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AUTOBIN

EMBEDDED SYSTEMS

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Abstract

This project presents the design and implementation of a smart automated waste bin system that combines automation with real-time monitoring. The system utilizes a PIC16F877A microcontroller programmed in embedded C. Key features include automatic lid operation based on proximity detection using an ultrasonic sensor, fill-level monitoring via two IR sensors, and environmental awareness through an LDR for night lighting. When the bin reaches full capacity, a buzzer is triggered to notify users. The integration of multiple sensors and actuators provides a cost-effective and scalable solution for modern waste management, demonstrating the practical application of embedded systems in enhancing daily life and public health.

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1 Introduction

This project presents a smart waste bin system designed to improve hygiene and automate the disposal process using embedded systems. The system uses an ultrasonic sensor to detect when a person approaches, automatically opening the lid via a DC motor. After a brief delay, the lid closes to maintain cleanliness. Two infrared (IR) sensors are placed at different heights inside the bin to monitor fill levels. A servo motor rotates a paper indicator to visually represent the current fill level (e.g., 0%, 50%, 100%). Additionally, an LDR sensor detects ambient light and activates a night light when the surroundings become dark. All components are controlled by a PIC16F877A microcontroller programmed in embedded C without external libraries. This project demonstrates how embedded technology can be applied to create practical, user-friendly automation solutions for everyday use.

2 Design

When a person remains near the ultrasonic sensor for a sufficient amount of time, it sends a signal to the DC motor to open the lid. The LDR checks the room's ambient light level, and if it is dark, an LED is turned on. After a short delay, the lid automatically closes—unless the ultrasonic sensor no longer detects presence. A servo motor rotates a paper indicator to display the bin's fill percentage (0%, 50%, or 100%) based on input from two IR sensors.

2.1 Software Design

The flowchart outlines the system logic. Initially, the system waits for a button press. If the ultrasonic sensor detects an object within a defined threshold, the DC motor opens the lid. If the lid is open, the LDR checks the light level. If it is below the threshold, the LED is turned on. Afterward, the lid is closed to maintain hygiene, and the LED is turned off to conserve power.

The system then enters a loop where it continues to check for nearby objects. If the lid is closed, the IR sensors are checked: if IR1 is triggered, the servo moves to indicate 50%; if IR2 is triggered, the servo moves to 100% and the buzzer is activated. The loop then restarts.

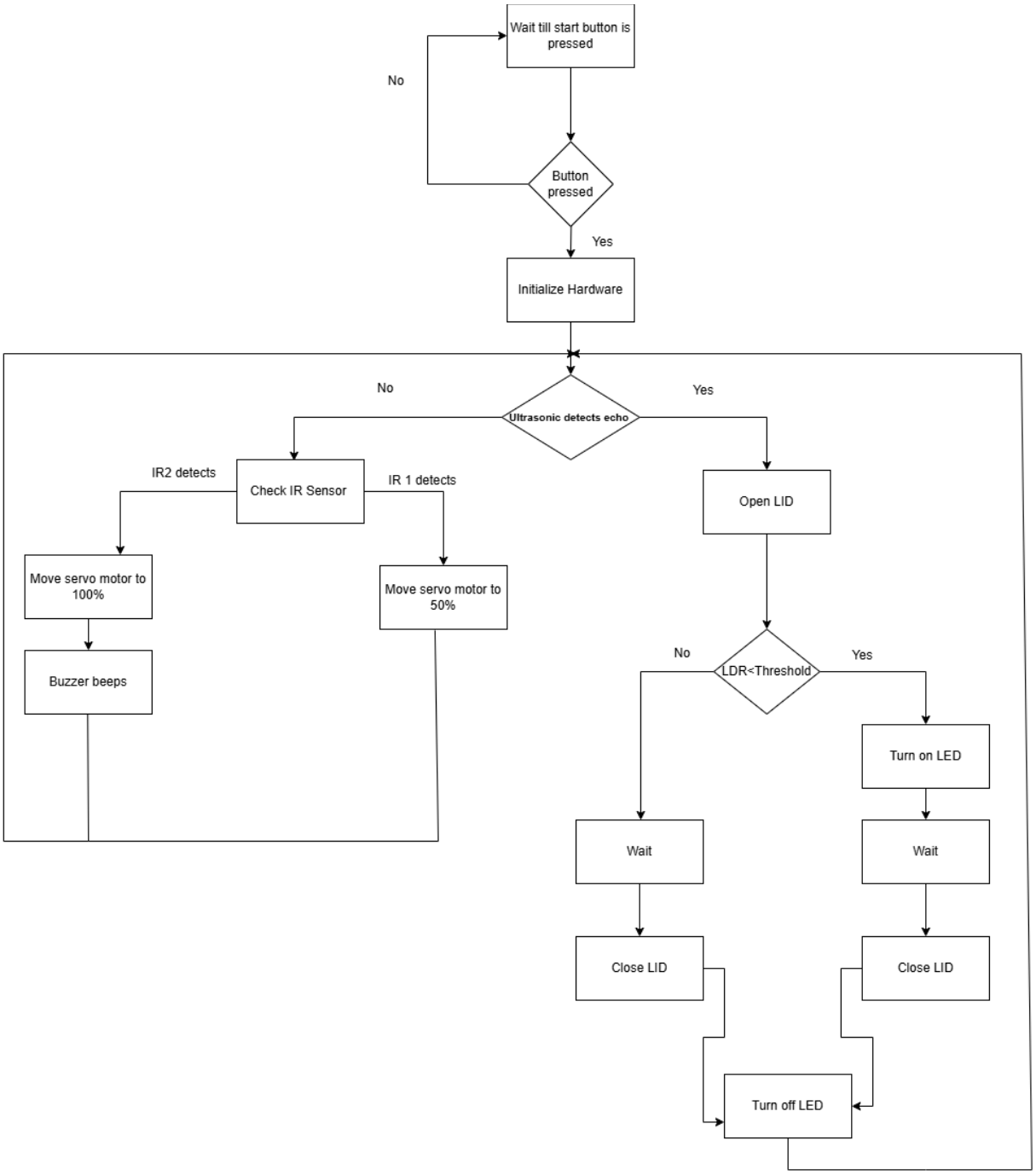


Figure 1: Flowchart of the project

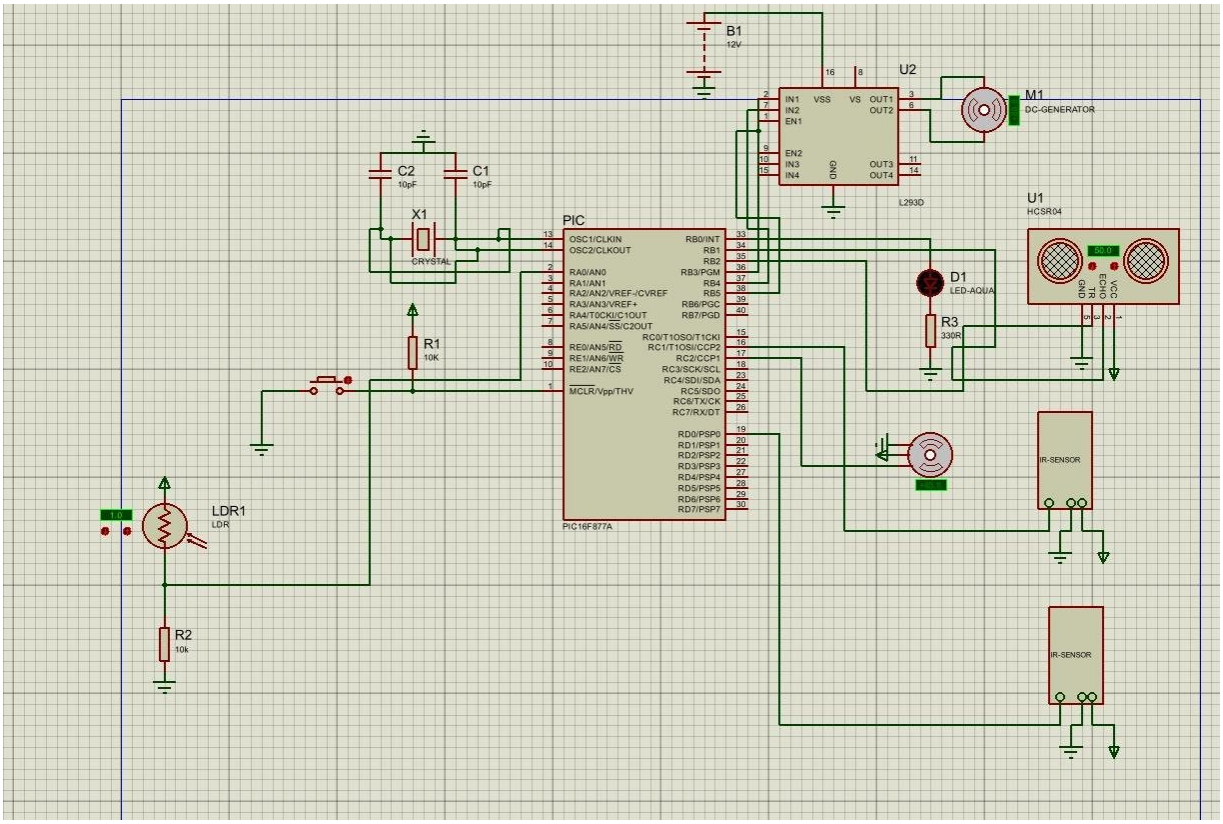
2.2 HARDWARE DESIGN

The microcontroller is connected to an 8 MHz crystal oscillator with two capacitors on pins 13 and 14, along with a standard reset button and pull-up resistors.

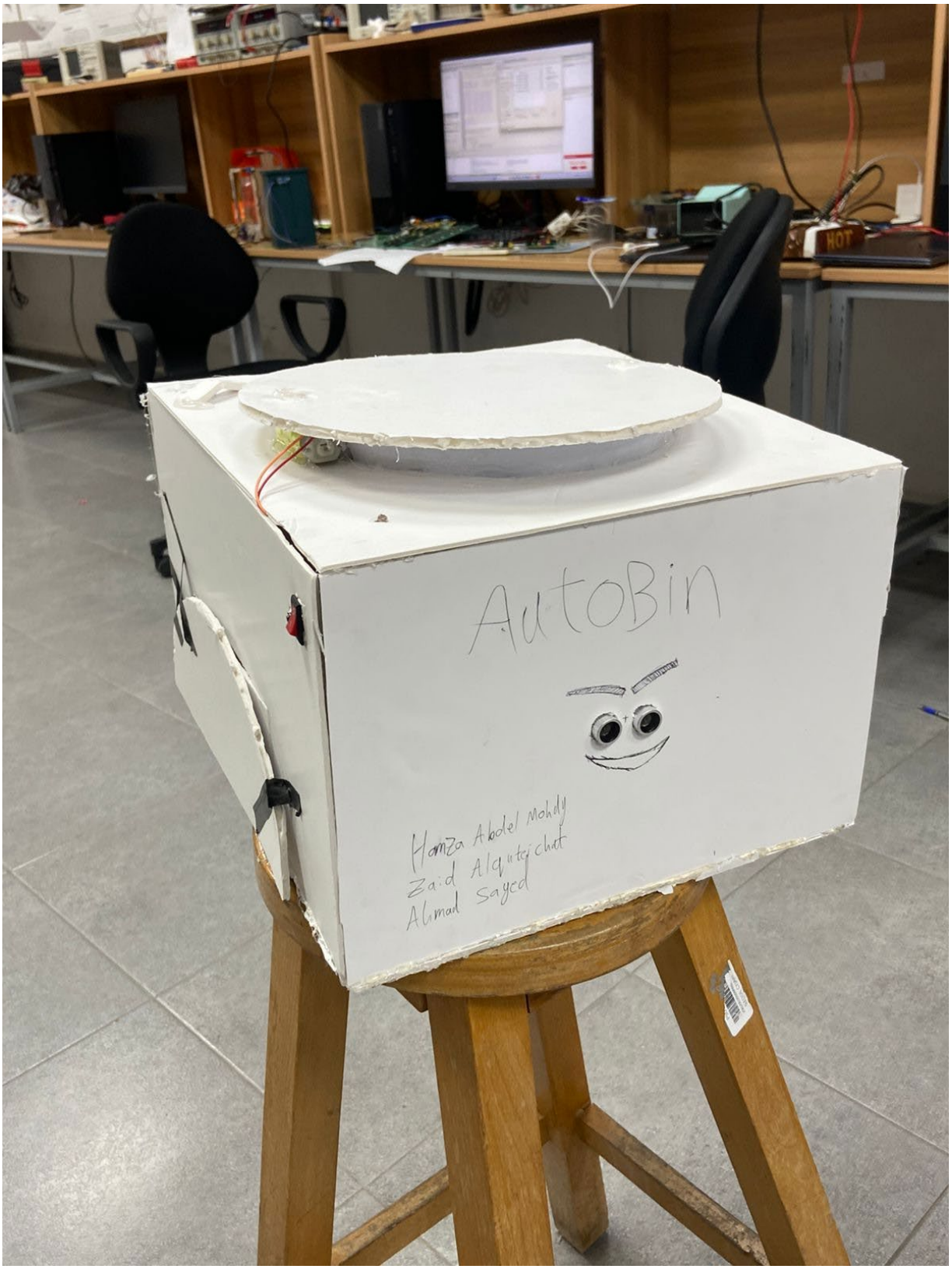
The LDR is connected with one end to VCC and the other through a 10 kΩ pull-down resistor. The junction between the LDR and resistor is connected to RA0 (an analog input). When the LDR reading is below the threshold, an LED (with its anode on RB0 and a 330 Ω resistor to ground) turns on.

The ultrasonic sensor's Echo pin is connected to RB1 and the Trigger pin to RB2. These are interfaced with a DC motor via an H-bridge circuit: IN3 to RB3, IN4 to RB4, and ENB to RB5.

The IR sensor outputs are connected to RC1 (IR1) and RD0 (IR2). The servo motor is connected to RC2, which supports PWM output (CCP pin).



2.3 REAL-LIFE MODEL


AutoBin
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Ahmad Sayed

3 Problems and Recommendations

The project was divided into three modules, each of which was tested and verified individually on the EasyPIC board. However, integrating all modules into one system led to unexpected issues. Conflicts arose from the timers, option register, and other configurations interfering with each other. After extensive debugging, we were able to resolve these issues and finalize a working version on the EasyPIC board.

Transferring the setup to a breadboard introduced additional problems. One of the IR sensors connected to RC3 consistently received a false signal, preventing the servo motor from working. Upon testing with a digital multimeter, we discovered the sensor was burnt. We replaced it and revised the code to use two IR sensors instead of three, connecting the new sensor to RD0.

After this fix, the LDR stopped lighting the LED due to a simple wiring mistake, which was corrected. Connecting the battery and on/off switch also presented challenges, but the system eventually worked as intended.

We recommend testing each component on the PIC microcontroller and immediately transferring the setup to the breadboard to avoid unnecessary delays. Basic soldering skills and knowledge of circuit design and embedded programming are essential. A strong understanding of the course material also plays a critical role in successful implementation.

4 Conclusions

The AutoBin project successfully demonstrates the integration of multiple sensors and actuators to automate a common household task efficiently and hygienically. By using ultrasonic sensing for proximity detection, the lid opens and closes without physical contact. Two IR sensors measure the bin's fill level, and a servo motor provides a visual indication of the status. When the bin is full, a buzzer alerts the user. An LDR sensor also enables a night light in low-light conditions. This project showcases the practical potential of embedded systems in real-world applications using simple and cost-effective components.

5 References

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