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VISIBLE LIGHT COMMUNICATION BASED SMART PARKING SYSTEM USING MSP430

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ABSTRACT

A major issue in public places like shopping malls, museums and hospitals is parking. Parking is the main service used by the people in these private units. The management of these public units invests more time and money in designing parking systems. Existing parking systems are equipped with appropriate sensors and controllers to count the parked cars automatically, but it does not indicate empty parking slots. These systems consume more power and tend to wireless interference. The proposed system, namely, Visible Light Communication based Smart Parking System introduces Visible Light Communication, a data communication technology using a low power MSP430F5529 microcontroller to help drivers to get real-time parking information. Real-time information on free parking slots helps drivers to save time and reduce fuel consumption. Visible Light Communication (VLC) or Li Fi or Optical Wireless technology means the wireless data transfer using LED. Wireless interference is greatly reduced by using VLC. The proposed system is suitable for multiple floor buildings, which involves data gathering from parking side modules integrated in multiple floors of the building. Parking side modules continuously collects the data and intimates the module integrated in the vehicle section. The module in the vehicle section interfaces a GSM modem to send the detected information to the user mobile. The result of the proposed system is validated in an indoor environment.

Keywords: VLC, Li-Fi, GSM, LED, phototransistor.

INTRODUCTION

In today's fast growing environment, Visible Light Technology has taken its own place in the data communication field. The communication technology which uses visible light for communication is Visible Light Communication. The visible light is what we see all around the life every day. The activities which we perform everyday relies on gathering information through our eyes. Lightings in the buildings, office appliances, road lights, traffic signals, displays and it also includes electronic home appliances such as LED TV's etc., are all examples of light communication. Now-a-days LED's are used in most of the electronic devices.[7][9] Operating characteristic of LED is fast on and off. Data can be transmitted at high speed through fast switching of LED between on and off. Problems related to infrared and radio communications are widely reduced using Visible Light Communication.

The applications of VLC include Smart Lightning. Smart Building is an excellent example for VLC. Smart Lightning through VLC provides the infrastructure with illumination, data communication and control of appliances. It also reduces the power consumption and reduces wiring within the building. VLC is considered to be safe and free from hacking data. Services based on locations, Defense, Security, Aviation, Tele-health, health care, etc., are all the massive applications of Visible Light Communication. The application also includes underground communication [7][9].

In the proposed project, Visible Light Communication (VLC) is the data communication technology used. The overview of the proposed system is that, the system is designed for multi-floor buildings. As the conventional radio communication technology is replaced with VLC technology, wireless interference can be greatly reduced. The developed system consists of three modules namely Parking Slot Enquiry Module, Parking Slot Monitoring Module, and Parking Slot Detector module. The Parking Slot Enquiry module is integrated in the car to send the parking query to the Parking Slot Monitoring module, which is integrated in the first floor of the parking side. The Parking Slot Detector Module, which is integrated on the second floor along with Parking Slot Monitoring module on the parking side, collects information about free parking slots and sends it to the module integrated in the car. The advantage of this system includes lower cost, reduces wireless interference, and reduces time consumption and ease to use.

LITERATURE REVIEW

Shweta Sagar et al in the year 2015 proposed a study based on these phenomena, called Visible Light Communication, multiple input-multiple output technique is used in this study to enhance the rate of data transmission [7]. In this study each individual LED has very limited bandwidth, and precise alignment of detectors and receiver array is not possible. The implementation of MIMO considers two limiting cases, first case is that array of receivers with corresponding optical concentrator is considered and imaging receiver is used in the second case.

In 2015 Tirmanwar et.al proposed a study based on Data Transmission by using Light Fidelity. Light Fidelity means the wireless data transfer using LED. The main concept behind the Li Fi is "Data through Illumination". Tianxing Li et al in the year 2015 presents LiSense. In this study VLC is used to construct the system which enables data communication and reconstruction of real-time human skeleton.

In 2015 Carlos Medina et al gives an overview of LED based VLC and provides a wide-ranging survey on advanced activities in this technology, fixing on numerous aspects such as key elements of VLC structures, potential applications and tests for practical implementation. In addition to this VLC is also compared with RF systems and enhances the future directions to speed up the data transmission. John E. Gancarz et al in 2015 describes the visible light communication (VLC) synthesis and lighting state control imposes modulation of data light which accommodates control of intensity. Optical wireless data transmission and LED intensity control have been proposed as a response to this need.

PROPOSED SYSTEM

The proposed design of smart parking system consists of a low power microcontroller MSP430F5529 to monitor and control the parking. To collect information about free parking slots IR detectors has to be interfaced with the MSP430F5529 Launchpad. LED's acts as Li-Fi Transmitter and Phototransistor acts as Li-Fi Receiver; which are also interfaced with the MSP430F5529 Launchpad. A GSM module is interfaced to send detected parking information to the car user. This chapter deals with the Block diagram of the project and details of each hardware component chosen in such a way that it suits best for the design of Visible Light Communication based Smart Parking System. The block diagram of the proposed system consists of three modules:

- Parking Slot Enquiry Module
- Parking Slot Monitoring Module
- Parking Slot Detector Module

The module Parking Slot Enquiry module is interfaced in the car which requires parking. The modules Parking Slot Monitoring module and Parking Slot Detector module are interfaced in the parking side.

Parking Slot Enquiry Module

Figure-1 shows the Block diagram of the Parking Slot Enquiry module. Parking Slot Enquiry module is integrated on the car, to intimate the drivers about free parking slots. The module consists of an LCD to display the parking information. LED is integrated with the MSP430F5529 Launchpad; which acts as the transmitter. Phototransistor which acts as the receiver is also integrated with the MSP430F5529 Launchpad. LED transmits the data serially to the module on the parking side; whereas the phototransistor receives the data serially. DPST switch is interfaced with the launch pad to send the query message. A GSM module is interfaced to send the detected information to the user mobile.

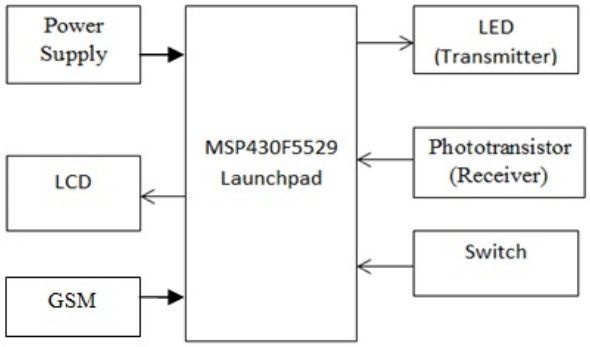

Figure-1. Block diagram of parking slot enquiry module.

Parking Slot Monitoring Module

The Block diagram of Parking Slot Monitoring module is shown in Figure-2. Parking Slot Monitoring module is integrated on the parking side, to detect the free parking slots. The module consists of an LCD to display the parking information. LED is integrated with the MSP430F5529 Launchpad; which acts as the transmitter. Phototransistor which acts as the receiver is also integrated with the MSP430F5529 Launchpad. LED transmits the data serially to the module on the parking side; whereas the phototransistor receives the data serially. In this module two IR Detectors are used to detect the free parking slots [1][2][3].

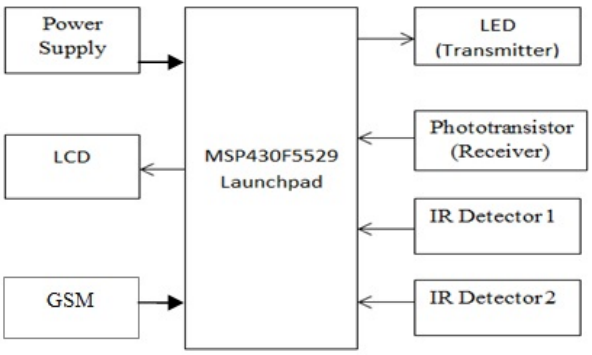

Figure-2. Block diagram of parking slot monitoring module.

Parking Slot Detector Module

Figure-3 shows the Block diagram of the Parking Slot Detector module. Parking Slot Detector is integrated on the parking side, to detect the free parking slots. The module consists of an LCD to display the parking information. LED is integrated with the MSP430F5529 Launchpad; which acts as the transmitter. Phototransistor which acts as the receiver is also integrated with the

MSP430F5529 Launchpad. LED transmits the data serially to the module on the parking side; whereas the phototransistor receives the data serially. In this module two IR Detectors are used to detect the free parking slots.

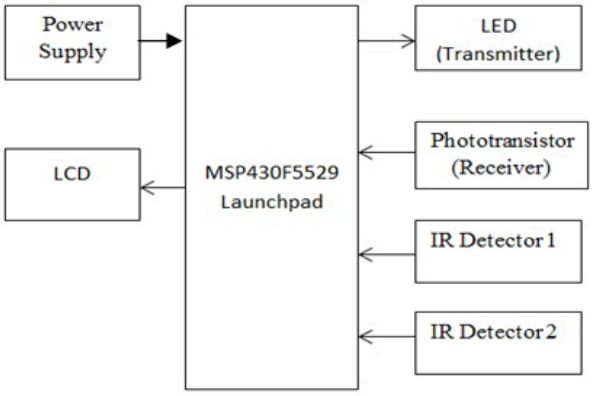

Figure-3. Block diagram of parking slot detector module.

SOFTWARE OF THE PROPOSED SYSTEM

Energia

Energia is an open-source platform for electronics. Energia IDE is a cross platform and supported by Linux, Windows and Mac OS. Mspgcc compiler is used by the Energia and is mainly based on wiring and Arduino framework. An IDE is included in the Energia which is based on processing. Energia is also considered to be as a portable framework. Other wireless interface modules namely Wi-Fi, ZigBee, cellular, NFC, etc., are included in the platform. Energia supports both Arduino and MSP boards for programming.

Software Algorithm

The free parking slots in first floor and second floor on the parking side are detected using the IR Detector and the values are analyzed and monitored in the MSP430F5529 microcontroller unit. Requested information about free parking slots is displayed on the interfaced LCD. The software algorithm for detecting and analyzing the free parking slots is as follows:

Step 1: Include header files for Interfacing LCD with the Microcontroller unit.
Step 2: Initialize all the macros and variables
Step 3: Initialize all the three modules namely Parking Slot Enquiry Module, Parking Slot Monitoring Module and Parking Slot Detector Module
Step 4: Initialize digital ports for interfacing two IR detectors to detect the free parking slots.
Step 5: Initialize the GPIO pin to interface a switch, to send the query about free parking slots
Step 6: Initialize ports for LCD operating in 4-bit Mode.
Step 7: Initialize the two serial ports Serial 0 and Serial 1.
Step 8: Begin the infinite while loop, read the digital value from the switch. If the read value is 0, a query request '*1' will be sent to the first floor module.
Step 9: First floor module detects the free parking slots and sends a query request '*1'to the second floor module.
Step 10: Second floor module upon acquiring request from the first floor module, it detects free parking slots in that floor and sends the detected results.
Step 11: The detected results from both floors are sent to the Parking Slot Enquiry Module by '#2' followed by detected results.
Step 12: Repeat from step 8 for further detecting the free parking slots.

EXPERIMENTAL RESULTS

The Visible Light Communication based Smart Parking System consists of three modules namely Parking Slot Enquiry module, Parking Slot Monitoring module and Parking Slot Detector module. Each module consists of an MSP430F5529 LaunchPad, powered by 5V supply voltage. A 16x2 LCD display unit is interfaced with the three modules to display the corresponding results. In the developed system LED's are interfaced to transmit the requested data; whereas phototransistors are interfaced to receive the transmitted data. The overall system module is shown in Figure-4.

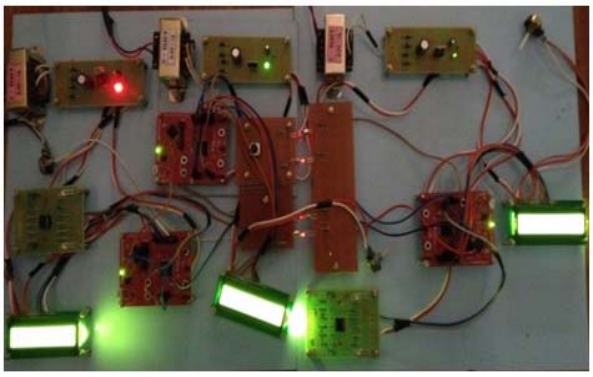

Figure-4. Visible light communication based smart parking system.

Parking Slots Empty Condition

In this condition, the IR Detector detects that all the parking slots in both the floors are empty. In the proposed system two parking slots are considered in both first floor and second floor. Each parking slot is been provided with an IR Detector. If the signal between the IR transmitter and IR receiver is cut down, then it is assumed that a car is parked in that particular slot. The parking slots are free in both the floors as shown in the Figure-5.

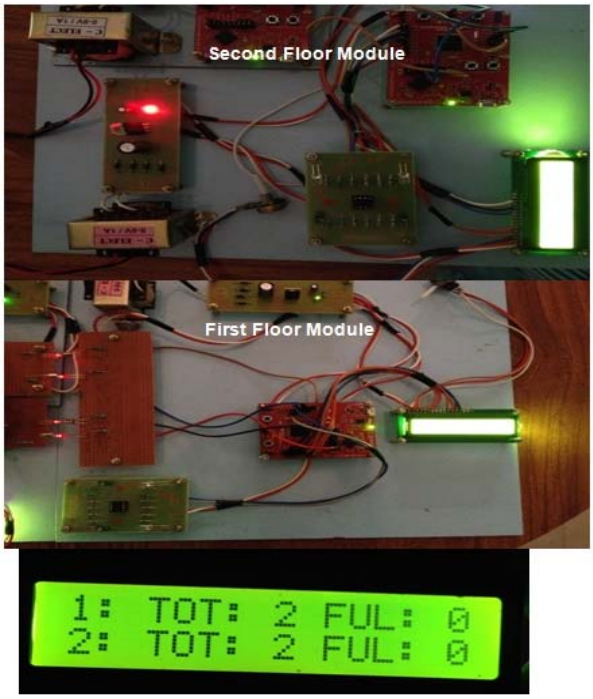

Figure-5. All parking slots are free.

One Parking Slot is Free in both Floors

In this condition, the IR Detector detects that one parking slot in both the floors are empty. In the proposed system two parking slots are considered in both first floor and second floor. Each parking slot is been provided with an IR Detector. If the signal between the IR transmitter and IR receiver is cut down, then it is assumed that a car is parked in that particular slot. In this condition one parking slot in both the floors are free as shown in the Figure-6.

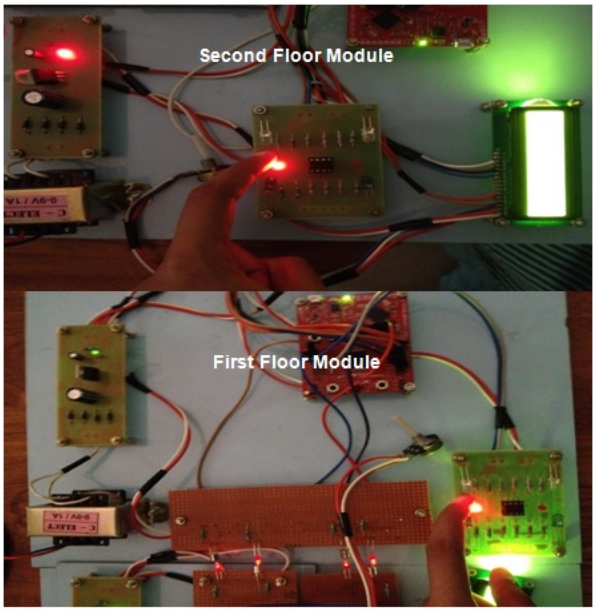

Figure-6. One parking slot is free in both the floors.

Parking is Full

In this condition, the IR Detector detects that no parking slot in both the floors are empty. In the proposed system two parking slots are considered in both first floor and second floor. Each parking slot is been provided with an IR Detector. If the signal between the IR transmitter and IR receiver is cut down, then it is assumed that a car is parked in that particular slot. In this condition no parking slot in both the floors is free as shown in the Figure-7.

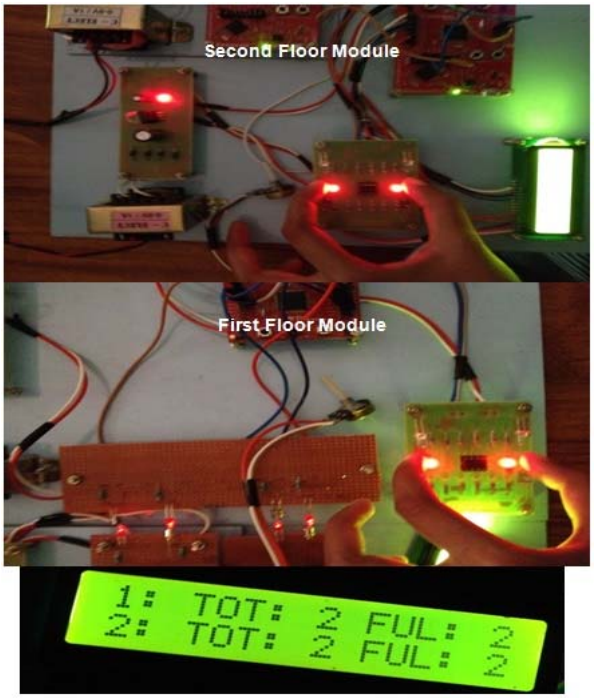

Figure-7. Parking is full.

GSM Modem Initialization

The GSM Modem SIM 800 initialization setup is shown in the Figure-8. The SIM800, a GSM modem is initialized through the AT Commands through software.

Figure-8. GSM modem initialization.

Message Sent to Phone

The parking slots detected through IR Detectors is sent to the mobile phone through GSM. The message received in the mobile phone is shown in the Figure-9.

Figure-9. Message sent to phone.

RESULT ANALYSIS

The experimental results of Visible Light Communication based Smart Parking System is shown in the Table-1. The result analysis shows the various conditions available in the project. There are four conditions available in the experiment as both the parking slots are free, both the parking slots are occupied and any one of the parking slot is empty. These conditions can be expressed in terms of boolean values as on and off. The on resembles 1 and off resembles 0.

Table-1. Experimental results.

Parking Slot/Condition	Slot 1	Slot 2	Result
Condition 1	Present	Present	No Parking Available
Condition 2	Present	Not Present	Parking Available
Condition 3	Not Present	Present	Parking Available
Condition 4	Not Present	Not Present	Parking Available

The result for Condition 1 explains that both the parking slots are occupied with vehicle which results that parking is full so no parking is available. The Conditions 2 and 3 shows that any one of the slot is occupied by vehicle which results that parking is available. The Condition 4 shows that both the slots are not occupied with vehicles which results that parking is available.

CONCLUSIONS

Thus the Visible Light Communication based Smart Parking System monitors and detects the free parking slots in the parking side and displays the detected free slots to the people who use the parking service by using the modules Parking Slot Enquiry module, Parking Slot Monitoring module and Parking Slot Detector module. IR Detectors are used to detect the free slots. A GSM module is also interfaced to send the free parking slot information to the mobile used by the car user. Thus the system eliminates the time required to find out the empty parking slot and reduces fuel consumption. As Visible Light Communication technology is used for data transmission and reception, energy consumption is also considered to be less. The system is simple, consumes less power and reduces wireless interference.

FUTURE WORK

As Visible Light Communication based Smart Parking System uses only single LED and phototransistor to transmit and receive data serially, the proposed system requires line-of-sight between LED and phototransistor. In future, the system can be implemented by using the readily market available LED bulbs which can be driven to transmit data; and also these LED bulbs acts as the lightning system. These LED's bulbs can be interfaced to enhance the data transmission at faster rate to enable users to communicate anytime and anywhere in safer manner. Apart from these LED bulbs, power LED's can also be used. The work can also be extended by providing direction map to the available free slots. Payment for parking can also be added by automating the payment through IOT via integrating the bank details. IOT can also be used to control the IR Detectors and maintain a database of parking slots.

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