SBC-CNC Software

User Manual V2.0

Thank you for choosing SBC-CNC software.

This manual provides details about how to install and use the software with your machine. It also helps you to understand different features and configuration of the software. Please read this manual for setting up your machine with SBC-CNC software.

For any quries related to software usage and technical support please reach us at below communication

email: purchase@sbc-cnc.com

Contents

1. **Introduction**

SBC-CNC stands for "Single Board Computer" CNC software. The software runs on any single board computer, Example: Raspberry Pi 4, and can be used to run any CNC Machine build with stepper/servo (Pulse, Dir) motors.

The software uses on-board GPIO pins of the single board computer to directly control the CNC Machine. You don't need any other controller. These single board computers use multi-core, high speed ARM processors with large Giga byte RAM. SBC-CNC software utilizes the processing power of these single board computers at near 90% efficiency by deploying multiple threads and task optimization. The software is tested on various platforms and is available for different flavors of Linux distro's as per your choice.

The software supports additional functions apart from executing G-Code. Shape cutting & 3D relief carving functions makes prototyping and executing your project with ease and fast. With touch-screen friendly software user interface (UI), all functions are kept simple to understand and easy to navigate across. The user settings & machine settings provide vast control of your CNC Machine.

Because SBC-CNC software runs on single board computer, the total development cost of your CNC machine is reduced considerably. The running cost, considering the maximum power consumption of Single board computers, is also reduced.

Along with a dedicated GPIO extension board (sold separately) you can run any Industrial grade CNC Machine without damaging your single board computer.

Special features of SBC-CNC software
- Control using direct SBC (single board computer) GPIO
- G-Code execution
- Shape Cutting
- 3D relief carving from Grayscale Image
- Custom control of your single board computer (SBC)
- USB camera support for remote control
- VNC server

2. **Installation**

Hardware: Raspberry pi 4
Recommended SD Card Size: 16 GB

Please visit the following google drive location to download the operating system image for your respective single board computer.

https://drive.google.com/drive/folders/1-O6MgXchQgQKbgEv3WTx6wlPjmRvbcL9?usp=sharing

Download the operating system image along with the latest SBC-CNC software for your Single board computer
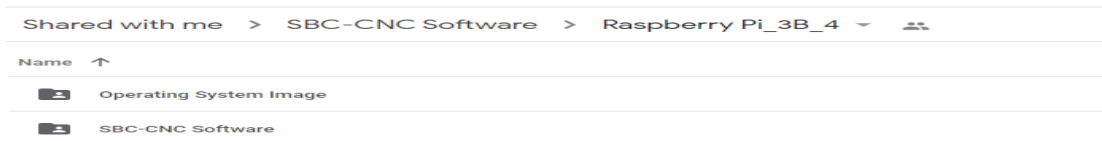
Use win32 disk image (or any other image writer application) to write ".img" file into the SD card. Please back-up data from the SD card as it will be completely formatted after this operation.
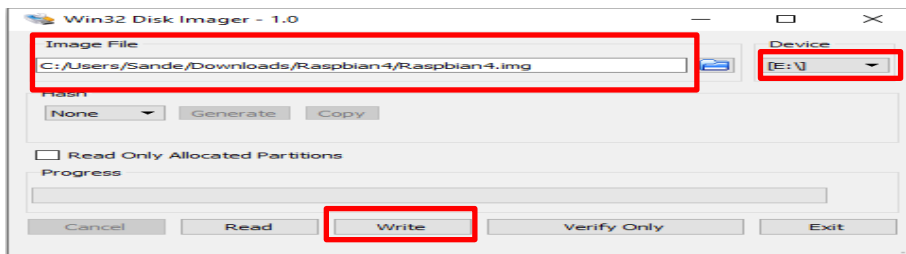
This will take some time to write. Once the Image is written remove the SD Card from your computer and insert it into your single board computer (SBC).

After booting your single board computer, copy SBC-CNC software to "/home/sbccnc/SBC-CNC Folder" (Refer Page: 27). To run SBC-CNC software double-click icon on your single board computer desktop. Refer Page:22 to learn how to wire your machine.
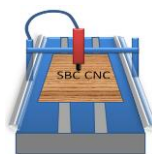
# 3. General Features

3.1 Tool Path/Camera window

3.1.1 Selects Tool Path

This option shows path of the tool only when auto-mode (G-Code/Shape cutting/3D relief carving) is running. During manual operation such as Jog/step/fine motion, no graphics will be drawn.

Set the Length, Width and Height options equal to your work-piece size. This will make the graphics appear quite good. There will be different Gray-shades for different Z values but only when it is negative.

3.1.2 Selects Camera

If you have a USB camera connected to your single board computer, the software will automatically detect it. You can visualize your machine operation or record videos using this camera. You can also remotely observe your machine operation when you use VNC viewer from your mobile or a different PC and than connect to the same network on which your single board computer is connected.
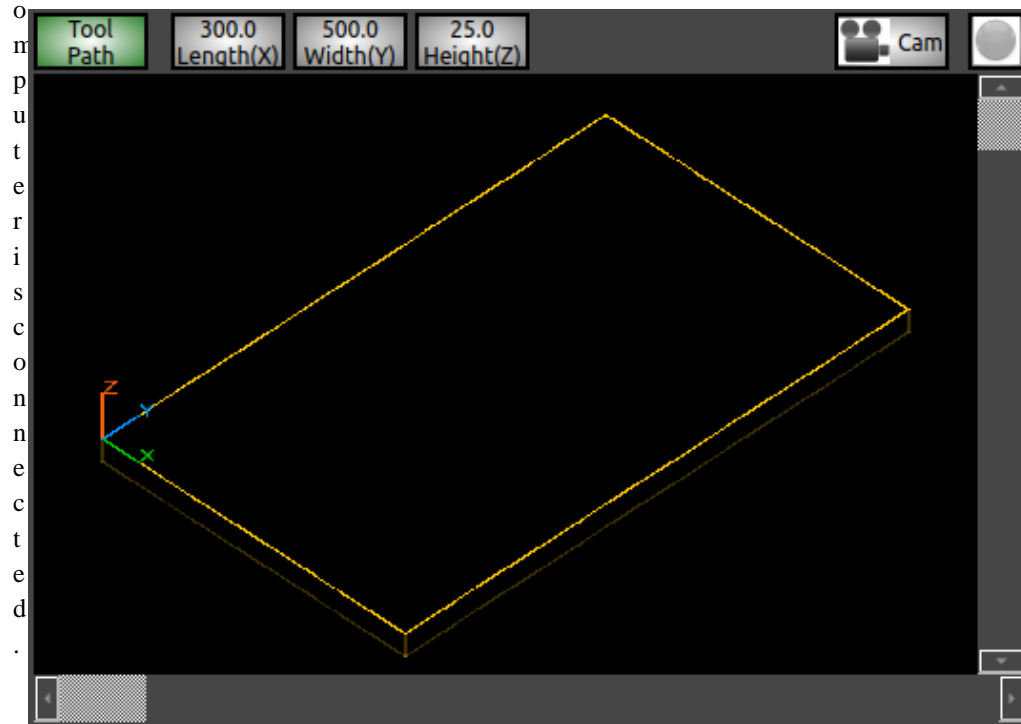
3.2 Manual control window
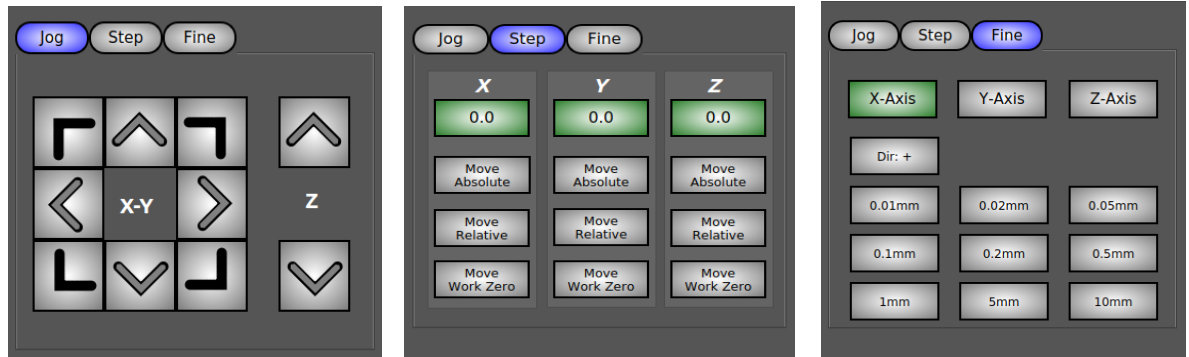
Manual control options are self explanatory and can be used to manually move the machine.
While in jog motion, the velocity reduces gradually.

3.3 Other options

3.3.1 Spindle speed setting option is only useful if you have a VFD controller to control you spindle speed. SBC-CNC provides 16 (4 Bit) spindle speed control options.

3.3.2 150% is equal to Max Feed supported by your machine.If the axis is in motion, the change in feed will be effective after the current movement is finished.

3.3.3 Spindle CW/CCW On/Off setting option is only available if you have a M03 and M04 outputs selected.

3.3.4 Emergency stop button will abruptly stop the machine and if any output is assigned, it will be changed to HIGH state. Also if any input is assigned to emergency stop, and when the state of the input changes to HIGH, the machine will be stopped abruptly

3.3.5 Current position is always with reference to work home position.

3.3.6 Simulation mode will disable Motor inputs. Axis will not move

4. G-Code

4.1 Supported commands

G00 (Rapid Move)

G01 (Liner Interpolation)

G02 (Clockwise circular Interpolation)

G03 (Counter-Clockwise circular Interpolation)

G15 (Cartesian co-ordinate selection)

G17 (X-Y Plane selection)

G20 (Unit Selection Inch)

G21 (Unit selection mm)

G28 (Move to Work Home)

G40 (Ignore cutting tool compensation)

G90 (Absolute motion)

G91 (Relative Motion)

M03 (Spindle Clockwise ON)

M04 (Spindle Counter Clockwise ON)

M05 (Spindle Clockwise OFF)

M06 (Manual tool change)

M07 (Lubricant ON)

M08 (Vacuum ON)

M09 (Lubricant, Vacuum OFF)

M30 (Program end)

M97 (Line jump)

M98 (Program jump)

M99 (Program return)

F   (Feed adjustment)

S   (Spindle speed adjustment)

4.2 Software functions

The G-code window provides you functions to load/edit/add and run G-Code. Any change to the G-code is automatically compiled and errors will be shown in the error window.

There is no maximum limit on the number of G-Code lines. All the lines will be loaded at the same time. For big files, this may take a while. ".txt" and ".ncc" file extensions are supported.
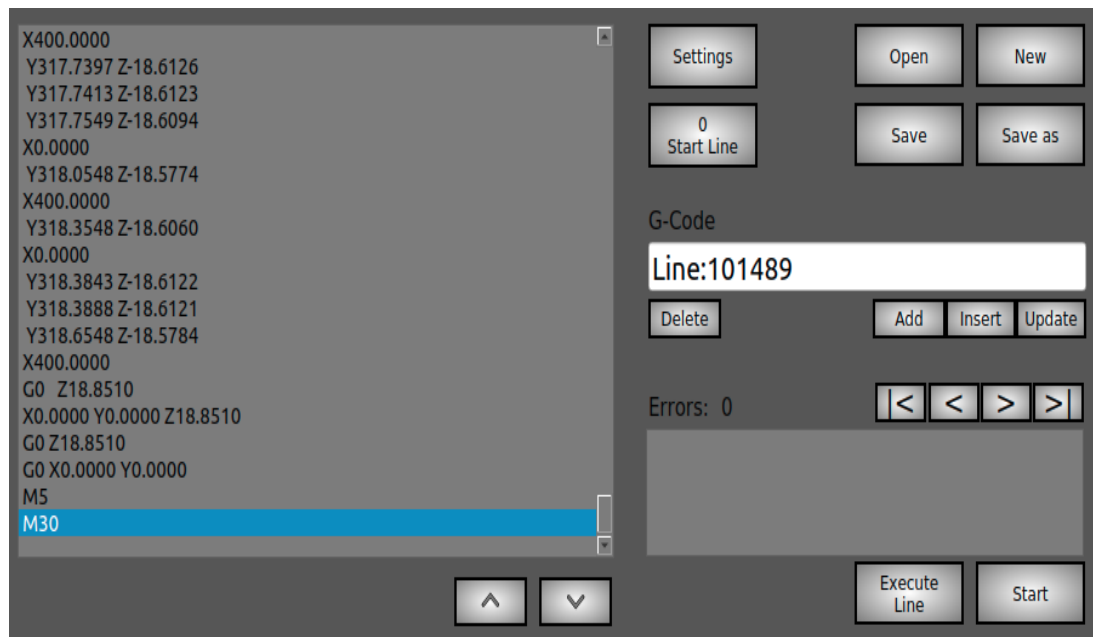
4.2.1 Settings

◦ Enabling "Use Program Feed" makes the feed to change according to the G-Code program file. Disabling this would make the motors run at a constant feed

◦ "Save Execution status" will save the current execution line. The saving happens in a cycle after every 10 lines gets executed. In case you loose power to your single board computer, you can use this option to continue your work with starting again.

◦ Enabling "Use Program Spindle speed" makes the spindle
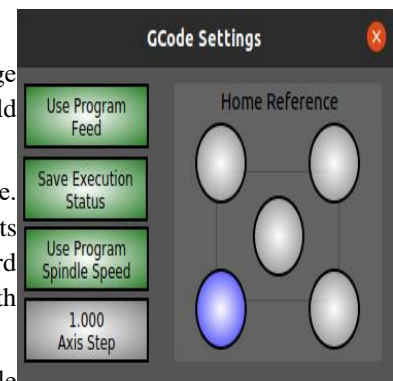
speed to change according to the G-Code program file. Disabling this would make the spindle to run at a constant speed.

° Axis step provides minimum step used by either X or Y axis while calculating the Linear/Circular interpolation. Software automatically decides which of the X will use this step.

° Home Reference is used to select the origin in the "Tool Path/Camera" window mentioned in section 3.1. This is used only to enhance the visualization in tool path window and has no importance in the executing G-Code.

4.2.2 G-Code Line editor
The user can add G-code line and press "ENTER" key on the keyboard to add it as last line in the G-Code file.

4.2.3 Error display window
Error display window display any error in the G-Code or if there are commands which are not supported by SBC-CNC software. User can also edit and update the G-Code line.

4.2.4 Execute single line
"this option will enable user to execute one line at a time. The index will automatically move to the next line after executing the current G-Code line. Repeatedly pressing this button will allow user to run manually test his G-Code file online at a time. User can run any line from the G-Code file, simply by selecting that specific line in the G-Code viewer.

5. Shape Cutting

Shape Cutting is an added functionality of SBC-CNC software to cut simple 2D and 3D shapes with ease. You have multiple options to create a shape: Manually draw the shapes with simple mouse clicks or let SBC-CNC software generate shapes from gray-scale images.

Multiple shapes can be drawn at the same time. Each shape can have its own depth. Creating shapes enclosed within each other and of different depths will create 3D shapes. For every shape added, you have option to either cut only the periphery, or cut it as a hole.

User can change the shape position or orientation at any later point of time after the shape is created. Shape cutting only runs on the X-Y positive plane. You work home must be always be set at the bottom left of X-Y Plane.
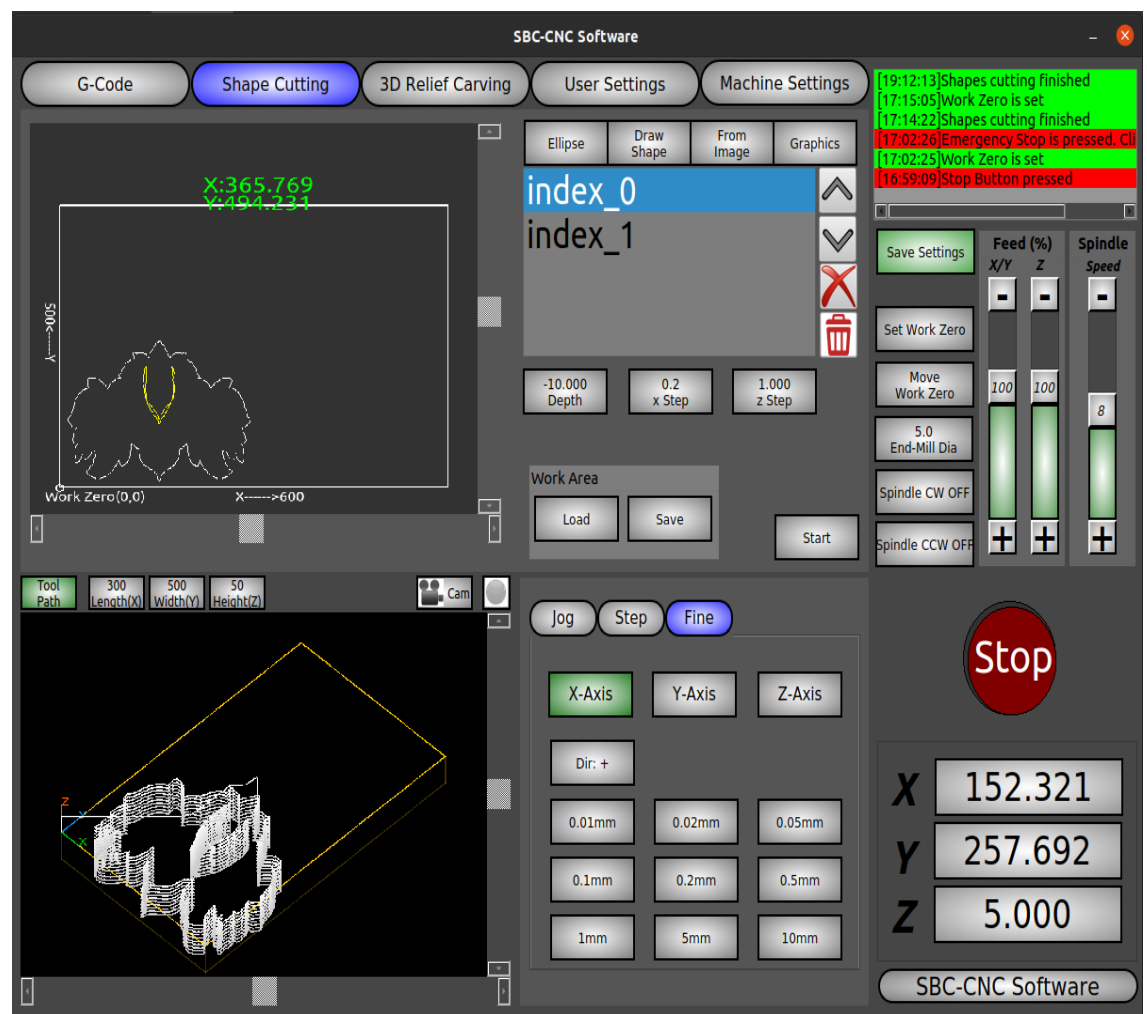
5.1 Ellipse

- To cut a circle, the Major axis diameter and Minor axis diameter must be equal
- For an ellipse, the Major axis diameter must be greater than minor axis diameter
- The shape can be moved within the canvas by clicking in the center and holding the mouse left button
- Hole option will allow you to either cut the circumference or inside the circle. Multiple circles/ellipses will be automatically generated once the hole option is selected. The gap between these shapes will be dependent on your end mill diameter.
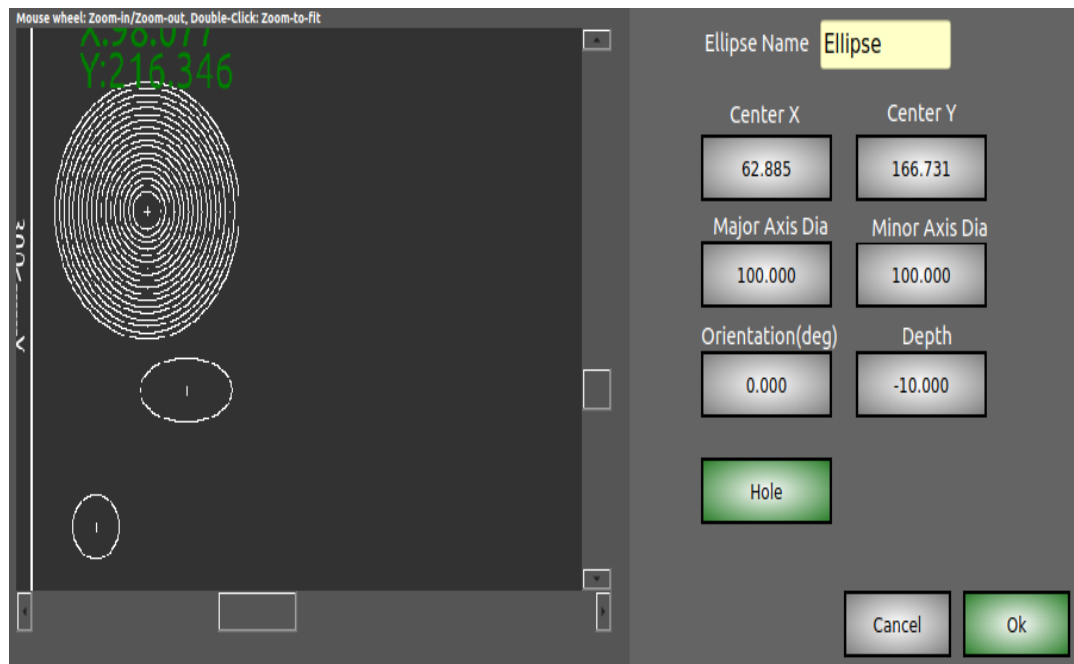
5.2 Draw Shape

- Background Image is used as guide to draw the shape. It is optional. You can draw any shape without using this as well
- Mouse left-click will add a point on the canvas and will connect it to the previous point. Mouse right-click will remove the last added point from the canvas
- If by mistake any point is added wrongly, user can continue without worrying about the wrong points. The shape can be edited in the shape editor after it is added
- Close shape will join the last added point to the first point
- Hole option will create multiple shrinking shapes within the added shape. This works good if the shape is convex (in a convex shape a line between two points, within in the shape, doesn't go out of the shape). If the shape is concave, user has to draw additional shapes to cut the inside material
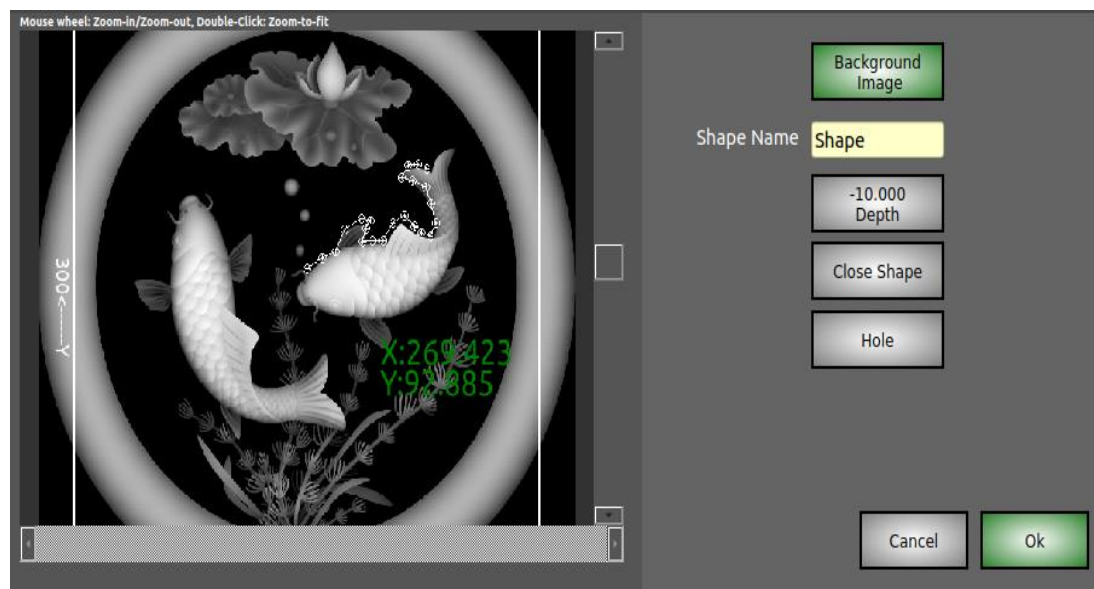
5.3 Shape From Image

- Only gray-scale images are supported
- Threshold value can vary from 1 to 255. Using image based edge detection algorithms, the shapes are found
- Using Min shape vertices you can filter small shapes which are of no interest
- Using Max shape vertices you can filter large shapes which are of no interest
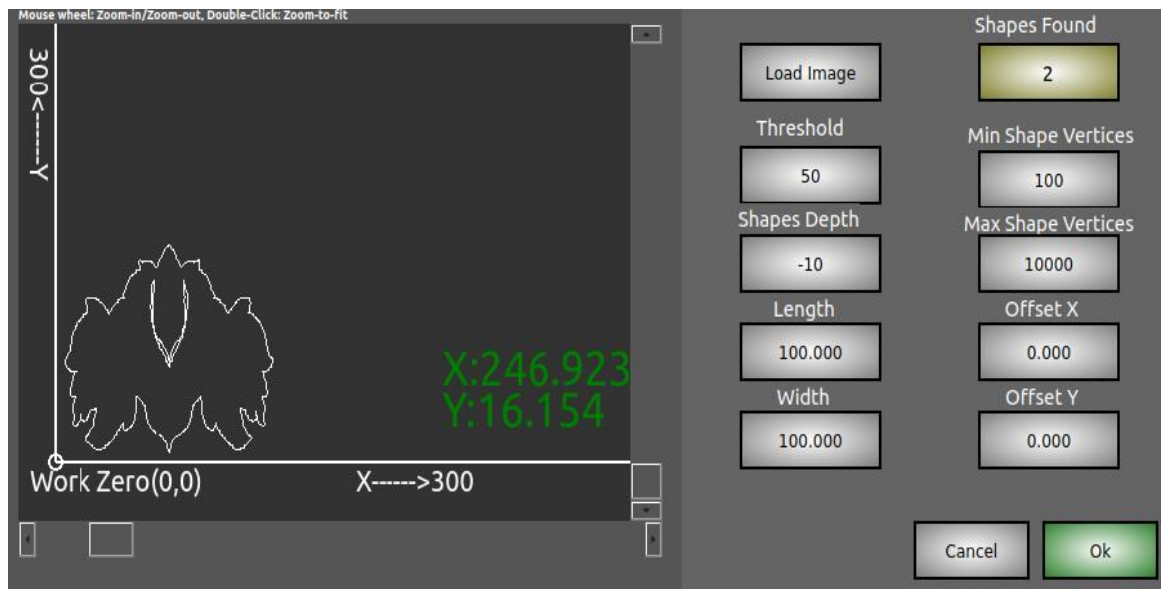

5.4 Shapes List

- Shapes list window shows list of shapes added
- Double click on any of the shapes to edit
- In the shapes edit window, double click on each of the point to edit or use the mouse to move the point in the canvas with mouse left button down. Mouse must be positioned near to the point
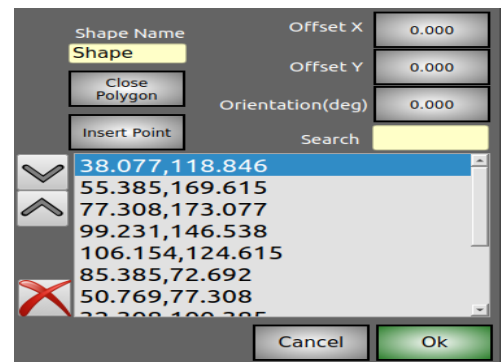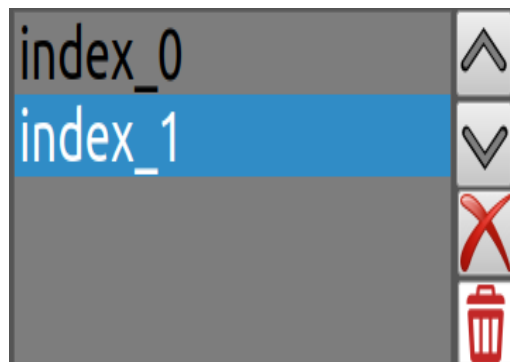
6. 3D Relief Carving

3D relief carving function can carve any gray-scale images into beautiful 3D reliefs. The function is quite simple to use. You can also do 2.5D carving using this function (in 2.5D carving X,Y and Z will not move at the same time)

3D relief carving function runs on the X-Y positive plane. Your work home must be always be set at the bottom left of X-Y Plane.
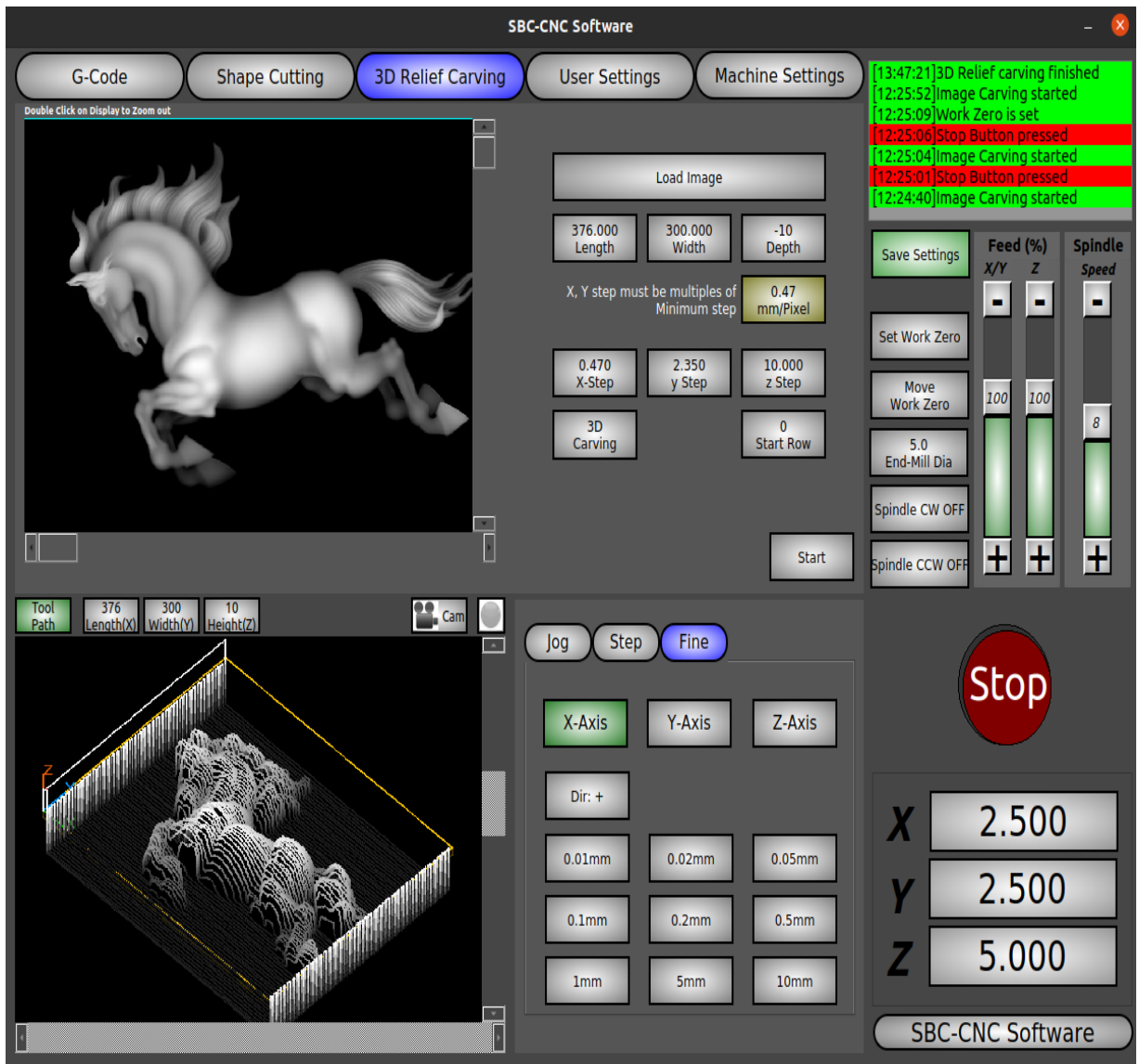
7. User Settings

User settings are used to control the machine by the user. Most of the controls are self explanatory.

All the inputs to the software are in mm, rpm & seconds: Distance: mm, Feed: mm/sec, Acceleration: mm/sec^{2,}, Spindle speed: RPM. However, in G-Code, user can use G20 command to change the units from mm to inch. When G20 is mentioned in G-Code, the distance and feed are measured in inch & inch/min respectively. The future version of the software, will allow the user to select any units: inch-min, mm-min, inch-sec, mm-sec

Axis Feed: this is the user selected axis feed. This is used by G00, G01, Shape cutting and 3D relief carving. The maximum value of axis feed is equal to 100% of Machine Max Feed. For example, If the machine maximum feed is set at 150 mm/sec, the user Axis Feed can be set maximum at 100mm/sec

Jog Feed: This is the feed used for Jogging the axis. The axis will decelerate when jogging is stopped as per the acceleration value provided in the machine settings. Keep this value less to avoid jerks.

Auto Homing Feed: This is used for Auto homing if the machine has homing sensors installed

8. Machine Settings

8.1 Motor Settings

There are two types of Feed curves supported: Trapezoidal and S-Curve. In Trapezoidal curve, the acceleration is a step curve and in S type curve, the acceleration is a Trapezoidal curve. The S-Curve smooths the motion characteristics. For the S-Curve, user has to provide the "Rate of Acceleration" in mm/sec^3 to define the slope of the Trapezoidal acceleration curve.
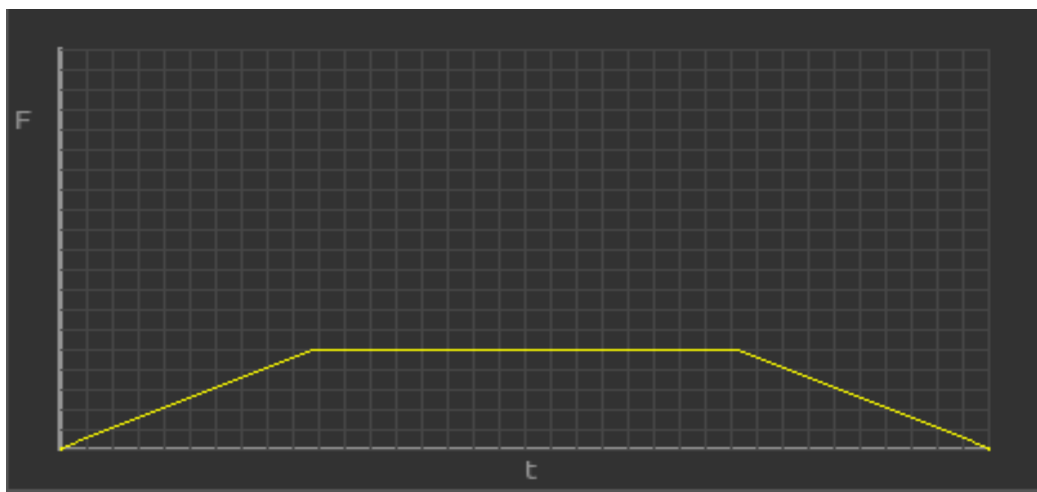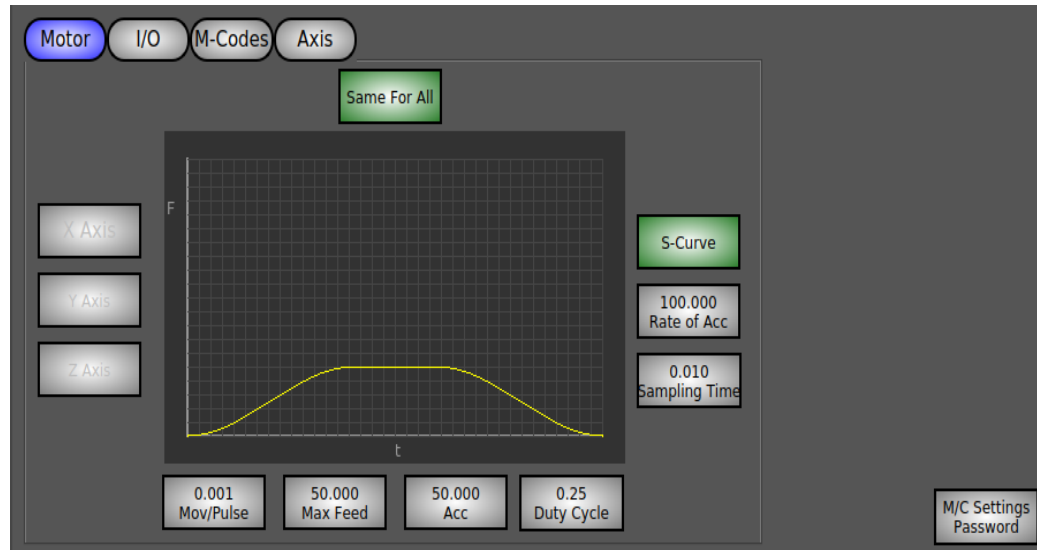
Sampling Time: It is the frequency at which you select how fast the feed increases from one value to the next. Keeping this value very less will make the curve very smooth as the feed will change very slow and increasing this value will reduce the smoothness as the Feed will change faster.

Move/Pulse: How much linear distance the axis moves per 1 pulse

Max Feed: The maximum rated Feed of the machine.
Acc: Acceleration of the machine

Duty Cycle: The ration of Pulse On-Time/Total pulse time of the motor driver

M/C Settings Password: This password is used to merely control accidental changes to Machine settings. It doesn't provide any security protection for the manufacture settings. Deleting the SBC-CNC.dat file will reset the password
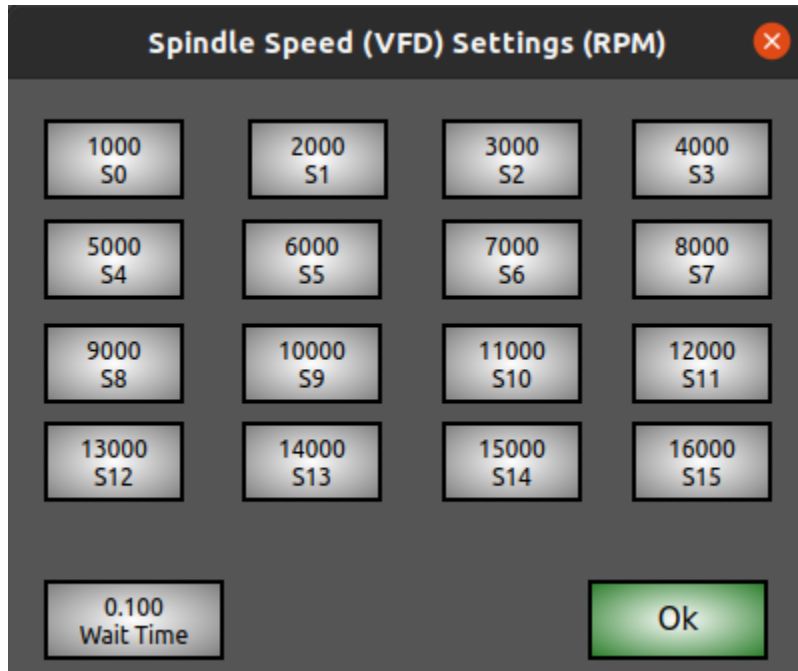
8.2 I/O Settings

In total, 28 inputs/outputs are provided by most of the Single board computer manufactures. Based on which board you are using the pin-out view will change accordingly. In this manual we will use Raspberry PI pin-out. The functionalities of this window will remain the same irrelevant to the board selected.

8.2.1 Spindle Ctrl VFD: if you have variable frequency drive connected to your spindle, you can use Pins 36-39 for controlling spindle speed. Maximum 16 spindle speeds are possible to be selected. During G-Code execution, the maximum nearest spindle speed will be selected if the exact speed value mentioned in the code is not available. Pins 36-39 must not be used for any other purpose, if you would like to use Spindle Ctrl VFD.

8.2.2 Spindle Speed Settings: This window allows you to select different speeds for each of the 16 possible combinations. The wait time is the number of seconds you would like to wait for the desired spindle speed to achieve during auto mode.

8.2.3 IO control: Using IO control window, user can manually control outputs. If you want a specific IO to be High, you can set it here. If the settings are saved after setting an Output High, the software will set the output high every time the software is started. The pin configuration in this window may change based on the boards selected. The below configuration is shown for Raspberry pi.
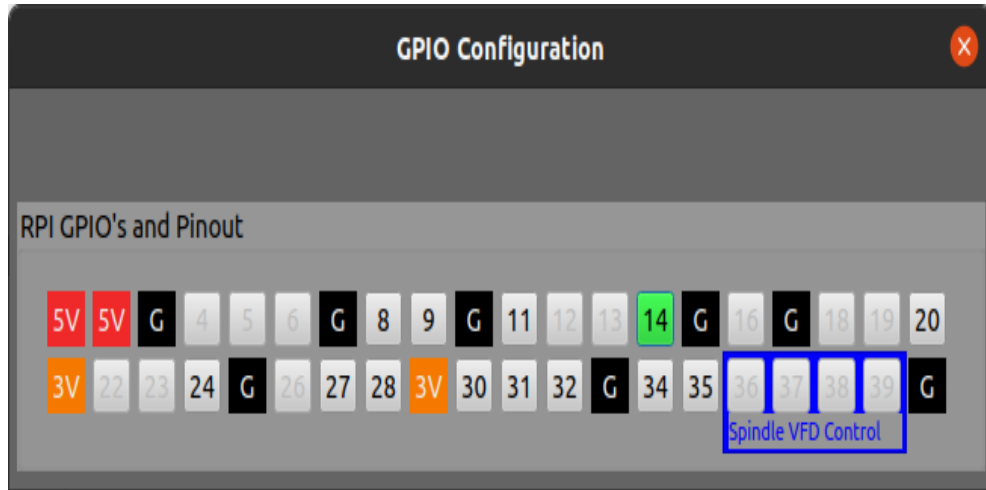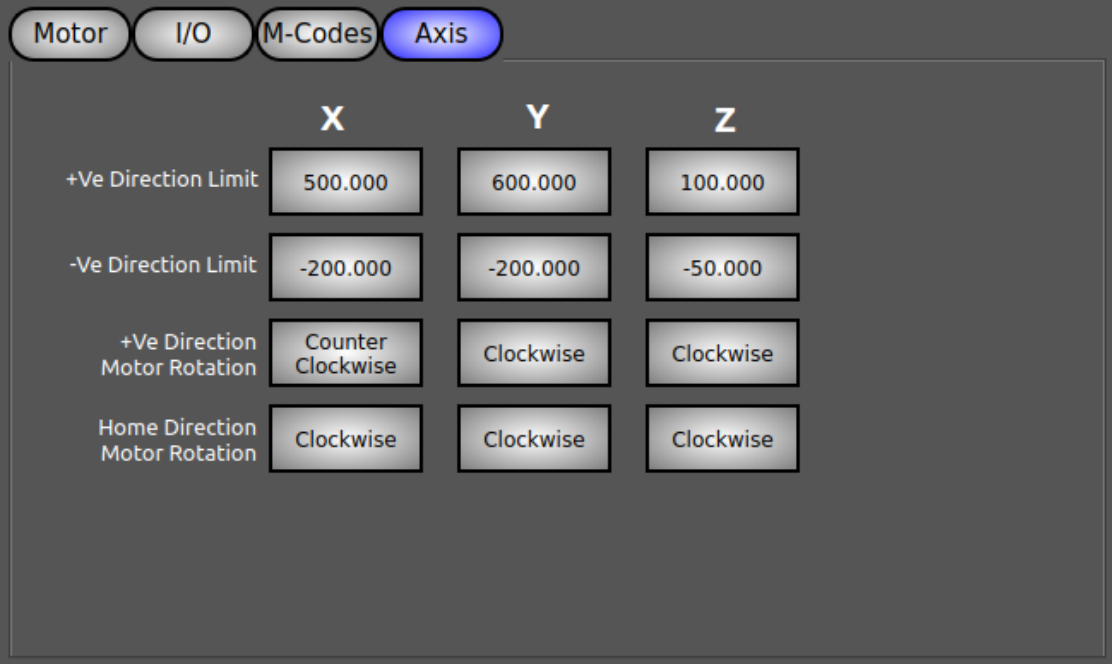

8.3 M-Codes

These are settings to control different peripherals of the machine
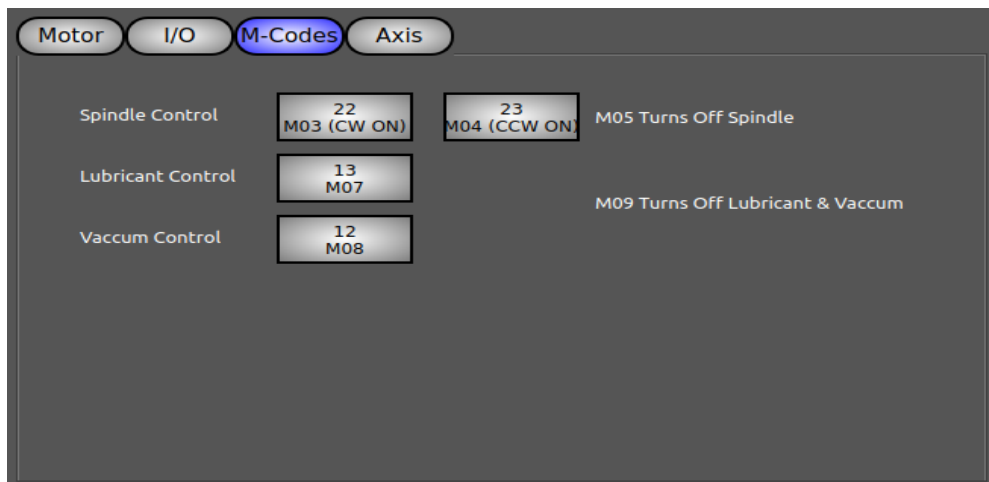
8.4 Axis

The Axis windows allows user to select the soft limits of his machine and motors direction for +Ve and -Ve axis movements.

		X	Y	Z
Motor	I/O	M-Codes	Axis	
+Ve Direction Limit		500.000	600.000	100.000
-Ve Direction Limit		-200.000	-200.000	-50.000
+Ve Direction Motor Rotation		Counter Clockwise	Clockwise	Clockwise
Home Direction Motor Rotation		Clockwise	Clockwise	Clockwise

9. Wiring

Apart from the components shown in the below image, you can control any IO peripherals as per your requirement.
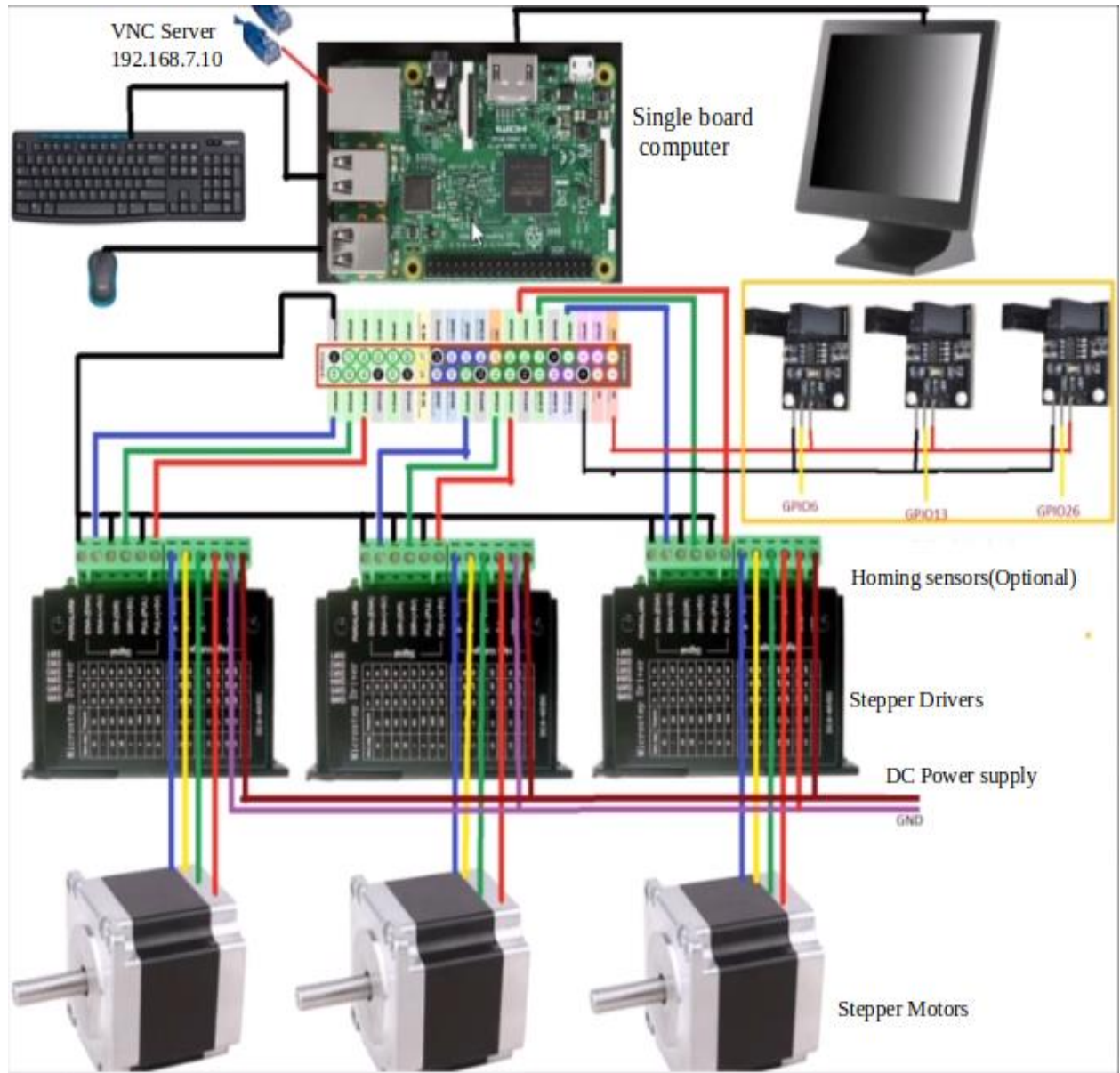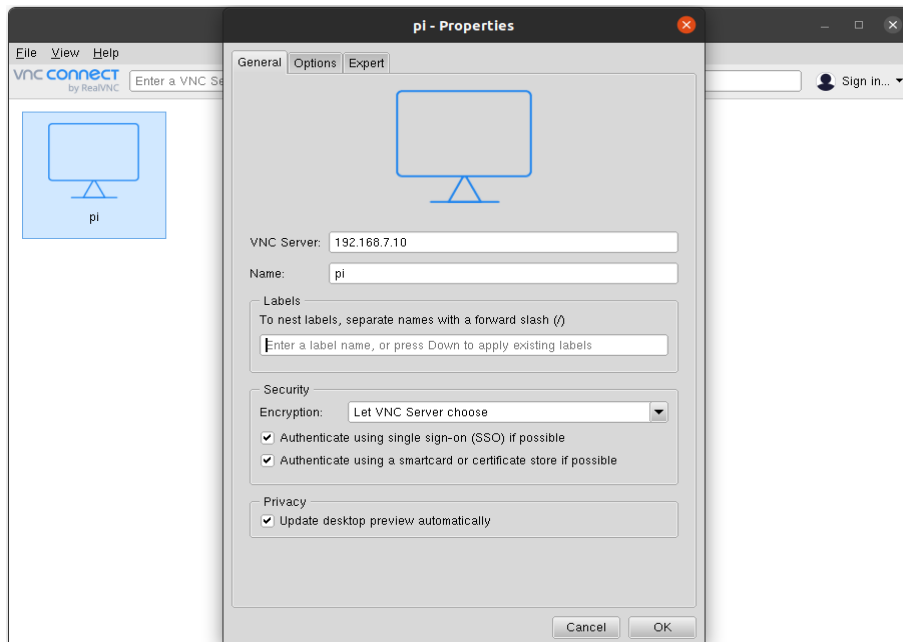
10. **Remote Control using VNC Viewer**

Install VNC Viewer in your PC (Laptop, desktop, android/mac mobile, tab)

<u>**VNC Viewer**</u> : https://www.realvnc.com/en/connect/download/viewer/

After installation, you should see the below screen
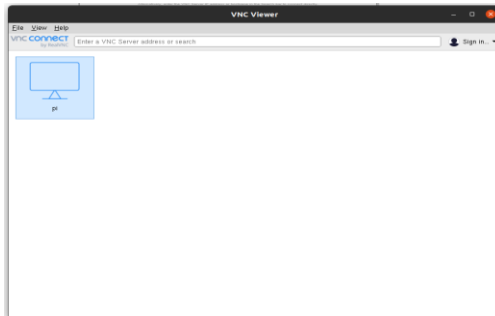Click on File and select new connection. Enter details as shown below and press ok

Connect a Network/Lan cable between your pc network port and single board computer on which SBC-CNC is installed.

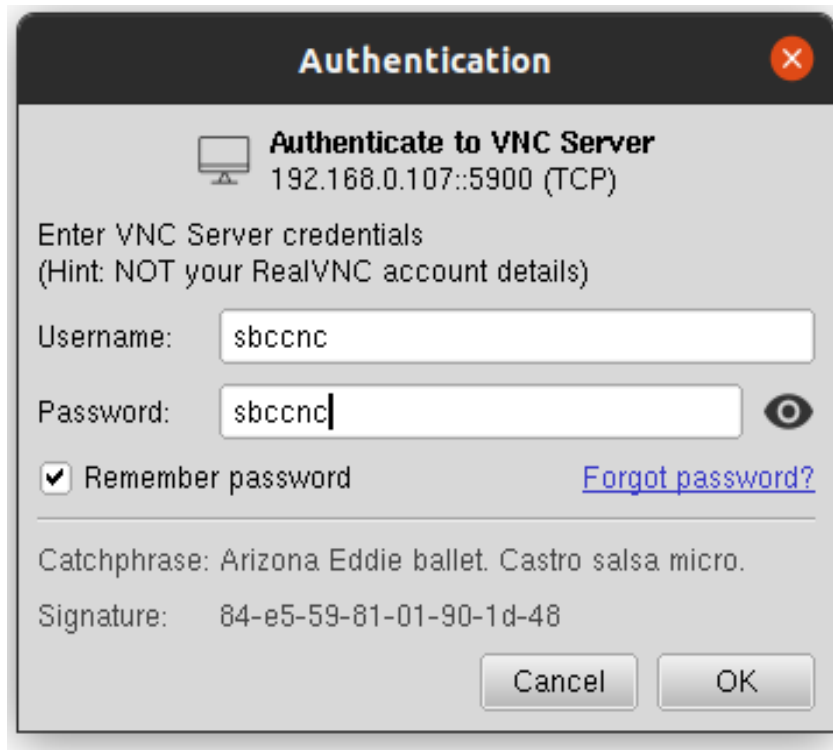Configure your pc network port exactly as shown below and press ok.
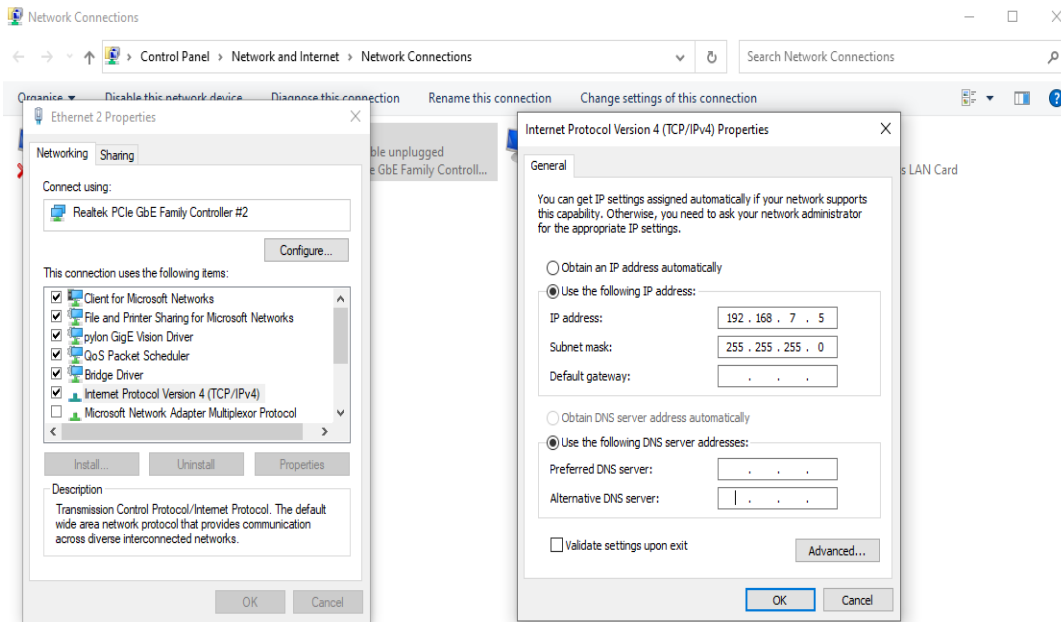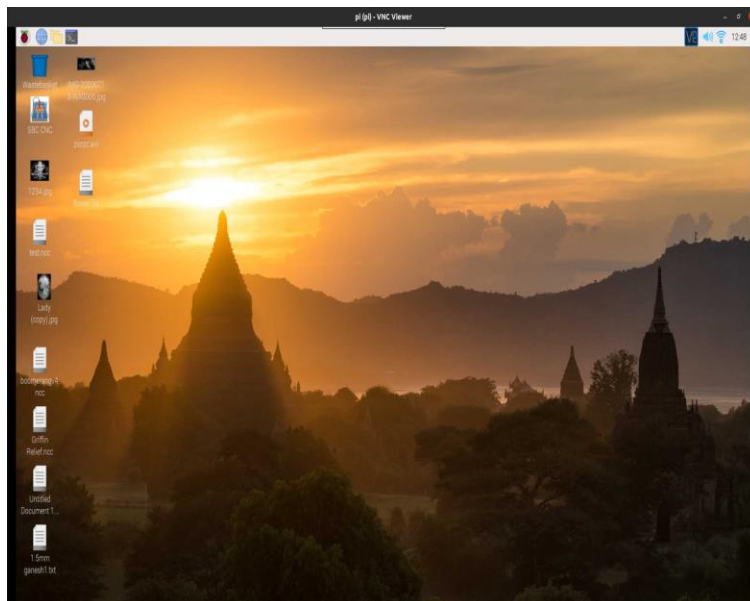

Double click on the icon in the VNC Viewer

For the first time below screen will appear. Enter details as shown and press OK.

You must now be able to control your single board computer remotely

You can repeat the same settings to connect on a wifi network. But for the first time, you need to connect and configure the IP assigned to your single board computer by your wifi router. You might want to assign a static IP to your SBC, on your wifi network, so that the IP address doesn't change every time when there is a power recycle. All the other steps remains the same, except you don't have to configure your PC's network port manually as your router will assign your IP on the same subnet.

To set a static IP to your SBC follow procedure as shown below. Below procedure is only applicable for raspberry pi but will be similar for other SBC's

For Raspberry pi, right-click with your mouse on the Wifi-Icon as show below anc click on "Wireless & Wired Network Settings" option
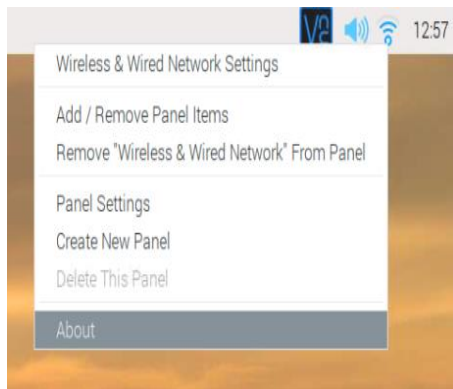
Enter details similar to what is shown below. In this example, the router is assigning addresses in the range 192.168.0.2 to 192.168.0.250. You can manually select one of them which is not assigned by your router to any other device. Click apply and reboot your device.
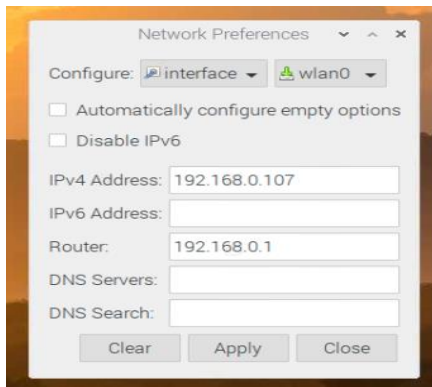
Now the user can connect to the raspberry pi from any device using the new assigned IP on the wifi network.
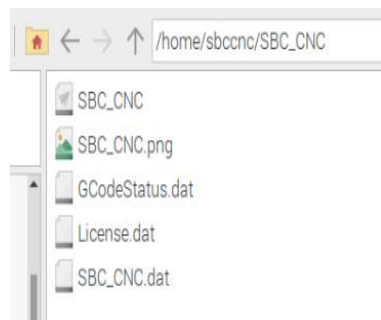
11. Folder structure

By default all single board/linux environments will have the home folder. Please go through the home folder to access SBC-CNC Files

Double-click on SBC_CNC Folder in the home directory.

Following files must be present in the SBC_CNC folder.

SBC_CNC is the application file

License.dat contains your license file for the application. When you would want to purchase the license for the software, you need to send the serial number of your single board computer to "purchase@sbc-cnc.com". To find your serial number just follow the installation procedure as mentioned in this document and open the SBC_CNC software . This will show a pop-up message with the serial number of   your single board computer.

GcodeStatus.dat file is used to save the execution status of your G-Code file.

SBC_CNC.dat contains all the settings of your software. This file will be automatically created. In case there is settings issue, just delete this file and the software will reset to default state.
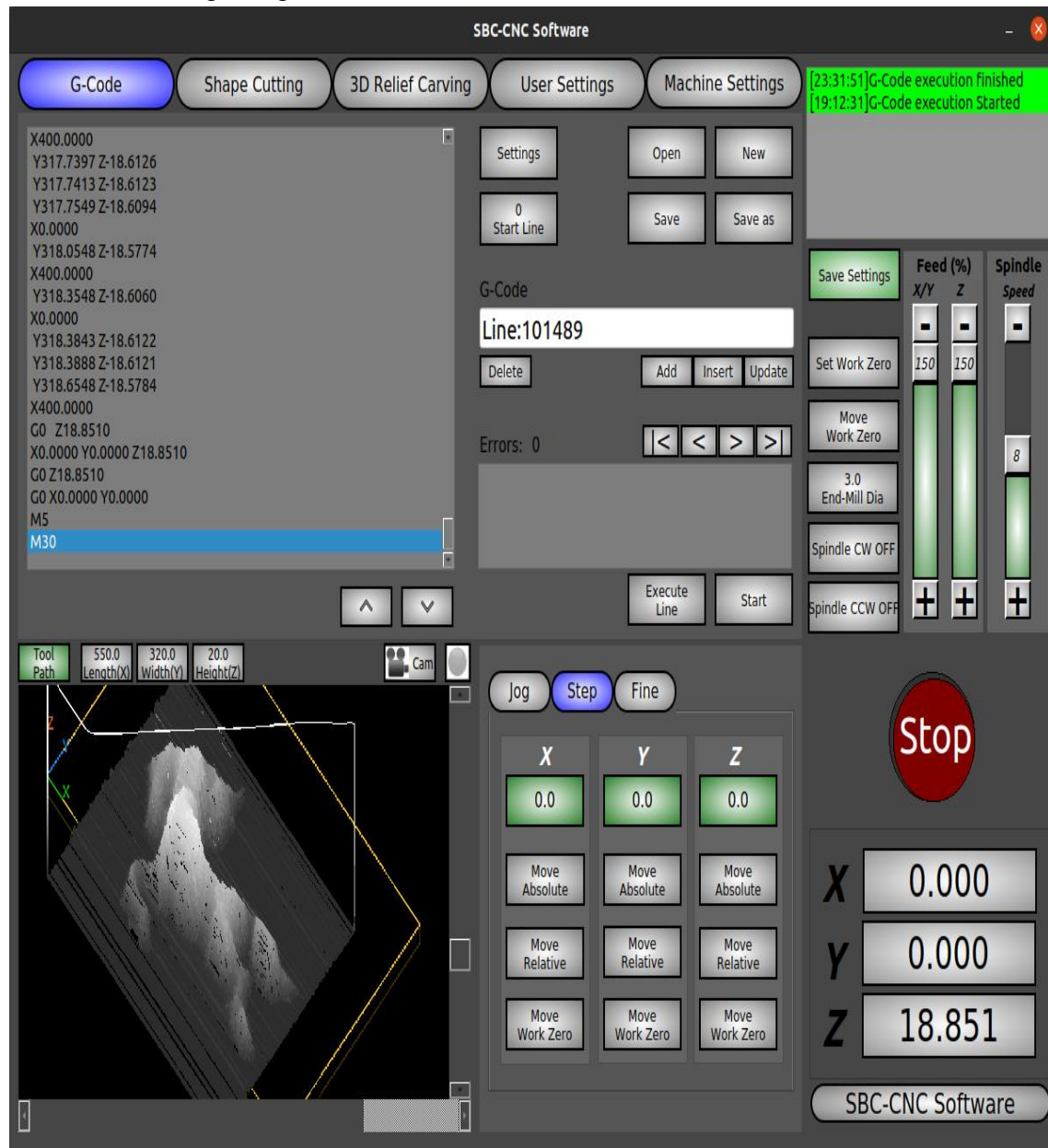
12. Appendix

Ganesh 3D relief carving
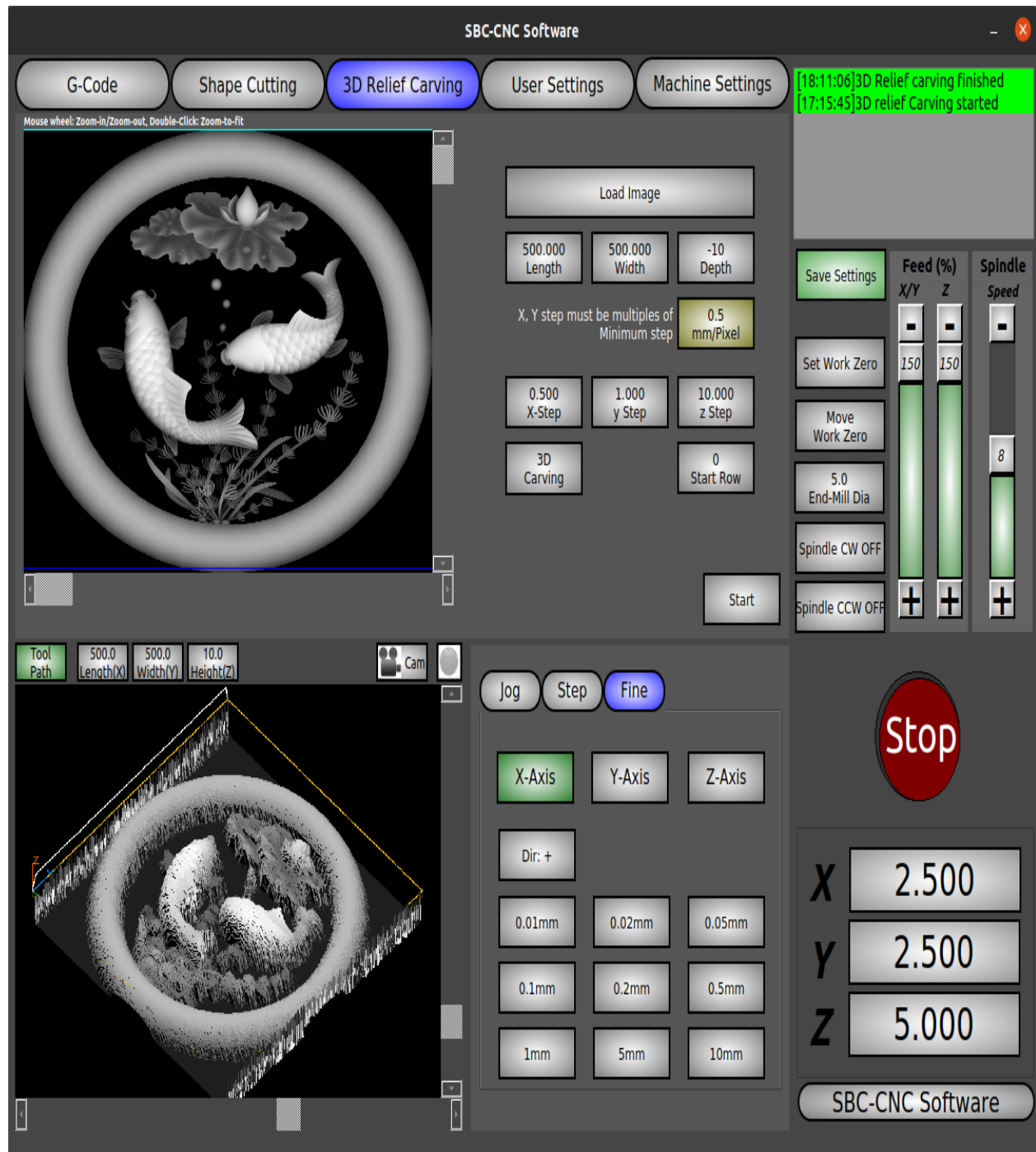

3D Flower Carving

3D Relief carving using G-Code

Peacock carving using 3D Relief Carving option

Fish carving using 3D Relief Carving option

SBC-CNC Software

Bird carving using 3D Relief Carving option