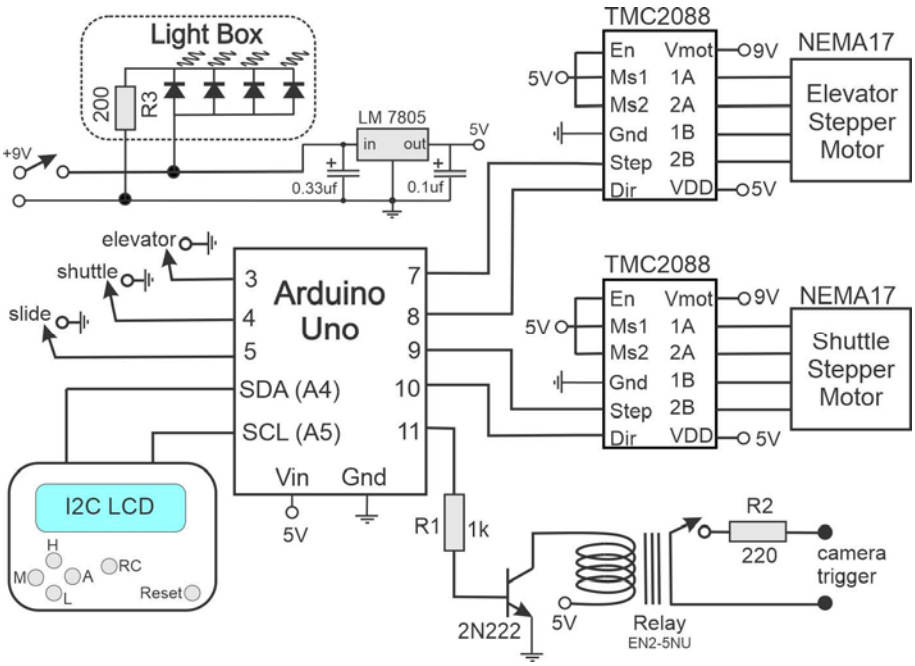
35 mm Slide Digitizer: Control Electronics

May 28, 2021

The slide scanner uses an Arduino Uno with a pair of shields to drive a controller board that actuates two stepper motors and trigger the camera. In addition, there are three limit switches which sense various machine positions. The schematic for the system is shown here.



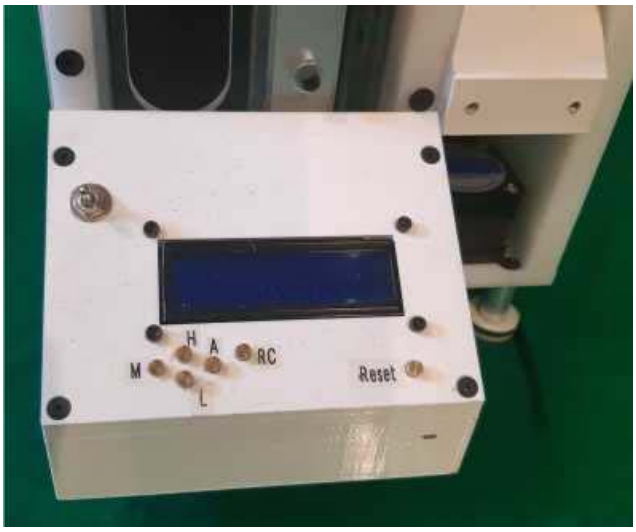
35mm Slide Scanner Control Electronics

The schematic involves a specific display board for the LCD which provides an I2C interface which can be sourced from AdaFruit[1]. This little board has the advantage of coming with 6 built in switches that will be used in the software to select various functions. As such, it is important to use this LCD or an identical equivalent for this project as the software expects this board. The schematic shows a small 5V relay which is driven from the Arduino. It would be tempting to drive the relay directly from the Arduino which very likely would work, however, it is prudent to be cautious about challenging the current capacity of the Arduino outputs (40mA limit). Thus, an NPN transistor was added to drive the relay. There are low power versions (EC2-5NU – from Kemet)[2] which claims a 31mA current draw which would probably work. There is a 220-ohm resistor in series with the "camera trigger". This was found to work well for the SLR camera used in the original build, but it would be prudent to consult the requirements for the camera which is being used.

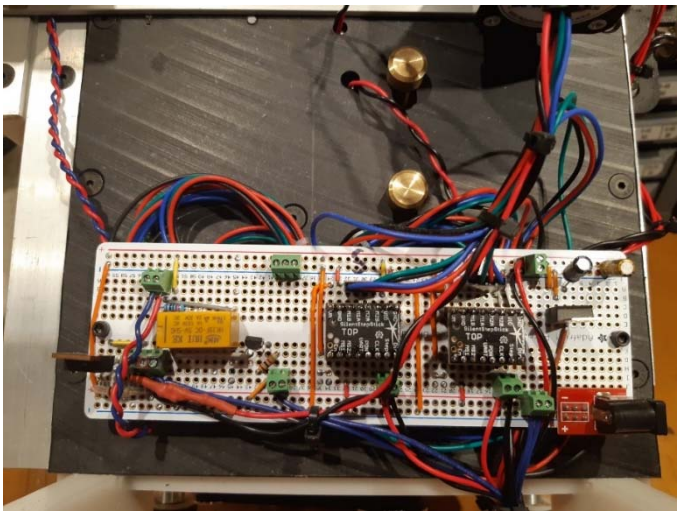
[1] https://www.adafruit.com/product/714

[2] See https://www.digikey.com and then search for EC2-5NU

The circuit uses a 9V wall power supply which generates 5V for the Arduino Uno through a standard 5V regulator. The 9-volt supply also serves to drive the stepper motors and the LED array for the light box. A 12-volt supply would provide a bit more torque for the motors if needed with no circuit changes. The Arduino has inputs for three limit switches which correspond to that which detects the proper position of the slide ("slide→ GPIO5"), the switch to home the shuttle("shuttle→GPIO4") and the third switch located within the frame to limit the upper position of the elevator leadscrew ("elevator→GPIO3"). The Arduino delivers pulses (step and direction) to two stepper motor controllers (Trinamic TMC2208[3]) which drive two NEMA17 (26 N-cm) stepper motors[4]. The Arduino and the LCD board were placed in a 3D printed enclosure mounted on the front of the scanner. The STL files for 3D printing this enclosure can be taken from the Fusion 360 Model[5]. The LCD is an Arduino shield that plugs directly into the Arduino Uno. In order to get easy access to the Arduino pins, an Arduino Uno compatible screw connector breakout board[6] was used between the Uno and the LCD. Note the 6 small buttons on the LCD which are used to control the scanner functions. These were machined to fit the openings in the mounting board for the Uno. The dimensions of these buttons can



The LCDisplay mounted in the Arduino enclosure. The buttons to control the software are seen below the LCD.



Controller board carrying the voltage regulator, transistor, stepper controllers and camera trigger relay.

[3] See https://www.digikey.com and then search for TMC2208B
[4] https://www.omc-stepperonline.com/nema-17-bipolar-1-8deg-26ncm-36-8oz-in-0-4a-12v-42x42x34mm-4-wires.html
[5] https://github.com/dbplewes/35mm_slide_scanner
[6] https://www.creatroninc.com/product/screw-terminal-shield-r3/

be found at https://github.com/dbplewes/35mm_slide_scanner. A small rectangular opening on the left of the enclosure allows access to plug a USB cable into the Arduino Uno for programming. Wiring is passed through the bottom of the enclosure to the control board routed below the scanner frame. The controller board carrying the power supply barrel jack, relay and motor controllers was mounted on the back of the scanner with appropriate wiring to the motors and limit switches.

Camera Trigger

Most cameras have the capacity to trigger the camera with an electronic "cable release". There are lots of commercial wireless options and wired versions. Searching online shows that wired versions is done with a simple button through a load resistor. The controller uses a low power relay with a current limiting resistor as seen on the schematic. Different cameras might require a different load resistor or perhaps none at all. A little experimenting should identify the best approach.

Scanner Control Software

The Arduino software to run the scanner is straightforward and can be downloaded from https://github.com/dbplewes/35mm_slide_scanner. As mentioned, the LCDisplay used for this project has the advantage of including 6 buttons which are used in the software. This provides a means to run the scanner in various modes. These can be seen in the previous Figure and are labelled (left→right) M, H, L, A, RC and Reset. The "M" button allows the scanner to be used in a manual manner, meaning that it will scan only one slide at a time. This is a useful aid in focusing the camera and making any adjustments to the camera's white balance. The button labelled "H" is used to home the scanner on startup. This button will move all the stepper motors to calibrate the location of the elevator and the shuttle. The button labelled "L" is used to load slides into the scanner. Pressing this button will lower the elevator stage the equivalent of about 15 slides and can be pressed repeatedly until complete box of slides are loaded. The button labelled "A" will run the scanner automatically. Once pushed the scanner will lift the elevator one slide at a time, the shuttle will capture that slide, move it over the light box, actuate the camera to take the picture and then deposit the slide into a second chute. The "RC" button is used to move the shuttle away from the hopper to permit loading slides into the hopper. Once the slides are loaded, this button is pressed again, to start either manual or automatic scanning. The last button labelled "Reset" is connected to the reset button of the Arduino and reloads the code. Reading

through the software should provide the user with an understanding of how to use the scanner. The software is written with adequate prompts shown on the LCD to guide the user through its use.