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Design of a Li-Fi based Data Transmission System

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ABSTRACT: Light Emitting Diode (LED) is used in different areas of everyday life. The advantage of the device is that in addition to their lightening capabilities, it can be used for data transmissions as well. Keeping in mind the importance and necessity of LED, in this project we shall be designing a Li-Fi based data communication system. In this work, a circuit is designed to transmit data from a computer to a receiver circuit using microcontroller (AT89C51) and with the help of a 16x2 LCD display the data being transmitted from the transmitter to the receiver. It is tested successfully in the laboratory.

KEYWORDS: Li-Fi, Light Emitting Diode, Microcontroller, LCD, Wi-Fi.

I. INTRODUCTION

One of the most important daily activities is the transfer of data from one side to another side. The current wireless radio networks which connect us to the internet are slow when multiple devices are connected. The number of devices as decreases that access the internet increases ,because of the fixed bandwidth available, makes it very difficult to enhance high data transfer rates and for connecting to a secure network. But for data transfer the radio waves, a smallest part of the spectrum is available. Light-Fidelity (Li-fi) is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-fi is fast and cheap wireless communication system. The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated technique could dramatically increase VLC data rate. University of Oxford and the University of Edinburgh are focusing on parallel data transmission using array of LEDs, where each LED transmit a different data stream. Again mixtures of red, green and blue LEDs are used to alter the light frequency encoding a different data channel. Li-fi has been dubbed, has already achieved blisteringly high speed in the lab. Researchers from Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second using a standard white-light LED.

Light is inherently safe and can be used in places where radio frequency communication is often deemed problematic, such as in air craft cabin of hospitals. So visible light communication has the potential to solve the problem of lack of spectrum space, but also can enable novel application. The visible light spectrum is unused, not regulated, and can be used for communication at very high speed.

II. RELATED WORK

Li-Fi is used to label the fast and cheap wireless-communication system and it is the optical version of Wi-Fi. This term was first used by Harald Hass in generation of high brightness light-emitting diodes. Harald Hass from the University of Edinburgh, UK, says if the LED is on, transmit a digital 1, if it's off transmit a 0. They can be switched on as well as switched off very quickly, which gives good opportunities for transmitted data. It is feasible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. The intensity of LED is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated techniques could increase VLC data rate. The University of Oxford and the University of Edinburgh, they are focusing on parallel data transmission using array of LEDs, where each LED transmits a different data stream.

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Some people are using mixtures of red, green and blue LEDs to alter the light frequency encoding a different data channel. Li-Fi has already each frequency encoding a different data channel. For such advancements promise a theoretical speed of 10 Gbps mean that people can download a full high-definition film in just 30 seconds. Fast data rates and depleting bandwidths worldwide are not only the reason that gives this technology an importance but also it has many advantages. Li-Fi uses just the light so it can be used safely in aircrafts and hospitals that are prone to interference from radio waves. This technology can work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations. Imagine only needing to hang under a street lamp to get public internet access, or downloading a movie from the lamp on your desk. There is a new technology on the block which could, quite precisely as well as figuratively throw light on and meet the ever-increasing demand for high-speed wireless connectivity. In Li-Fi, a method of data transmission, radio waves are replaced. Switched on and off method for Light-emitting diodes are faster than the human eye can detect, causing the light source to appear to be on continuously. A flickering light can be incredibly exasperating, but has turned out to have its upside, being precisely makes it possible to use light for wireless data transmission. This invisible on-off activity enables a kind of data transmission using binary codes denoting switching on an LED is a logical '1' and switching it off is a logical '0'. Therefore the Information can be encoded in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. Using rapid pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC), which has potential to compete with conventional Wi-Fi and has inspired the popular characterization Li-Fi.

III. SYSTEM DEVELOPMENT

The system design of this scheme is divided into two parts: Hardware implementation and Software implementation.

III.1 Hardware Architecture

The circuit has been implemented on vero-board. After analysing the circuit diagram, the components are placed at their respective places and fix them by soldering on the vero-board.

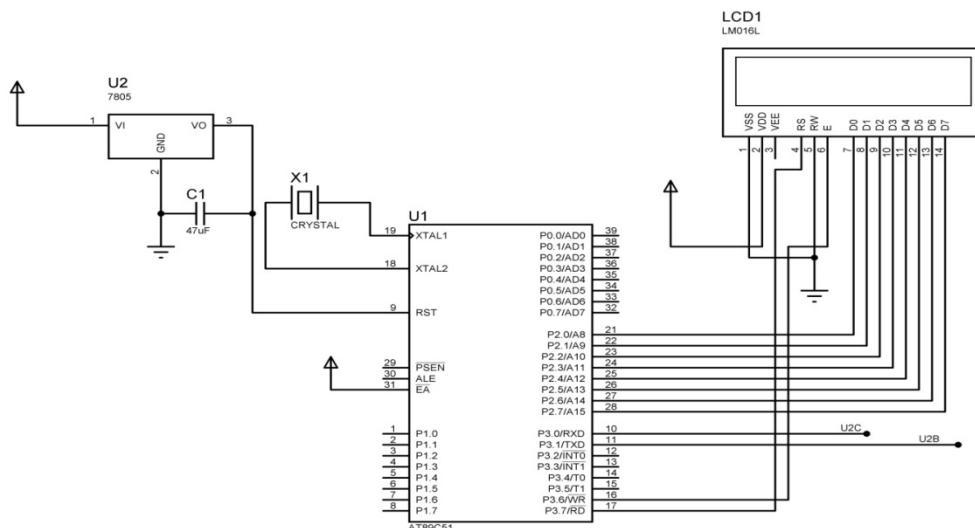


Fig. 1- Receiving circuit

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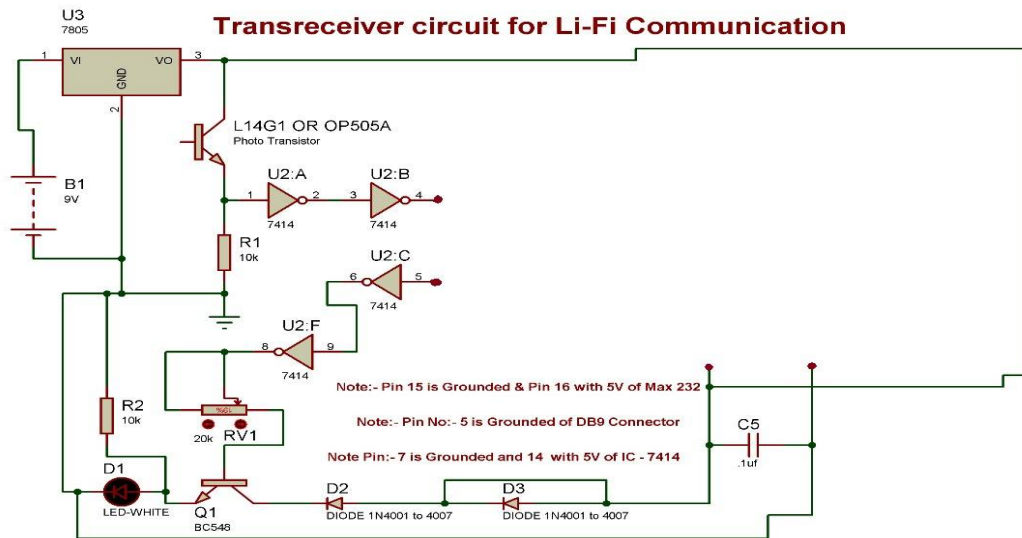


Fig. 2- Trans-receiver Circuit

In the receiver circuit as shown in Fig. 1, a Photo transistor on a device picks up the digital information send by LED through Rs-232 communication protocol relevant signal are coming where Light switch on and off in higher speed where human eye can't detect there switching, these data switch/trigger Schmitt-Trigger. We are doing this to amplify signal to first stage Pin2 and make amplified signals with reduced noise of original signal and then signal goes to pin 10 of 8051 where high voltage / uneven signals processed to TTL level of 5V which is processed and out to pin 10 of MAX232 IC. Now these signals are ready to process by application or simulators like HyperTerminal which is set by 2400 baud rate or high/low in both computers or Microcontroller. A LCD is connected to port 2 of 8051, where ever it receive any data from serial port and convert it to ASCII and display on LCD.

In trans-receiver circuit, through DB9 pin no. 3 output data in Low current -15 to +15V (by computer original not USB to serial converter) or by USB to Serial converter 5v to Max-232 IC pin 13 where signal convert to TTL level 5V to further circuit require through pin 12 we get TTL output and feed to buffer noise free output at pin 8 of 7414 Schmitt trigger inverter chip where it is connected to base of transistor for very high current and voltage amplification which can drive LED. We can take high voltage/current MOSFET to drive hundreds of LED to transmit a data as well, Now Circuit is ready to transmit.

II.2 Software Development

The clock works in 12 hour mode and is configured by programming the microcontroller AT89C51. The program uses a delay function for producing a delay of 1 second. Seconds are increased after every 1 second by making use of delay function. As second reaches 59, minute is incremented by 1 and second is reset to 0. Similarly as minute reaches 59 and second reaches 59, all of them are set to 0 and AM/PM mode is changed accordingly. When clock time becomes equal to the alarm time, a message 'Alarm' is displayed on LCD and the alarm pin of microcontroller goes high for some duration. This pin can be connected to a buzzer to sound the alarm at the pre- set time.

Programming language and Programming Software (KEIL software)

In the work, the compiler adopted is Keil C. This software is easily understandable and one of the most popular embedded C compilers. After these two important selections, the circuit should be built, appropriate coding must be done, software should be tested for any errors or warnings, the circuit must be simulated and finally the code must be dumped into the microcontrollers via a loader. This step by step approach in circuit designing is important for successful implementation of any circuit.

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μ Vision is a window-based software development platform that combines a robust and modern editor with a project manager and make facility tool. It integrates all the tools needed to develop embedded applications including a C/C++ compiler, macro assembler, linker/locator, and a HEX file generator.

The Cx51 Optimizing C Compiler is a complete implementation of the American National Standards Institute (ANSI) standard for the C language. The Cx51 Compiler is not a universal C compiler adapted for the 8051 target. It is a ground-up implementation, dedicated to generating extremely fast and compact code for the 8051 microprocessor. The Cx51 Compiler provides us with the flexibility of programming in C and the code efficiency and speed of assembly language.

The burner used is SUNROM#1118 from Sunrom Technologies.

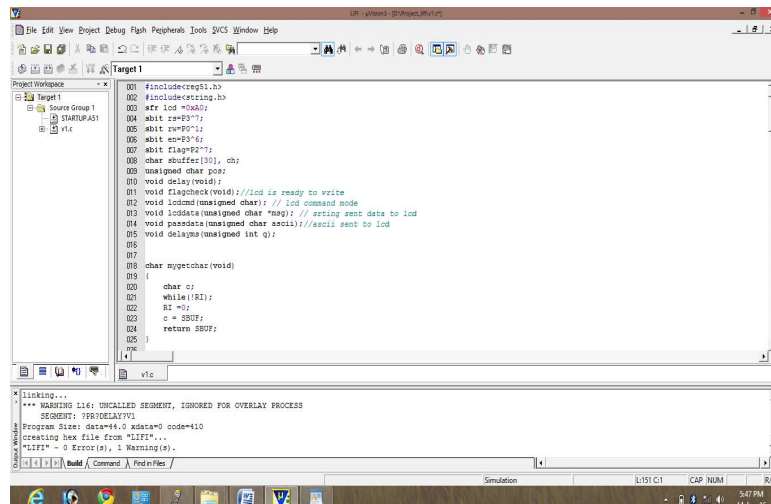


Fig. 3- Screenshot of KEIL

Circuit designing using Proteus 7.0

Proteus 7.0 is a Virtual System Modeling (VSM) that combines circuit simulation, animated components and microprocessor models to co-simulate the complete microcontroller based designs. This is the perfect tool for engineers to test their microcontroller designs before constructing a physical prototype in real time. This program allows users to interact with the design using on-screen indicators and/or LED and LCD displays and, if attached to the PC, switch and buttons. One of the main components of Proteus 7.0 is the Circuit Simulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with an event-driven digital simulator that allow users to utilize any SPICE model by any manufacturer. Proteus VSM comes with extensive debugging features, including breakpoints, single stepping and variable display for a neat design prior to hardware prototyping. In summary, Proteus 7.0 is the program to use when you want to simulate the interaction between software running on a microcontroller and any analog or digital electronic device connected to it.

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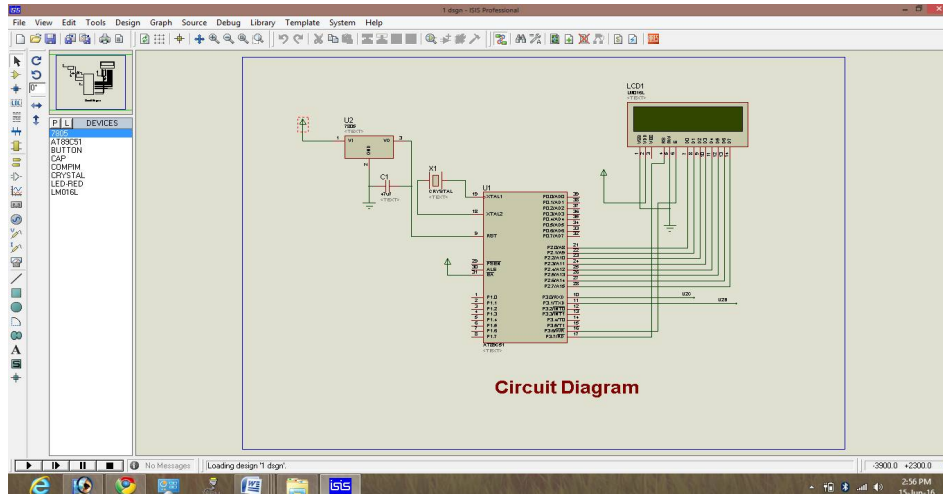


Fig. 4- Screenshot of Proteus

The flowchart of the algorithm is shown is Fig. 5. The sequential steps in the algorithm for the design are as follows.

1. Start.
2. Initialize the I/O and serial port.
3. Check for serial receiver.
 - a) if valid go to step 4.
 - b) if not valid then go to step 3 .
4. Display on LCD.
5. Send it.
6. End.

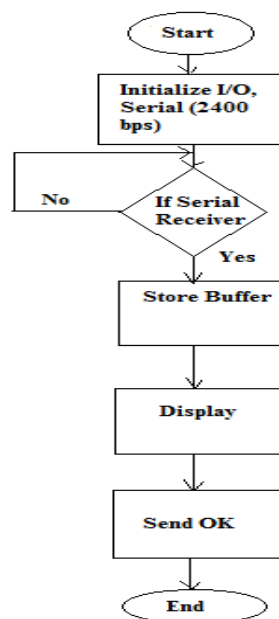


Fig. 5-Flow chart

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IV. EXPERIMENTAL RESULTS

After soldering the components in the Vero-board the following circuit is obtained:

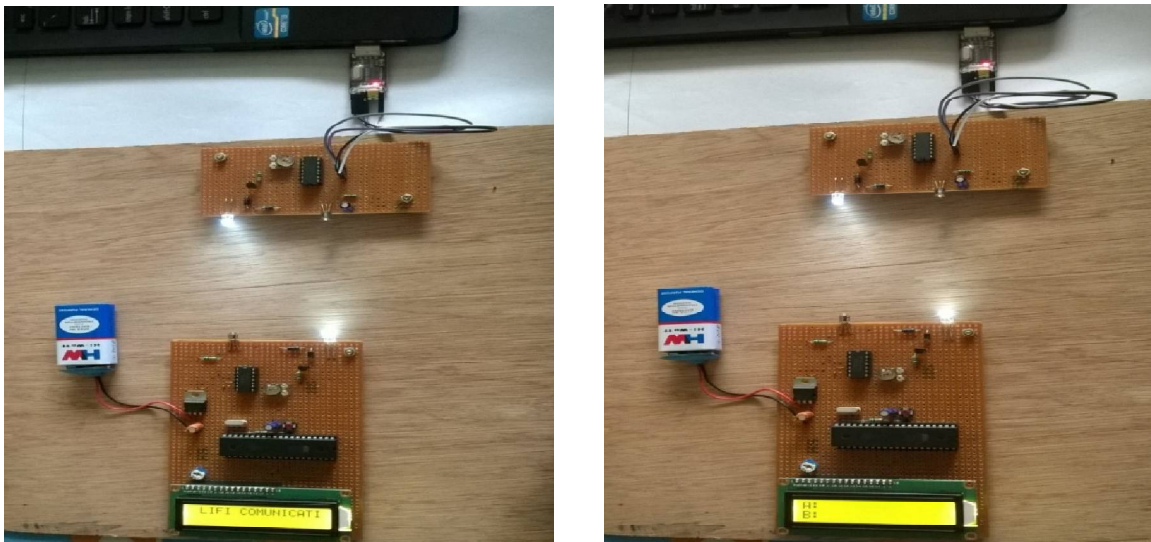


Fig. 6-Displays obtained after connection

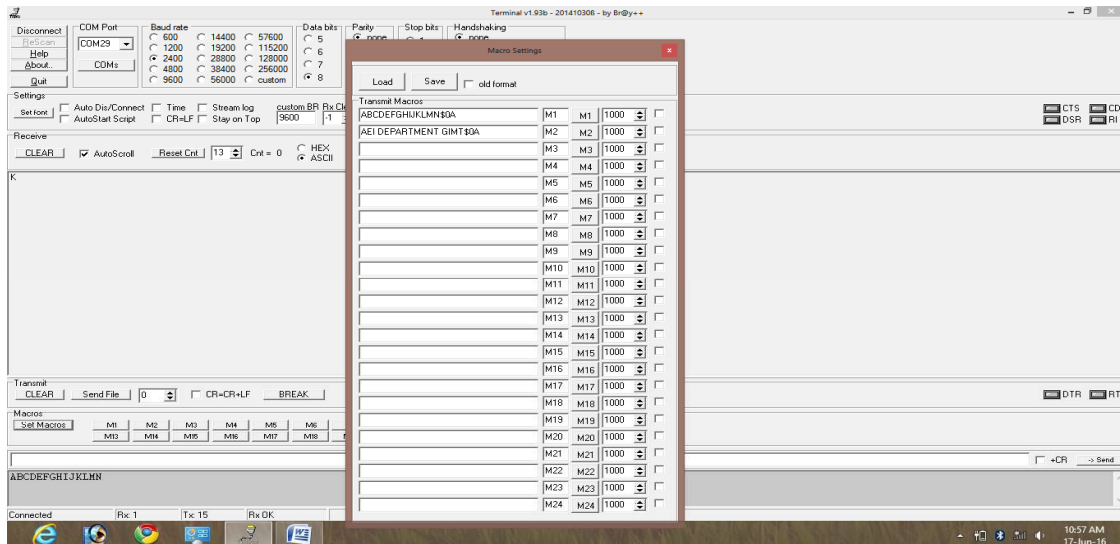


Fig. 7-Screenshot of the transmitted data

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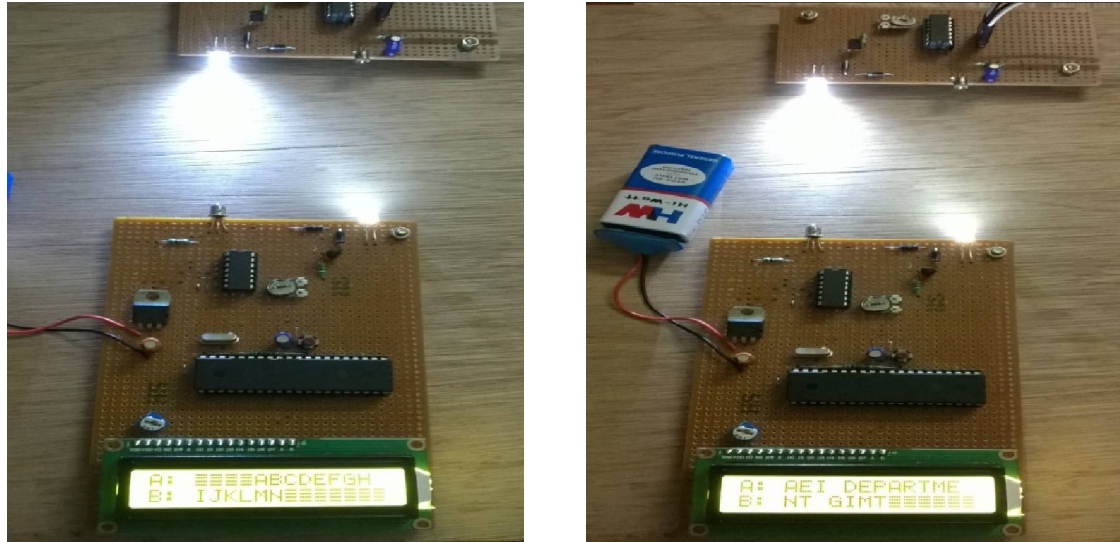


Fig. 8-Received data

V. CONCLUSION

The planning, design, implementation or execution of the whole work has successfully done in the laboratory. The concept of Li-Fi is gradually a great deal of interest because it may offer a genuine and very efficient alternative to radio-based wireless system. As huge number of people and their many devices access wireless internet, the airwaves are becoming increasingly blocked, making it more and more difficult to get a reliable, high-speed signal. It is a demonstration model but it can be implemented in field of transmission. It can be modified by adding some advanced circuitry.

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