Custom Control Module for the Teach-Robot

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Abstract

This paper is being presented not only as a final report for the CSCI 595 course, but also as a point of reference for the control module made by David Cumbow, Christopher Dufault and John O'Connor during the course of this class. All data within this document is released under the Creative Commons License and is free to use with proper reference.

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1 Introduction

Going into this Independent Study, we had a vague idea of what we wanted to complete. While there were many options to continue previous projects or complete a project based on the OOPic Microcontroller, we wanted something different. Given this we chose to create a control module for a set of robotic arms made by Baden-Baden that were purchased by the school many years ago. With very little online and physical documentation for the arms, we were certain this was going to be a challenge.

1.1 Vision

Our vision for this project is to create a fully programmable control module with the ability to monitor feedback from the motors to calculate the position of the arm in space. Ideally, the module would be fully programmable using C/C++/Java and can be reprogrammed on the fly or controllable by a computer using the RS232 protocol.

1.2 Plan and Research

Our first introduction to any kind of control module for these robots was a simple push button control unit that asserted a given voltage to either poll of the motors. We found the motors to be brushed DC-motors with hall effect sensors. Seeing as we were starting from scratch, we had to combine our knowledge of analog and digital electronics to find the best setup possible for what we wanted to do.

Noticing that we would not be able to drive the motors with any of a computers I/O ports, we realized we needed a relay like system. A relay is easily described as an electronic on/off switch. Knowing this, we started to research whether an analog or a digital solution would be best. While we were back and forth over the many different choices we had, Mr. O'Connor made the best find with a H-bridge controller that could handle the voltages and amperages needed to drive our arm.

An H-bridge controller is a bi-directional drive circuit that allows a motor to be turned in two different directions. Additionally, H-bridge controllers are controlled by a standard 5 volt V_{CC} and can drive the motors with up to 36 volts at 1 amp using a second power source. This solution proved ideal because the motors were not able to be controlled using just 5 volts.

Many microcontrollers were researched for this project. Ideally, the microcontroller would have enough pins to drive each of the 6 motors in either direction. Also, in order to control the robot through a computer, we needed a microcontroller with an onbourd USART for RS232 communication. Finally, we wanted a microcontroller that could capture and process the analog data from the motors' feedback sensors. The PIC16F884 microcontroller produced by Microchip provided all of these functions as well as additional features that can be utilized by future students interested in this project.

1.3 Building the Module

We originally designed a schematic based on a set of initial requirements that did not include H-bridge controllers or an external control interface. However, in designing the schematics, we discovered several flaws which emphasized the needs for more hardware. The H-bridge controllers were added to the schematic and drive inputs were changed from the microcontroller to physical switches. The design was then breadboarded, tested and modified as needed. Finally, the design was transferred to a semi-permanent perf-board and encased.

2 Hardware and Software Information

2.1 Motors

The motors used are a low-cost brushed DC-motor. The ideal application for these motors is a non-electrically sensitive environments.

Green and blue wires on motor are power.

Motor 1	Finger
Motor 2	Hand
Motor 3	Forearm
Motor 4	Elbow
Motor 5	Shoulder
Motor 6	Body

2.2 Arm Pinout

This is the pinout for the DB-25 connector for the robot:

Pin	Description
1	Brown wire – sends a strong signal every 1/4 turn on any motor.
2	NULL
3	feedback for motor 1
4	power for motor 1 (pos.)
5	power for motor 1 (neg.)
6	NULL
7	Feedback for motor 2
8	power for motor 2 (pos.)
9	power for motor 2 (neg.)
10	NULL
11	Feedback for motor 3
12	power for motor 3 (pos.)
13	White - attached to motor and sends a signal every 1/4 turn on every motor.
14	Power for motor 6 (pos.)
15	Power for motor 6 (neg.)
16	Feedback for motor 6
17	Power for motor 5 (pos.)
18	Power for motor 5 (neg.)
19	Feedback for motor 5
20	NULL
21	Power for motor 4 (pos.)
22	Power for motor 4 (neg.)
23	Feedback for motor 4
24	NULL
25	Power for motor 3 (neg.) – see pin 12

2.3 H-Bridge

For information on the H-Bridge controller, please see attached document number SLRS007B by Texas Instruments. Refer to chip number SN754410. If needed, the document can be found at `http://www.sparkfun.com/commerce/product_info.php?product_id=315`.

2.4 Microcontroller

For information on the microcontroller, please see attached document number DS41291D by Microchip. Refer to chip number PIC16F884. If needed, the document can be found at `http://www.microchip.com/`.

2.5 Sample Microcontroller Source Code

Please see the attached code implements our microcontroller on the MPLab I.D.E.

3 Conclusion

At the time of this writting, the controller module is about 90% fucntional. The microcontroller is only implemented in schematic and simulated code. Unfortunately time was a restraint in our case. We hope that we have sparked an interest in upcoming students to continue this project and complete our vision. Although not fully completed, this project has proved a valuable learning experience and has produced a new interest for us in controller design.