Design of EdBot Micro (PIC)

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Objectives

This project is a continuation of the original EdBot. The previous version of the EdBot was 7 inches long, 7 inches wide, and 3 inches tall. Our main goal was to make the new EdBot smaller. Our new EdBot Micro is 3 ½ inches long, 2 inches wide, and 1 inch tall. The main reason we were able to make everything smaller is because we took all the components and put them on one board and removed the big wheels. Physically, the new EdBot Micro is a complete redesign of the previous one. The ultrasonic sensors were changed out for infrared, the motors were made smaller and faster, and an RGB LED was added. The only main component that was carried over was the PIC18F1220 PICkit chip.

Alternative Solutions

Some of the alternative solutions researched for our project were:

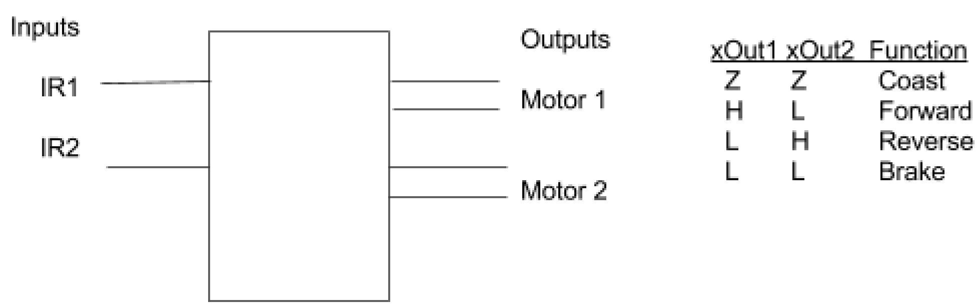
- Use an op amp to drive the motors.
- Use an Arduino instead of a PICkit for the programming.
- Make all the components through-hole for ease of building.
- Use 3V button cell.

We ended up using a dual h-bridge motor driver (DRV8833C) to drive the motors because op amps needed more voltage to run than our battery supplied. We used the PICkit because the EdBot is used as a tool to learn assembly language and switching over to arduino would defeat that purpose. Lastly, we didn't use all through-hole components for two reasons. The first one being that we simply couldn't find through-hole components for every piece. Specifically, we could not find a through-hole motor driver. The second reason was because surface mount components are smaller, and the main goal of this project was to reduce the size of the EdBot. We ended up using a 3.7 Lithium Polymer (Li-Po) battery because a 3V button cell had too low of a voltage, and discharged very quickly without ability for recharge. We used pager motors without tires, which are small and are able to propel the device quickly.

Solution Specification

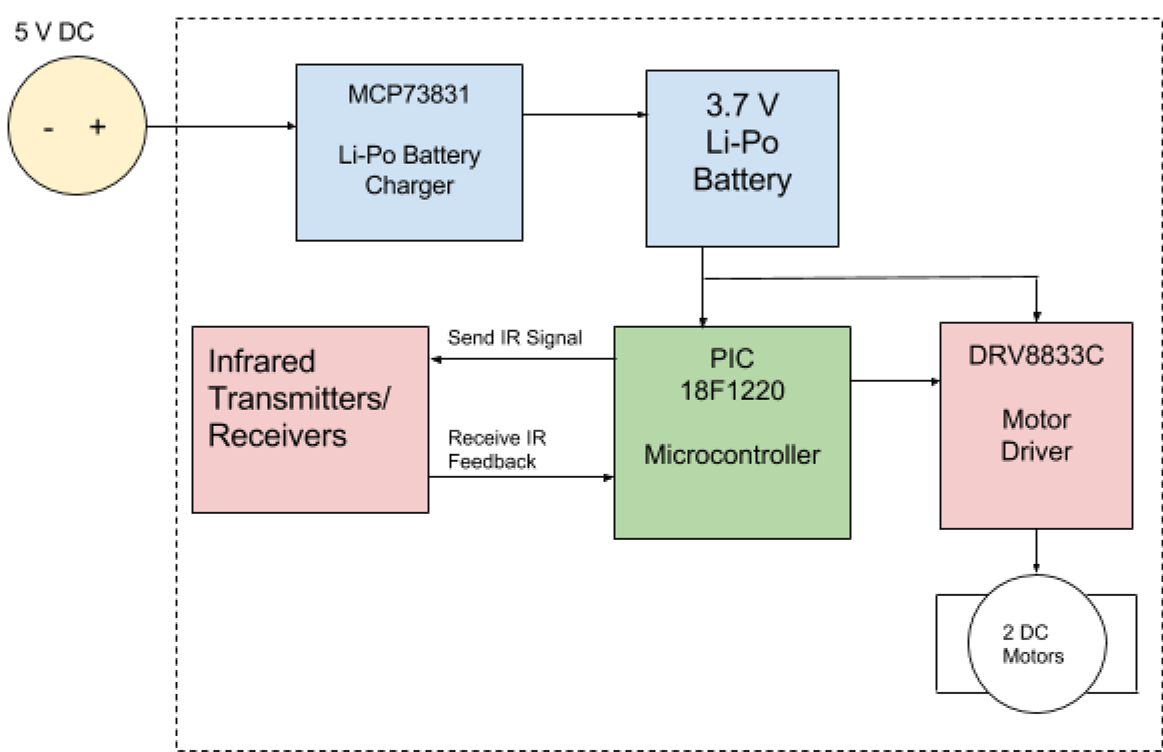
System Diagram

Below is the system diagram of the EdBot. The inputs are from 2 infrared sensors, and the outputs are the rotational direction of the 2 rear motors.



Block Diagram

Below is a block diagram.



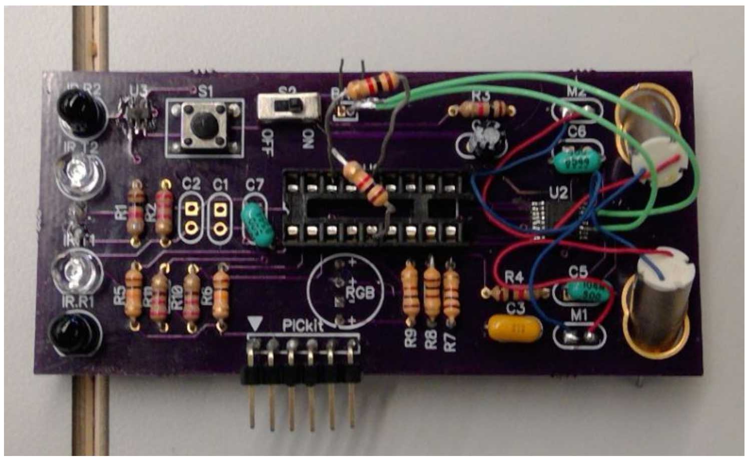
Schematic

*See attached file for full schematic.

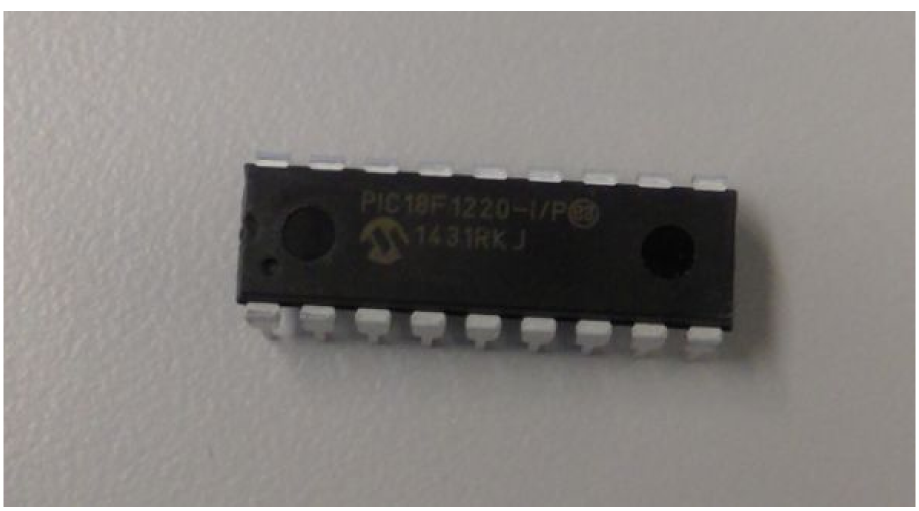
Parts List

*See attached Excel spreadsheet for full list of parts.

Photos of Key Components

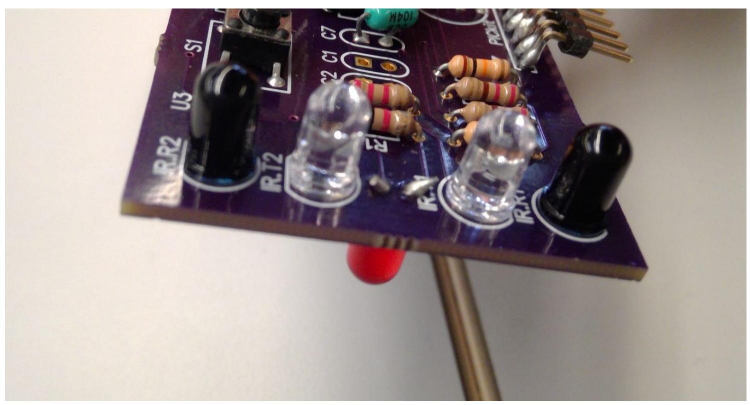


EdBot Micro

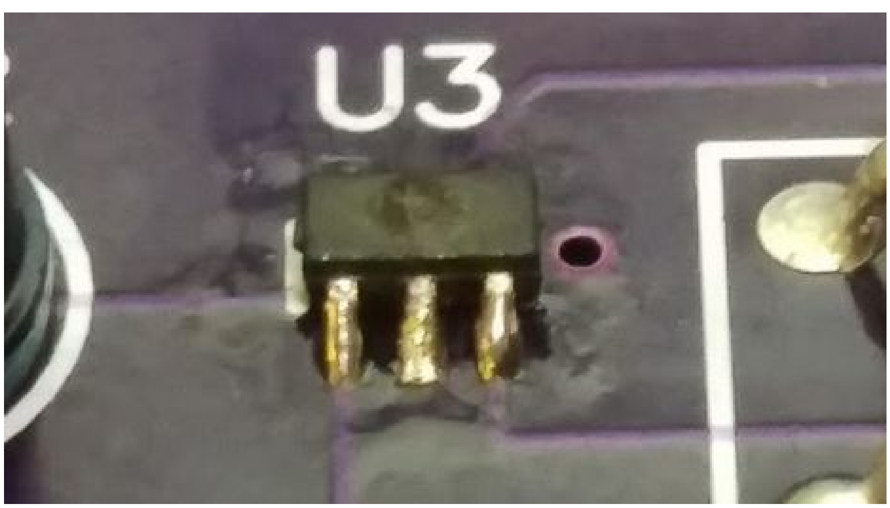


Pic18F1220 Micro Controller

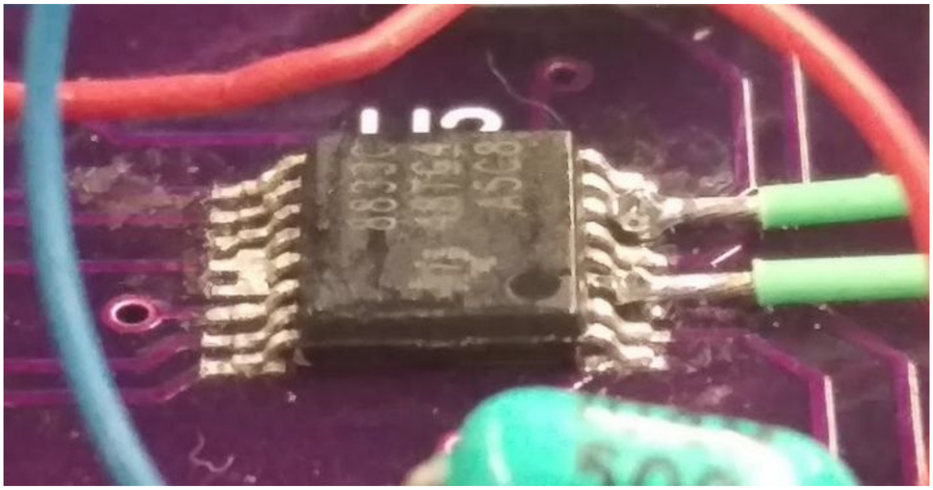
3.7 Lithium Polymer Battery



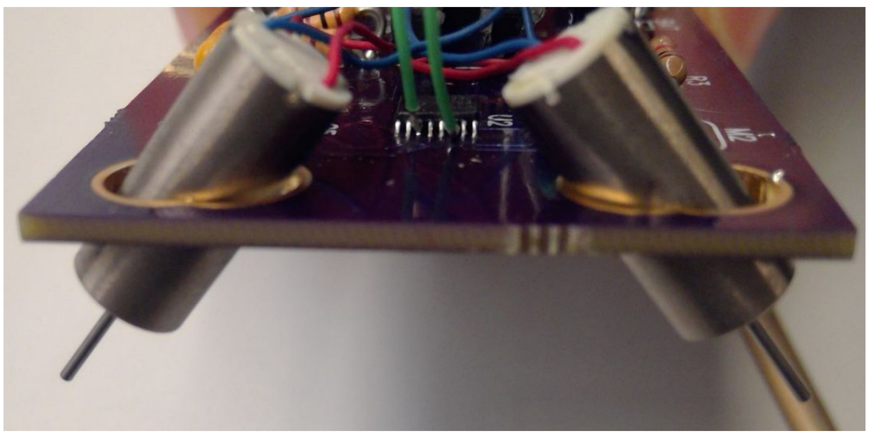
IR sensors



Battery Charger - MCP73831



Motor driver - DRV8833C



Motors

Verification

To verify that the EdBot Micro is functional, each component block is able to be tested independently from the others. Afterword, the device as a whole is tested.

- **Motors:** To test the motors, supply at least 3 V drop across the positive and negative terminals of the motors. The motors should spin.
- **Motor Driver:** To test the motor driver, the PIC18F1220 socket was hardwired directly from pin to pin to simulate the pic chip configured for the xIn1 = HI and xIn2 = LO, so the motors spin forward. Specifically, pin 14 was connected to 18 and 15, while pin 5 was connected to 10 and 16. When power was delivered to the circuit, the motor driver should turn on and the motors should spin.
- **Infrared Sensors:** The infrared sensors are used to detect approaching objects and obstacles, to allow the EdBot Micro to avoid a collision. A change in voltage drop should be significant when

an object is close to the infrared receiver. The change in voltage should be at least 1 V, so that the PIC chip can detect the change over surrounding noise, which is about 25 mV. This voltage change should occur when an object comes within less than 8-12 inches of the receiver. Any less than that may not allow the EdBot Micro to avoid a collision. During our testing, we were able to create a 3 V change in voltage beginning around 8 inches. The voltage difference varied with the distance, which can be utilized to determine distance from object.
- **Battery Charger:** To test the battery charger, first measure the voltage across the Li-Po battery. It should measure less than 3.7 V if it needs to be charged. Next, supply 5V into pins 2 and 3 from the PICkit port. The battery charger's LED should illuminate. After 20 minutes, the Li-Po battery's voltage should have increased. When we tested the Li-Po battery, it initially measured 1.83 V, and after 30 minutes of charging it measured 3.68 V confirming the proper functioning of the battery charger.
- **PIC18F1220:** To test the PIC18F1220, first, all other components must work. This is important to segregate coding errors from hardware errors. Also, each pin should be checked for proper voltage and ground, especially pins 14 and 5. If all components worked, then problems can be isolated to a programming error.

Future Enhancements

Some possible future enhancements to make the EdBot Micro even better are:
- Make the EdBot Micro even smaller, possibly to the point where it looks like a flash drive and can be plugged into a computer like a flash drive for programming/charging. Using all surface mount components can help decrease size.
- Make it modular so that components such as sensors can be easily changed out.
- Add some more basic components such as a speaker or a light to display general battery charge.
- Add wireless components so that the EdBot Micro could be programmed or controlled from a remote device.
- Add AI component and use infrared sensors to map out the room the EdBot Micro is driving in.
- Circuit protection to prevent overloading the Pic chip and motor driver.

Lessons Learned

This project has taught us how to go through the entire design process, from concept and design to testing and implementation and the final product. In general, most lessons are learned when a problem arises and has to be solved. For this project, that proved to be true more than once. The two general problems we ran into were component specifications and the physical building and testing of our board.

The lessons learned about component specifications pertained to matching specifications from one component to another and understanding specification sheets. When we were trying to use op amps to drive the motors, we could not supply enough voltage so we learned that our specifications were mismatched. We either needed a different driver that required less voltage to drive the motors or a higher voltage power source to use with the op amps. The other lesson learned was that we needed to better understand the specification sheet for the motor driver we used. We did not ground the 2 xISEN pins because we thought that they would have no effect on our circuit, but without them grounded, the motor driver did not function. That problem alone set us back by multiple weeks.

The lessons learned from the physical building and testing were that small components are harder to work with and test. We had to use a surface mount for the motor driver which was difficult to solder and test because the pins were so small. If we could go back, we would have ordered a separate board for the motor driver that would have leads coming out so that we could easily test the driver.

During the testing function, we learned how to use Arduino to simulate parts of our circuit to test whether the circuit we designed will work. This was especially true when we had to decide on the value of the resistors used for the infrared sensors.

We learned how to use Diptrace to create the schematic and printed circuit board. During this process, we learned how to create components and patterns for parts that are not already included in the Diptrace library. This required us to read drawings on the datasheet to obtain the correct dimensions. We now know how to fully implement a circuit, design and purchase a circuit board, and solder all of the components to create the final product.

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