Project 5 - The Carousel

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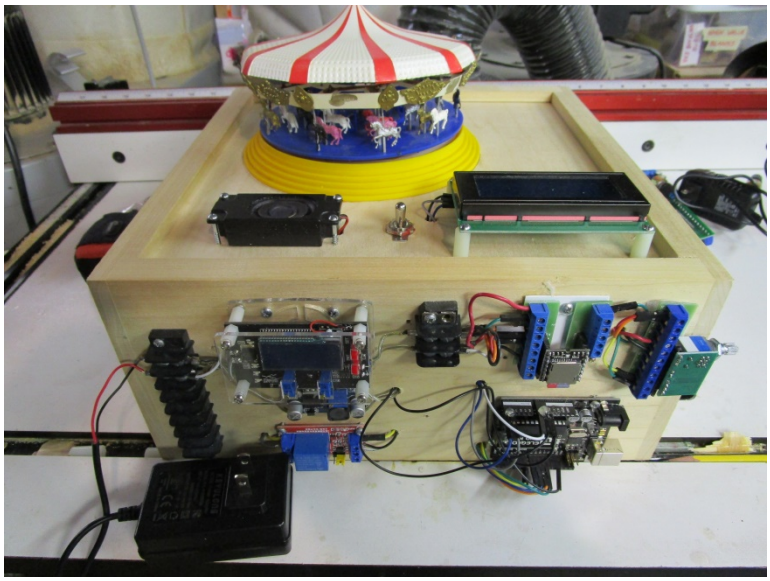
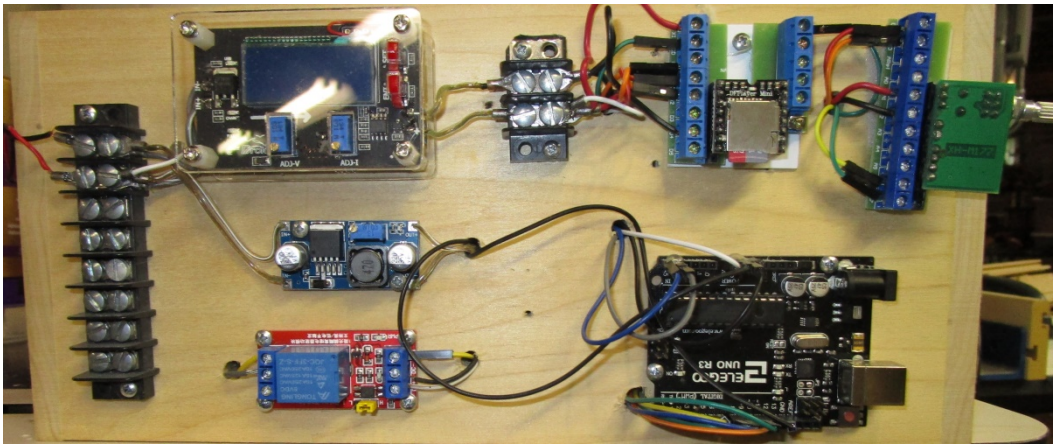


This project takes an old IHC carnival carousel, replaces the supplied motor with a quieter, more powerful Hankscraft 12V, 4RPM motor, and adds an Arduino controlled MP3 player and amplifier playing a collection of John Philip Souza marches. A toggle switch starts and stops the carousel on demand. When a song completes, the carousel stops to allow riders to dismount and new ones to board. A status display shows how the ride is progressing. The result is a more attractive depiction of a classic carousel.

To start this project, please read Chapter 9 of my web site, http://daackm.github.io, for instructions on how to build an Arduino circuit that plays MP3 files from a DFPlayer Mini. Construct the circuit and mount it on a fascia board or other surface.

The photo below shows the overall circuit layout.

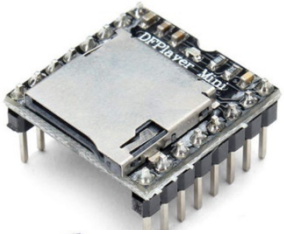


Start by placing a barrier strip similar to the one on the left of the board and wire in a 12VDC power supply. You do not need as large of a barrier strip as I used, one with

two active positions will do. If you are not certain which wire is powered and which wire is ground, use a voltage meter.

Downstream of the Power Supply's barrier strip I connected two "Buck Converters" (aka: voltage regulators). The upper one has a plastic shield and voltage display, and is a bit of "overkill", In subsequent projects I generally use a buck converter from SainSmart, Amazon ASIN: B01299MVD8 for $8, because while it does not have a plastic protective cover, it still has a display, which I find useful. This buck converter drops the 12V from the power supply to a lower voltage of 4.2 volts as required by the audio circuitry. Wire in its inputs using red wire for the powered wires and black ones for ground.

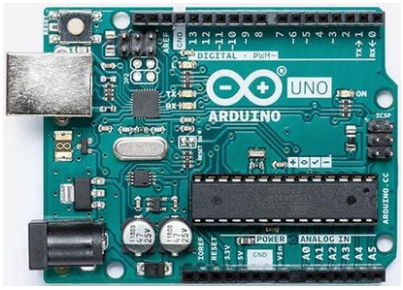
But before wiring in the audio components, turn the buck converter down to its minimum, around 1VDC. We do this because out of the box the buck converter supplies 35V, and if connected to an audio component would immediately fry these sensitive electronics. After you turn it down and wire in the audio components, you can turn it back to its operating voltage of 4.2V.



Let's now go to wiring in the audio circuitry. To the right of the upper buck converter and its barrier strip you will find a "DFPlayer Mini" MP3 player chip. Chapter 9 of my web site describes how to wire this in and build an expansion board to make it easier to mount and wire in, so make sure you understand that part of the documentation. While it can run without an amplifier (in this case the speaker would be wired directly into the MP3 player), doing so sacrifices the ability to turn the volume up and down using a knob; I always use an amplifier, as they are only $4.

Just below the first buck converter we find another, simpler one. This one does not have a display and must be dialed down to about 8 volts using a volt meter before connecting it to anything. I chose this one (AMAZON ASIN: B07VVXF7YX, 10 for $18) because it was less expensive and I wanted to try it out, and it does indeed work. I did not place another barrier strip downstream of this buck converter, but you will be happier if you do. As before, turn it down to around 1V before hooking it up to

anything other than the barrier strip. We will be using power from this device to power the carousel motor and the Arduino. Yes, we could power the Arduino directly from the barrier strip downstream of the power supply, but the secondary buck converter was closer to my Arduino. So run red and black wires from the secondary buck converter's barrier strip into the VIN and GND pins of the Arduino.



And speaking of Arduinos, although I used an "Uno" for this project, I prefer to use "Nanos" and expansion boards. This project was an early one for me, before I became comfortable with Nanos, and if built again, I would use a Nano.

Now wire in the display. This is described in Chapter 11 of the web site. Power for the display should be taken downstream of the first "Buck Converter", not directly from the power supply. To get its contrast adjusted properly, you may have to turn the blue "trim potentiometer" on the back side. Also, you may have to alter the sketch to match the hardware address of your display, but Chapter 11 of the web site at http://daackm.github.io describes the details.

Souza marches are particularly suited for carousels, and may be easily located and downloaded from the Internet. I like a collection by the Marine Corps Band which can be found by searching for "Souza Marines Downloads". Just copy the files to a small SD card, place the card in the MP3 player and you are all set.

But the music won't play until you there is a toggle switch to start the show. I describe how to connect such a switch in Chapter 8 of the web site listed above, and have wired mine to pin D9 of the Arduino. The music will play and the carousel will turn as long as the toggle switch is in the "ON" position. Should you prefer, a push button switch will also work, but make sure it is one that is "latching" and "normally off"; "momentary" switches are not suitable for this project.

We still need to wire in the carousel motor, but I'm going to put that off for a bit longer. Let's first check that the music plays.

I have created software that drives the MP3 Player and carousel, and this can be found under the "Projects" section of my website at http://daackm.github.io. Copy the code to the Windows clipboard, start the Arduino Interactive Environment (the IDE), do a "File/New", delete the default code, and paste in the code from the web site.

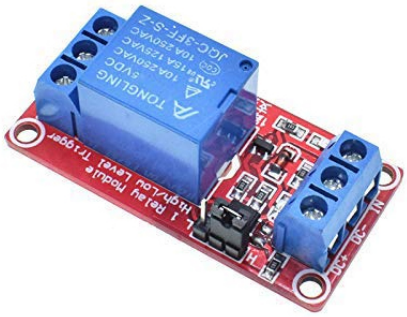
Prior to running the sketch, take a look at the code around line 23. In order to randomly play the MP3 files properly, you need to modify the sketch to indicate the number of songs you have downloaded on the SD card. So, change the sketch to reflect the number you downloaded and save the sketch.

```
17   I REALLY hate to do this, but I can't make the "readFileC
18   for the DFPlayerMini, unless the USB cable between the Ar
19   is connected.  I think it is related to some "COM" port i
20   So, I have "bitten the bullet" and require you to hard co
21   number of MP3 files on your SD card in order for this to
22  */
23 int maxSongs = 14;  //How many songs are on the SD card?
24
25
```

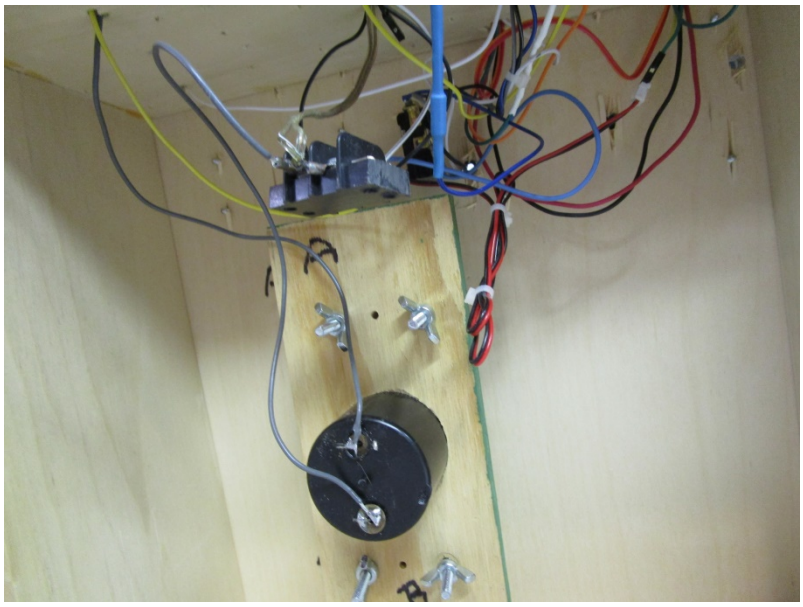
Follow the instructions for running an Arduino “sketch” (basically, use the “Tools” menu item and select the proper Board and Port). Click on the “Download and Run” icon and music should begin to play. If not, check your audio cables and make sure the SD card is firmly inserted in the player; they do tend to occasionally pop out.

If everything sounds right, let’s go to the carousel motor. My carousel was over 30 years ago, and I had long since lost the motor. Anyway, I remember it to be noisy and erratic, so I decided to use a 12V, 4RPM motor from Hankscraft (available on eBay and sometimes at train shows) to power the carousel. But a 12V power supply made the carousel spin faster than prototypical, so I used the second buck converter to reduce the power to about 8 volts to suit my liking; 8 volts is still enough to power the Arduino, but if you reduce the voltage below 7V you will need to get Arduino power from the power supply’s barrier strip instead.

Before we wire in the actual motor, we need to talk about the relay just below the second buck converter, and to the left of the Arduino. Arduinos can handle voltages up to 5V, and the carousel needs 8V coming out of the second buck converter, so we can’t control the carousel motor directly from the Arduino; we have to isolate it from the Arduino through a relay. Chapter 13 of the web site describes how this is done, but briefly, wire the 5V pin of the Arduino into the “DC+” socket of the Arduino, and a ground to “DC-“. I wired the control pin for the relay (the “IN” pin) to pin 7 of the Arduino. I wired the output from the 8V buck converter into the NO and COM connectors on the output side of the relay. Now if you run the sketch, in addition to hearing the carousel music, you should hear the relay click on and off. Yes, I could have controlled this with a transistor, but relays are inexpensive and a transistor would have been harder to mount on the fascia.



Here we see the underside of the Carousel. We see the wires coming from the toggle switch, wrapped neatly with nylon ties. If you look right above the letter “A”, you will see a barrier strip with wires connected to both the output of the relay and the motor, which is just below the letter “A”. The motor is mounted on a mounting block with four 8-32 bolts, 3” long. That’s enough explanation for the electrical connections; the mechanicals are next.



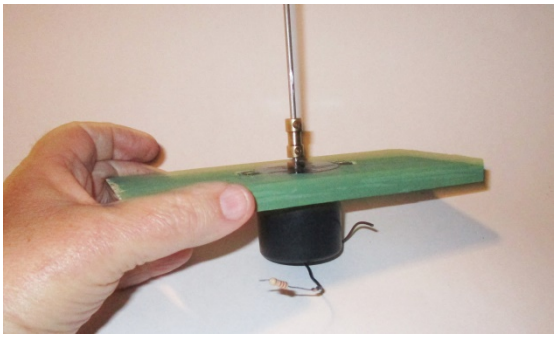
There is a 1/8” drive shaft on the Hankscraft motor we are using, and a similar 1/8” plastic shaft on the rotating part of the carousel. Initially, I hoped to join them with plastic tubing, but there was not enough friction between the motor and the tubing; the motor spun, but the carousel did not. Collars didn’t help, either. While experimenting with other techniques, disaster struck as I clumsily snapped of the plastic shaft from the rotating table of the carousel. And I ended up with a much better solution.

For starters, I placed the yellow carousel bottom where I wanted it on the layout, made a mark in the center and drew a line around its circumference.

To make a motor mount, I took a piece of 3/4” plywood, roughly 3” by 6”, and drew lines from opposing corners. The intersection is where I needed to drill a 1.75” hole for the motor. The diameter of the Hankscraft motor is just a shade over 1.75 inches, so using a hole saw, I cut a hole in my layout to that size, and then using a sanding drum, I enlarged its hole until the motor would slide into its plywood mount all the way, albeit snuggly; the dimension here is not critical.

With the motor in the motor mount, I rotated the motor such that its “ears” were aligned with the long axis of the board. I marked where the mounting hole ears were, and removed the motor. I marked the side with the ears as “TOP”. Using a Forstner bit, I drilled about 1/4" into the board where the “ears” were marked, to allow the motor to be mounted flush with the top of the board. This step is not absolutely essential, as you can mount the motor with the ears on top, but I liked the way it looks, and then removed the motor from the mount.

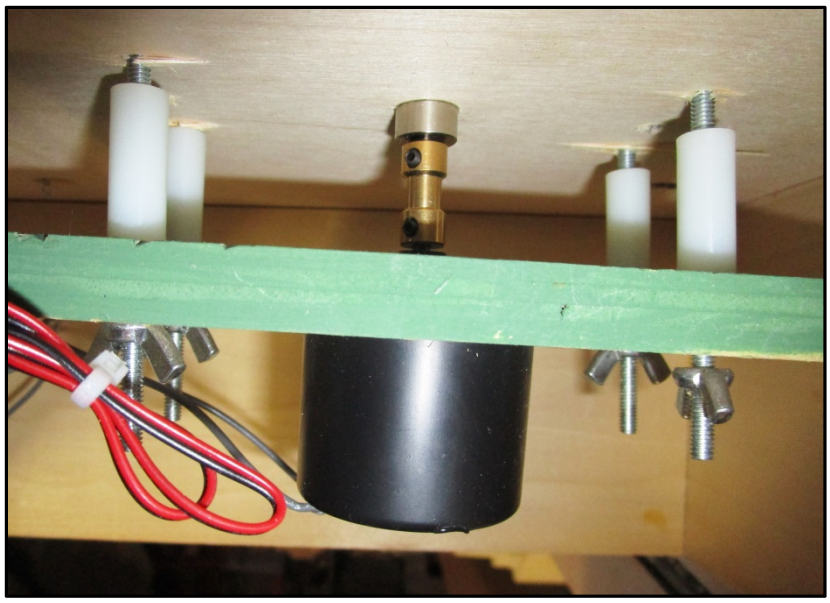
I lined up the holes in the layout and the motor mount, such that the mounting block was parallel to the edge of the layout and clamped them together. Using a #17 drill bit, I drilled a hole about 1.25” from the center, to the right of the hole and about 0.75” above the centerline. Into this hole I placed a 3.5” bolt, and tightened it down with a washer and wingnut. I used bolts with Phillips pan heads; don’t worry too much about the heads, as they won’t be visible when we are done. I drilled another bolt hole about 1.25” to the left of the large hole and 0.75” below the centerline, again bolting it down. With the two bolts secured into position, I removed the clamps and drilled additional holes on either side of the motor. I marked one side of the layout hole with an “A” and the same side of the mount with another “A”, pulled out the bolts and removed the mount. Why the markings? So that when I went back and permanently mounted the motor, the holes could align properly.



Remember that I said that I clumsily broke off the plastic axle on the carousel’s rotating table? Well, I decided the best thing to do was to replace the plastic axle with a metal one. I cut a 5” piece of 1/8” metal rod and attached it to the Hankscraft motor with a coupler I bought from AMAZON (ASIN: B07H1JTN53), snugging it down with set screws. I inserted the metal rod into the coupler and snugged it down. I placed the motor in the mount and secured it with short #4 screws through the “ear holes”.

Anticipating the time when I might need to re-tighten the set screws, I decided to offset the motor mount from the bottom of the layout. I found some nylon offsets at my local hardware store, and cut them down to 1.50” long on my band saw (I have a home-built “sled” on my band saw which makes this a safe operation, but if you have nothing similar, place the tubing in a vice and cut it with a hacksaw; dimensions are not critical here). Alternately, use plastic tubing, or even cut short lengths of lumber and drill through them with a #17 drill bit.

I reinserted one bolt through the layout, ran a spacer onto the bolt, aligned the motor mount properly, and snugged it down with a wing nut. I did the same thing to secure the motor with a bolt on the opposite side, finally installing the remaining two bolts.



I placed the yellow carousel base into position and hot-glued the base to the layout surface. I placed the revolving table, the one where I broke the shaft, on top of the base, running the metal rod through the hole where the broken shaft once was. The metal rod may extend two inches or so above the revolving table, and if this is objectionable to you, take a marker and mark a spot about 1/2" above the top of the table, remove the motor, and shorten the rod with a hacksaw and re-install the motor. Where the rod came through the revolving table, I generously applied epoxy to connect the rod to the table, and gave it a day to cure.

When power was applied, it turned OK, but not well enough. I chipped off the epoxy and decided to do some re-engineering to the base. Thirty years ago, when I bought my carousel, the base had three circles of 5 “bumps” which caused the horses to rise and fall as they rotated. I found mounting the horses in the carousel top to be tedious, so back then I glued them into the top, and thus no longer had any need for the bumps, so I removed them with a hobby knife. I took 1” pieces of 1/2" UHMW tape (really slippery stuff) and placed them around the perimeter of the base, where the bumps once were, and it made the whole mechanism run much more smoothly. Newer versions of the carousel are machined differently, so if you run into one of these you may need to get creative or search for an older model.

I reassembled the carousel and again applied the epoxy, and the unit has run well ever since.

I would like to credit Fernando Koyanagi for his work on an “MP3 Player with Arduino” as can be found in Instructables.com; his work is the foundation of my implementation of animating a model railroad carousel, and I encourage you to review his web page at https://www.instructables.com/id/MP3-Player-With-Arduino/ before attempting this project. I found it well worth the effort to understand his excellent work.