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Smart Room Entry System with Occupancy Detection

Project Report Submitted to

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Of

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in
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By

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1.ABSTRACT

In response to the growing need for energy-efficient solutions in modern living spaces, this mini-project “Enhancing Room Automation and Energy Efficiency: Smart Room Entry System with Occupancy Detection” introduces a Smart Room Entry System equipped with occupancy detection sensors and adaptive fan control. The objective is to design and implement a system that optimizes energy utilization while enhancing user experience. By automatically adjusting room amenities such as lighting and fan speed based on human presence, the system aims to promote energy conservation and improve comfort levels for occupants.

The Smart Room Entry System utilizes a combination of sensors, including IR sensors, to detect human presence within the room. Upon detection, the system activates the necessary amenities such as turning on lights and adjusting fan speed. Conversely, when the room is vacant, the system switches off lights and reduces fan speed to conserve energy. The integration of a servo motor enables the system to adjust fan speed dynamically based on the number of occupants present, ensuring optimal comfort levels.

This mini project showcases the potential of embedded systems in creating intelligent living spaces tailored to modern lifestyle needs. By leveraging sensor technology and adaptive control mechanisms, the Smart Room Entry System offers an innovative solution to enhance room automation and energy efficiency. The proposed system serves as a demonstration of how technology can be harnessed to create sustainable and user-friendly environments, contributing to a more energy-conscious future.

2.INTRODUCTION

2.1 SCOPE

This project "Enhancing Room Automation and Energy Efficiency: Smart Room Entry System with Occupancy Detection " encompasses the design and implementation of a sophisticated room automation system. This system utilizes sensor technology and adaptive control mechanisms to optimize energy utilization and enhance user comfort in residential and commercial spaces. Using occupancy detection sensors, the system can automatically activate and adjust lighting and fan speed based on occupancy levels. Additionally, the system is designed to conserve energy by switching off lights and reducing fan speed when the room is vacant, thereby promoting sustainable energy practices.

2.2 PROJECT DESCRIPTION

The "Enhancing Room Automation and Energy Efficiency: Smart Room Entry System with Occupancy Detection " project involves the development of a sophisticated system designed to automate room entry and regulate amenities based on occupancy levels. The system utilizes a combination of advanced sensors and control mechanisms to optimize energy utilization while enhancing user comfort and safety. At the core of the system is the LPC 1768 microcontroller, which serves as the central processing unit for data collection and control op Two IR sensors are employed to detect human presence within the room. These sensors are strategically placed to cover the entire room area effectively. Upon detecting occupancy, the system activates the necessary amenities such as lighting and fan control. Additionally, a servo motor is integrated into the system to dynamically adjust fan speed based on the number of occupants present, ensuring optimal comfort levels. At the core of the system is the LPC 1768 microcontroller, which serves as the central processing unit for data collection and control operations. Two IR sensors are employed to detect human presence within the room. These sensors are strategically placed to cover the entire room area effectively. A built-in LED indicator serves as a visual cue to users, signaling when room conditions fall below predefined thresholds. This indicator enhances safety and usability, particularly in congested environments where awareness of occupancy levels is crucial. The integration of the LED indicator adds an extra layer of functionality to the system, further improving user experience.

2.3 PROBLEM STATEMENT

In modern living and working environments, there is a pressing need for efficient management of room amenities such as lighting and ventilation to ensure comfort and promote energy conservation. However, conventional methods of room automation often lack adaptability and responsiveness to dynamic occupancy levels, leading to energy wastage and suboptimal user experience. Additionally, the absence of real-time feedback mechanisms regarding room occupancy and amenity status poses challenges for users in effectively managing room usage.

2.4 OBJECTIVE

The objective of the "Enhancing Room Automation and Energy Efficiency: Smart Room Entry System" project is to develop an advanced room automation system that optimizes energy utilization and enhances user experience and safety. The project aims to design and implement a smart system equipped with occupancy detection sensors and adaptive fan control mechanisms to regulate room amenities such as lighting and fan speed based on occupancy levels. By integrating advanced sensor technology and control mechanisms, the project seeks to enhance user comfort, promote energy conservation, and improve safety in residential and commercial spaces. Additionally, the project aims to provide real-time feedback to users regarding room occupancy and amenity status through an LCD screen and LED indicator, thereby enhancing user awareness and interaction with the system. Ultimately, the objective is to create a dependable and user-friendly room automation system that prioritizes energy efficiency and user convenience, contributing to a more sustainable and secure living environment.

3.Methodology:

3.1. Components Required:

a) Hardware Requirements:

1.Power Supply(5V)

2.Cross-cable for programming and serial communication.

3. 10 core FRC cables, 8 inches in length.

4.One-working USB portin the host computer system and PC for downloading the software.

5.LM393 IR Sensor (2)

6.USB-to-B-type cables

7. LPC1768 Microcontroller

8. 16x2 LCD Display

b) Software Requirements:

1.Language: C

2. Application: Keil MicroVision, Flash Magic

Fig 1: hardware of LPC1768 Kit

3.2.Block Diagram

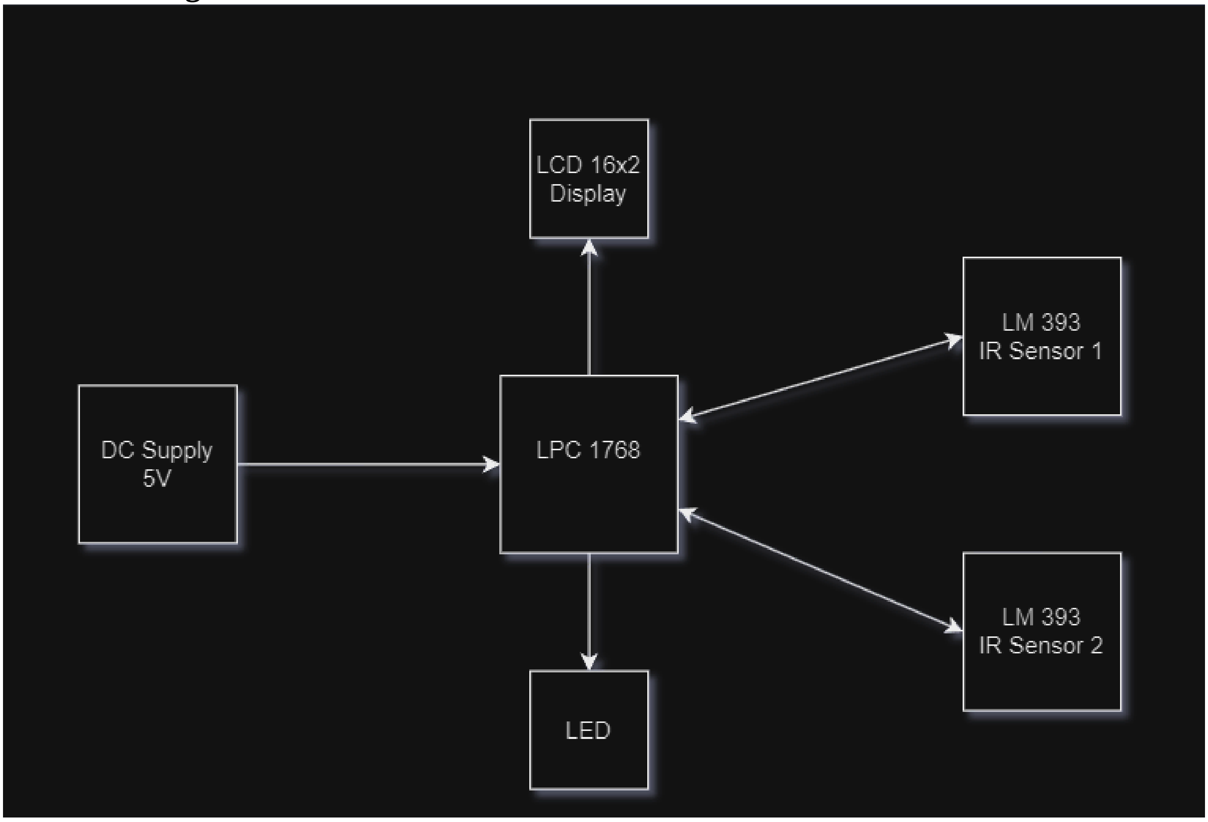

Fig 2: Block Diagram

3.3.Description about the connection

In this setup, the two LM393 IR Sensors are connected to the LPC1768 microcontroller's pins P2.12 and P2.13. These sensors detect the presence of individuals within the monitored area. The microcontroller processes the signals from these sensors, utilizing a simple algorithm to determine occupancy status. If at least one person is detected, the microcontroller sends a signal to pin P2.11, causing the connected LED to glow. This LED serves as a visual indicator, providing immediate feedback on the presence of people in the room. Additionally, the microcontroller updates the LCD display, showing the current count of individuals inside the room. This setup enables real-time monitoring of occupancy levels and provides a user-friendly interface for users to quickly assess the situation. Testing ensures the accurate functioning of the sensors, LED, and LCD, guaranteeing reliable performance in various scenarios.

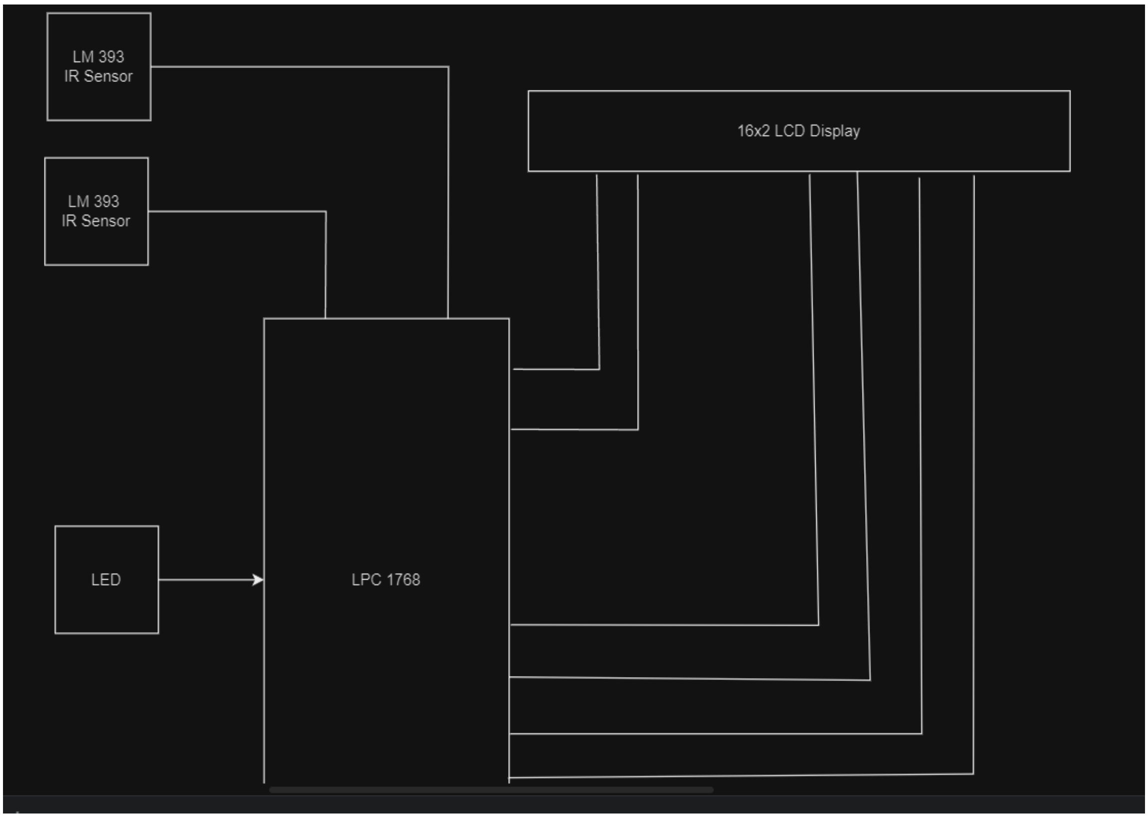

FIG 3: Circuit Diagram

a) Method

3.4.Working Principle:

1. LPC1768 Microcontroller:
The LPC1768 is a microcontroller based on the ARM Cortex-M3 architecture. Its primary function is to process digital and analog inputs, execute program instructions, and interact with various peripheral devices. The working principle of the LPC1768 involves the following key aspects:
Central Processing Unit (CPU): The microcontroller's CPU executes program instructions stored in its flash memory. It performs arithmetic and logical operations, controls program flow, and manages data.
Input/Output (I/O): The LPC1768 has various digital and analog input and output pins. It can read digital signals from sensors, control external devices, and interface with peripherals like displays, sensors, and communication modules.
Memory: The microcontroller has both flash memory for program storage and RAM for data storage. It uses flash memory to store the program code that it executes.
Peripherals: LPC1768 has various built-in peripherals, including UART, I2C, SPI, PWM, and ADC. These peripherals allow it to communicate with other devices and perform tasks like analog-to-digital conversion (ADC) to read analog sensor data.
Programming: The microcontroller is programmed using a programming language like C/C++ and a development environment like Keil. The programmer writes code to define the microcontroller's behavior, which is then compiled and loaded onto the microcontroller's flash memory.[2]

2.IR Sensor
The LM393 infrared (IR) sensor functions by utilizing the principle of detecting infrared radiation emitted or reflected by objects in its field of view. This sensor typically consists of an IR emitter and a receiver. The emitter emits infrared radiation, while the receiver detects the radiation reflected from nearby objects.

When an object is present within the sensor's range, it absorbs some of the emitted infrared radiation and reflects the rest back towards the sensor. The receiver then detects this reflected radiation and measures its intensity.

The intensity of the received infrared radiation is converted into an electrical signal, which can be processed to determine the presence, distance, and sometimes even the composition of the detected objects.

3. Output through LCD:

The data obtained from the IR sensor is transformed into actionable insights through various output mechanisms in collaboration with the LPC1768 microcontroller:
LCD: Number of people entering and exiting a room is showcased on a LCD, offering a continuous and comprehensive overview of the number of people present in the room. In summary, the LPC1768 microcontroller manages the operation of the IR Sensor, processing its analog output to find out the number of people present in the room. The IR sensor, utilizing its ability to detect Infrared radiation. The combined system effectively communicates with the IR Sensor input through an LCD providing users with versatile tools for accuracy.

4.List of Figures

5.Results and Discussion

The IR-based Smart Room Entry system, calibrated within a predefined range, showcases the number of people entering and exiting a room. When IR sensor detects the Infrared Radiation, it processes signals and feeds it to the LPC1768 and counts the number of times it detects the IR radiation, that is the number of people entered. The LCD then displays the number of people in the room. This dual-response system with the IR sensor and LCD display ensures accurate and timely feedback for effective Room Entry management.

1.Infrared Radiation Detection:
LM393 IR sensor detects the presence of Humans and provides digital readings.
2. LCD Updates:
Whenever a person enters the room or exits the room, the LCD updates the number of people in the room.

6.Relevance

This project features the IR-sensor, LPC1768 microcontroller, and LCD display and offers practical applications in real-world scenarios, particularly in automating the Room Entrance.

By automating the process of tracking entries and exits, the system reduces the need for manual monitoring and record-keeping. This frees up human resources for more productive tasks and provides convenience in managing room access. Especially in the context of public health concerns such as during pandemics, contactless entry systems minimize physical interactions and help in maintaining hygiene protocols by reducing the need for touch-based access controls. The data collected by the system provides valuable insights into room occupancy patterns over time. This information can be used for space planning, optimizing seating arrangements, and scheduling maintenance or cleaning activities based on usage patterns. By automating the tracking of people entering and exiting a room, the system enhances security measures. It can help in monitoring unauthorized access and detecting any anomalies in real-time, thereby improving overall safety within the premises.

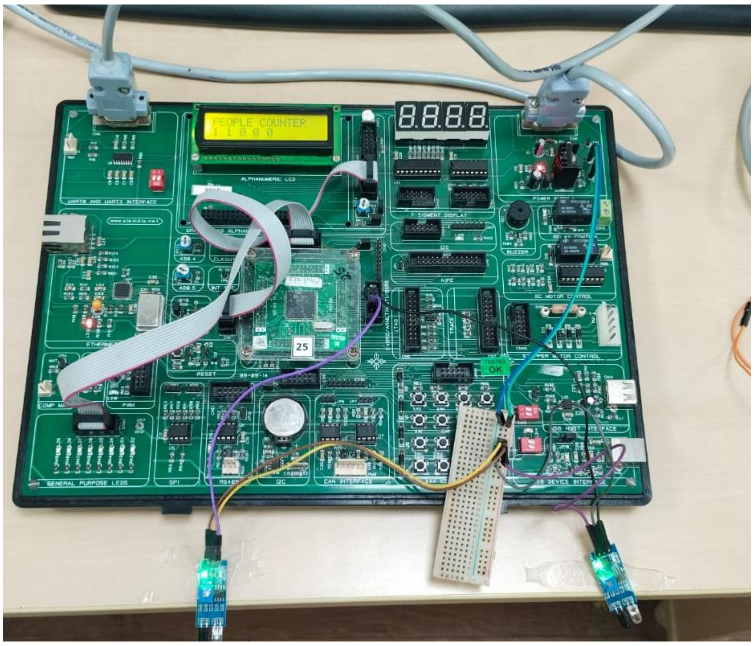

FIG 4: Demonstration Of IR Sensor counting number of people entering and exiting a room

FIG 5: LM 393 IR Sensor

7.CONCLUSIONS AND FUTURE WORK

The project focusing on the Smart Entry Room System, utilizing IR sensors, showcases a significant advancement in entry control and occupancy management. By seamlessly integrating IR sensors with the LPC1768 microcontroller, the system efficiently detects and manages room occupancy, thereby enhancing security and convenience.

This innovative project ensures precise monitoring of room occupancy and dynamically adjusts entry control mechanisms based on real-time data from IR sensors. The LPC1768 microcontroller oversees the system's operation, processing sensor data to provide accurate occupancy status and initiating automated responses tailored to the room's environmental conditions.

Real-time occupancy data is prominently displayed on an LCD screen, facilitating continuous monitoring and enabling users to make informed decisions regarding room access.

The successful execution of this project underscores the team's expertise in sensor integration, data processing, and microcontroller programming. Overcoming challenges during development underscores the team's adaptability and problem-solving skills, particularly in addressing the intricacies of smart entry room systems.

As advancements in sensor technology and microcontroller capabilities persist, projects like these pave the way for smarter, more responsive environments, revolutionizing access control systems and optimizing resource utilization in various settings.

FUTURE SCOPE:

This project presents promising avenues for future developments:

1. IOT Integration: Incorporate Internet of Things (IoT) capabilities to enable remote monitoring and control of the entry system via mobile applications or web interfaces, allowing users to manage access permissions and receive real-time notifications.
2. Multi-Sensor Fusion: Combine data from multiple sensors, such as IR sensors, motion sensors, and environmental sensors, to create a comprehensive understanding of room occupancy, activity levels, and environmental conditions.
3. Integration with Smart Building Systems: Integrate the entry system with broader smart building systems, allowing for seamless interaction with other building automation components such as lighting, HVAC, and security systems.

8.References if any (in IEEE format)

1. https://www.electronicshub.org/automatic-room-lighting-system-using-microcontroller/
2. https://www.researchgate.net/publication/235934526_Development_of_a_Microcontroller-Controlled_Security_Door_System

9.C code with comments:

```
#include <LPC17xx.h>

#include <stdio.h>

#include <string.h>


#define DATA_CTRL 0xF << 15

#define RS_CTRL 0x1 << 19

#define EN_CTRL 0x1 << 20



#define DELAY 5000000


void lcd_init(void);

void write_command(void);

void clear_disp(void);

void delay(unsigned int);

void lcd_command_send(void);
```

```
void write_data(void);
void lcd_data_send(void);
void clear_ports(void);
void lcd_puts(unsigned char *);
extern unsigned long int temp1, temp2;
unsigned long int temp1 = 0, temp2 = 0;
unsigned int space=10;



int main(void)
{
   unsigned char lcd_line_1[50] = "No. Of people";
   unsigned char lcd_line_2[50] = "";
   unsigned int sen1, sen2, flag1, flag2, count;

   SystemInit();
   SystemCoreClockUpdate();

// Set P0.21-P0.15 as LCD output
   LPC_GPIO0->FIODIR = RS_CTRL | EN_CTRL | DATA_CTRL;
   LPC_GPIO2->FIODIR=1<<11;



   lcd_init();

delay(100000);

      temp1 = 0x80
      lcd_command_send();//Command sent to write to first line of lcd
      delay(800);
```

```
        lcd_puts(&lcd_line_1[0]);


    while (1)

    {

        sen1 = (LPC_GPIO2->FIOPIN & (1<<12)) >> 12;


        sen2 = (LPC_GPIO2->FIOPIN & (1<<13)) >> 13;


/*if(!sen1 & !sen2){

continue;

}*/


        if (!sen1 & !flag2) {//if first sensor detects motion and the second sensor has not yet detected, flag1 is set to 1(first detector has detected motion)

            flag1 = 1;

        }


        if (!sen2 & !flag1) {//if second sensor detects motion and first sensor has not detected,flag2 is set to 1.

            flag2 = 1;

        }


        if (flag1 & !sen2){//if second sensor detects after first sensor has detected, person enters, count is increased and space is decreased.

    flag1 = flag2 = 0;//flags are reset, for subsequent iterations

            count++;

    space--;

        }


        if (flag2 & !sen1){//if first sensor detects after second sensor has detected, person leaves, count is decreased and space is increased.

            flag1 = flag2 = 0;//flags are subset for subsequent iterations
```

```
    count--;
   space++;
        }
if((count>0)&&(!LPC_GPIO0->FIOPIN&&1<<23)//checking if the LDR detects light in the
day.
{
LPC_GPIO2->FIOSET=1<<11;//if there is atleast one person in the room, the light is
switched on
}
else
{
LPC_GPIO2->FIOCLR=1<<11;//if there are no people in the room, the light is switched off.
}


             temp1 = 0xC0;
        lcd_command_send();
        delay(800);
        sprintf(lcd_line_2, "         %u  %u   ", space, count);//printing number of people and
space available in room
        lcd_puts(&lcd_line_2[0]);


delay(DELAY);
}
}


void lcd_init()
{
    clear_ports();
    delay(3200);
    temp2 = (0x30 << 15);
    write_command();
```

```
    delay(30000);
    temp2 = (0x30 << 15);
    write_command();
    delay(30000);
    temp2 = (0x30 << 15);
    write_command();
    delay(30000);
    temp2 = (0x20 << 15);
    write_command();
    delay(30000);
    temp1 = 0x28;
    lcd_command_send();
    delay(30000);
    temp1 = 0x0C;
    lcd_command_send();
    delay(800);
    temp1 = 0x06;
    lcd_command_send();
    delay(800);
    temp1 = 0x01;
    lcd_command_send();
    delay(10000);
    temp1 = 0x80;
    lcd_command_send();
    delay(800);
    return;
}

void lcd_command_send(void)
{
```

```
    temp2 = temp1 & 0xF0;
    temp2 = temp2 << 11;
    write_command();
    temp2 = temp1 & 0x0F;
    temp2 = temp2 << 15;
    write_command();
    delay(1000);
    return;
}

void write_command(void)
{
    clear_ports();
    LPC_GPIO0->FIOPIN = temp2;
    LPC_GPIO0->FIOCLR = RS_CTRL;
    LPC_GPIO0->FIOSET = EN_CTRL;
    delay(25);
    LPC_GPIO0->FIOCLR = EN_CTRL;
    return;
}

void lcd_data_send(void)
{
    temp2 = temp1 & 0xF0;
    temp2 = temp2 << 11;
    write_data();
    temp2 = temp1 & 0x0F;
    temp2 = temp2 << 15;
    write_data();
    delay(1000);
```

```
    return;
}

void write_data(void)
{
    clear_ports();
    LPC_GPIO0->FIOPIN = temp2;
    LPC_GPIO0->FIOSET = RS_CTRL;
    LPC_GPIO0->FIOSET = EN_CTRL;
    delay(25);
    LPC_GPIO0->FIOCLR = EN_CTRL;
    return;
}

void delay (unsigned int limit)
{
    unsigned int i;
    for (i = 0; i < limit; i++);
    return;
}

void clear_disp(void)
{
    temp1 = 0x01;
    lcd_command_send();
    delay(10000);
    return;
}

void clear_ports(void)
```

```
{
    LPC_GPIO0->FIOCLR = 0xF << 15;
    LPC_GPIO0->FIOCLR = RS_CTRL;
    LPC_GPIO0->FIOCLR = EN_CTRL;
    return;
}

void lcd_puts(unsigned char *buf1)
{
    unsigned int i = 0;
    while (buf1[i] != '\0')
    {
        temp1 = buf1[i++];
        lcd_data_send();

        if (i == 16)
        {
            temp1 = 0xC0;
            lcd_command_send();
        }
    }
    return;
}
```

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