibited or refrained to avoid interference with critical systems. Moreover, a huge amount of unregulated bandwidth is available at infra-red and visible light frequencies. Visible spectrum covers wavelength from 380nm to 750nm. This system rapidly and subtly fluctuates the intensity of LEDs to create a binary code (on=1, off=0) in a way that is imperceptible to the human eye. The light then hits a sensitive photo sensor that decodes the data. This technology is known as visible light communication (VLC). [2]

We have designed a prototype VLC system. Our idea is to transmit an image from one PC to another PC using VLC. So we have used the software MATLAB for image processing at the transmitting end and also for reception at the receiving PC. We have deployed Atmega 89c2051 microcontroller for toggling of the LED at the transmitting end and again for binary conversion of received stream of data into a suitable image to be recognized by the PC software. A domestic LED is used as a source of light in this system. One could also use a laser source for better coherence and reliability.

2. Description

2.1 Input Interface

Each input port is connected to a bridge rectifier which converts AC to DC (and DC input remains unaffected). The rectified voltage is then passed through a RC-filter (3 resistors with R=4.7 ohms/2W connected in series and

C=10uF, 415V) to moderate the ripples. [3] IC 7805 voltage regulator has been used to produce an output of 5V dc.

2.2 Transmitter Section

MAX -232 is used to convert the signals from the PC RS - 232 serial port to TTL compatible signals to be used by the microcontroller. Atmega 89c2051 microcontroller has been used for conversion of these decimal signals to binary signals which hence flicker the LED for data transmission. A crystal of frequency 11.0592 kHz provides clock pulses to the microcontroller.

2.3 Receiver Section

L14G2 npn- phototransistor has been used which receives the LED pattern in binary form. The microcontroller converts this data back into decimal form to be retrieved. MAX-232 converts these TTL logic levels back to serial logic levels used by the RS-232 of the receiving PC. LM 324 comparator has been used at the source (LED) for quantizing the data bits received via the photo-diode.

Microcontroller assembly level program has been burned using the software Flash Magic. Data has been transmitted serially and received successfully using Visual Basic. LM 324 comparator has been used at the source (LED) for quantizing the data bits received via the microcontroller.

3. Block Diagram

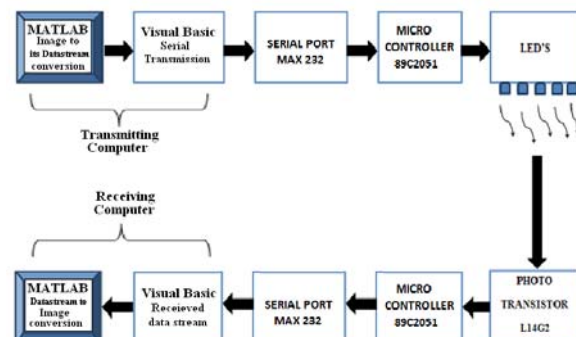


Figure 1: Block Diagram

The block diagram consists of the following major blocks:

3.1 PC MATLAB

The PC generates an image which is processed using MATLAB software and a VB text box is linked and at the receiver it re-constructs back the original image.

3.2 Visual Basic Interface

The interface transmits the data bits serially via the PC RS-232 port. At the receiver, it receives all the data bits serially via the photodiode.

3.3 Serial Port MAX 232

MAX 232 is 16 pins IC, which converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. At the receiver it again converts back the TTL logic levels back to serial signal levels.

3.4 Microcontroller 89c2051

It receives the signals at TTL levels at various ports and converts this data to binary form. At the receiver, it again converts the binary data to decimal data.

3.5 LED's

This acts as a light source which transmits the binary output of the microcontroller in the form of light intensity pattern which is then transmitted.

3.6 Photo Transistor L14G2

It receives the light patterns transmitted by the LED. L14G2 is an NPN photo transistor. It acts as a photo detector in the sense that it can convert the incident light into electric response.

4. Circuit Diagram

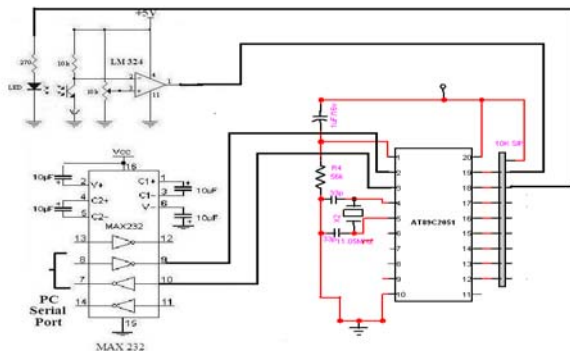


Figure 2: Circuit Diagram

The hardware shown above shows the trans-receiver circuit. This circuit can act as a transmitter and a receiver at the same time, making it a half-duplex form of communication.

The data via the PC serial port is given to the pin 6 of the MAX-232. Pin 9 produces the TTL compatible output. This goes to the pin 2 of the 89c2051 microcontroller. Decimal data is converted to its binary equivalent using the microcontroller. Pin 18 gives this output to the LED which flickers and produces a data pattern.

While data is being received, the data from the transmitting LED is received by the photo-transistor. The collector of the

L14G2 is given to the pin 2 of the comparator LM-324. It quantizes the data bits received and sends them to the microcontroller pin 19 through pin 1 of the comparator. Again the microcontroller converts this data back to binary form and via its pin 3 gives this data to pin 10 of the MAX-232 where this data is converted back to serial signal levels. Finally pin 7 of the Max-232 transmits these signals serially to the PC.

5. Working

The aim of the project is to transfer an image from one computer to another using serial communication. In order to achieve this we require the necessary processes to be done which are as follows:

1. A dedicated program which will execute in the OS and will take the image as an input and split it into pixels and then transmit it through serial port.
2. A dedicated hardware to take the data serially from the computer and then convert these binary data streams into optical (light) data streams and vice – versa.
3. A signal converter to convert RS 232 signal to TTL logic signal and TTL logic signal back to RS 232 signal.
4. A dedicated program at the other end to convert this serially received pixel data back into an image and then display it on the computer.

To develop the above mentioned process we use software known as MATLAB. The MATLAB code to read a selected image stored in the computer and then split the selected image into pixel value. After splitting the image, a Visual Basic text box is linked with the MATLAB code and he data is then serially transmitted via the VB text box interface.

Next, a microcontroller is used to communicate with a computer which converts the received data stream into an optical data stream. This is achieved by configuring one port of the microcontroller to act as an output port and drive the led connected to that port. The microcontroller is used to convert the data send by the PC serially into optical data stream. This is how we transmit an image file from a computer using a LED.

The transmitted data is decoded back to its original form by reversing the above mentioned process at the other end. At the other end the L14G2 photo-transistor is used to receive the optical data stream. At the receiving end, after the photo-transistor we used LM-324 comparator which quantizes the data and gives a digital data to the microcontroller. The microcontroller converts the received data back into decimal form. The VB interface created receives this stream of data and links the MATLAB code which reorders the pixel value back into an image file. After this data reordering process is completed, the image will be displayed on the monitor.

6. Approach

The selected image is loaded in MATLAB & initialization of the serial port is done using the MATLAB code. We split the loaded image matrix generated by MATLAB pixel by pixel and convert this image matrix to a data stream array.

Visual Basic is linked to MATLAB using the text box. This data stream is transmitted through the serial port using Visual Basic.

Microcontroller receives the data from serial port and converts this decimal data to binary form. The microcontroller flickers the LEDs for every '0' bit in the bit stream generated using MATLAB, LEDs act as an optical transmitter.

The Phototransistor (L14G2) acts as an optical receiver and sends the data to the microcontroller which again converts this binary data back to decimal form. Data is serially received using Visual Basic (VB) and MATLAB receives this data through VB text box linked to it. MATLAB then reorders the pixel data into image. The output image is displayed after image reconstruction.

7. Result

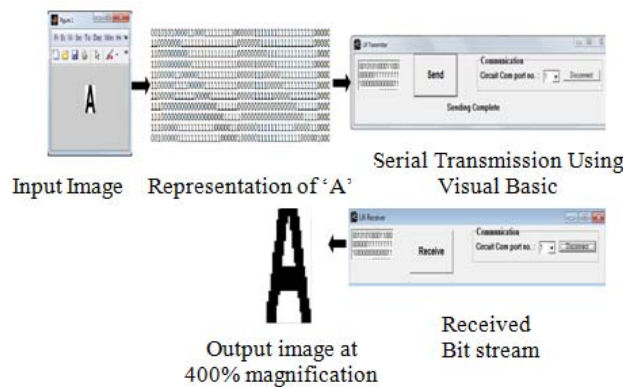


Figure 3: Result and Implementation

A Binary Image was transferred to the receiver terminal wirelessly by using light as the medium of transmission. The output image was found to have an accuracy of 90 %.

8. Applications

- 8.1 It can be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.
- 8.2 Can be used in the places where it is difficult to lay the optical fiber like hospitals.
- 8.3 This technology could be used in conjunction with Power line Communication (PLC). The idea is that voltage changes in an electrical wire, which serves as PLC carrier, are reflected by the flickering of a light source.
- 8.4 Vehicle to Vehicle communication. A full-duplex vehicular system which was tested in large-scale experiments resulting in interesting endings such as how multipath effects can be advantageous.
- 8.5 On a larger scale, lasers can be used to transmit high rates of data between satellites in space or to dishes on the ground. Such systems can allow military or telecoms information to pass between two towers or from space to the earth.

9. Cost

One module of “Wireless Data Transfer Using Light Fidelity” costs approximately Rs 650.

References

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