Project 4 - Lumberjack

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David Ackmann – Gateway Division NMRA

Have you ever been to the Museum of Science and Industry in Chicago and lingered over “The Great Train Story” exhibit? Just past the port of Seattle, if you are walking clockwise, perhaps you saw the logging operation up on the hill. Did you push the button to make the tree fall? I did, more than once, and had to have a similar animation for my railroad. Here’s how I did it.

I can’t remember whether their animation had a lumberjack or just the falling tree, but I also wanted a lumberjack swinging an ax. My layout is pretty flat, so no hillside covered in pine trees for me. But more, it had to have sound effects, and a fire to burn the unwanted branches. All would be controlled with an Arduino microprocessor.

Before we get any further, you can find the Arduino sketch that I used for this project at http://www.github.com/daackm, under the lumberjack repository. If you want to see it in action, visit YouTube and search for the “Model Railroad Lumberjack Animation” video.

But where to start? For me, I decided where I wanted the tree, and where I wanted it to fall. I cut a slot in the layout surface, about 2.5” long and 0.75” wide; the tree would be positioned at one end. I wanted this to look as good as possible, so I bought a pair of Woodland Scenics’ “Premium Pine Trees”, and one of these would be the centerpiece, mounted on a small motor and rotated on demand, about 70° in all.

You might ask, Dave, ”What motors did you use use”. I ended up using metal geared servo motors from AMAZON (ASIN: B07NV476P7, 2 for $10). I wanted to use a servo instead of a stepper motor, because servos use absolute positioning, which means they always can be returned to a specific position on demand; not so with a stepper motor. I was concerned about using plastic gears because of their inclination to strip, but if I had to do it over, I might give plastic geared motors a try (AMAZON ASIN: B07MLR1498). Why? Because the metal geared motors are pretty noisy, mechanically.

The tree would not be mounted directly on the motor, but on an “arm” (aka: “horn”), and this turned out to be a frustrating process. I tried to drill a hole through the trunk, but soon learned that the armature was composed of fine wires which got tangled during drilling, and once exposed did not present a good surface for attaching to the motor arm. What finally worked was a 5 step process: 1) I carefullysanded about a half inch up one side of the bottom of the trunk. I used a stationary belt sander which allowed me to use both hands to control the tree during the operation; 2) I epoxied the tree to the arm, making sure not to obstruct the mounting hole; make sure that the round part of the arm which will mate with the motor shaft is pointing away from the tree; 3) I discovered epoxy was not enough to hold the tree to the arm, so I tightly wrapped the epoxied tree trunk in three turns of white Teflon tape usually used for sealing plumbing threads; 4) I covered the tape with another layer of epoxy; 5) I painted over the taped area with a mixture of brown and black acrylic paint.

To mount the tree motor to the layout, I needed a mounting block. I started with a piece of 1 by 2 lumber, about 2" long. I cut a notch in one side, near one end, just large enough to hold the servo motor. I drilled a 1/4" hole in one side to allow the wires to pass through, and then attached the motor to the block with the screws that came with the motor. I then glued the block into place (I like "Titebond" glue), near the edge of the slot, such that the motor shaft extends into the slot about 1/4".

After the glue dried (I allowed it to dry overnight) it is time to mount the tree onto the motor. Press the round part of the arm onto the motor shaft and secure using the screw provided with the motor.

Next comes the Arduino. I am going to assume that you have already read my documentation on why I like the Arduino Nano (its expansion board), how to power it with an external power supply, how to use motors, displays and how to add sound to a project, so I won't go into details on these topics again; if you have not done so, visit http://www.github.com/daackm , open the "Amazing Arduino Animation Tutorials" and start at the beginning. But at the end of this project document I have included a block diagram and spreadsheet with wiring pinouts. You are free to use any wires you like, but I am pretty strict about using red or white wires for positive voltages, black for ground wires, and just about any other colors you like for data wires. I like 20-24 gauge wires, and often use jumper wires directly plugged into expansion boards, then screwed down for a tight connection. So place a Nano into an expansion socket, wire it into a barrier strip and a power supply, and connect the tree motor to power, ground and socket D4 on the Arduino.

Now would be a good time to add an external power supply. My choice is a 12VDC, 2 Amp unit, specifically AMAZON ASIN: B07VBR327W. Wire it into a barrier strip and from there into the VIN and GND points of the Nano and plug it in.

The animation is initiated by a momentary, normally open push button switch. I used one that comes in an 8-pack (AMAZON ASIN: B07XG4N6J1). Wire it to pin D12 on one side and any ground point on the other, making sure to solder in a 10KΩ resistor somewhere in-line; cover the joints with heat-shrink tubing.

You are now ready to load the software into the Arduino. I will assume you know how to do this, so just open my GitHub account (http://www.github.com/daackm) and open the Lumberjack repository. In there you will find a file labeled "Project 4 – Lumberjack"; right click on it and the sketch will open in a "text-like" window. Highlight the entire file (a Control/A works well for this) and then use a Control/C to copy it to the Windows clipboard. Open the Arduino IDE and under the FILE tab, create a NEW sketch. Highlight and delete all the code which normally comes with a new sketch, then paste the Lumberjack code in its place (Control/V works for this, or you can click on the EDIT tab, then the Paste command). Save the sketch in a location of your choice.

You would think that you could now press the button and test things out, but that is not the case. The sketch you just downloaded will not run unless you have also installed the audio circuitry, which you have yet to do. But I couldn't wait either, so I wrote a small sketch called "Tree---Test" that is also in in the GitHub Lumberjack repository; download it and save it in a location of your choice. Use the TOOLS tab to select the "Arduino Nano" board (or different board, if you insist), then the proper port, then the dark green arrow in the light green circle to download the sketch into the Arduino. This sketch drives both the lumberjack motor and the tree motor, and since the tree motor doesn't start until after the lumberjack motor (which you have yet to install), you will need to wait patiently about 14 seconds for the tree to begin to fall. Then wait about another 15 seconds for the tree to return to its upright position. Your patience will be rewarded.

Now reload the Lumberjack sketch into the Nano. The next step is to install a Buck Converter (an upscale voltage regulator), another barrier strip, a DFPlayer mini MP3 player, an amplifier and speaker. You MUST include the Buck Converter because the audio circuitry is very specific on its voltage requirement. Part 9 of the "Amazing Arduino Animations Tutorials" describes this task in detail, just remember to turn the potentiometer on the Buck Converter down to 4.2VDC before connecting it to the MP3 player or the amplifier; ***failure to do this first will fry these components.*** Download the "Single Chop.MP3" file to your SD card, and secondly (not at the same time as the previous file, these MUST be loaded separately), download the "Falling Tree.mp3" file onto the SD card; place the card into the MP3 player.

If you are following the circuit diagram at the rear of this document, you see that I use an amplifier to control the audio volume. You can save $4 by eliminating the amplifier, removing the wires on pins 4 and 5 of the MP3 player, and then wiring the speaker into pins 6 and 8 of the MP3 player. For me, the amp and its volume control is worth $4, but the choice is up to you.

Press the start button again, and you should hear the lumberjack's ax hitting the tree five times, and then hear and watch the tree fall (and even bounce once, kinda cool). The sketch waits 15 seconds before restoring the tree to its upright position, then 15 seconds more to allow the lumberjack time to rest. If you hear nothing, remember the first 3 laws of Computer Science are 1) check the cables; 2) check the cables again; 3) have someone else check the cables. The project is designed to stall if it cannot successfully initialize the MP3 player, and failure to initialize is often caused by incorrect wiring or a missing DC card. It really helped me to build a spreadsheet of pinouts between the various components, and I encourage you to do the same.

Next, I recommend that you install a display. This is covered in detail in Part 12 of the "Amazing Arduino Animation Tutorials" available on Github. Installation is really nothing more than connecting pins A4 and A5, plus 5V and GND from the Arduino to the display (assuming that you bought the proper display, AMAZON ASIN: B071FGZX8G). The display tells a visitor to "Press Button To Start", and informs them to wait while the tree is on the ground and while the lumberjack is resting. The display is not absolutely essential, but it is good human engineering.

I wanted a pile to burn some brush. In Part 5 of the "Amazing Arduino Animation Tutorials", I mentioned that a YouTube video from "Ron's Trains and Things" is a great introduction to Arduinos, and at the end it describes how to use LEDs to make a campfire (https://www.youtube.com/watch?v=wBn7pHEIdWI); I liked what he did. I built one as a pile to burn discarded brush from the logging operation, using digital pins 3, 5 and 6 using the PWM modality. Normally pins 9,10, and 11 are also available for use as PWM pins, but if a servo motor is also in use, as is the case with this project, pins 9 and 10 lose their PWM ability.

Now it's time to add the lumberjack, but how do we know where to place him? I knew I wanted to use a servo motor to rotate him, such that at the end of the stroke his axe would be touching the tree. I had to make sure the motor which would drive him would not interfere with the falling tree and its motor. How did I do it? I temporarily placed my figure such that his ax was touching the tree, then moved his feet to a position I liked, and marked the spot between his feet. I drilled a #30 hole through the layout surface, and this would be the spot for an axle around which he would rotate.

Now he needs a platform on which to stand. I made one by cutting out a 3/8" diameter circle of 0.02" styrene. I also cut a 2"piece of 1/8" plastic rod, glued it to the platform and painted it to match the layout surface. Once dry, I inserted the rod through the hole. Next, I constructed a trapezoidal wooden block from a 2 x 2 piece of wood about 3" long, and cut a notch through the short side. Now I needed a "transmission" to connect the motor to the lumberjack, and some way to align the mounting block such that the motor would align with the lumberjack's axle.

I discovered that Evergreen Plastic #227 could be jammed securely around the drive shaft of the motor, but its inside diameter was too big to hold the axle. But if I inserted a piece of Evergreen #225 inside the #227 and glued it with Plastic Weld, it would stay secure, although the interior diameter was now a bit too small for the axle. I drilled it out with a #30 bit, and it held snuggly. I decided to enlarge the hole in the platform just a tad, using a #28 bit. I then inserted the axle into the hole, applied Titebond glue to the mounting block, aligned the transmission with the axle and glued the block into place, making certain that the position would not obstruct access to the screw holding the tree to its motor.

Once the lumberjack mounting block was secure, I loaded a different "utility" sketch on the Arduino, whose purpose was to rotate the lumberjack's platform into the "contact position” with the tree (open http://www.github.com/daackm and then open the lumberjack repository for the “Platform_Alignment” sketch). When the utility had rotated the platform into the striking position, I applied some tacky glue to the platform and positioned the lumberjack figure so that his ax was touching the tree and his feet where in the center of the platform, then let it dry overnight. At first the figure tended to fall until the glue was about 15 minutes into its cure, so keep an eye on it for a while.

That just about completes this project. Sure, you might want to add a few more trees and shrubbery, maybe a few rocky outcrops, and maybe a logging truck or a few stumps, but you get the general idea. If I made another one of these, I might go with a higher quality servo, specifically one where I could get aftermarket horns (not available on the lower cost 9g servos); the customer support provided for the metal geared servo I used was uncommonly poor. I would use a right angle horn for the tree, and on the horizontal horn I would attach a wooden rectangular plug to cover the hole, so that the hole wouldn’t be so obvious when the tree was standing, and the right angle horn would allow the plug would rotate out of the way when the tree was falling. I also might animate a chainsaw figure cutting branches, which would require a second MP3 player. I still have pin 11 available and could make the fire even bigger. Maybe I should add a relay to control a smoke generator. And for a comic touch, I might add a relay and motor to animate a bulldozer to push the tree back to the upright position.

For me, it’s been a fun and challenging project. I hope you enjoyed reviewing it.