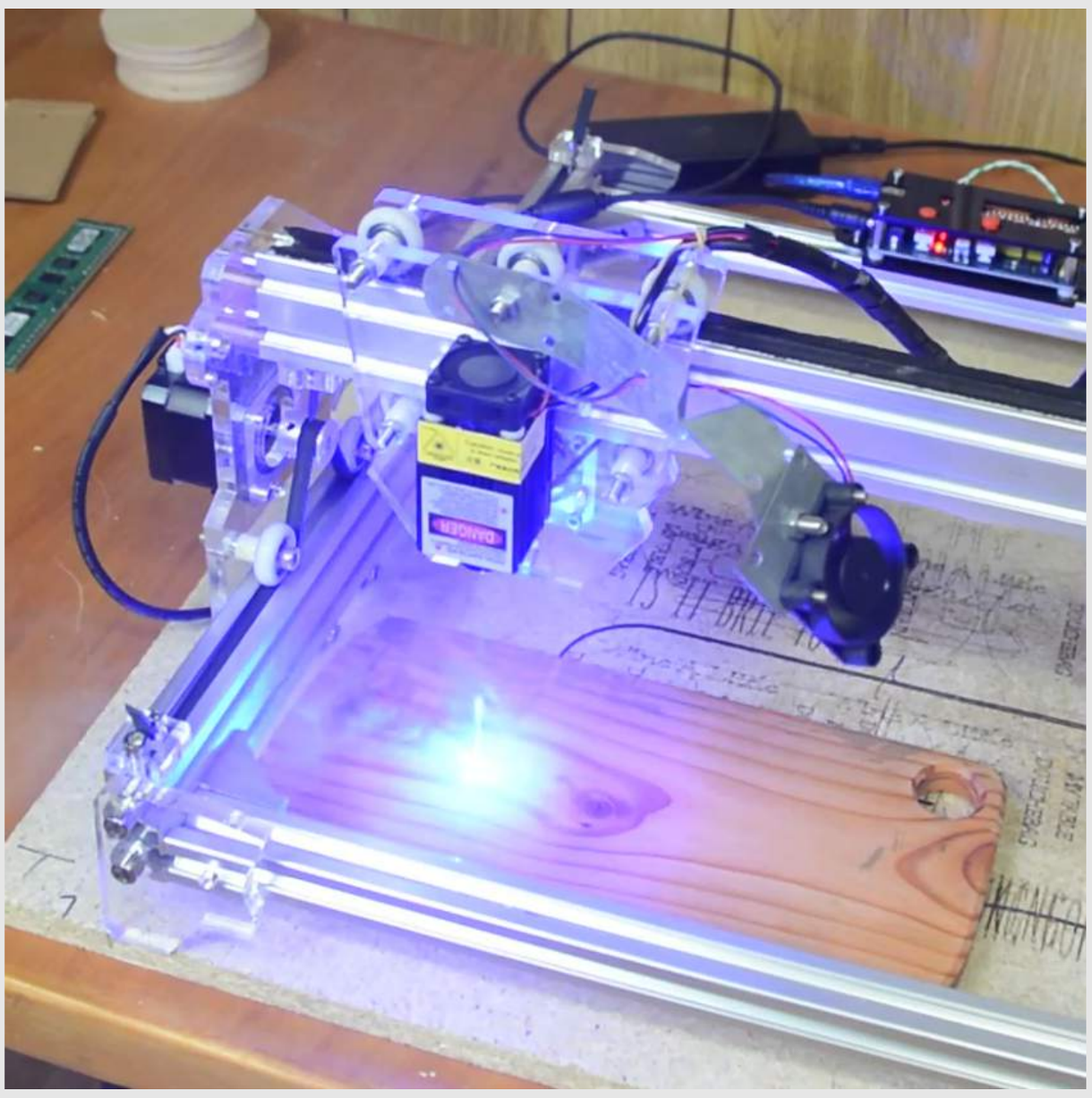
CNC Laser Engraver

CNC: Numerical control (also computer numerical control, and commonly called CNC) is the automated control of machining tools (such as drills, lathes, mills) and 3D printers by means of a computer- according to Wikipedia.



CNC Laser Engraver: It is a type of CNC machine that uses laser to do 2D designs on wood, lather etc by burinng. It is controlled by g-code(numerical control (CNC) programming language). And the g-code is implemented by GRBL based software like LaserGRBL, UniversalGRBL, Benbox etc.

The engraver, that was made, can engrave within 40x40mm wood and lather. The whole machine dimention is 18x13x15cm. It is controlled by Arduino UNO(-main processor) and a CNC driver V3.

Objective: The main objective of this machine is to engrave any 2D design on wood, lather, vinyl sticker. Its burn is 1mm deep in wood and lather.

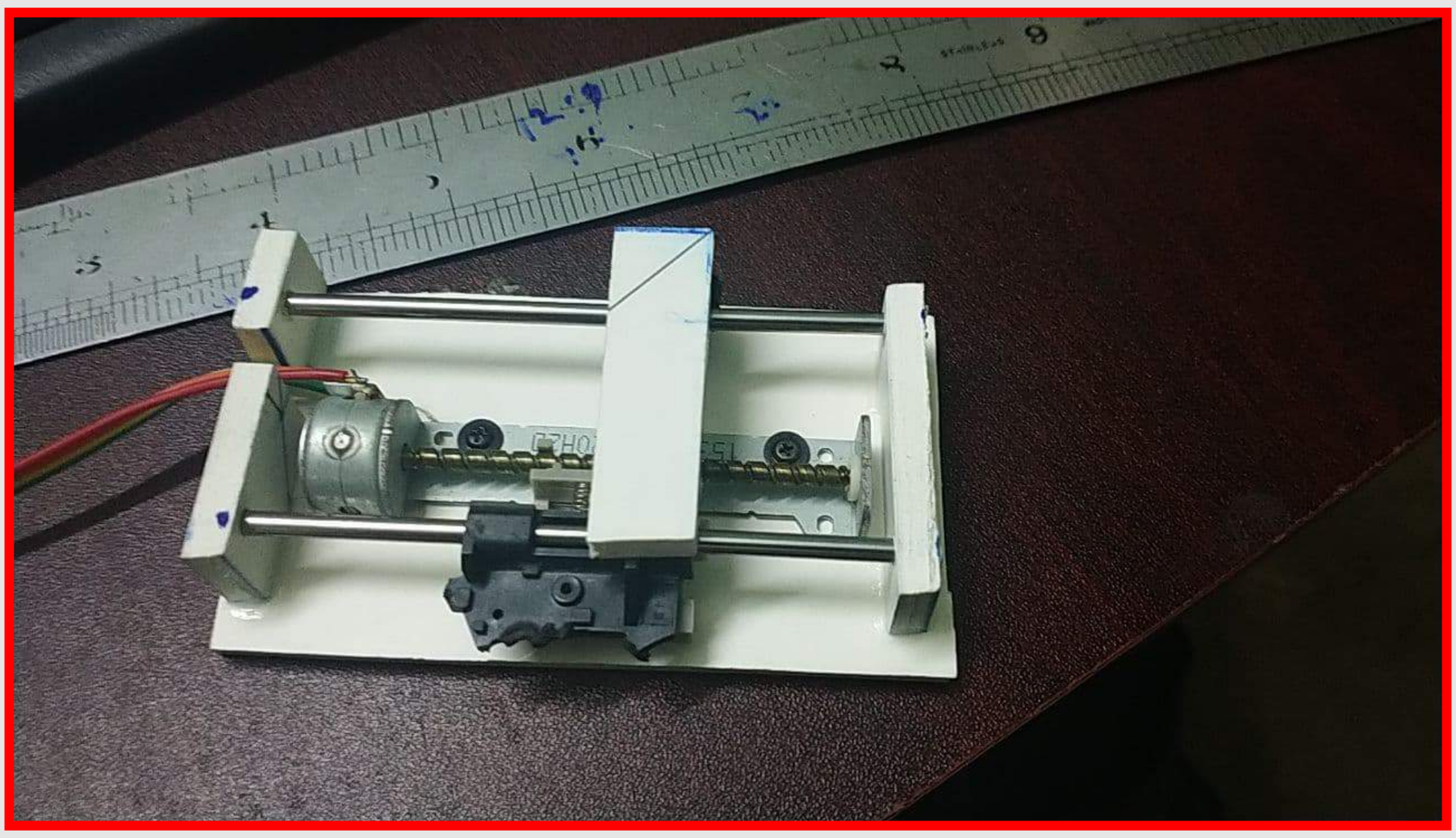
Parts and cost:

NAME	QUANTITY	PRICE(BDT)
Arduino UNO	1	450/-
CNC Driver V3	1	300/-
DVD R/W for Stepper Motor	2	200/- each
Focusable Laser(250mW, 635nm)	1	804/-
A4988 Stepper Motor Driver	2	90/- each
PVC Board 3x3ft (4mm thick)	1	300/-
Jumpper Wire	3 Sets	80/-
12v 2A Power Adapter	1	150/-
5v 1A Power Adapter	1	100/-
Relay Module(Relay, LEDs, Resistors etc.)	1	76/-

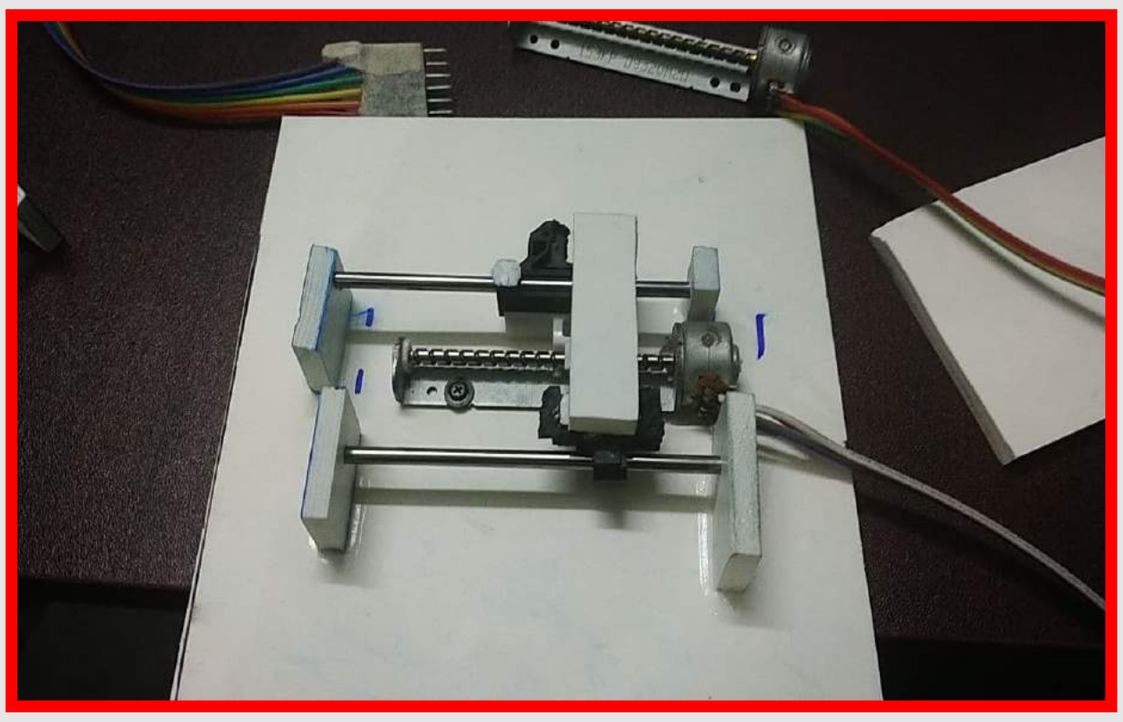
So, total cost is 2840/- BDT which is under 3000/- BDT

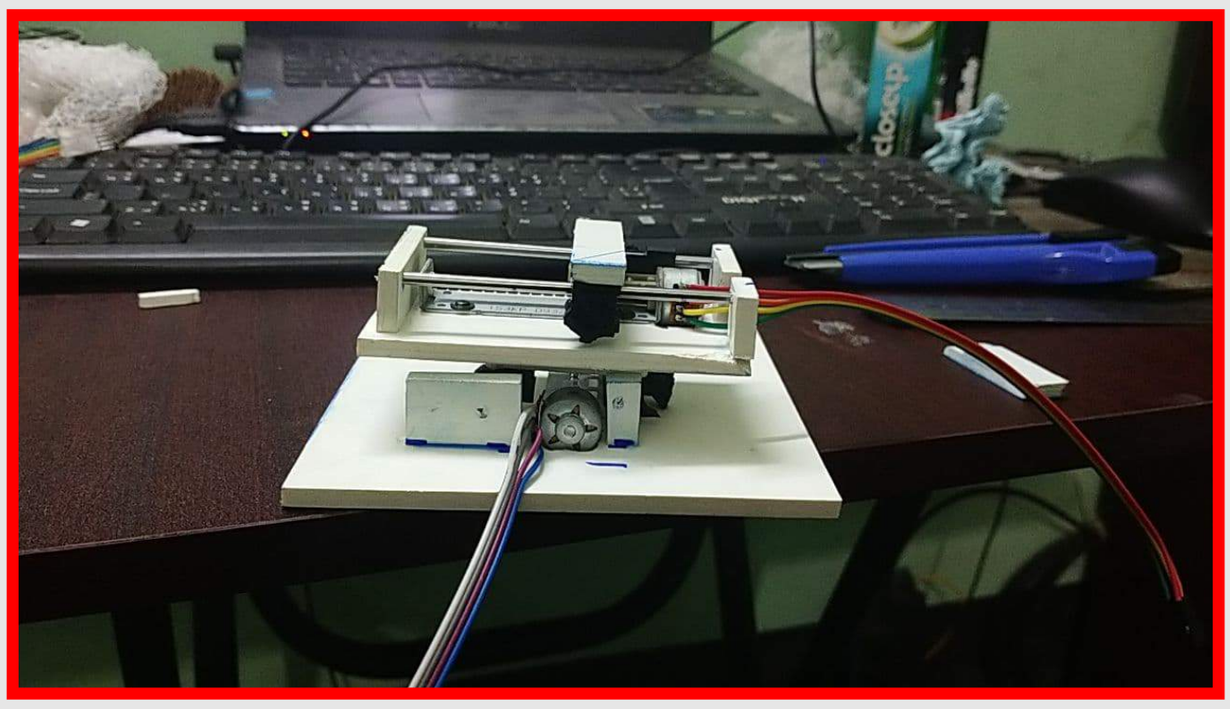
Here, the relay module consists of a relay(20/-BDT), 2 LEDs(3/- BDT each), resistor(5/- BDT), copper connector (20/- BDT) and a PCB board(25/- BDT)

Process: 1. First, the base(12x8cm) was made of PVC board. Then placed the stepper motor(salvaged from DVD R/W) in the center and screwed it. Then input the slider using super glue. Hence, the base was made.



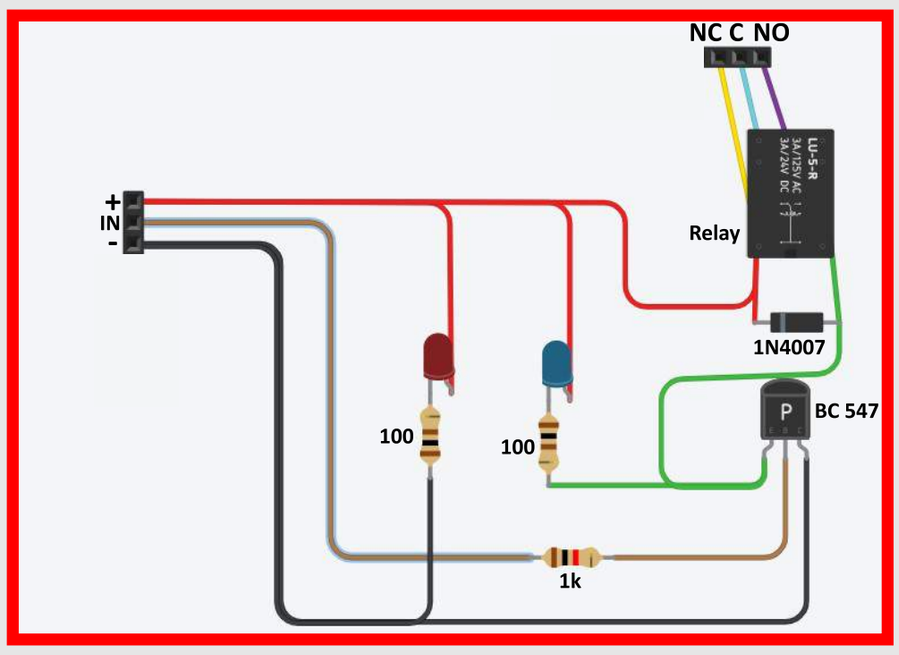
2. Similiarly, the second part was made and glued to the base. It was made sure if the slider could move freely without resistance.





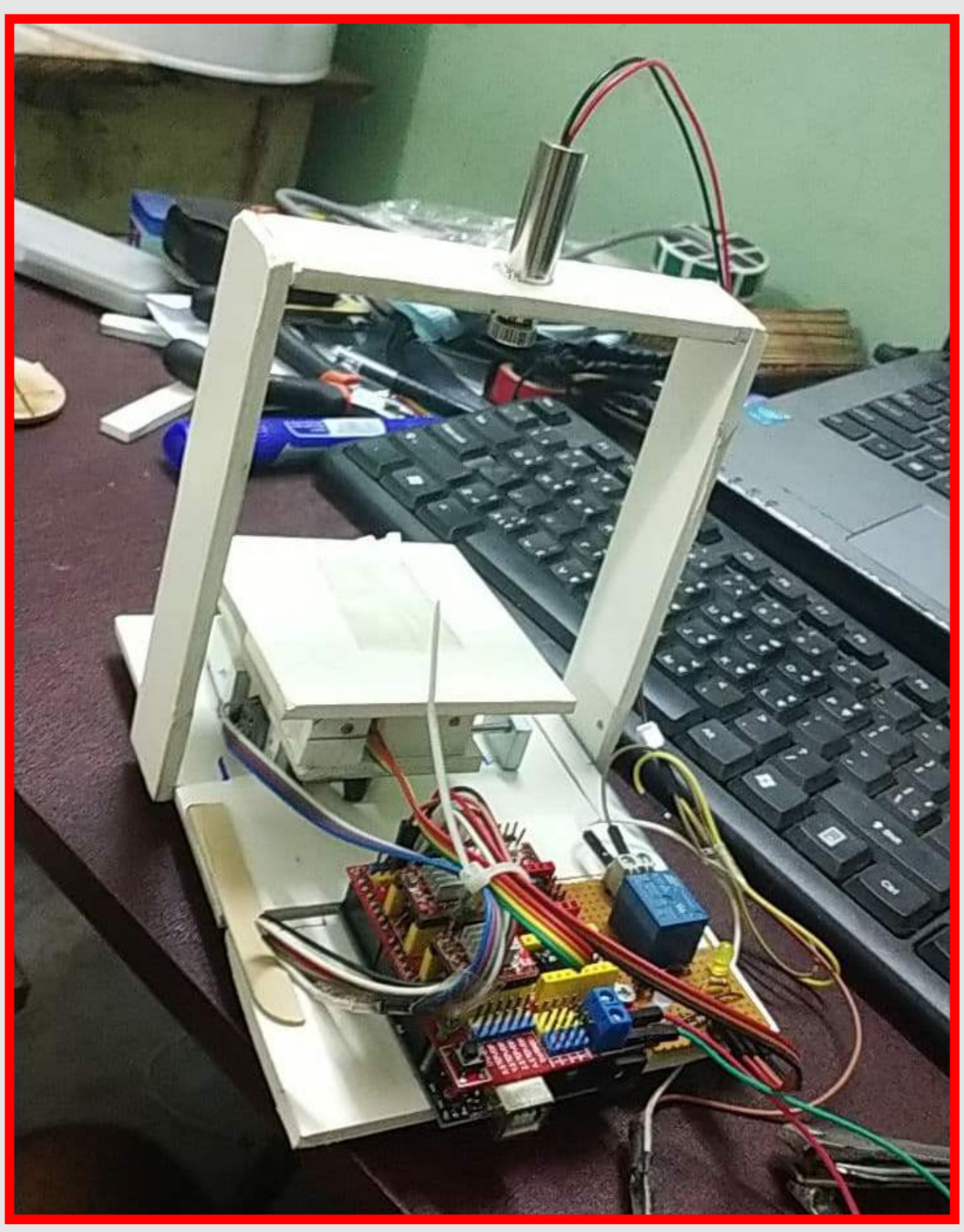
3. Then a 6x6cm PVC board was cut for the base where the wood for burning will be placed. After that the base was extended so that it could be attached to Arduino and Relay module. Therefore, the base became 18x13cm. Then, two 15x3cm and one 13x3cm PVC boards were made in order to attach the laser. Finally everything was glued together and the whole structure was done. Some toothpicks were put to give it some extra strength.

4. After making the body, the relay module was made using Vero-board. The circuit is similar the circuit schematic diagram given below. Everything was soldered to the vero-board and the copper side was secured with wax.



5. Then, Arduino and CNC Shield V3 was both attach and A4988 stepper motor drivers were also connected to the CNC Shield. After that, everything was mounted on the Structure and screwed to the base. Now, the power supply pins can be connected. The 12v 2A power supply was connected to the CNC Shield and 5v 1A power supply was connected to the relay and the laser's anode-cathode pin.

6. After finishing all the electrical work, the laser was mounted on the top of the structure using super glue. The relay module was also glued to the base.



7. From step 1-6 was the mechanical or structural work. The main thing the G-code. Therefore, the g-code was installed to Arduino so that it can understand g-code. Then, using the serial monitor on Arduino IDE the steps of stepper motor, its revolution, speed etc was given. But unfortunately, the measures were wrong. Then, LaserGRBL software was install to provide command. In LaserGRBL, using the grbl configuration option, all the measurements were fixed and twicked tilled everything was perfect. Here is a screenshot of the configuration.

Grbl $$ configuration

#	Parameter	Value	Unit	Description
$0	Step pulse time	10	microseconds	Sets time length per step. Minimum 3usec.
$1	Step idle delay	25	milliseconds	Sets a short hold delay when stopping to let dynamics settle before disabling steppers. Value 255 keeps motors enabled w...
$2	Step pulse invert	0	mask	Inverts the step signal. Set axis bit to invert (00000ZYX).
$3	Step direction invert	6	mask	Inverts the direction signal. Set axis bit to invert (00000ZYX).
$4	Invert step enable pin	0	boolean	Inverts the stepper driver enable pin signal.
$5	Invert limit pins	0	boolean	Inverts the all of the limit input pins.
$6	Invert probe pin	0	boolean	Inverts the probe input pin signal.
$10	Status report options	3	mask	Alters data included in status reports.
$11	Junction deviation	0.020	millimeters	Sets how fast Grbl travels through consecutive motions. Lower value slows it down.
$12	Arc tolerance	0.002	millimeters	Sets the G2 and G3 arc tracing accuracy based on radial error. Beware: A very small value may effect performance.
$13	Report in inches	0	boolean	Enables inch units when returning any position and rate value that is not a settings value.
$20	Soft limits enable	0	boolean	Enables soft limits checks within machine travel and sets alarm when exceeded. Requires homing.
$21	Hard limits enable	0	boolean	Enables hard limits. Immediately halts motion and throws an alarm when switch is triggered.
$22	Homing cycle enable	0	boolean	Enables homing cycle. Requires limit switches on all axes.
$23	Homing direction invert	1	mask	Homing searches for a switch in the positive direction. Set axis bit (00000ZYX) to search in negative direction.
$24	Homing locate feed rate	50.000	mm/min	Feed rate to slowly engage limit switch to determine its location accurately.
$25	Homing search seek rate	635.000	mm/min	Seek rate to quickly find the limit switch before the slower locating phase.
$26	Homing switch debounce delay	250	milliseconds	Sets a short delay between phases of homing cycle to let a switch debounce.
$27	Homing switch pull-off distance	1.000	millimeters	Retract distance after triggering switch to disengage it. Homing will fail if switch isn't cleared.
$30	Maximum spindle speed	1000	RPM	Maximum spindle speed. Sets PWM to 100% duty cycle.
$31	Minimum spindle speed	0	RPM	Minimum spindle speed. Sets PWM to 0.4% or lowest duty cycle.
$32	Laser-mode enable	0	boolean	Enables laser mode. Consecutive G1/2/3 commands will not halt when spindle speed is changed.
$100	X-axis travel resolution	40.000	step/mm	X-axis travel resolution in steps per millimeter.
$101	Y-axis travel resolution	40.000	step/mm	Y-axis travel resolution in steps per millimeter.
$102	Z-axis travel resolution	314.961	step/mm	Z-axis travel resolution in steps per millimeter.
$110	X-axis maximum rate	635.000	mm/min	X-axis maximum rate. Used as G0 rapid rate.
$111	Y-axis maximum rate	635.000	mm/min	Y-axis maximum rate. Used as G0 rapid rate.
$112	Z-axis maximum rate	635.000	mm/min	Z-axis maximum rate. Used as G0 rapid rate.
$120	X-axis acceleration	50.000	mm/sec^2	X-axis acceleration. Used for motion planning to not exceed motor torque and lose steps.
$121	Y-axis acceleration	50.000	mm/sec^2	Y-axis acceleration. Used for motion planning to not exceed motor torque and lose steps.
$122	Z-axis acceleration	50.000	mm/sec^2	Z-axis acceleration. Used for motion planning to not exceed motor torque and lose steps.
$130	X-axis maximum travel	40.000	millimeters	Maximum X-axis travel distance from homing switch. Determines valid machine space for soft-limits and homing search dist...
$131	Y-axis maximum travel	40.000	millimeters	Maximum Y-axis travel distance from homing switch. Determines valid machine space for soft-limits and homing search dist...
$132	Z-axis maximum travel	170.000	millimeters	Maximum Z-axis travel distance from homing switch. Determines valid machine space for soft-limits and homing search dist...

8. Finally everything worked fine and it could cover 40x40mm area. But the laser is still not focused so that it can burn. In order to do that, all the custom buttons of LaserGRBL were installed. Then the laser was turned on and using the screw on the laser, it was focused. After some tweaking the laser was focused and it could burn a dept of 1mm.

9. So, now it could engrave. But to be 100% sure, some simple designs were given. On the first trial, it could engrave straight lines but could do curves or complex designs. So the problem was that the stepper motor was moving fast and also the laser was not properly focused as it performed before. Hence, the laser was again focused and this time it worked perfectly without any error.

Results: Here are some engraved wood from the CNC;

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