**Department of I & CT**

**MIT, Manipal**

# Distance Based Automated Dustbin

**ICT 2223**

**Embedded Systems Lab Mini Project**

**IVth Sem B.Tech (IT)**

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# ABSTRACT

In today's world, hygiene and automation play a vital role in improving public health and convenience, and embedded systems provide smart solutions for everyday challenges. This project focuses on the development of a Distance-Based Automated Dustbin using the LPC 1768 microcontroller. The system integrates multiple input and output components including an ultrasonic sensor for proximity detection, a servo motor to automate lid movement, and an LCD to display user feedback. This smart dustbin is designed to enhance waste disposal practices by enabling contactless interaction, thereby reducing the risk of germ transmission and promoting a cleaner environment.

The project utilizes the LPC 1768 microcontroller and is programmed using the Keil uVision IDE. The methodology involves continuously monitoring the area in front of the dustbin using the HCSR04 ultrasonic sensor. When the sensor detects an object—typically a user's hand—within a range of 30 cm, it sends a signal to the microcontroller. The LPC 1768 then commands a servo motor to open the dustbin lid, while the LCD display provides messages such as "Lid Opening" and "Dispose Your Waste." After a delay of five seconds, the lid closes automatically, ensuring efficient operation and minimal user contact. Key components used in the design include the ARM Cortex-M3 LPC 1768 microcontroller, HCSR04 ultrasonic sensor, SG90 servo motor, and a 16x2 LCD display.

The results demonstrate that system effectively automates waste disposal through intelligent proximity sensing and motion control. The ultrasonic sensor accurately detects user presence, while the servo motor ensures smooth and timely lid movement. This project highlights the practical application of embedded systems in public sanitation, offering a responsive, hygienic, and user-friendly solution to everyday waste management.

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# INTRODUCTION

The demand for smart automation systems has surged in recent years due to growing concerns about hygiene, waste management efficiency, and public health. With technological advancements, embedded systems have become the foundation of modern automation solutions, offering reliable, cost-effective, and energy-efficient ways to enhance daily life. These systems enable the development of compact, responsive, and autonomous devices that perform complex tasks with minimal human intervention. One such application is the Distance-Based Automated Dustbin, which promotes cleanliness and hygiene by enabling hands-free waste disposal in public and private spaces. These systems integrate sensors, microcontrollers, and actuators to create a seamless, real-time mechanism that detects user proximity and operates accordingly. This project focuses on designing a smart, contactless dustbin using the LPC 1768 microcontroller, a powerful ARM Cortex-M3-based device known for its efficiency and adaptability in embedded applications.

The primary objective of this project is to develop an automated waste disposal system that enhances convenience and hygiene while reducing direct contact with the dustbin. The system utilizes an HCSR04 ultrasonic sensor to detect approaching users. When a person is detected within 30 cm, the microcontroller triggers a stepper motor to rotate and automatically open the dustbin lid, allowing waste to be disposed of without physical contact. To provide user feedback, an LCD display updates the status in real time, showing messages such as “Lid Opening” and “Dispose Your Waste.” After a delay of five seconds, the stepper motor rotates in the opposite direction to close the lid, ensuring efficient and hygienic operation. By enabling fully automated, contactless control, this design minimizes the spread of germs and enhances waste disposal efficiency in homes, offices, and public spaces.

This project explores the capabilities of the LPC 1768 microcontroller in implementing a real-time, sensor-driven waste management system that seamlessly integrates basic peripherals such as an LCD display,

ultrasonic sensor, and stepper motor. Programmed using Keil uVision IDE, the system functions as an intelligent, standalone solution for waste disposal, providing an easy-to-use interface and reliable automation. The ultrasonic sensor continuously monitors user proximity, the stepper motor ensures precise and controlled lid movement, and the LCD display provides clear, real-time feedback. This combination of accessible hardware components and robust software allows the system to function efficiently, demonstrating the potential of embedded systems in smart automation. By leveraging the full capabilities of the LPC 1768, this Distance-Based Automated Dustbin serves as a model for using embedded technology to create innovative, responsive, and practical solutions for modern waste management challenges.

# METHODOLOGY

## a. ***Components Required***

**LPC 1768 Microcontroller:**
The ARM Cortex-M3-based LPC 1768 microcontroller serves as the central controller, managing all operations of the Distance-Based Automated Dustbin. It processes sensor inputs, controls the stepper motor for lid movement, and updates the LCD display to provide real-time feedback. The microcontroller ensures fast, efficient, and autonomous operation.

**HCSR04 Ultrasonic Sensor:**
This sensor detects the presence of users approaching the dustbin. It continuously scans the surrounding area and sends distance measurements to the microcontroller. When an object is detected within 30 cm, the system triggers the stepper motor to open the lid automatically.

**Stepper Motor (e.g., 28BYJ-48) with Driver Module (e.g., ULN2003):**
The stepper motor controls the opening and closing of the dustbin lid with precise rotational control. Upon receiving a signal from the microcontroller, the motor rotates the lid open for waste disposal and then rotates back to its original position after a five-second delay to close the lid. The driver module facilitates proper voltage and current supply to the stepper motor.

**LCD Display:**
The LCD provides real-time feedback to users by displaying messages such as Lid Opening and Dispose Your Waste. It helps users understand the system status and confirms when the dustbin is ready for use, ensuring an intuitive and user-friendly experience.

**Connecting Cables (FRC, Data, and Jumper Cables):**
Flat ribbon cables, data cables, and jumper wires connect the various components to the LPC 1768 microcontroller. These cables ensure stable communication and power distribution, allowing for reliable system performance and an organized hardware setup.

## b. ***Block Diagram***

**Power Supply:** Provides electrical power to the LPC 1768 microcontroller and all connected components, ensuring uninterrupted system operation.

**LPC 1768 Microcontroller:** Acts as the central processing unit, coordinating input from the ultrasonic sensor and controlling outputs such as the servo motor and LCD display. It manages the logic for proximity detection and automated lid control.

**Input Block:**

- **Ultrasonic Sensor (HCSR04):** Continuously monitors for user presence within a 30 cm range. Sends distance data to the microcontroller to initiate lid opening when proximity is detected.
- **Reset Button:** Allows manual reset of the system in case of malfunction or unexpected behaviour.

**Output Block:**

- **LCD Display:** Provides clear user feedback by displaying real-time messages like "Lid Opening" and "Dispose Your Waste," enhancing usability.

**-Stepper Motor (e.g., 28BYJ-48):** Rotates to open the dustbin lid when a user is detected and returns it to the closed position after 5 seconds, ensuring hygiene and convenience through precise and controlled movement.

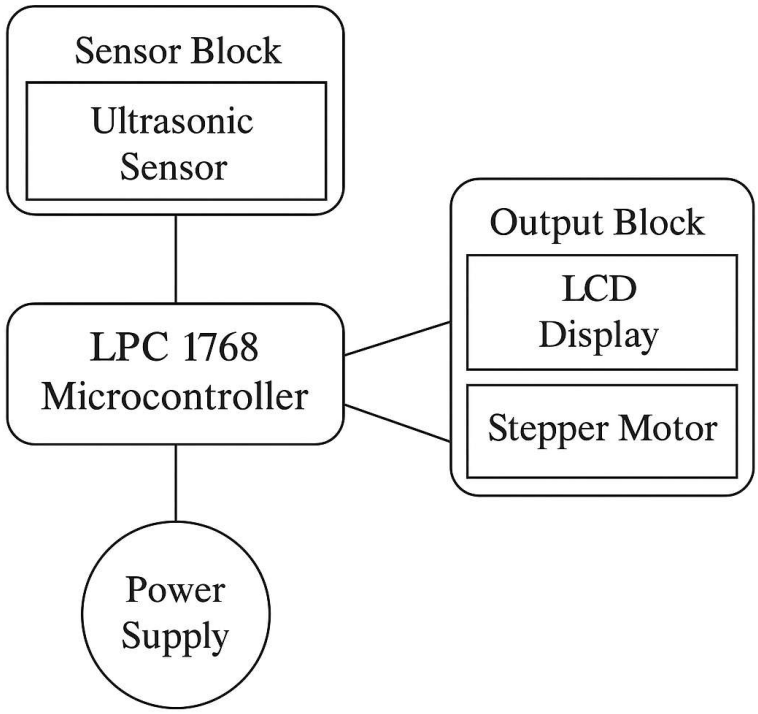



Fig. 1: Block Diagram

## c. ***Connection Description***

- **LCD Display:** The 16x2 LCD provides status updates such as "Bin Open," "Waiting for Input," or "Closing." The **RS pin is connected to P0.27**, allowing the microcontroller to switch between command and data modes. The **Enable (E) pin is connected to P0.28**, which triggers data latching. Data lines **D4-D7 are connected to P0.23-P0.26**, enabling 4-bit parallel communication. The LCD operates on **5V power** and is grounded via GND.

- **Ultrasonic Sensor (HCSR04):** The ultrasonic sensor detects the presence of a user in front of the dustbin. The **Trigger (T) pin is connected to P0.15**, which sends an ultrasonic pulse, while the **Echo (R) pin is connected to P0.16**, which receives the reflected pulse. The sensor operates at **5V** and calculates the distance to an approaching user. If the distance is within a preset threshold (e.g., 30 cm), the microcontroller commands the **stepper motor** to rotate and open the bin lid.

- **Stepper Motor:** The stepper motor controls the dustbin lid. It requires **four control pins (e.g., P2.0 to P2.3) for step sequence generation**. A **stepper motor driver module (such as ULN2003, A4988, or DRV8825)** is used to regulate the motor's power. When an object is detected within range, the LPC1768 signals the stepper motor to rotate **a fixed number of steps** to open the lid. After a set time delay, the motor rotates back to close the lid automatically. The stepper motor operates on **5V or 12V**, depending on the model used, and is powered via the driver module.

- **Power Supply:** The LPC1768 and connected components operate on **3.3V and 5V**. A **regulated power source** ensures stable voltage to prevent malfunction. The stepper motor may require an additional **external power source (e.g., 12V) depending on its specifications**.

## d. ***Method***

- **Initialization:** When the system is powered on, the **LPC1768 microcontroller initializes all components**, including the **LCD display, ultrasonic sensor, and stepper motor**. The LCD screen displays a **"System Ready"** message, indicating that the smart dustbin is operational.

- **Object Detection:** The **ultrasonic sensor (HCSR04)** continuously emits ultrasonic pulses and measures the distance of nearby objects. The **Trigger (T) pin (P0.15)** sends out the pulse, and the **Echo (R) pin (P0.16)** receives the

reflected signal. If an object (such as a user's hand) is detected **within a predefined range (≤ 30 cm)**, the microcontroller proceeds to the next step.

- **Lid Operation:** When an object is detected, the **LPC1768 signals the stepper motor to rotate the dustbin lid open**. The stepper motor is controlled via **four GPIO pins (e.g., P2.0 - P2.3) connected to a stepper motor driver (such as ULN2003 or A4988)**. The LCD displays **"Lid Opening..."** to provide visual feedback.

- **Lid Closure Delay:** The microcontroller maintains the lid **open for a few seconds (e.g., 3–5 seconds)** to allow the user to dispose of waste. After the delay, the stepper motor **rotates back to its original position**, closing the lid. The LCD displays **"Lid Closing..."** before returning to its default state

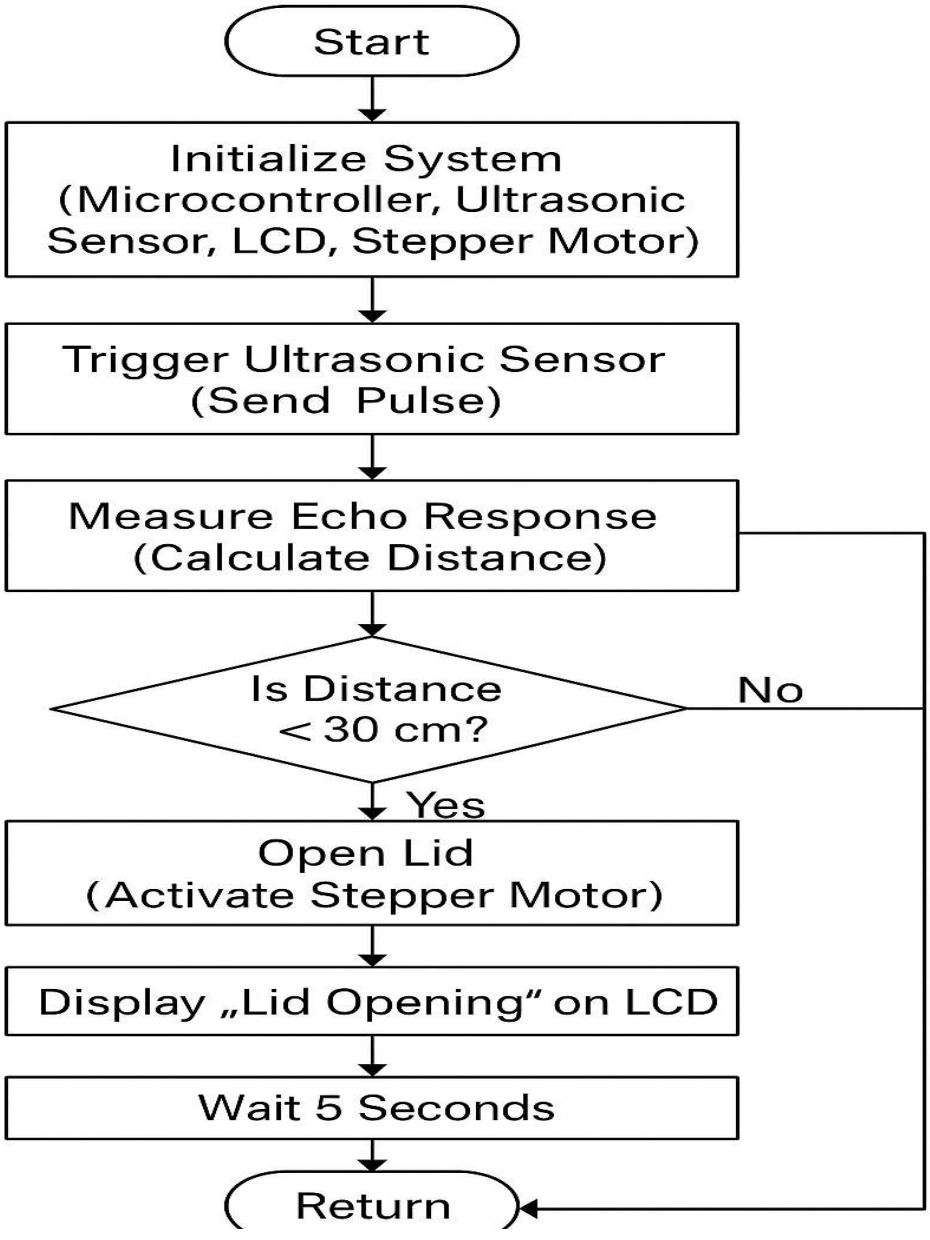
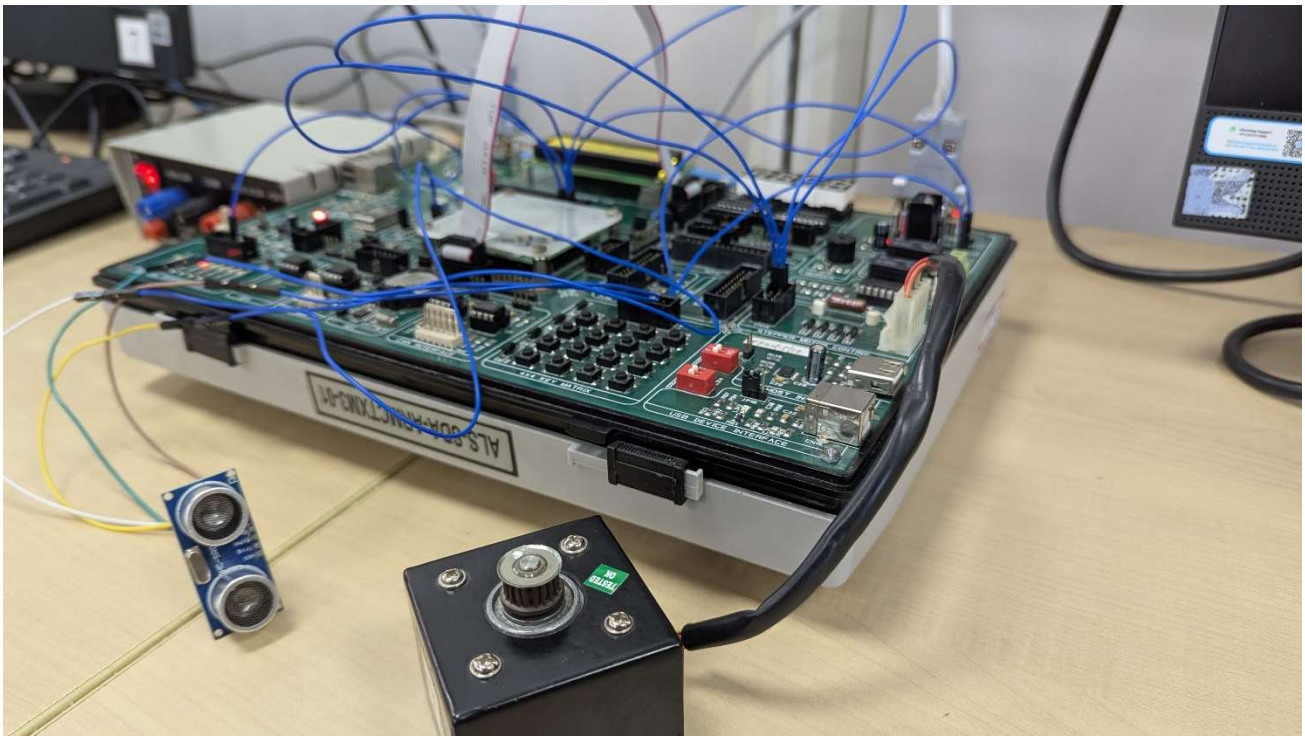
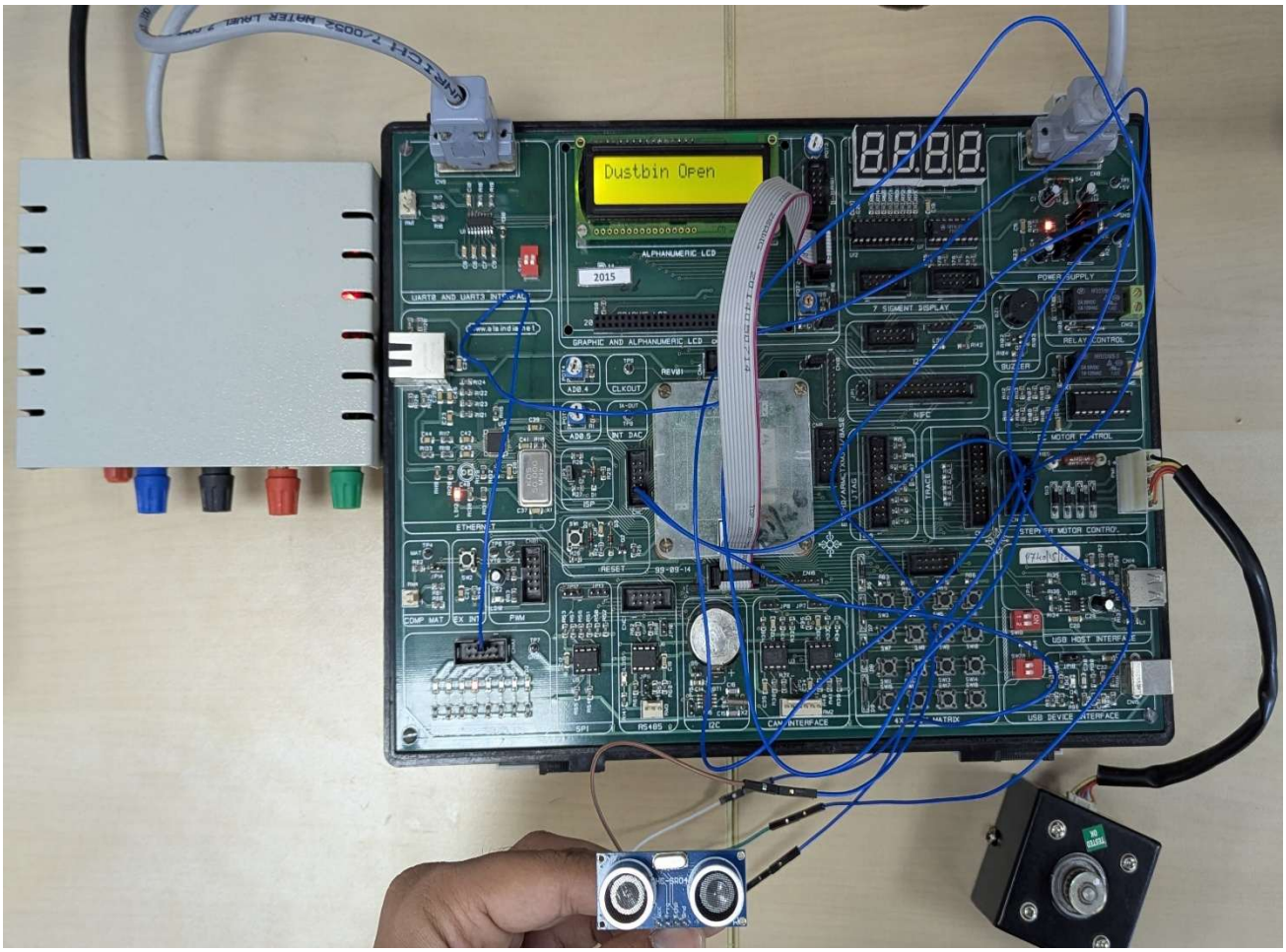



Figure 3: Flowchart Of The System

# Results and Discussion:

## a. ***Photographs***





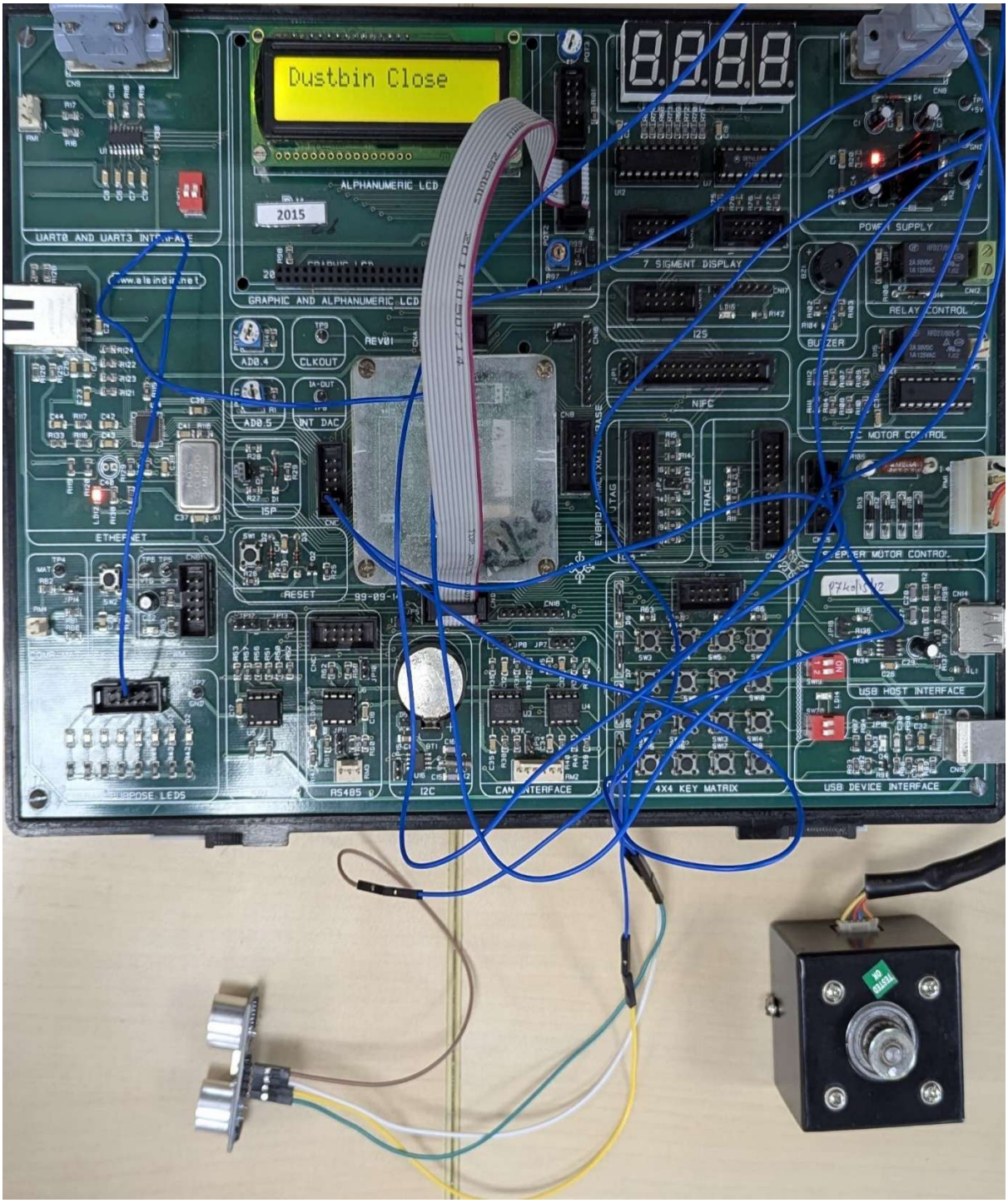



Fig. 4: Photographs of the System

## b. ***Working and relevance of the system***

The **Distance-Based Automated Dustbin** is an innovative and hygienic solution designed to enhance waste management in both public and private environments. By integrating the **LPC1768 microcontroller** with an **ultrasonic sensor** and a **stepper motor**, the system enables **fully automatic, touch-free disposal of waste**.

When a user approaches the dustbin within a preset distance (e.g., **30 cm**), the ultrasonic sensor detects their presence. The **LPC1768 then controls the stepper motor** to rotate and lift the dustbin lid, allowing the user to dispose of their waste without any physical contact. After a short delay, the stepper motor rotates in reverse to close the lid, and the system returns to standby mode.

This system is especially relevant in today's context, where **maintaining hygiene** and **minimizing surface contact** are crucial. The design is **compact, low-power, and cost-effective**, making it ideal for deployment in **homes, hospitals, offices, and public places**. Its **non-contact operation** significantly reduces the risk of germ transmission, while the **LCD display** offers user-friendly visual feedback such as **"Lid Opening..."**, **"Lid Closing..."**.

By leveraging **simple embedded hardware** and **reliable microcontroller logic**, this project showcases how embedded systems can be harnessed to create **smart, efficient, and health-conscious solutions** for everyday life.

## c. ***References:***


[1] Eran Bamani, Eden Nissinman, Inbar Meir, Lisa Koenigsberg, Avishai Sintov. "Ultra-Range Gesture Recognition using a Web-Camera in Human-Robot Interaction." 2023. Available:**sciencedirect.com**

[2] Abdullah Mujahid, Mazhar Javed Awan, Awais Yasin, Mazin Abed Mohammed, Robertas Damaševičiu, Rytis Maskeliūnas and Karrar Hameed Abdulkareem. "Real-Time Hand Gesture Recognition Based on Deep Learning." 2023. Available at: **mdpi.com**

[3] Mr. Ch. Lakshmi Narayana, M. Venkata Praveena. "Real-Time Hand Gesture Recognition System Using CNN." 2023. Available at: **rjpn.org**

# C code with comments:

```
/*
 * Smart Dustbin Project using LPC1768
 * ----------------------------------
 * This embedded system project automates the opening and closing of a dustbin lid using a stepper motor.
 * It uses an HCSR04 ultrasonic sensor to detect objects within 30 cm range. If an object (like a hand) is
 * detected, the system activates a stepper motor to rotate the lid open (anticlockwise), waits briefly,
 * and then rotates it back (clockwise) to close the lid. An LED indicates activity, and a 16x2 LCD displays
 * the current status ("Dustbin Open" or "Dustbin Close"). This system runs on an LPC1768 microcontroller.
 */

#include <LPC17xx.h>

// Pin definitions
#define TRIG_PIN 15
#define ECHO_PIN 16
#define LED_PIN 8
#define STEPPER_MASK 0x000000F0  // Stepper motor on P0.4 to P0.7

// Stepper motor 4-step full sequence
unsigned int step_sequence[] = {
    0x10, // 00010000
    0x20, // 00100000
    0x40, // 01000000
    0x80  // 10000000
};

// LCD pin definitions
#define RS (1 << 27)
```

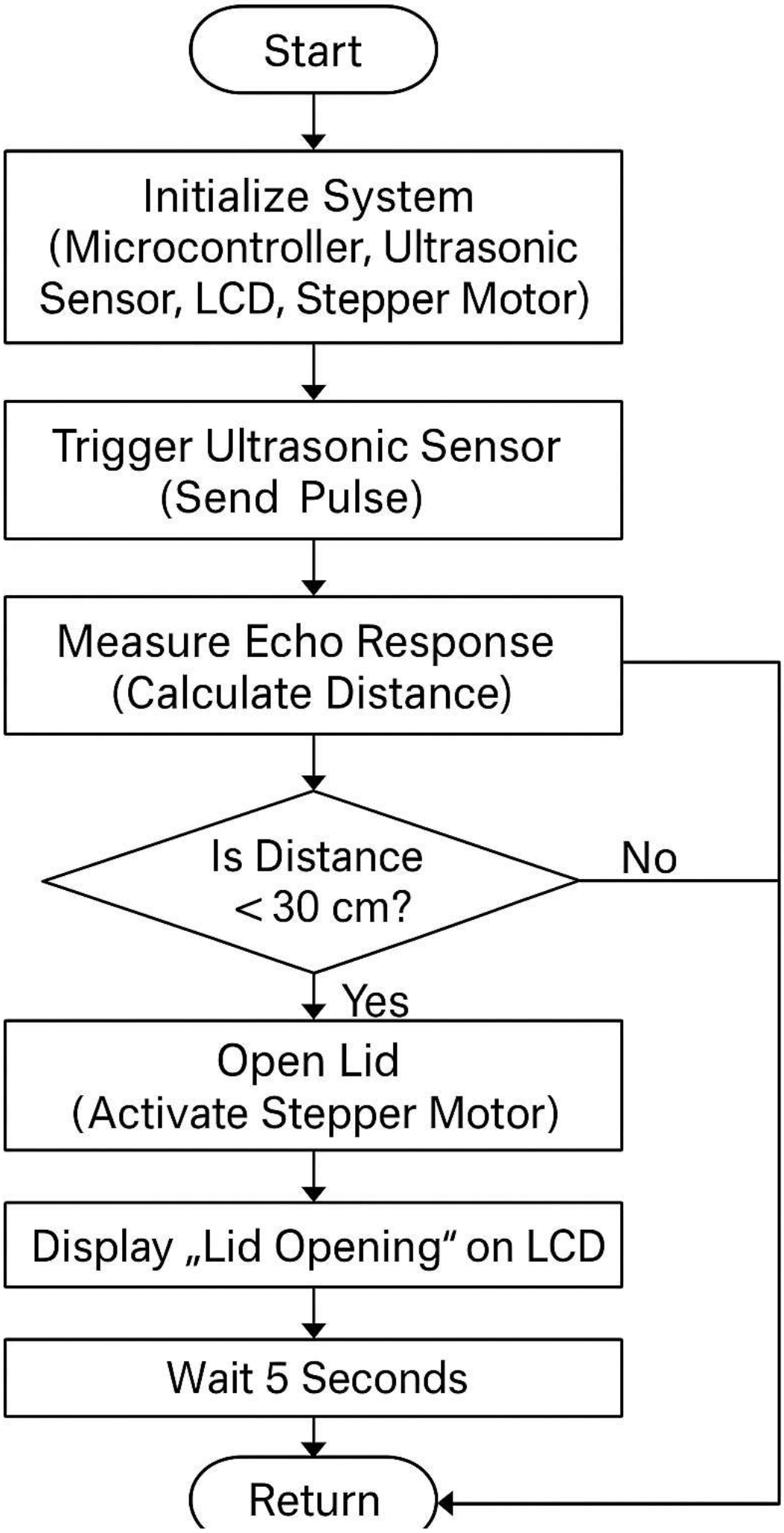
```
#define EN (1 << 28)
#define LCD_DATA_MASK 0x07800000  // Data lines D4-D7: P0.23 to P0.26

// Microsecond delay using Timer1
void delay_us(uint32_t us) {
    LPC_TIM1->TCR = 0x02;        // Reset Timer1
    LPC_TIM1->PR = 99;           // Prescaler for 1us (assuming 100MHz / 4 PCLK)
    LPC_TIM1->TCR = 0x01;        // Start Timer1
    while (LPC_TIM1->TC < us);   // Wait until desired time
    LPC_TIM1->TCR = 0x00;        // Stop Timer1
}

// Millisecond delay using delay_us
void delay_ms(uint32_t ms) {
        int i;
    for (i = 0; i < ms; i++) {
        delay_us(1000);
    }
}

// Configure GPIO directions
void init_GPIO() {
    LPC_GPIO0->FIODIR |= (1 << TRIG_PIN) | (1 << LED_PIN);   // TRIG and LED as output
    LPC_GPIO0->FIODIR &= ~(1 << ECHO_PIN);                   // ECHO as input
    LPC_GPIO0->FIODIR |= STEPPER_MASK;                       // Stepper motor pins as output
    LPC_GPIO0->FIODIR |= RS | EN | LCD_DATA_MASK;            // LCD control and data pins as output
}

// Initialize Timer1
void init_timer1() {
    LPC
```


Start
Initialize System (Microcontroller, Ultrasonic Sensor, LCD, Stepper Motor)
Trigger Ultrasonic Sensor (Send Pulse)
Measure Echo Response (Calculate Distance)
Is Distance < 30 cm?
No
Yes
Open Lid (Activate Stepper Motor)
Display „Lid Opening“ on LCD
Wait 5 Seconds
Return

```
_SC->PCONP |= (1 << 2);  // Power up Timer1
    LPC_TIM1->TCR = 0x00;       // Disable Timer1
    LPC_TIM1->PR = 0;           // Clear prescaler
    LPC_TIM1->TCR = 0x02;       // Reset Timer1
}

// Measure distance using ultrasonic sensor (in cm)
uint32_t measure_distance_cm() {
    uint32_t duration;

    LPC_GPIO0->FIOCLR = (1 << TRIG_PIN);  // Clear TRIG
    delay_us(2);
    LPC_GPIO0->FIOSET = (1 << TRIG_PIN);  // Send 10us pulse
    delay_us(10);
    LPC_GPIO0->FIOCLR = (1 << TRIG_PIN);

    while (!(LPC_GPIO0->FIOPIN & (1 << ECHO_PIN)));  // Wait for
ECHO to go high
    LPC_TIM1->TCR = 0x02;  // Reset Timer
    LPC_TIM1->TCR = 0x01;  // Start Timer

    while (LPC_GPIO0->FIOPIN & (1 << ECHO_PIN));  // Wait for
ECHO to go low
    LPC_TIM1->TCR = 0x00;  // Stop Timer
    duration = LPC_TIM1->TC;

    return duration / 58;  // Convert time to distance (based on speed of
sound)
}

// Generate EN pulse for LCD
void lcd_enable_pulse() {
    LPC_GPIO0->FIOSET = EN;
    delay_us(10);
    LPC_GPIO0->FIOCLR = EN;
    delay_us(10);
}
```

```
// Send 4-bit data to LCD
void lcd_send_nibble(unsigned int nibble) {
    LPC_GPIO0->FIOCLR = LCD_DATA_MASK;
    LPC_GPIO0->FIOSET = (nibble << 23) & LCD_DATA_MASK;
    lcd_enable_pulse();
}

// Send command to LCD
void lcd_cmd(unsigned char cmd) {
    LPC_GPIO0->FIOCLR = RS;  // Command mode
    lcd_send_nibble(cmd >> 4);
    lcd_send_nibble(cmd & 0x0F);
    delay_ms(2);
}

// Send data (character) to LCD
void lcd_data(unsigned char data) {
    LPC_GPIO0->FIOSET = RS;  // Data mode
    lcd_send_nibble(data >> 4);
    lcd_send_nibble(data & 0x0F);
    delay_ms(2);
}

// Initialize LCD in 4-bit mode
void lcd_init() {
    delay_ms(20);          // LCD power-on delay
    lcd_send_nibble(0x03); // Initialization sequence
    delay_ms(5);
    lcd_send_nibble(0x03);
    delay_us(100);
    lcd_send_nibble(0x03);
    lcd_send_nibble(0x02); // Switch to 4-bit mode

    lcd_cmd(0x28); // Function set: 4-bit, 2-line, 5x8 dots
    lcd_cmd(0x0C); // Display ON, cursor OFF
    lcd_cmd(0x06); // Entry mode: increment cursor
```

```
    lcd_cmd(0x01); // Clear display
}

// Print string to LCD
void lcd_print(char *msg) {
    int i = 0;
    while (msg[i]) {
        lcd_data(msg[i++]);
    }
}

// Rotate stepper motor
// direction = 0 (anticlockwise), 1 (clockwise)
// steps = number of steps to rotate
void stepper_rotate(int direction, int steps) {
    int i, j;
    for (j = 0; j < steps; j++) {
        for (i = 0; i < 4; i++) {
            int index = direction ? i : 3 - i;  // Choose step sequence direction
            LPC_GPIO0->FIOPIN &= ~STEPPER_MASK;          // Clear
all motor pins
            LPC_GPIO0->FIOPIN |= step_sequence[index];   // Set next
step
            delay_ms(10);                               // Wait between steps
        }
    }
    LPC_GPIO0->FIOPIN &= ~STEPPER_MASK;  // Turn off motor
after movement
}

// Main application loop
int main(void) {
    SystemInit();       // Initialize system clocks
    init_GPIO();        // Configure GPIO pins
    init_timer1();      // Setup Timer1 for ultrasonic sensor
    lcd_init();         // Initialize LCD display
```

```
    while (1) {
        uint32_t distance = measure_distance_cm();  // Get distance

        if (distance > 0 && distance < 30) {
            LPC_GPIO0->FIOSET = (1 << LED_PIN);  // Turn on LED

            lcd_cmd(0x01);       // Clear LCD
            lcd_cmd(0x80);       // Move to first line
            lcd_print("Dustbin Open");

            stepper_rotate(0, 28);  // Open lid (180° rotation)

            delay_ms(500);  // Wait before closing

            lcd_cmd(0x01);     // Clear LCD
            lcd_cmd(0x80);
            lcd_print("Dustbin Close");

            stepper_rotate(1, 28);  // Close lid (180° rotation)
        } else {
            LPC_GPIO0->FIOCLR = (1 << LED_PIN);  // Turn off LED
        }

        delay_ms(300);  // Short delay between readings
    }
}
```