Design of Arduino and PLC-Based Controls for an OWI Robotic Arm

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ABSTRACT

The design of an Arduino (PLC and direct) controlled OWI 5 motor robotic arm system, which is currently obsolete for Windows 10 PCs, will be presented. Multiple methods for robotic arm control will be discussed to include updated USB driver fix (using LabView and other programs) and wireless, voice-activated, and direct motor control using H Bridge and switched relay control. An inexpensive dual +/-3V power supply that can replace the four D batteries will be discussed. New CAD drawings for 3D printing, PWM speed control, and motor encoders will also be discussed.

BACKGROUND

Initial build (OWI-535 Robot Arm Edge)

During the Windows 7 days, pre-pandemic. Ivy Tech bought OWI Robotic Arms that interfaced to the computers via a controller.. The arm contained five motors and one led to could be power in three positions, clockwise, counterclockwise or stationary through a hand controller or the USB adapter. Each motor could be individually driven with +3VDC, -3VDC or zero volts. The based housed 6 D batteries which were connected in series with the middle junction between the batteries being the zero-volt reference.

These inexpensive robot arms cost about $50 each and were sold as a kit that had to be assembled. It took several hours to assemble the arms. Each motor assemble contains a “gearbox” which reduces the motor rotor speed significant and increased the torque at each mechanical junction.

Option 1 – USB Interface Kit

A USB adapter was sold separately can could be added to replace the manual controller. This USB kit allowed the student to use a computer program to control the rotation of each geared motor assembly. Software allowed the user to control the arm, grip and lamp. This kit required some assembly and the software had to be installed on the computer. This option worked well during the Windows 7 OS days.

BACKGROUND (continued)

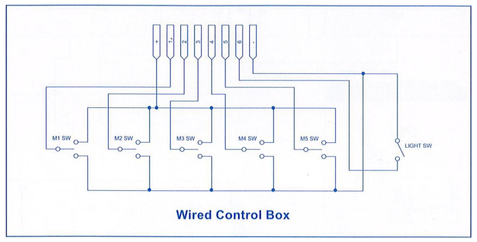
Option 2 – Speech Interface Kit

Another option explored was the use of a speech-controlled module that could move the robot arm. Ivy Tech purchased some the Speech Control circuit boards and experimented with using voice to control the robot arm. This never really went very far but has some interesting potential. Some assembly was required and there was some robot training needed to get the arms to work correctly upon command.

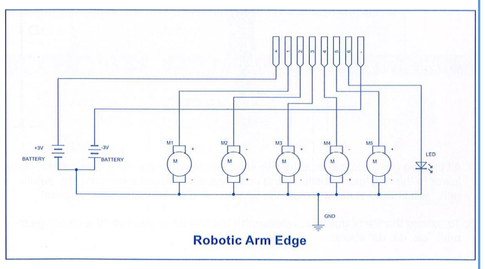
Option 3 – Wireless Control (OWI-537)

A wireless controlled version is also available and does not interface with the computer. This version has been built and works well. Arm must still be assembled but the controller allows for wireless connection. Still requires 4 D batteries and is not

Basic Schematic



Wired Control Box



Robotic Arm Edge

PROPOSED DESIGN

Project Requirements – use a PLC to control a robotic arm such as the OWI Robot Arm.

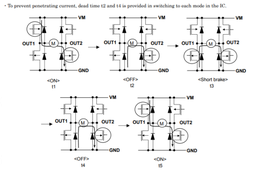
- Power must be supplied with a +/- 3VDC Power Supply, not batteries.
- The robot arm will be based on the OWI Robot Arm
- Five 3VDC motors
- on/off switch for the LED
- Each motor must be individually controlled
- Each motor must have three modes
  - CW Rotation (typically will be either + or – 3VDC)
  - CCW Rotation (typically will be either + or – 3VDC)
  - Stationary (typically no voltage applied)
- Modes can be selected with either
  - H-Bridge
  - Relays
- Mode Control
  - Wireless
  - USB
  - Voice
- Optional
  - Speed control
    - DC voltage
    - PWM
  - Position Feedback
    - Pots
    - Optically Sens

TOSHIBA TB6612FNG

H-SW Control Function

Input				Output		
IN1	IN2	PWM	STBY	OUT1	OUT2	Mode
H	H	H/L	H	L	L	Short brake
L	H	H	H	L	H	CCW
		L	H	L	L	Short brake
H	L	H	H	H	L	CW
		L	H	L	L	Short brake
L	L	H	H	OFF (high-impedance)		Stop
H/L	H/L	H/L	L	OFF (high-impedance)		Standby

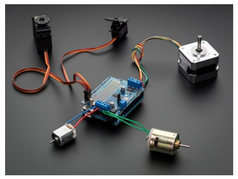
H-SW Operating Description



Motor Drive using H Bridge

Adafruit Motor/Stepper/Servo Shield for Arduino v2 Kit - v2.3

Would need two for 5 motors since this board can only do 4 motors. These are available for $20 each and can be stacked. May need to do a little soldering to make the boards stackable. This design will require the use of just +3VDC which should be provided from batteries or a small power supply.

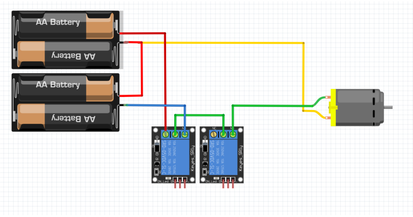


Adafruit Motor/Stepper/Servo Shield for Arduino v2 Kit - v2.3

PROPOSED DESIGN (cont)

Motor Drive using Relays

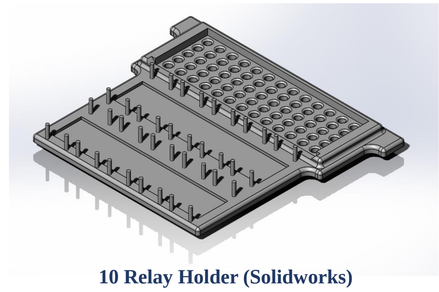
The second option is to use 10 (maybe 11 if we want to turn “on” and “off” the LED using a relay) or two relays per motor. A 10 pack of 5V One Channel Relay Motors currently sells for $14 on Amazon.



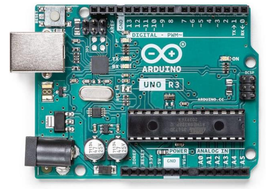
Single Motor Control (with relays)

Motor Drive using Relays

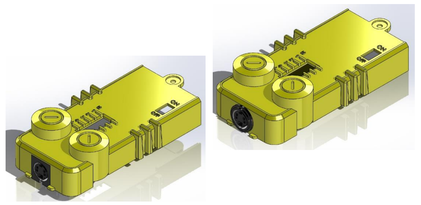
A 10-relay holder was also designed with Solidworks and could easily be 3D printed. This will make the design easier to build but other options may be available. Only needs to control 3VDC motors and should be controlled with the Arduino UNO digital 5VDC outputs.



10 Relay Holder (Solidworks)



Arduino UNO



OWI Robot Arm Part for Power

PROPOSED DESIGN (cont)

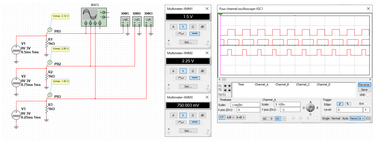
DC Motor Power

The only real option evaluated was the use of the Jameco Dual Power supply for $35. This adjustable supply can be used to produce the +/- 3VDC for the motors in theory. These kits are typically built by our students for one of their electronics course and would allow for a higher motor drive voltage if needed.

However, it would also be possible to use several 3VDC adapters instead, about $6 each. You would just need to adapt the output to connect to the design.

Speed Control (PWM)

Speed control and possibly direction could be implemented using a Pulse Width Modulation approach. This has worked well in previous designs



Future Plans

Possibly use Arduino Industrial Shield. It could be programed with LabView vs C++ and this would better align with our overall design goals.

Industrial Shield PLC 16DA

References

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2.) **Control an OWI Robotic Arm With Arduino** - https://www.instructables.com/Intro-and-what-youll-need/

3.) **Adafruit Motor/Stepper/Servo Shield for Arduino v2 Kit - v2.3** https://www.adafruit.com/product/1438

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5.) **OWI KITS** - https://owirobot.com/robot-kits/

6.) **Industrial Arduino based PLC programming with LabVIEW 2**
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