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A SMART TOLL COLLECTION SYSTEM USING VISIBLE LIGHT COMMUNICATION

S. Praba[1], R. Santhosh[2], K. Ram kumar[3], S.E. Selvam[4], S. Mohan[5]

[1]Assistant Professor, Department of Electrical and Electronics Engineering, Panimalar Institute of Technology, Chennai, Tamil Nadu, India.

[2,3,4,5] UG Scholar, Department of Electrical and Electronics Engineering, Panimalar Institute of Technology, Chennai, Tamil Nadu, India.

Abstract - *This paper focuses on faster data transmit at toll plaza by using Li-Fi module which will reduce the problemsthat arise in ETC. Li-Fi has the advantage of being able to be used in sensitive area such as in Aircraft and other transportation without causing interference. The Li-Fi mechanism is implemented in every vehicle (four wheelers) and at toll plaza. At the toll plaza, once the vehicle's Li-Fi transmitter is paired with the Li-Fi receiver, the system at toll plaza automatically identifies the vehicle details. This paper is based on Li-Fi technology; the Li-Fi system uses Li-Fi which collects information of vehicle passing through the toll plaza and automatically debits the toll amount from prepaid account of vehicle owner, which in return reduces the traffic congestion and human errors. The vehicle owner has to register his vehicle with Li-Fi, creating a rechargeable account. When the vehicle will pass through toll gate the amount of toll will automatically be reduced from its account and give deduction message to vehicle owner. This OWC technology uses light from Light-Emitting Diodes (LEDs). The light received by photodiode is converted to binary data and is fed to the microcontroller. The microcontroller is connected to the serial port of the PC. The basic advantages of the system is travelling time is decreased, congestion free network, less emissions in toll area and no infrastructure cost is required. This gives a win condition for both toll authorities and toll customers*.

Keywords: Li-Fi (Light Fidelity), *PIC16F877A*, Li-Fi Transmitter, *Li-Fi Receiver,* Internet of Things, GSM Modem

I. INTRODUCTION

The growth in number of vehicles, we need for expansive roads catering to thousands of vehicles moving across India has become inevitable. However, considering the present situation of the current toll system has several drawbacks. Due to the limited number of toll booths and manually collection process, the average waiting time per vehicle is 10-15 minutes. This results in loses worth thousands of crores of Rupees in terms of fuel wastage. This long wait time often results in drivers getting irritated and in verbal spats and physical fights among people and the toll attendants. This paper finds a solution to problems which regarding manually toll payment with the help of Li-Fi module. Automatic toll payment system uses li-fi technology which is constitutes a unique id and a Li-Fi module with user details, which is placed in the mobile. When the car crosses the toll booth it acts as a Li-Fi transmitter, while the toll booth acts as a receiver and receives details and payment. The OWC technology uses light from Light-Emitting Diodes (LEDs) as a medium to deliver networked, mobile, high-speed communication. Li-Fi is a bidirectional, high speed and fully networked wireless communications system similar to Wi-Fi. It uses visible light communication. Li-Fi could lead to the Internet of Things with LED lights on the electronics being used as Li-Fi internet access points.

II. TECHNOLOGY USED

A*)* Li-Fi (Light Fidelity): Li-Fi stands for Light-Fidelity. Li-Fi technology, proposed by the German physicist—Harald Haas, it provides for transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. This paper focuses on How to developing a Li-Fi based system and analyzes its performance with respect to existing technology? Wi-Fi is great for general wireless coverage within buildings, whereas Li-Fi is ideal for high density wireless data coverage in confined area. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi. Li-Fi has already achieved by list erringly high speed in the lab. The low cost of LEDs and lighting units there are many opportunities to exploit this medium.

B***) PIC16F877A*:** PIC16F877A was used to implement Li- Fi transceiver module using an LED and a photodiode. It is a low-cost, low power consuming microcontroller. It has a UART module which supports baud rate from 0.3 kbps to 57.6 kbps. In this paper, 2.4 kbps was chosen as the data rate of the Li-Fi communication system.

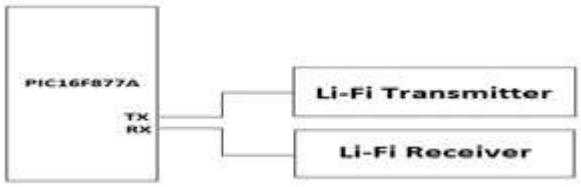

FIG1. Li-Fi TRANSCEIVER MODULE

C) Li-Fi Transmitter: When the vehicle approaches the toll gate, initially the IR sensors placed on either side of the toll booth for detect the arrival of a vehicle as it interrupts the IR waves passing. This point of time, the gate gets closed and the vehicle's position is in such a way that the Li-Fi transceiver in the vehicle door. The Li- Fi receiver at the toll booth communicate where the former transmits the vehicle details stored in the microcontroller and the latter receives**.** In the circuit diagram of a basic Li-Fi transmitter shown in Fig.2 , a NPN transistor, BC547, is used as a current amplifier in CE configuration. Other types of current amplification circuits or signal power amplifying circuits can be used depending upon the LED lamp to be driven. STP55NF06 is a N-channel power MOSFET used to modulate the intensity of the LED lamp as per the data stream at a data rate of 2.4 kbps. The UART transmitter pin of PIC16F877A is connected to the 'Tx' pin of Li-Fi transmitter module. This module supports data transmitted at baud rates 1.2 or 2.4 kbps. Any LED based headlights which are available in market can be converted into a Li-Fi transmitter by connecting it with the circuit shown in Fig 2.

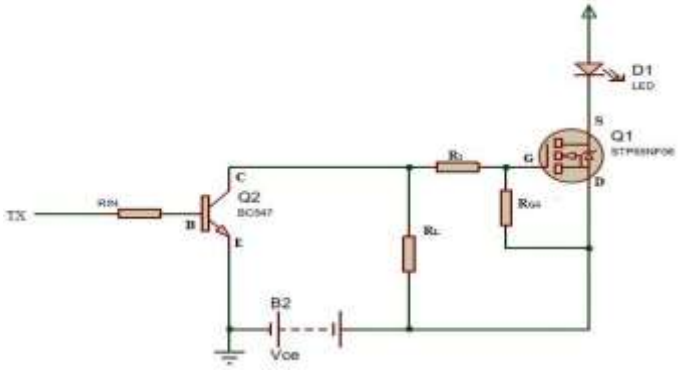

Fig 2.Circuit diagram of Li-Fi transmitter module

***D) Li-Fi Receiver*:** The OWC technology uses light from light-emitting diodes (LEDs) as a medium to deliver networked, mobile, high-speed communication. Li-Fi could lead to the Internet of Things with LED lights on the electronics being used as Li-Fi internet access points. LED and photodiode are the major components of Li-Fi circuit. LED are used to transmit the data at transmitting end. At receiving end a photodiode is connected to PC which senses the transmitted data. Transmitted data feed to the PC. A PIC microcontroller can be used for toggling of LED at transmitting end. At receiving end also one has to use a PIC microcontroller connected to output of photodiode.

Fig. 3, shows the receiver circuit which consists of a photodiode, an operational amplifier LM358N, a potentiometer and resistors. The output of the photodiode is connected to the non-inverting terminal of the op-amp and the potentiometer is connected to the inverting terminal. By comparing the input voltage from the photodiode with the reference voltage set using the potentiometer, the op-amp will either set the output to the maximum positive voltage or maximum negative voltage. In this way, the op-amp differentiates between logic 1 and logic 0 of the transmitted bit stream.

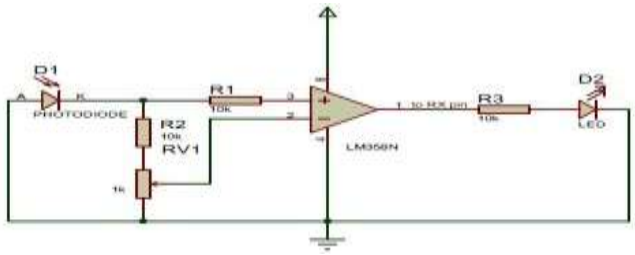

Fig 3. Circuit diagram of a Li-Fi receiver module

E) INTERNET OF THINGS: IoT (Internet of Things) is an innovative automation and analytics system which adventures networking, sensing, big data, and artificial intelligence technology to provide complete systems for a product or service. These systems achieve greater transparency, control, and performance when it is applied to any industry or system. IoT systems have many applications across industries through their unique flexibility and ability to be appropriate in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful facilitating technology.

IoT systems which allow users the attain the deeper mechanization, examination, and integration within a system. They achieve the reach of these areas and their accuracy. IoT uses existing and emerging technology for sensing, networking, and robotics. IoT achieves the recent advances in software, falling hardware prices, and modern attitudes towards technology. Its new and advanced elements which bring major changes in the delivery of products, goods, and services; and the social, economic, and political effect of those changes. Here we are using IOT for Vechicle theft control and Detection Purpose.

F) GSM Modem: A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem

behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, you can do things like: Reading, writing and deleting SMS messages, Sending SMS messages ,Monitoring the signal strength., Monitoring the charging status and charge level of the batter., Reading, writing and searching phone book entries.

THE GSM NETWORK:

GSM provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason for this is to limit the designers as little as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS).

GSM Modem Application:

III. EXISTING SYSTEM

In the existing system, the toll payment is with manually is linked to a prepaid account from which the applicable toll amount is deducted. A manual lane can process approximately 400 vehicles per hour in comparison to a free flow freeway lane, with capacity approaching 2,000 vehicles per hour.

In this system, an RFID based tolling system is carried out. This elimination of the queuing system is not perfectly done as it takes time for RFID receiver to receive and analyses data. Also a human operation is required to monitor the driver's details and open the toll. Next to that they use QR code for toll gate but it also takes time for scanning process add to that it can be misused by placing others QR code will reduce money for different person. To overcome from this problem we can proposed new system toll using Li-Fi.

DISADVANTAGES:

- Time taken is very high.
- Manual operation is needed.

IV. PROPOSED SYSTEM

In the existing time, all vehicles which get manufactured are initially registered by their manufacturing company with the government authority. The registered vehicles display a vehicle registration plate and carry a vehicle registration certificate. This certificate is different from vehicle licensing and road worthiness certification. These details get stored into the microcontroller embedded within the vehicle which is the actual data which gets transferred through Li-Fi to the toll plaza. At the time of police verification these details may be transferred at a stretch with ease. When the vehicle approaches the toll gate, initially the IR sensors placed on either side of the toll booth detect. The arrival of a vehicle as it interrupts the IR waves passing. This point of time, the gate closed and the vehicle's position is in such a way that the Li-Fi transceiver in the vehicle door and the Li- Fi receiver at the toll booth communicate where the former transmits the vehicle details stored in the microcontroller and the latter receives.

The Li-Fi receiver at toll booth updates the contents in the server and the database. Hence the vehicle details gets stored and the fare amount (toll) gets deducted from the prepaid account of the user which is also notified to the user via SMS. This payment procedure is done the vehicle is free to move out of the toll plaza. All this happens within few seconds as Li-Fi is very fast in transmission. An

additional feature to our idea is the Li-Fi transmitter attached to the vehicle key. Which when matched with the unique id of the Li-Fi transceiver in the vehicle door gets the door opened else doesn't get opened. This is to enhance our idea in terms of security

A. BLOCK DIAGRAM

CAR SECTION:

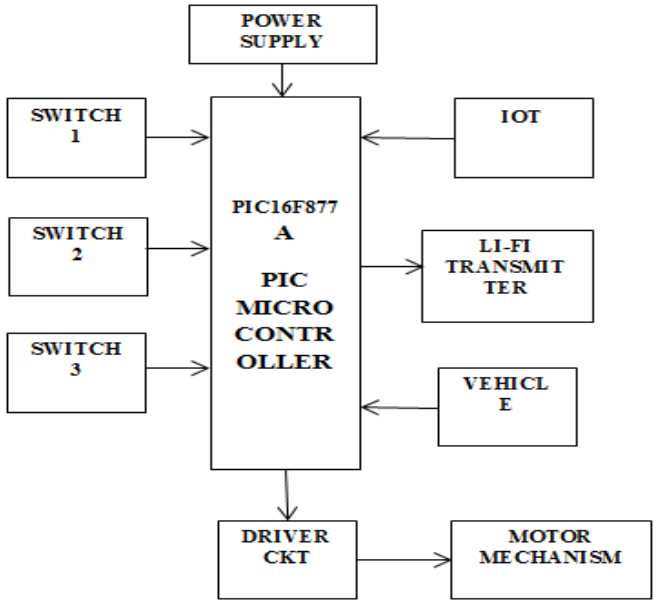

Fig4. CAR SECTION

TOLL GATE SECTION:

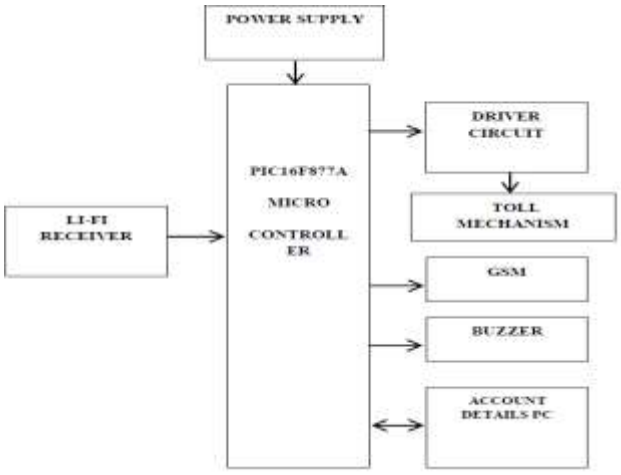

Fig5.TOLL SECTION

B. BLOCK DIAGRAM EXPLANATION:

The drawbacks in the existing system are eliminated by this system. The three switch used in the block diagram are the types of vehicles to define the payment mode. The system consists of three car based prototype consisting of three Li-Fi data in the controller. Here we need to start the vehicle using biometric identity for gathering the user details.

Whenever a specific car is selected, then the data of that car is transmitted using Li-Fi. The details of vehicle and person details is received by the Li-Fi receiver placed at the toll section. The toll section, after the reception of data provides the data to the controller. The controller checks whether the person has money for paying the toll. If money is present in the driver's account, then he is permitted to pass through. Now the toll mechanism is operated and the vehicle to let to pass through. If the driver's account has lower balance for paying the toll, then the vehicle is restricted to pass through and the message will be send to the user. In the monitor section, LCD displays the status of the project and beep sound using buzzer.

ADVANTAGES OF PROPOSED SYSTEM:

The proposed system uses the Li-Fi modules, it possesses several advantages mentioned below:

1. **Capacity** : Li-Fi spectrum is 10,000 times greater.
2. **Availability:** Light waves are available everywhere.

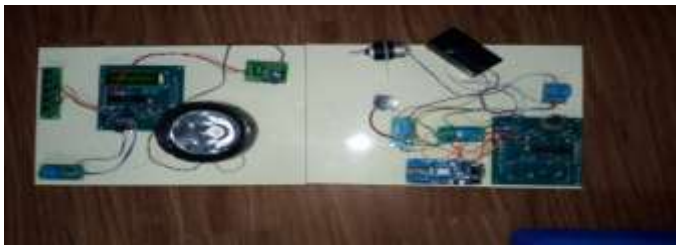

FIG6. HARDWARE PICTURE

EASE OF USE

The paper mainly motives to reduce the manual paper work and to save time, effort, and man power through processing the toll payment automatically. It would be useful in finding out how many times a vehicle is passing through the toll gate in a day as it stores all details in database.

V. CONCLUSION AND FUTURE USE

The use of Li-Fi technology along with Wi-Fi in automatic toll payment will be more efficient. This idea not only reduces the time for the users but also reduces the manual paper work that is being done at the present. Thus the use of Li-Fi will increase the speed of data transfer and also it is accessible in many banned places. And our paper can be extended with Gi-Fi technology which can be a replacement to Wi-Fi. Now Wi-Fi is getting overloaded and it used for short-range high-data rate links, it useful to offload the excess demand to Li-Fi. The idea of Li-Fi technology is currently attracting us and it offers tremendous scope for future research and innovation. As light is everywhere and free to use possibilities increases to a great extent to the use of Li-Fi technology.

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