Lift Automation Using Ultrasonic Sensor

Project Report Submitted

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1. Abstract

This project focuses on the integration of the LPC1768 microcontroller and an ultrasonic sensor to create an intelligent lift control system. The LPC1768, armed with an ARM Cortex-M3 processor, forms the core of the system, providing robust processing capabilities. The ultrasonic sensor facilitates distance measurement, enabling automatic control of lighting and fan within the lift cabin. The system incorporates safety features like a user-triggered emergency alarm and manual overrides for added reliability. Rigorous testing ensures energy efficiency and seamless functionality. The success of this integration showcases the potential for scalable solutions in embedded systems, offering real-world applications in smart and energy-efficient control systems. Future directions include enhancements in user interfaces, IoT integration, energy optimization, accessibility features, and security measures.

2. Introduction

Objective:

The " Lift Automation Using Ultrasonic Sensor" project aims to develop an innovative solution for enhancing the safety and efficiency of elevator systems. The objective of this embedded systems project is to design and implement an intelligent and automated lift control system using the LPC1768 microcontroller with the Keil uVision IDE and Flash Magic programming tool. The system aims to enhance energy efficiency and user safety by automatically controlling the lighting and fan inside the lift cabin. The implemented features include the automatic activation of lights upon detecting an occupant in the lift and the subsequent automatic deactivation of lights and fan when the lift is vacant. Additionally, the system incorporates a user-triggered alarm mechanism, allowing individuals inside the lift to signal for assistance in the event of an emergency or malfunction. Furthermore, manual control switches are integrated to override the automated system, ensuring functionality even in the case of sensor failures or other technical issues. This project seeks to provide a reliable and user-friendly lift control system that prioritizes both energy conservation and user safety.

Scope:

This project involves designing and implementing an intelligent lift control system using LPC1768, Keil uVision, and Flash Magic. The system will automatically control lighting and fan based on occupancy, integrate an emergency alarm system through a buzzer and matrix keyboard, provide manual override switches for fail-safe operation, ensure a user-friendly interface, and prioritize reliability through rigorous testing and comprehensive documentation.

Project Description:

This embedded systems project focuses on creating an intelligent lift control system using the LPC1768 microcontroller, Keil uVision, and Flash Magic. The system employs occupancy sensors to enable automatic control of lighting and fan within the lift, optimizing energy usage. Upon detecting occupants, the lights and fan activate, ensuring a comfortable environment. When the lift is unoccupied, the system automatically turns off the lights and fan, contributing to energy efficiency. In addition, a user-triggered emergency alarm system is integrated using a buzzer and matrix keyboard, allowing individuals inside the lift to seek assistance in emergencies or if they become stuck. To enhance reliability, manual override switches are included for independent control, ensuring functionality in case of sensor failures or technical issues. The user interface is designed to be intuitive, with clear LED or display indications. Rigorous testing is undertaken to guarantee the system's dependability, and comprehensive documentation is provided for maintenance purposes. This project aims to deliver a sophisticated, energy-efficient, and user-friendly lift control system, prioritizing both comfort and safety in lift operations.

Hardware Requirements:

LPC1768 Development board
Ultrasonic Sensor (HC-SR04)
LED (for light simulation),
Buzzer (for alarm)
Wires
Power Supply

Software Requirements:

Language: Embedded C
Software: Keil uVision, Flash Magic

3. Working Principle:

Fig 1. Lpc1768 kit and Ultrasonic Sensor

Lpc1768 Microcontroller:

The LPC1768 is a microcontroller based on the ARM Cortex-M3 architecture, and it is manufactured by NXP Semiconductors. It is part of the LPC1700 series of microcontrollers, which are designed for embedded applications.

Processor Core:
Utilizes an ARM Cortex-M3 processor core for high performance and low power consumption, handling the execution of instructions.

Peripherals:
Integrates on-chip peripherals (e.g., UART, SPI, I2C, GPIO, timers) for communication with external devices and general-purpose input/output operations.

Memory:
Utilizes Flash memory for program storage and SRAM for data storage during program execution.

Clock System:
Features a sophisticated clock system for precise control of the processor clock frequency, crucial for meeting performance requirements and minimizing power consumption.

Communication Interfaces and Development Tools:
Supports various communication interfaces (e.g., UART, SPI, I2C) for serial communication and is programmed and debugged using development tools like Keil uVision and Flash Magic.

HC-SR04 Ultrasonic Sensor:

The ultrasonic sensor contains a transducer that converts electrical energy into ultrasonic waves (sound waves with a frequency higher than the human audible range, typically above 20 kHz). These waves are often referred to as ultrasonic pulses.

Wave Propagation:

The sensor emits ultrasonic pulses in a specific direction, usually by using a piezoelectric crystal that vibrates at the desired frequency. The ultrasonic waves travel through the air and reflect off objects in their path.

Object Detection:

When the ultrasonic waves encounter an object in their path, they reflect back towards the sensor. The time taken for the waves to travel to the object and back is measured.

- **Ultrasonic Sensor Setup:**

Connect the ultrasonic sensor to the LPC1768 microcontroller, typically using digital pins for trigger and echo signals. The trigger pin initiates the ultrasonic pulse, and the echo pin receives the reflected signal.

- **Pulse Generation**:

The LPC1768 microcontroller sends a short pulse (trigger signal) to the ultrasonic sensor through the trigger pin. This pulse triggers the ultrasonic sensor to emit a burst of ultrasonic waves.

- **Echo Reception:**

The ultrasonic waves travel through the air and, upon encountering an object, reflect back towards the sensor. The ultrasonic sensor detects the reflected waves and generates an echo signal on the echo pin.

- **Time Measurement:**

The LPC1768 microcontroller measures the time it takes for the ultrasonic pulse to travel to the object and back. This time measurement is typically done by recording the duration between sending the trigger pulse and receiving the echo pulse.

- **Distance Calculation:**

Using the known speed of sound in air, the microcontroller calculates the distance to the object using the formula:

Distance= 2 x Speed of Sound Round/trip Time

where the speed of sound is approximately 343 meters per second in air at room temperature.

- **Control Logic:**

Implement control logic in the microcontroller based on the calculated distance. For example, if the calculated distance is below a certain threshold, it can trigger actions like turning on a light, activating a buzzer like relevant response.

- **Integration with Other Components:**

Depending on the project requirements, integrate other components of the LPC1768 microcontroller, such as GPIO pins, communication interfaces (e.g., Flash Magic,), or external devices, to enhance the functionality or provide additional control features.

By combining the distance measurement capabilities of the ultrasonic sensor with the processing power and control features of the LPC1768 microcontroller, this integrated system can be utilized for applications such as obstacle detection, smart lighting control, or any scenario where distance-based control is required.

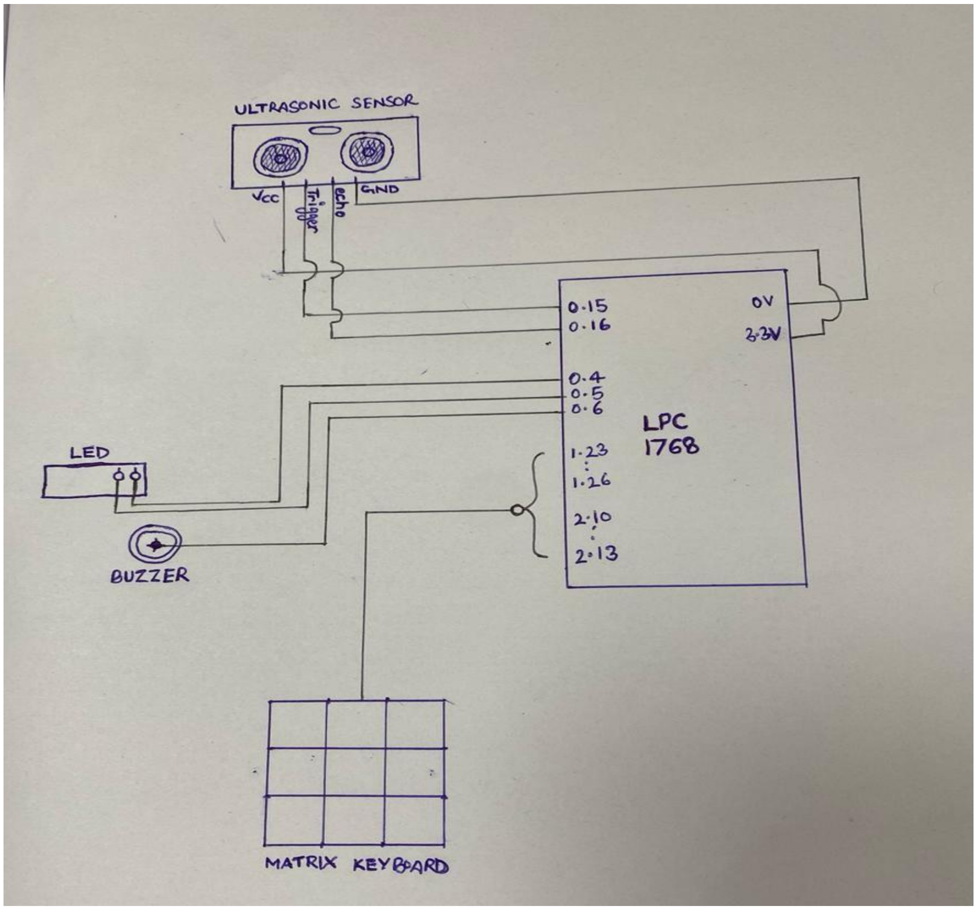

Fig 2. Circuit Diagram used for the project

4. Embedded C Working Code:

```
#include <LPC17xx.h>

#include <math.h>

#define PRESCALE 29999999

#define TRIG (1 << 15) // P0.15

#define ECHO (1 << 16) // P0.16

int temp, temp1, temp2 = 0, row, flag2, x, col, key;

int flag = 0, flag1;

int i, j, k, l, r, echoTime = 5000;
```

```
float distance = 0;

void clear_ports(void);

void delay(unsigned int r1);

void clearDisplay(void);

void startTimer0(void);

float stopTimer0();

void initTimer0(void);

void delayUS(unsigned int microseconds);

void delayMS(unsigned int milliseconds);

void delayUS(unsigned int microseconds) // Using Timer0

{
LPC_SC->PCLKSEL0 &= ~(0x3 << 2); // Set PCLK_TIMER0 to divide by 1

LPC_TIM0->TCR = 0x02; // Reset timer

LPC_TIM0->PR = 0; // Set prescaler to 0

LPC_TIM0->MR0 = microseconds - 1; // Set match register for 10us

LPC_TIM0->MCR = 0x01; // Interrupt on match

LPC_TIM0->TCR = 0x01; // Enable timer

while ((LPC_TIM0->IR & 0x01) == 0)

; // Wait for interrupt flag

LPC_TIM0->TCR = 0x00; // Disable timer

LPC_TIM0->IR = 0x01;

}
void delayMS(unsigned int milliseconds) // Using Timer0

{
delayUS(milliseconds * 1000);

}
void initTimer0(void)
```

```
{
// Timer for distance

LPC_TIM0->CTCR = 0x0;

LPC_TIM0->PR = 11999999;

LPC_TIM0->TCR = 0x02; // Reset Timer

}

void startTimer0()

{
LPC_TIM0->TCR = 0x02; // Reset Timer

LPC_TIM0->TCR = 0x01; // Enable timer

}

float stopTimer0()

{
LPC_TIM0->TCR = 0x0;

return LPC_TIM0->TC;

}

void delay(unsigned int r1)

{
for (r = 0; r < r1; r++);

}

int main()

{
int ledflag = 0;

float rounded_down;

SystemInit();

SystemCoreClockUpdate();

initTimer0();
```

```
//configuring trigger, echo, light, fan, buzzer
LPC_PINCON->PINSEL0 &= 0x3fffc0ff;
LPC_PINCON->PINSEL1 &= 0xfffffffc;
//configuring keyboard
LPC_PINCON->PINSEL3 &= 0;
LPC_PINCON->PINSEL4 &= 0;

LPC_GPIO1->FIODIR |= 0 << 16| 0<<23; // Direction for ECHO PIN and keyboard
LPC_GPIO0->FIODIR |= TRIG;
LPC_GPIO2->FIODIR |= 0xf<<10;
LPC_GPIO0->FIODIR |= 0x00000070; // Direction for Light, fan and buzzer
LPC_GPIO0->FIOCLR |= TRIG;
while (1)
{
LPC_GPIO0->FIOSET = 0x00000800;
// Output 10us HIGH on TRIG pin
LPC_GPIO0->FIOMASK = 0xFFFF7FFF;
LPC_GPIO0->FIOPIN |= TRIG;
delayUS(10);
LPC_GPIO0->FIOCLR |= TRIG;
LPC_GPIO0->FIOMASK = 0x0;
while (!(LPC_GPIO0->FIOPIN & ECHO))
{ // Wait for a HIGH on ECHO pin
}
startTimer0();
// LPC_GPIO0->FIOSET = LED_Pinsel << 4;
```

```
// echoTime--;

while (LPC_GPIO0->FIOPIN & ECHO)

; // Wait for a LOW on ECHO pin

echoTime = stopTimer0(); // Stop Counting

// LPC_GPIO0->FIOCLR = LED_Pinsel << 4;

distance = (0.0343 * echoTime) / 2;

if (distance < 20)

{
LPC_GPIO0->FIOSET = 0x00000030;

}

else

{
LPC_GPIO0->FIOCLR = 0x00000030;

}
    for (row=0;row<4;row++)

{                   flag2=0;

LPC_GPIO2->FIOPIN = 1<<(10+row);

//sending high on ith row

x = ((LPC_GPIO1->FIOPIN>>23) & 0xf); //CHECK IF ANY COLUMN LINE IS HIGH

if(x)

{
flag2=1;

//some key is pressed

if (x == 1)  //finding col no.

col = 0;

else if (x ==2)

col=1;
```

```
else if (x ==4)

col =2;
else if (x ==8)
col =3;

key = 4*row + col;
}

}

if(key == 0)

{
LPC_GPIO0->FIOSET = 0x00000040;

}

if(key == 1)

{
LPC_GPIO0->FIOSET = 0x00000030;

}

if(key == 2)

{
LPC_GPIO0->FIOCLR = 0x00000030;

}
                    if(key == 3)

{
LPC_GPIO0->FIOCLR = 0x00000040;

}

delay(88000);

}

}
```

5. Demonstration Of the lift automaton System using Lpc1768:

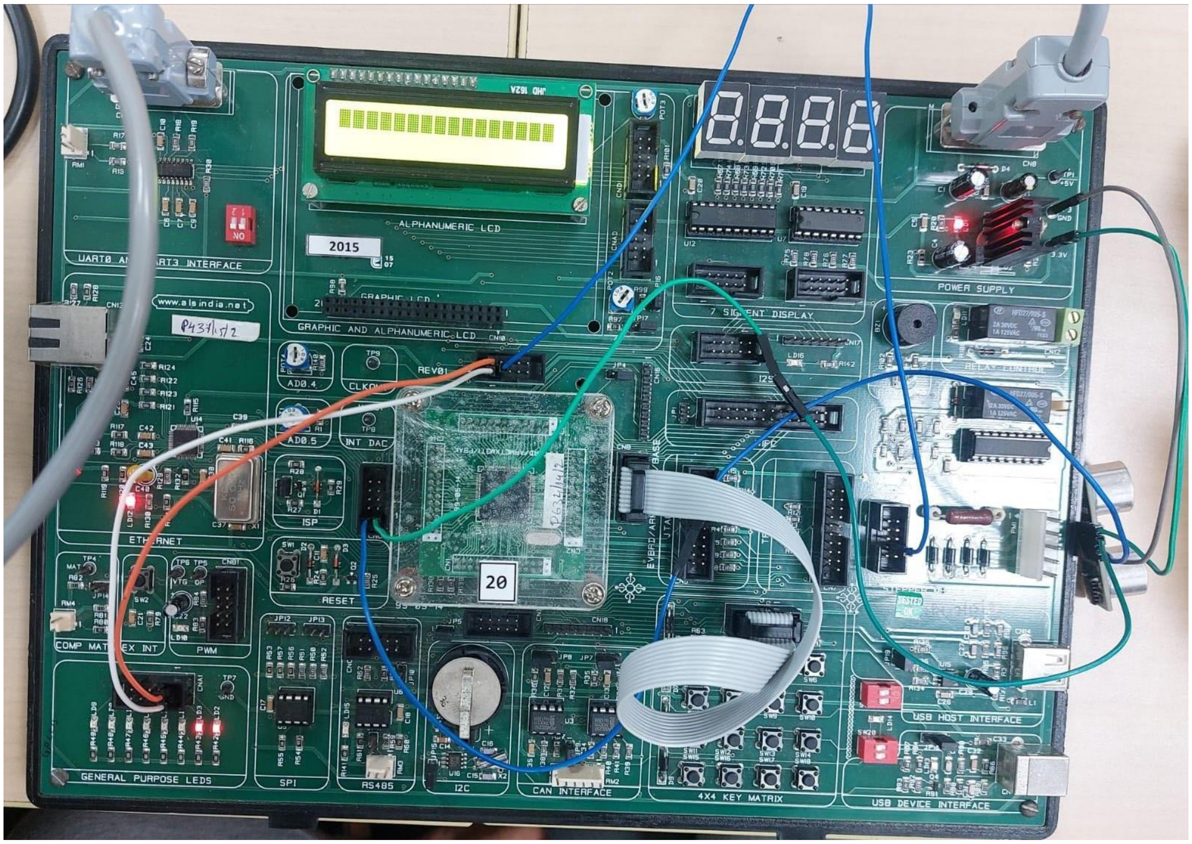

Fig 3. Working Project

6. Conclusion:

In conclusion, the integration of LPC1768 and the ultrasonic sensor in our lift control system project has proven effective for intelligent distance-based control. The ARM Cortex-M3 processor of LPC1768, along with its peripherals, provides a robust platform for real-time processing, enabling automatic lighting and fan activation based on ultrasonic sensor measurements. The system's safety features, including a user-triggered emergency alarm and manual overrides, enhance its adaptability and reliability. Rigorous testing ensures energy efficiency and seamless functionality. This project demonstrates the successful synergy of microcontroller and sensor technologies, offering a scalable solution for intelligent control systems in diverse applications.

7. Future Scope:

1. **Smart Building Integration:**
Extend the system's capabilities by integrating with broader smart building systems, enabling seamless communication and coordination with other building components.
2. **IoT Integration for Remote Monitoring:**
Explore the integration of Internet of Things (IoT) technologies to allow for remote monitoring and control, providing real-time data insights and facilitating remote diagnostics.
3. **Energy Efficiency Enhancements:**
Investigate advanced energy optimization strategies, incorporating additional sensors for environmental monitoring and occupancy prediction, coupled with adaptive control algorithms to further reduce energy consumption.
4. **Accessibility Features:**
Implement features to enhance accessibility, such as voice-guided controls and considerations for users with diverse needs, making the lift system more inclusive.
5. **Security Measures and Upgrades:**
Strengthen cybersecurity measures to protect against potential threats and regularly update software and firmware to incorporate the latest security standards, ensuring the system's resilience against evolving risks.

8. References:

[1] Rokhsana Titlee and Muhibul Haque Bhuyan, “Design, Implementation and Testing of Ultrasonic High Precision Contactless Distance Measurement System Using Microcontroller”, SEU Journal of Science and Engineering, vol. 10, no. 2, 2016

[2] Li Zhengdong, Huang Shuai, Lin Zhaoyang, Luo Weifang and He Daxi, “The Ultrasonic Distance Alarm System Based on MSP430F449”, Fifth Conference on Measuring Technology and Mechatronics Automation, 2013