Microprocessors & Embedded Systems
Final Design Project Report
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Smart Dustbin

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Abstract:

This documentation report presents a design for a smart dustbin that utilizes an ultrasonic sensor, a buzzer, and an LCD display. The design of this smart dustbin offers a solution to the problem of managing waste by making the process more efficient and preventing the spread of germs, and also saves energy by not opening the cover when it is full.

Introduction and Background:

Waste management is a critical issue that affects the health and well-being of communities around the world. The increasing population and consumption patterns have led to a significant increase in the amount of waste generated, which has put a strain on existing waste management systems. One of the most critical challenges in waste management is ensuring that waste is properly collected and disposed of in a timely manner. This is where the concept of smart dustbins comes in. A smart dustbin is an innovative solution that uses advanced technology to improve the efficiency and effectiveness of waste management. These dustbins are equipped with sensors, microcontrollers, and other components that allow them to automatically detect when they need to be emptied and alert the relevant authorities. They also provide users with real-time information about the status of the bin, such as its fill level and when it was last emptied.

Mechanical Design:

The mechanical design for the smart dustbin involves the use of a servo motor to control the opening and closing of the lid, as well as a mechanism for measuring the level of garbage inside the bin. The servo motor is attached to the lid of the dustbin and is controlled by a microcontroller, which receives input from the ultrasonic sensor measuring the distance of an object from the bin. When the distance is less than 30cm, the servo motor is activated to open the lid.

The mechanism for measuring the level of garbage inside the bin involves the use of a second ultrasonic sensor, which is placed at the top of the bin. The sensor sends out a pulse, which reflects off the surface of the garbage and returns to the sensor. The microcontroller then calculates the distance between the sensor and the surface of the garbage, which is used to determine the level of garbage inside the bin.

The smart dustbin also includes a buzzer that is activated when the garbage level reaches a certain threshold. The buzzer serve as a visual and auditory indication that the bin needs to be emptied. In addition, a display, such as an LCD display, is used to show the garbage level and distance in cm of an object from the dustbin. The LCD will display “EMPTY” when the dustbin is empty and “FULL” when the dustbin gets to be full. Finally, the dustbin is made up of a durable plastic material that can withstand the wear and tear of daily use. The overall design is compact and can easily fit in any environment.

Figure 1: Mechanical Design.

Electrical Design:

- **Pic16F877A**

It is the core of the smart Dustbin that the other parts connect through by programing it.

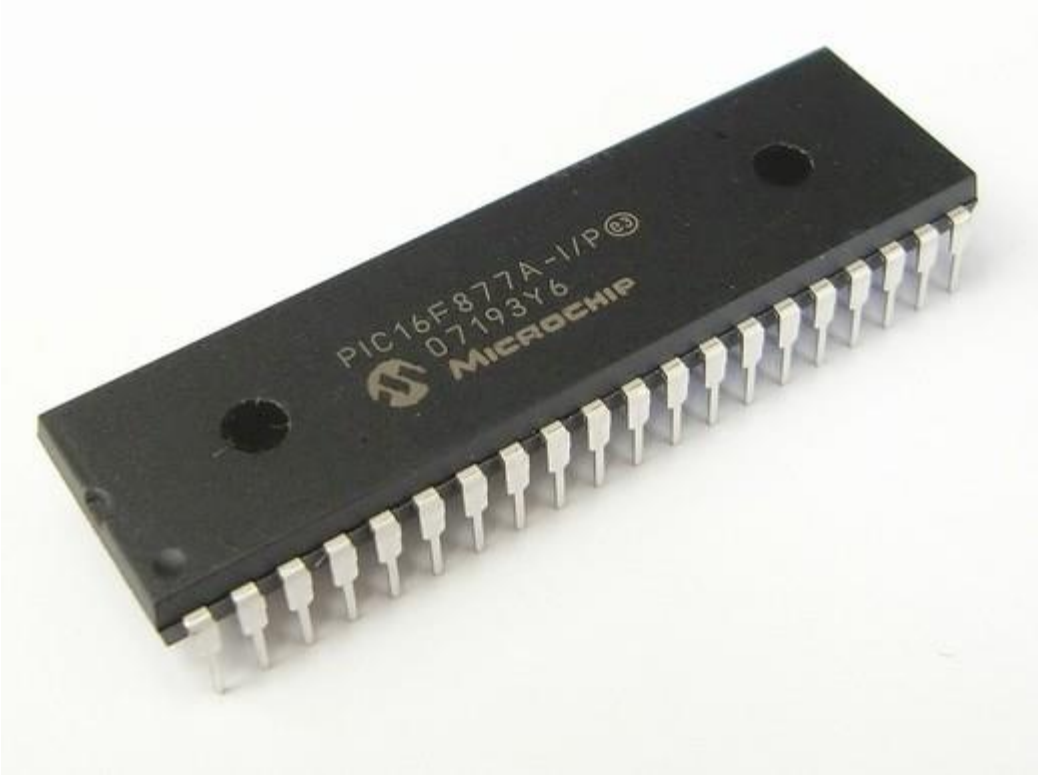

Figure 2: PIC16F877A.

The specifications of PIC16F877A are:

- 8-bit RISC architecture
- 35 instruction sets
- Operating voltage: 4-5.5V
- CPU clock frequency: DC - 20 MHz
- Flash program memory: 8 KB
- RAM: 368 bytes
- EEPROM data memory: 256 bytes
- Interrupt capability: 15 sources
- Timers: 3 (8-bit, 16-bit)
- Communication interfaces: USART, SPI, I2C
- ADC: 8-channel, 10-bit
- Digital I/O: 33
- PWM: 2
- Power-saving sleep mode
- In-Circuit Serial Programming (ICSP) capability
- 40-pin DIP package

- **The Ultrasonic sensor:**

In our project we used two ultrasonic sensors one used to calculate the distance that let the servo motor open and close the dustbin cover, and the other one used to measure the capacity of the dustbin.

Figure 3: Ultrasonic Sensor.

The specifications of the ultrasonic sensor are:

- Operating frequency: typically, between 40 kHz and 70 kHz.
- Detection range: typically, between 2 cm and 400 cm, but can vary greatly depending on the sensor.
- Accuracy: typically, between +/- 1 mm and +/- 3 mm.
- Resolution: typically, between 0.1 mm and 1 mm.
- Angular resolution: typically, between 2 degrees and 15 degrees.
- Output: typically, a distance reading or a digital signal indicating the presence of an object.
- Operating voltage: typically, between 5 V and 24 V.
- Communication interface: typically, a digital interface such as I2C, RS232 or RS485.
- Operating temperature: typically, between -20°C and +70°C.

- **Servomotor:**

We used the servomotor to open and close the lid of the dustbin.

Figure 4: Servo Motor.

The specifications of the Servomotor are:

- Power supply voltage: typically, between 4.8V and 6V, but can go up to 12V for some high-torque models.
- Rotation angle: typically, between 180 to 360 degrees, but some models can rotate up to 540 degrees.
- Speed: typically, between 0.1s/60degrees to 0.18s/60degrees, but can vary greatly depending on the model.
- Torque: typically, between 1kgf.cm to 20kgf.cm.
- Shaft type: typically, a round shaft, but some models have a spline shaft.
- Communication: typically uses PWM signal to control the rotation angle and speed.
- Feedback: typically provides position feedback using potentiometer or encoder.
- Size: typically ranges from 20mm to 40mm in diameter and 30mm to 60mm in length.
- Weight: typically ranges from 30g to 250g.
- Operating temperature: typically, between -20°C and +60°C.

- **Buzzer:**

We use the buzzer to notify that the smart Dustbin is full.

Figure 5: Buzzer

The specifications of the Buzzer are:

- Operating voltage: typically, between 3V and 12V DC, but can vary greatly depending on the model.
- Operating current: typically, between 10mA and 50mA, but can vary greatly depending on the model.
- Sound output: typically, between 70dB and 110dB, but can vary greatly depending on the model and the distance from the buzzer to the listener.
- Frequency range: typically, between 2kHz and 4kHz, but can vary greatly depending on the model.
- Operating temperature: typically, between -20°C and +70°C, but can vary greatly depending on the model.

- **LCD(LM016L):**

We use the LCD to show the capacity of the smart Dustbin.

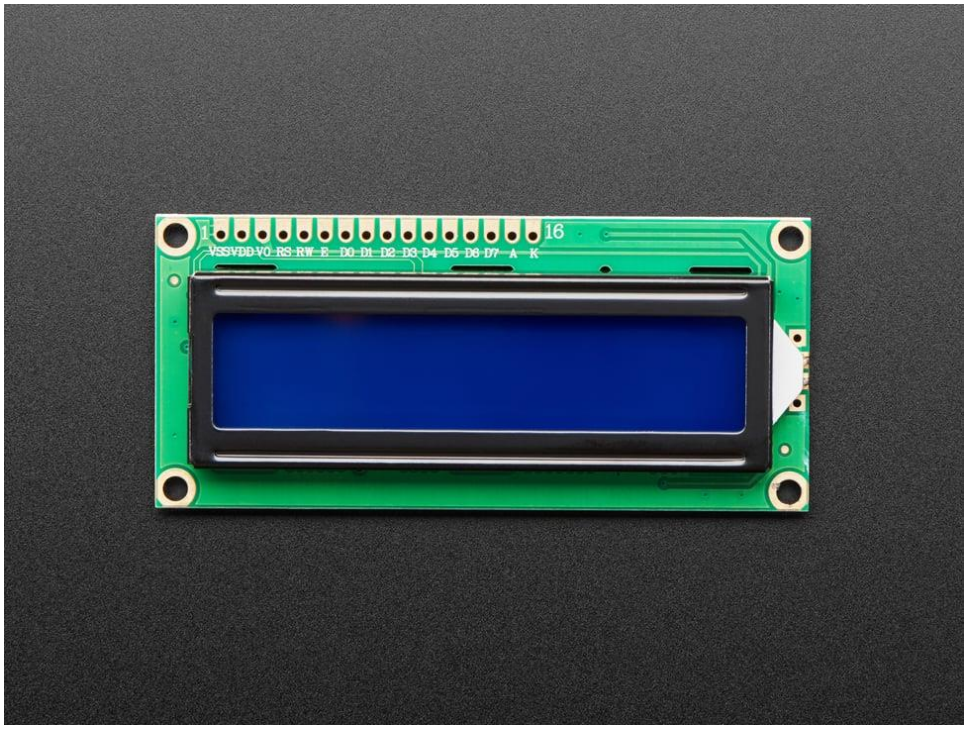

Figure 6: LCD Display.

The specifications of the LCD are:

- Display format: 2 lines x 16 characters.
- Module size: 80.0mm(W) x 36.0mm(H) x 11.4mm(T)
- Operating temperature: -20°C to +70°C
- Viewing angle: 12 o'clock
- Power supply voltage: 5.0V DC
- Power consumption: 2.5mA (typical)
- 5x8 dots with cursor
- Built-in controller (HD44780 or equivalent)
- +5V power supply (also available for +3V)
- 1/16 duty cycle

Software Design:

The software design for the smart dustbin project was implemented using the MikroC Pro for PIC compiler. The code was written in C language and was executed on a PIC16F877A microcontroller. The microcontroller used in this project is a powerful and versatile microcontroller that can handle the various tasks required for the smart dustbin system. The software design of the smart dustbin system begins with the measurement of the distance between the dustbin and the object using an ultrasonic sensor. The ultrasonic sensor sends out a signal (Trigger) and measures the time taken for the echo to bounce back (which means once the echo is sent the Timer1 starts and once the echo is received back the Timer1 stops), using this information the microcontroller calculates the distance between the dustbin and the object.

Once the distance is measured, the microcontroller compares it with a predefined threshold value of 30cm. If the distance is less than 30cm, the microcontroller sends a signal to the servo motor to open the lid of the dustbin. The servo motor is controlled by For Loop that has delays in it making the servo motor rotate to open and close the lid of the dustbin.

The second ultrasonic sensor is used to measure the level of garbage inside the dustbin. The microcontroller compares the garbage level with a predefined threshold value and if the garbage level is above the threshold value, it sends a signal to turn on the buzzer, indicating that the dustbin is full. The garbage level is also displayed on an LCD display which is connected to the microcontroller.

Overall, the software design of the smart dustbin system is designed to be simple and easy to understand, while also being efficient and effective in controlling the various components of the system. The use of interrupts ensures that the system is always monitoring the garbage level and alerts the user when the dustbin is full. The use of ultrasonic sensors makes the system contactless and prevents the spread of germs.

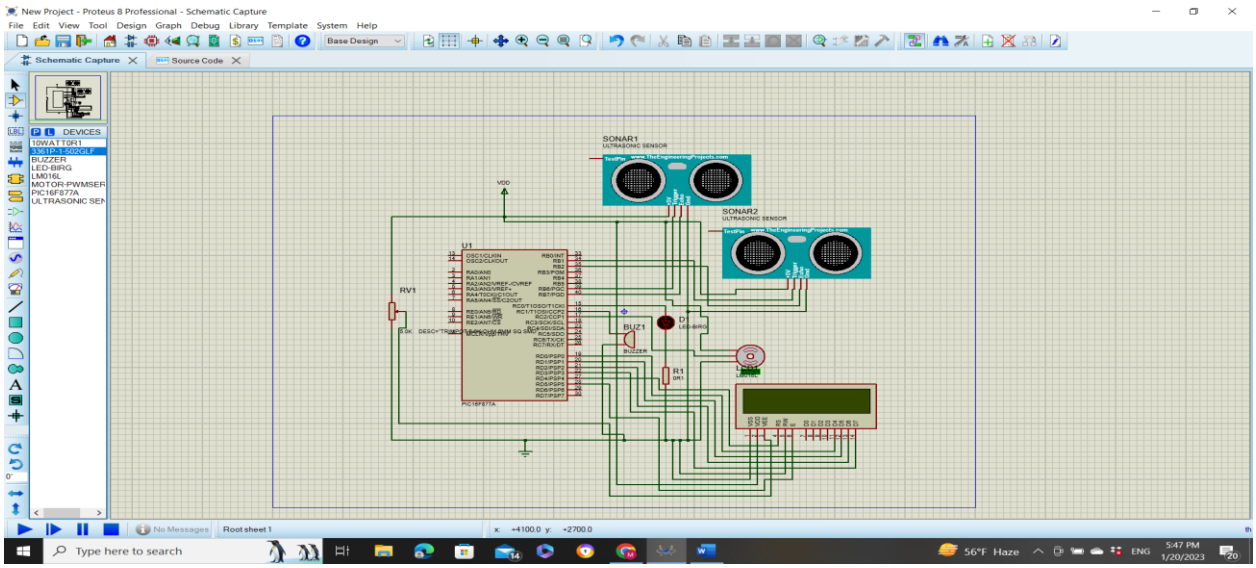

Figure 7: Proteus Circuit Diagram.

Problems and recommendations:

- When building all the codes together the Servo motor did not work with the Ultrasonic sensor.
  Solved by making the servo motor work using for loops and delays.

- The Ultrasonic sensor was not giving the appropriate measurement.
  Solved by achieving the correct equation.

- The measurements weren't shown on the LCD, only the "Distance" word was shown on the LCD.
  Solved by using the "ByteToString" function.

Conclusion:

In conclusion, the smart dustbin is a functional and efficient solution for waste management. The use of ultrasonic sensors to detect hand gestures and control the servo motor, allows for easy and hands-free opening and closing of the dustbin cover. Additionally, the use of an ultrasonic sensor to measure the depth of the trash inside the dustbin, and the integration of an LCD display, and a buzzer, enables the user to easily monitor the fill level of the dustbin and be alerted when it is full. The smart dustbin is an innovative solution that improves the convenience and hygiene of waste management, and it can be implemented in various settings such as homes, offices, and public spaces.