

Design and Development of Li-Fi Visitor Tracker System

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Abstract - Security requirements of modern organizations are challenging and growing increasingly. To manage and track visitors, an automated Visitor Management System is utmost essential. This paper aims to present a Li-Fi Visitor Tracker System that is user friendly, reliable and fast. It deals with the collection of entries that handle the information about visitors including customers, suppliers, colleagues, maintenance staff, guest and sometime a completely unknown person. The data stored is secure and the set of entries can only be handled either by the admin or the receptionist. The databases are frequently updated at the time of the registration of the new visitor. Some visitors will be stopped at the reception area, whereas some visitors would be allowed to access specific areas, offices and labs in the building. Furthermore, some visitors are there on a short visit, while others may be there for a longer period, say days or weeks or months.

In addition, the security is expected to keep track of all the visitors as any lapse can compromise the security and safety of the physical, intellectual and human assets of an organization. For this purpose, visitor pass with visitor name, photograph, organization name, contact details and reporting person or officer will be customized with the help of RFID cards. The location of the visitor will be tracked using Li-Fi technology. The light fidelity technology refers to visible light communication that uses light as a medium to deliver high-speed data in a manner which is much greater than that of Wi-Fi.

Key Words: Li-Fi, RFID cards, Wi-Fi.

1. INTRODUCTION

Visitor management system, typically refer as a structure to keep tracking visitor's activities in organization or public building. It can provide necessary output and information to the users and record the incoming and outgoing visitors within the shortest time.

Nevertheless, VMS also capable to streamline the registration process and provide an authentic and integrated data of the visitors. Generally, there are many organization or offices who are still using the conventional paper log or

guest book to record the access of the visitors. But the problem is this manual method consumes longer time when the number of visitors is exceeded the limit.

Meanwhile, an increasing number of visitors indicates that the security issues should be concern in the organization or college. This is mainly because the operators have lack of time to verify the identification of each visitor when there are tons of guest entering the building.

Moreover, paper log is inadequate to offer greater traceability which cannot be archived or efficiently retrieved after several years. Due to above circumstances, VMS contribute a good solution to solve the problems that exist in the conventional method.

An integrated VMS with Identification Card of the visitors, one credential to be used for secure and efficient processing, issuing, encoding and location tracing using

Li-Fi (Light Fidelity technology) is the recent technology that has been emerging in the Field of wireless communication.

Thus, an automated visitor management system is an easy way to identify and record the visitor's personal information and track the locations visited in the building.

This authentication system also helps the security officer to determine visitor's entry is recorded and restricted in the building.

In this paper, we have proposed an automated VMS that will be designed and developed to assure the simplification of enrolment process before entering the premises.

2. LITERATURE SURVEY

Radio Frequency Identification (RFID) is a generic term for technologies that use radio waves to automatically identify people or objects from a distance of several inches to hundreds of feet. This is an Automatic identification (Auto-ID) technology [1] by which any object can be identified automatically. Barcode, Magnetic Strip, IC card, Optic Character Recognition (OCR), Voice Recognition, Fingerprint and Optical Strip etc are also identification technologies. RFID technology use automatic data capture system which helps in

increasing system efficiency. Combination of tag and reader is used for identification purpose. A code is stored in RFID tag and this tag is attached to a physical object. Now object becomes unique identifiable. Then object transmit code from tag. In this way reader get information about object. RFID is not actually a new technology, but it is applied in new ways [2]. RFID is rapidly growing technology. RFID offers much advantage over traditional identification device like barcode. To read the barcode, the barcode scanner needs to be in line of sight with the label. It means that the manual movement of the objects or scanner is necessary [3]. RFID, on the other hand can read data from tag without line of sight. Also, no alignment is necessary in RFID technology. Singh et al. [4] provides a brief overview of the RFID technology. RFID has high reading speed and this can work in presence of barrier. This technology is more effective when longer read range, fast scanning and flexible data carrying capability is required. RFID system has received more and more attention in many areas like manufacturing companies, agriculture, transportation and industries [5] etc. As more and more people and their many devices access wireless internet, clogged airwaves are going to make it increasingly difficult to latch onto a reliable signal. But radio waves are just one part of the spectrum that can carry our data. What if we could use other waves to surf the internet? One German physicist, DR. Harald Haas, has come up with a solution he calls "Data Through Illumination"—taking the fiber out of fiber optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. It's the same idea behind infrared remote controls, but far more powerful. Haas says his invention, which he calls D-Light, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. He envisions a future where data for laptops, smart phones, and tablets is transmitted through the light in a room. And security would be a snap—if you can't see the light, you can't access the data.

Li-Fi is now part of the Visible Light Communications (VLC) PAN IEEE 802.15.7 standard. Li-Fi is typically implemented using single coloured phosphor-coated white LED light bulbs because fluorescent bulbs emit light in a much wider band of wavelengths, which makes it a relatively less efficient light source than LED. White LED, on the other hand, is a light source that emits light in a very narrow band of wavelengths, making it a more efficient light source over RGB LEDs. These devices are used for illumination by applying a constant current through the LED. Since, the variations of the current are fast and subtle, the optical output can be made to vary at

extremely high speeds making it unperceivable for the human eye to detect the transmission.

Whether you're in a mall, coffee shop or in any other public Wi-fi zone, I hope you always complain about speed and strength of the signals. Always competing for the bandwidth and "net" speed. To overcome this problem, in 2011, Professor Harold Haas from the University of Edinburgh in the UK suggested an idea about the new form of wireless network technology which is named as "Data through illumination" [6]. In Li-Fi technology, we can connect the internet with the help of an LED beam in a finite range. In Li-Fi technology, we can connect the internet with the help of an LED beam in a finite range [7]. This is the major advantage of using Li-fi based system. As the visible light cannot be penetrating through the walls so it is (Li-Fi) considered as secure means of data transmission system. We fix LED bulbs at the downlink transmitter [8]. Such advancements promise any theoretical speed of 10 Gbps – which means that one can download an entire high-definition film in just 30 seconds. There are motivations to incline toward LED as the light source in VLC, though many other light gadgets like fluorescent light, radiant light etc. are available [9]. Comparison between Li-Fi & WI-FI is needed to describe visible light communication technology put on highspeed wireless transmission.

3. Design Component

The basic main components involved in this project are transmitter and receiver. LED is used for transmitting the signal and LDR is used for reception purpose. In the presented design a white light LED, Buck converter for 5V voltage regulation (LM2596), LED driver circuit, Tip 122 Darlington transistors, LDR module, Microcontroller AT Mega 328P, Liquid Crystal Display 16x2(JHD162A) and Buzzer are used.

The proposed system had been designed on the PROTEUS 8 professional software and after finding satisfactory results then hardware was designed. The whole system is divided into two sections, first transmitter section and other one is receiver section.

Software: Arduino IDE 1.8.7

System Flow Diagram

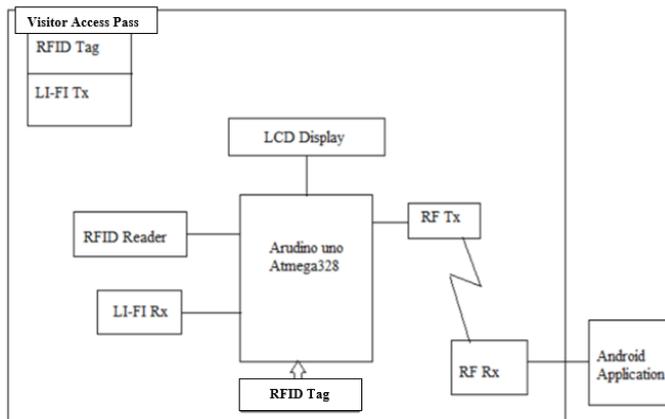


Figure1: Proposed system (Architecture)

Transmitter:

The transmitter consists of following components that are as follows and the circuitry is shown in figure 2.

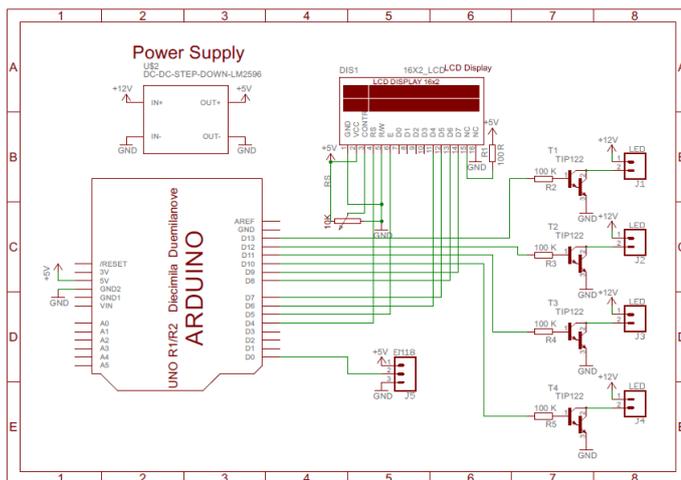


Fig 2: Transmitter section

a. Liquid Crystal Display

In our project, we have used a 16x2 LCD display which is a basic LCD module. In a 16x2 LCD 16 characters per line can be displayed and there are 2 such lines in a single one. This LCD has two registers, namely, Command register (to insert a special command into the LCD) and Data register (to insert a data in LCD). Command is a special set of data which is used to give internal command to LCD such as clear screen, move to line, etc.

b. EM-18 RFID Reader Module

The EM-18 RFID Reader module reads RFID tags at an operating frequency of 125KHz. The Reader module comes with an on-chip antenna which can be powered up with a 5V power supply. The transmitter (Tx) pin is connected to the

receiver (Rx) pin of the microcontroller. After showing the card within distance, it transmits unique ID of 12bytes serially to the microcontroller using UART communication and the card number is thrown at the output (LCD).

c. DC- DC Buck Converter Step Down Module LM2596 Power Supply

A buck converter (step-down converter) is a DC-to-DC power converter that steps down voltage (while stepping up current) from its input (supply) to its output (load). It's capable of driving a 3-A load with excellent line and load regulation. These devices are available in the fixed output voltages of 3.3V, 5V, 12V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

d. LED (Light Emitting Diode)

When a light-emitting diode is switched on, electrons that are released and they recombine with holes within the device, and energy is released in form of photons and this effect is known as electroluminescence, and the colour of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs have major advantages over incandescent light sources including longer lifetime, lower energy consumption, improved physical robustness, and faster switching.

Receiver:

Receiver is able to receive the signal with the help of photo detector by flickering of light. The small changes in the rapid dimming of LED bulbs is then converted by the receiver into electrical signal. It includes various components as follows and circuitry is shown in figure 3.

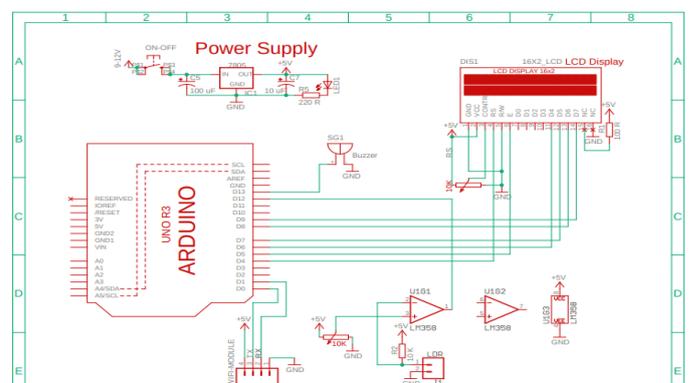


Fig 3: Receiver section

a. Photo Resistors

In this project for the purpose of photo detection, a Light Dependent Resistor (LDR) is used. An LDR is a component that has variable resistance which changes with the change

in intensity of the light that falls upon it i.e. it exhibits photo-conductivity. Thus, LDR can be used in light sensing circuits.

b. Buzzer

Buzzer is a handy sound generator used in electronic circuits to give audio indication. It is widely used as an alarm generator in electronic devices. It is available in various types and size to suit the requirements. When the buzzer is powered, the oscillator generates a frequency around and the element vibrates accordingly to produce the sound. An ordinary buzzer works between 3 – 12 volts DC.

c. ESP-01 ESP8266 Serial Wi-Fi Wireless Transceiver Module

The ESP8266 is a Wi-Fi module that allows microcontrollers access to a Wi-Fi network.

4. Working

Li-Fi uses fast pulses of visible light as a medium for wireless transmission of data. This is possible through the use of a Visible Light Communications (VLC) system and uses visible light of electromagnetic spectrum between 400 THz and 800 THz as optical carrier for data transmission via illumination. A Li-Fi system has two qualifying components:

1. A light source (high brightness LED) equipped with a signal processing unit for the transmission of signals and;
2. At least one device containing a silicon photodiode in order to receive light signals.

The light emitting diodes (LED) serve as the light source. They are outfitted with a chip that serves as the signal processing unit. LED is also a semiconductor, which implies that it can amplify light intensity and switch rapidly making it unperceivable for human eye to detect and the bulbs appear with a stable intensity. The light source transmits data using emitted light as the medium. Switching the LEDs on and off can make them generate digital strings or codes with different combination of 1s and 0s. When the LED is ON, a digital “1” is transmitted and when it’s Off, a digital “0” is transmitted. To generate a new data stream, data can be encoded in the form of light by varying the flickering rate of the LED. In this way, the LEDs work as a sender by modulating the light in a specific time period with the data signal. The LED output appears constant to the human because they are made to flicker at a phenomenal speed (millions of times per second) and it’s nearly impossible for human eye to detect this frequency. At the receiver’s end, a photodiode is used to receive the LED flashes which strengthens the signal & gives the output. This refers to a **single bit data transmission**. An array of LEDs can be

connected so that a large amount of data transmission takes place. Once these signals are received and demodulated, they can now be converted into a continuous stream of binary data that contains videos, images, audio, text, or applications that are readily-consumable on any internet-enabled device.

5. Result and discussion

In this project, the four LED pillars indicate the four locations we have considered namely: Cafeteria, Blended Learning, Emergency Room and Sports Arena. These can be tracked with the help of Li-Fi and when the receiver section containing will come under any of the LEDs, the colour of respective LED will change from Red to Green to indicate the location of the visitor. The simulation will be displayed as output in the Android mobile app.

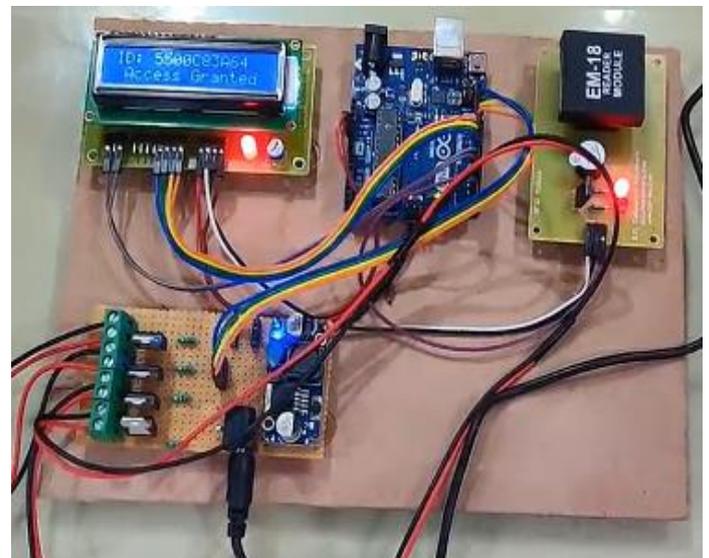


Fig 5: Transmitter section output

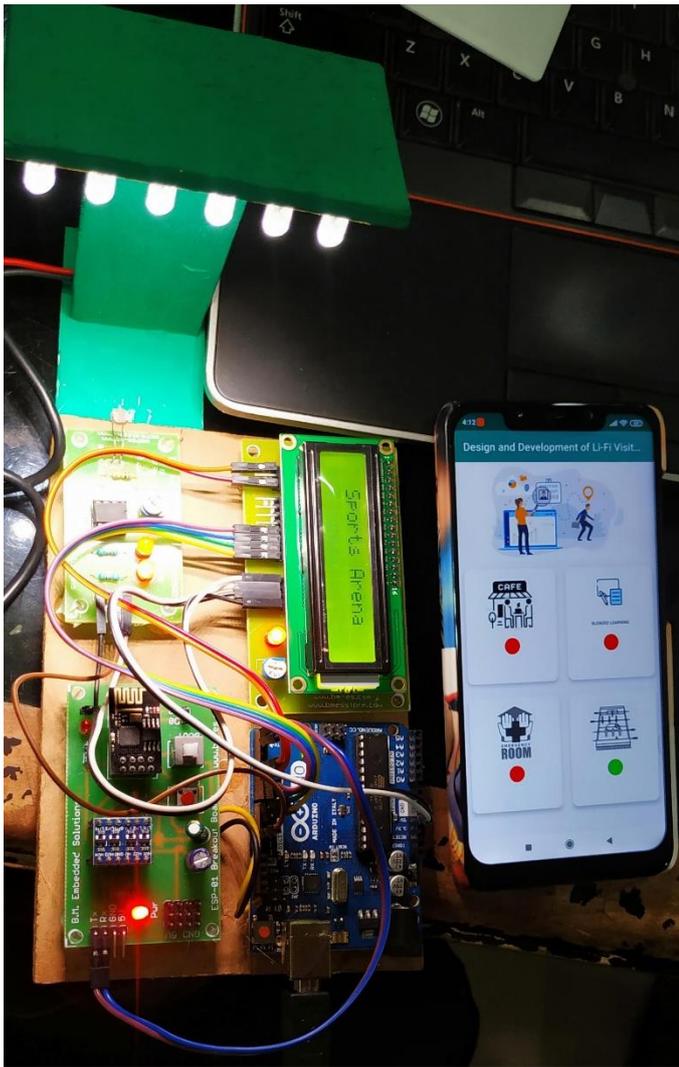


Fig 6: Receiver section output

6. Conclusion

In this paper, navigation application of Li-Fi technology has been discussed successfully. The technology of Li-Fi is spreading exponentially because it is faster, secure and increased capacity than Wi-Fi. Transmission and Reception of information takes place in form of light energy which is used for tracking and getting real-time location of a visitor inside the premises. The idea of transmitting using the visible light spectrum allows light to modulate at fast rate so that can be picked by receivers equipped with light sensors at very high speeds of hundreds of megabytes per second, enabling the light source to transmit data. The utilization of Li-Fi technology provides a great chance to replace radio based wireless technologies. This technique could result extremely beneficial in managing and enhancing visitor records and thereby setting up a purely automated environment for visitor management system and tracking of activities.

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