Princess Sumaya University for Technology

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Electrical Engineering Department

Smart Grass Cutter

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Contents

Abstract

The aim of this project is to develop a smart grass cutter that helps in maintaining a neatly trimmed lawn. It works using a combination of devices such as the PIC 16F microcontroller, IR sensor to detect the grass, a PIR sensor to detect people, buzzer to alertIf people are detected, DC motors provide power. It works alone by powering the system to turn the sensors on and according to what the sensors detect the grass cutter will work. This will help people by reducing the time and effort required for lawn .maintenance, ensuring safety

Introduction

Maintaining a well-manicured lawn requires regular grass cutting, a task that can be time-consuming and labor-intensive. To address this challenge, we propose the development of an automated grass cutter equipped with advanced sensing technologies and controlled by a PIC 16F877A microcontroller. This grass cutter aims to operate efficiently and safely, incorporating an Infrared (IR) sensor to detect the distance from the grass, ensuring the device activates only when needed. Additionally, a Passive Infrared (PIR) sensor is integrated to detect the presence of living beings, such as pets or children, to prevent accidents and enhance safety.

The use of the PIC16F877A microcontroller enables precise control and coordination of the sensors and cutting mechanism, making the grass cutter both effective and reliable. This report details the design, implementation, and functionality of the grass cutter, highlighting the integration of the IR and PIR sensors and their interaction with the PIC 16F877A microcontroller. Through this automated system, we aim to achieve a seamless and secure grass cutting process that saves time and reduces manual effort while ensuring safety and precision.

Project Description and Components

To implement our design, we will use the following components:

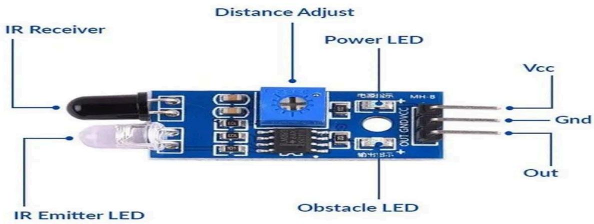
1. PIC microcontroller (16F877A)

The PIC16F877A microcontroller offers several features that, while not directly controlling the grass cutter's primary functions, are crucial for the overall efficiency and reliability of the project. Its 10-bit ADC with 8 channels is instrumental in accurately reading analog signals from the IR sensor, ensuring precise distance measurement from the grass. The multiple timers available, such as Timer0, Timer1, and Timer2, facilitate precise timing operations needed for synchronized sensor readings and motor control, contributing to smooth and efficient cutting operations.

Furthermore, the microcontroller's EEPROM provides non-volatile memory storage, allowing the system to retain important configuration settings and calibration data even when powered off, enhancing the grass cutter's usability and reliability. Additionally, its power-saving modes help manage energy consumption effectively, making the grass cutter more energy-efficient and suitable for prolonged use. Lastly, the robust interrupt handling capabilities ensure that the system can quickly respond to critical events, such as detecting a living being through the PIR sensor, thereby enhancing safety and responsiveness.

2. IR digital single array line sensor

A digital single array line sensor IR functions by emitting infrared light onto a surface and detecting its reflection using a photodiode or phototransistor. This reflection is converted into an analog signal, which is then compared against a predefined threshold. Depending on whether the reflected light intensity surpasses this threshold, the sensor outputs a corresponding digital signal—typically high for detection and low for non-detection. Its linear array structure enables detection across multiple points along a surface, making it ideal for applications such as line-following robots where accurate path tracking is essential. This sensor's capability to swiftly differentiate between reflective and non-reflective surfaces based on infrared light intensity facilitates precise navigation and automation in various industrial and robotic systems.



3. **The Sharp GP2Y0A21YK0F IR Range Sensor**

A 10 cm to 80 cm is an infrared range finder designed to accurately measure distances from 10cm (~4 inches) up to 80cm (~30 inches). It operates on an analog interface, providing distance readings as analog voltage outputs. This sensor is RoHS compliant and lead-free, ensuring environmental safety and compatibility with modern electronics standards. It serves as a direct replacement for the discontinued GP2D12 model. The GP2Y0A21YK0F is notable for its minimal sensitivity to the color and reflectivity of objects, making it suitable for applications where consistent distance detection is crucial. It features a straightforward 3-wire interface (power, ground, and output), eliminating the need for an external control circuit and offering cost-effective distance sensing solutions.

4. **Buzzer**

controller and consume low power, making them an ideal choice for embedded systems where space and power are at a premium. The two wires of the buzzer are connected to the VCC and ground.

5. Oscillator 8MHZ

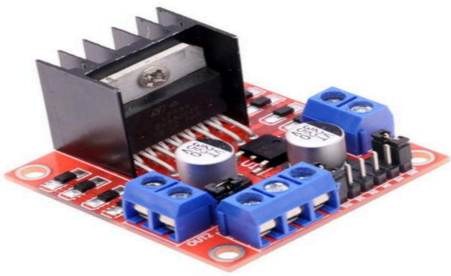
8MHz oscillator (8MHz) is a device that produces a continuous electrical signal at a frequency of 8 million cycles per second. For electrical circuits like microcontrollers, clocks, and other digital devices, it is often utilized as a timing source. Numerous technologies, including as quartz crystals, LC circuits, and RC circuits, can be used to build oscillators. They are frequently contained in tiny, low-cost gadgets called crystals or ceramic resonators. The oscillator has two pins (CLK in and CLK out) that are connected to the microcontroller.

6. DC motor gearbox wheel and tyre

The DC Motor Gearbox Wheel and Tyre unit is a lightweight and versatile component ideal for constructing robots or toy vehicles, compatible with platforms like Arduino and other development systems. Featuring a low power consumption range of 3-6VDC and variable speeds ranging from 125 to 230 revolutions per minute (RPM), the unit offers efficient power transmission with reversible direction capability. With a compact design and a soft rubber tyred wheel providing excellent traction, this Grade B unit delivers reliable performance and durability, making it perfect for hobbyist projects, educational demonstrations, and prototyping endeavors in robotics and automation..Two motors are connected the H-bridge motor driver, controlled by the PIC16F877A microcontroller. These motors are dedicated to the forward motion of the grass cutter, providing precise control over its movement across the lawn. The third DC motor is independently utilized to spin the cutting blades.The PIC microcontroller sends control signals to the motor driver to dictate the motor’s behavior (forward, backward, stop).

6. H-Bridge

An H-bridge is an electronic circuit that enables control over the direction and speed of a DC motor. It consists of four switches arranged in an "H" configuration, hence the name. By selectively turning these switches on and off, the H-bridge can reverse the polarity of the voltage applied to the motor, thereby changing its direction of rotation.H-bridges serve as crucial interfaces between the microcontroller and the DC motors. They allow the microcontroller to send signals to control the motor's speed and direction effectively. H-bridges also provide protection features such as overcurrent and overvoltage protection, safeguarding the motor and the circuitry from damage.



The implementation of our Smart Grass cutter is divided into two stages:

1) Hardware design
2) Software design

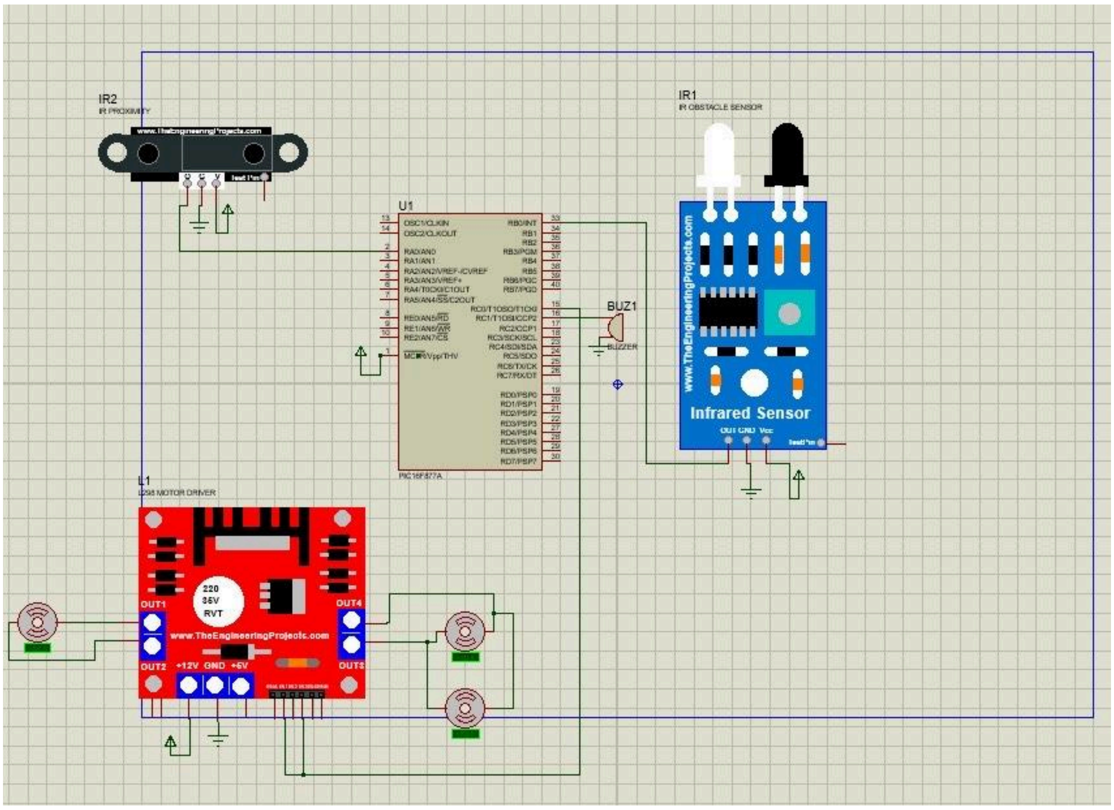
The software design was accomplished using mikroC which is a proprietary integrated development environment (IDE) and programming language for

microcontrollers. MikroC syntax is similar to C language. MikroC also has a built-in library of pre-written functions for a wide range of peripheral devices, including LCD displays, sensors, communication interfaces, and more. However, in our project we used only the following built-in libraries: Conversions, C_String, Lcd, Lcd_Constants. We call the functions that we read the sensors values from in the main function in the while loop that works forever as long as there is a power source connected to the system.
Another software tool used is Proteus Design Suite that is used for designing, simulating, and testing electronic circuits and microcontroller-based systems. Proteus helped us to design and test circuits and microcontroller systems in a virtual environment, before building and testing the design on real hardware.

Below is the code programmed using mikroC and the design simulated on Proteus:

```
void ADC_Init() {
   ADCON1 = 0x07;  // Set all ports to digital while AN7 is analog for the sharp IR
sensor
   ADCON0 = 0b01110101;  // Enabeling ADC
   TRISC |= 0x08;  //set RC3 as input
}



unsigned int ADC_Read() {
   ADCON0 &= 0xC7;
   ADCON0 |= 0x38;
   ADCON0 |= 0x04;  //start  conversion
   while(ADCON0 & 0x04);  //complete conversion
   return ((ADRESH << 8) + ADRESL);  //return to main result
}



void init() {
   TRISC &= 0xFC;  //set RC0 and RC1 as outputs
   PORTC = 0x00;  // turn off all pins on port C
   ADC_Init();    // call for initializing ADC
}



void startMotor() {
   PORTC |= 0x01;  //motor works  at port RC0
}


void stopMotor() {
   PORTC &= 0xFE;  //motorstopss  at port RC0
}



void activateBuzzer() {
```

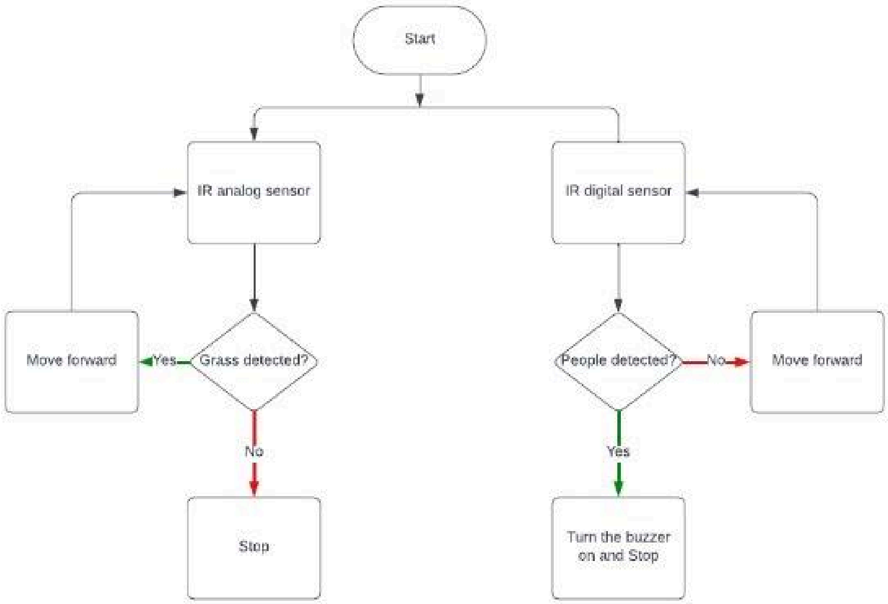
```
   PORTC |= 0x02;  // buzzer on at port RC1
}

void deactivateBuzzer() {
   PORTC &= 0xFD;  //buzzer off at port RC1
}

void main() {
   init();  // set all ports in the main

   while (1) {
      if (PORTB & 0x02) {                    // Check if the push button is pressed
         while (PORTB & 0x02);

         while (1) {
            if (!(PORTB & 0x01)) {  // Digital IR sensor outputs zero when it detects
movement(not 1)
               stopMotor();
               activateBuzzer();
               while (!(PORTB & 0x01));  //  no movement
               deactivateBuzzer();
            } else {

               unsigned int adcValue = ADC_Read();  //read  value from the analog IR
sensor and put it in adcvalue
               if (adcValue > 512) {
                char i =0;
                 startMotor();
                  for(i;i<255;i++){}  //delay

               } else {
                  stopMotor();  //Stop if no grass
               }
            }
         }
      }
   }
}
```



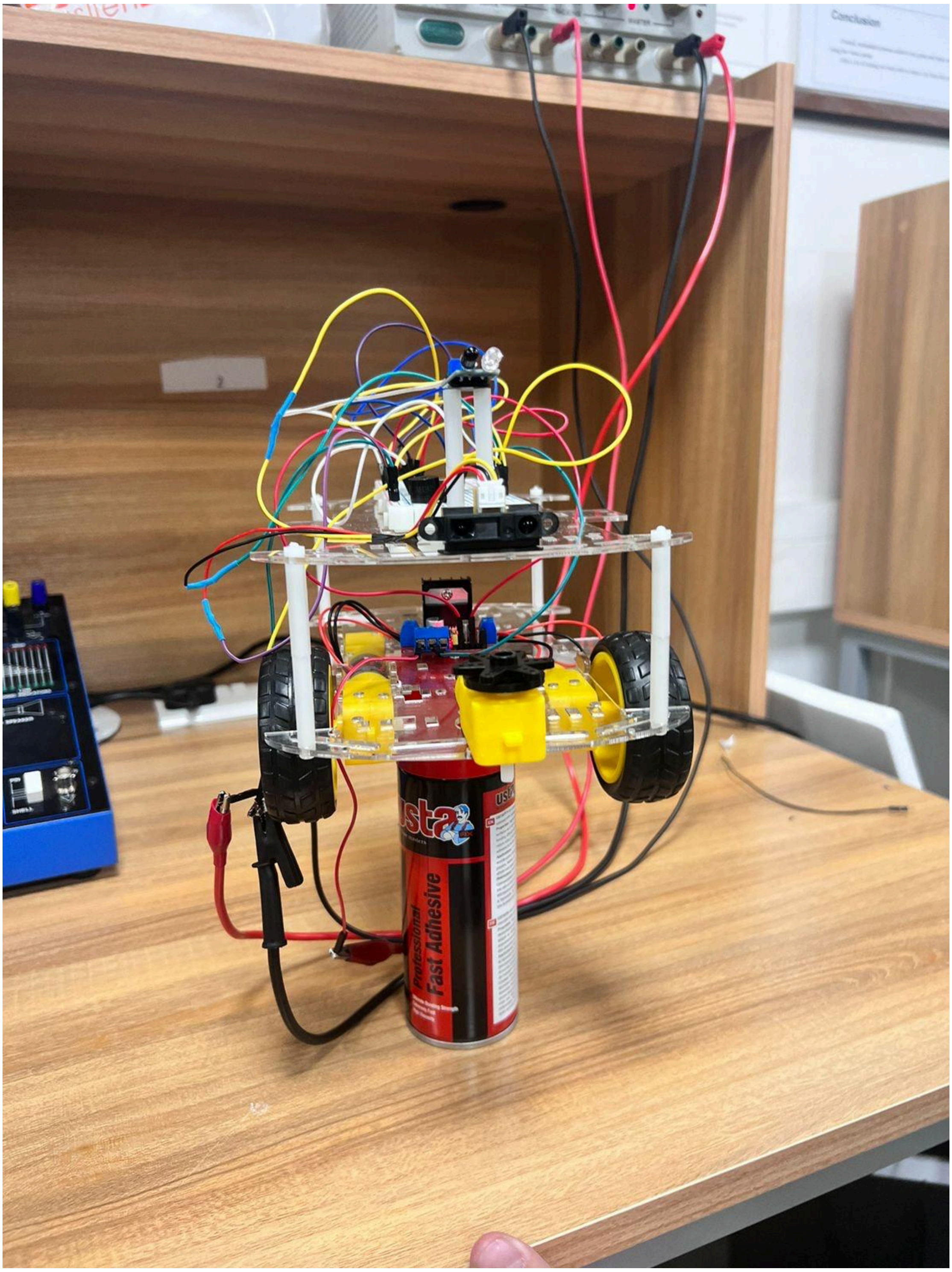
Proteus Electrical Design

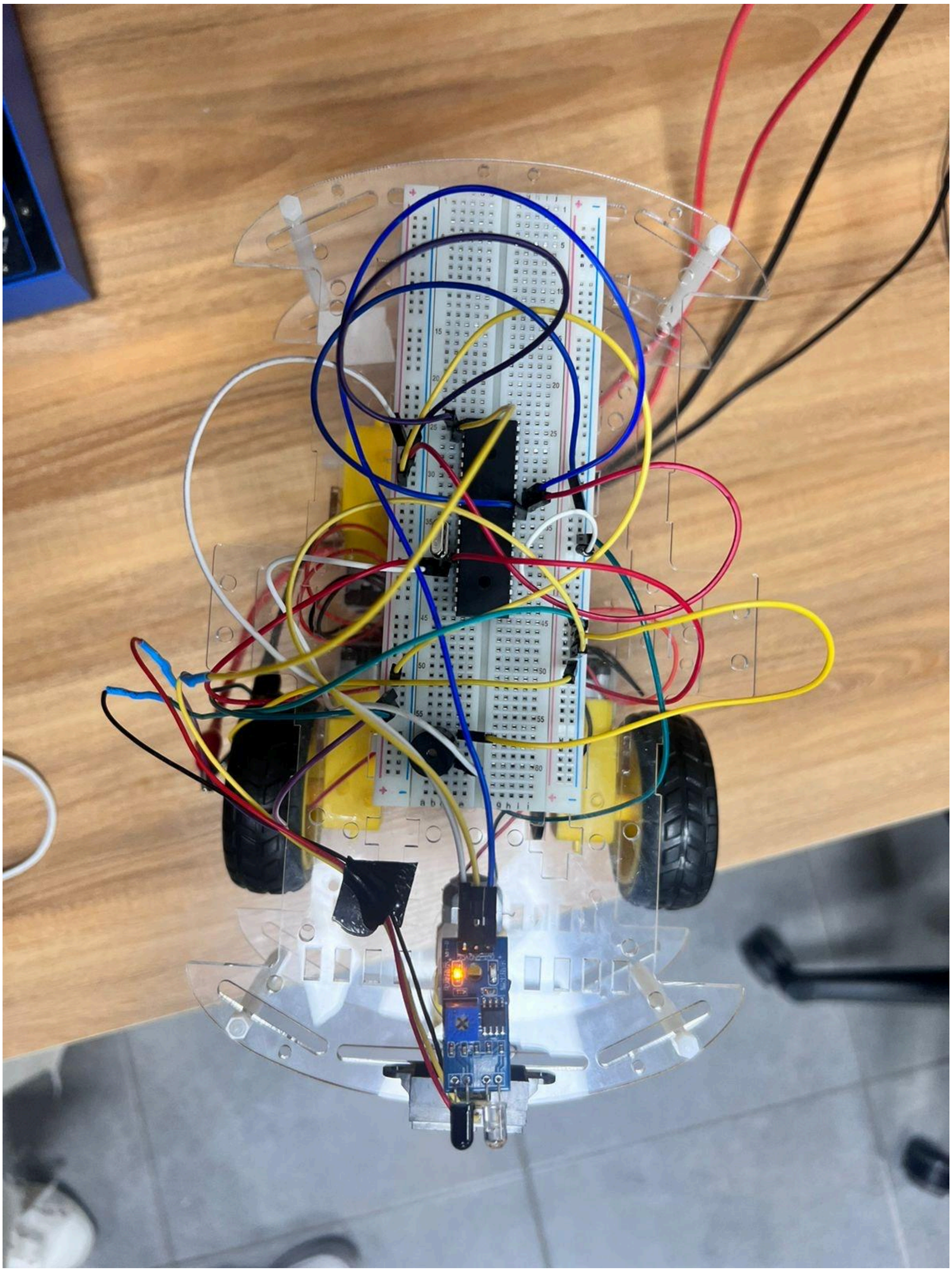
The smart grass cutter system incorporates an array of hardware components to facilitate its autonomous operation. At its core, the system relies on both digital and analog sensors to perceive its environment. The digital IR sensor, situated at PORTB bit 0, acts as a motion detector, outputting a low signal when it senses movement nearby. In tandem, the analog IR sensor, linked to AN7/RC3, provides continuous feedback on the presence of grass in the cutter's vicinity. Leveraging the Analog-to-Digital Converter (ADC), the microcontroller translates the analog output from the IR sensor into a digital value for processing. Motor control, crucial for the cutter's movement, is orchestrated by an H-bridge mechanism, powered by a 9-volt supply. Activation and deactivation of the grass cutter's cutting mechanism are managed by the startMotor and stopMotor functions, which manipulate the RC0 pin accordingly. Additionally, a buzzer, wired to RC1, serves as an audible alert system, triggered when movement is detected by the digital IR sensor. The activateBuzzer and deactivateBuzzer functions toggle the buzzer's state to emit sound when required. This intricate hardware setup ensures the system's ability to navigate its environment autonomously, halting its operation in the presence of obstacles or individuals while efficiently mowing the grass when needed. Through the orchestration of these hardware components, the smart grass cutter epitomizes efficiency and safety in lawn maintenance, heralding a new era of autonomous landscaping technology.

Flow Chart


Start
IR analog sensor
IR digital sensor
Move forward
Yes
Grass detected?
People detected?
No
Move forward
No
Yes
Stop
Turn the buzzer
on and Stop

Prototype





Problems and Recommendations

As I developed the hardware for the smart grass cutter system, I encountered a few challenges and learned valuable lessons along the way. One notable issue was related to the power supply for the H-bridge motor control. Initially, I powered the H-bridge with a 12-volt supply, assuming it would work seamlessly with the PIC microcontroller operating at 5 volts. However, I soon realized that this setup caused voltage compatibility issues and potential damage to the microcontroller. To address this error, I revised the power supply arrangement and found that the H-bridge was able to function with only 6 volts ensuring that the H-bridge operated within the safe voltage range for the microcontroller. Additionally, during testing, I observed that the analog IR sensor occasionally provided inconsistent readings, leading to inaccuracies in grass detection. To improve sensor reliability, I implemented shielding measures to minimize interference and optimized the sensor placement for better signal reception. Furthermore, I encountered mechanical issues with the cutting mechanism, such as motor overheating during prolonged operation. To mitigate this issue, I refined the mechanical design, incorporating features like thermal management systems to ensure smooth and safe operation of the grass cutter. Through these challenges and the subsequent adjustments made, we gained valuable insights into the importance of thorough testing, careful component selection, and iterative refinement in hardware development projects. These experiences ultimately contributed to the successful implementation of a reliable and efficient smart grass cutter system.

Conclusion

In conclusion, the development of our smart grass cutter project has exemplified the practical application of embedded systems in a real-world context. By integrating components such as the PIC 16F877A microcontroller, analog and digital IR sensors, and H-bridge motor drivers, we've created a sophisticated system capable of autonomously navigating and maintaining lawns. This project underscores the importance of understanding hardware-software integration, sensor interfacing, motor control, and safety protocols within embedded systems design. It has provided invaluable hands-on experience in applying theoretical knowledge from our embedded systems course to solve practical challenges, such as precision grass cutting and obstacle avoidance. Moving forward, this project serves as a testament to the versatility and impact of embedded systems in enhancing automation, efficiency, and safety across diverse applications in modern technology.

To improve the project, we could optimize sensor placement and calibration, implement PID control for motor precision, integrate obstacle detection sensors for enhanced safety, strengthen mechanical components, and refine the user interface for better operational feedback.