

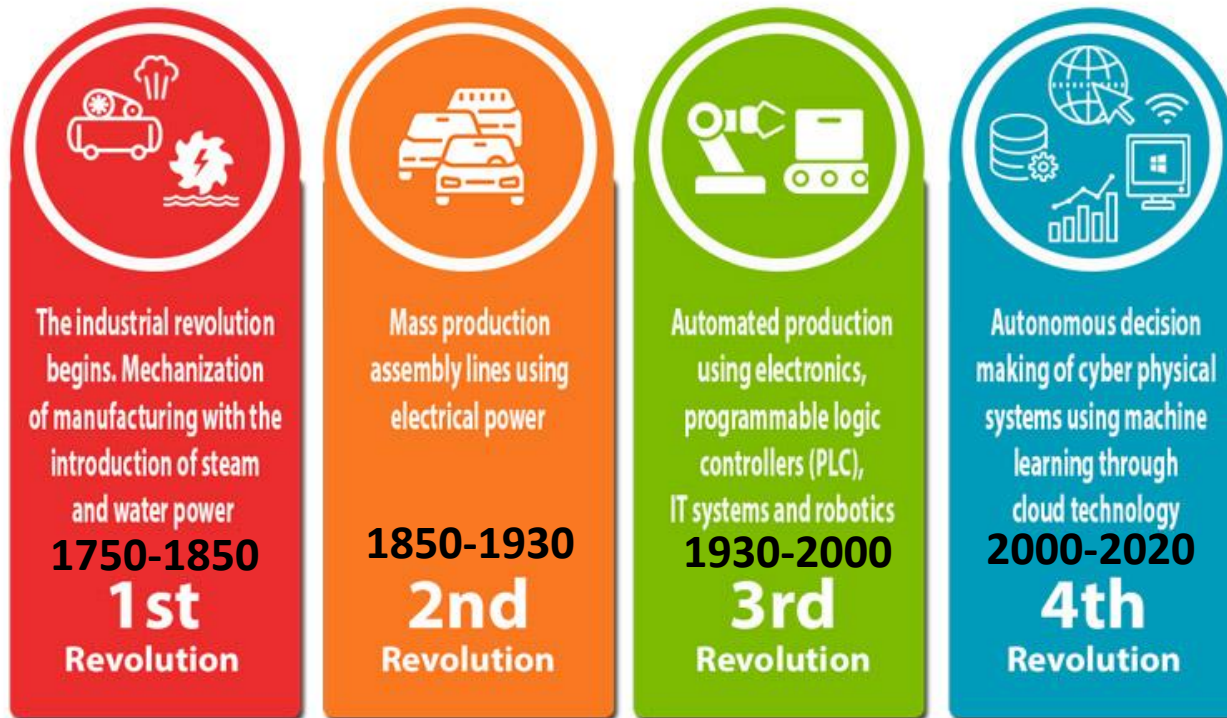
Implementation of IR 4.0 and IIoT in various research and TnL activities at IIUM

By

Ir. Dr. Tanveer Saleh

Background about phases of Industrial Revolutions

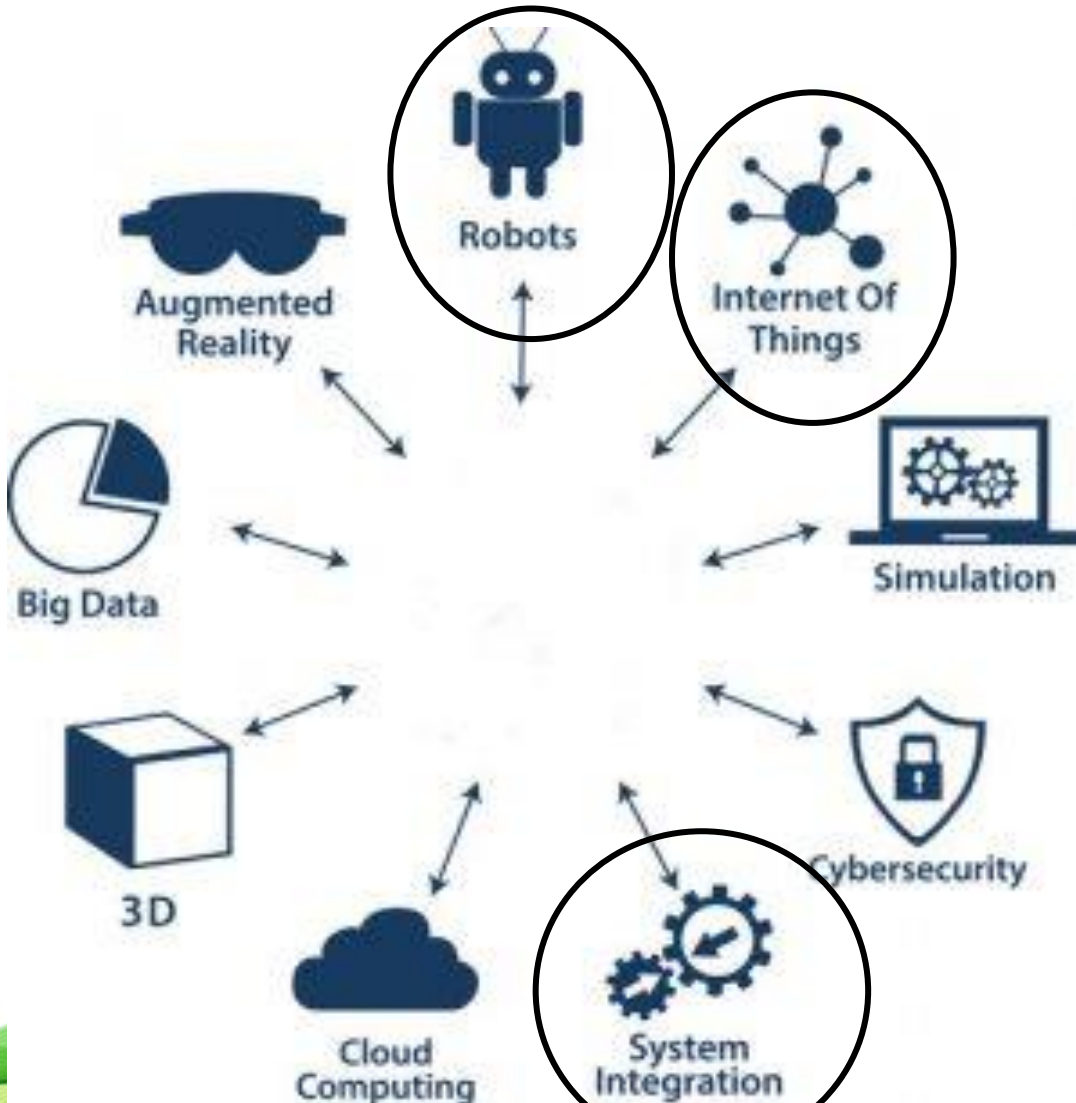
INDUSTRIAL REVOLUTION



Next phase: IR 5.0
Collaborative Robotics, Mass customization by the synergy of technologies like 3-d Printing, AR/VR and 6G communication

Widely circulated picture to describe phases of IRs

Aspects of IR 4.0



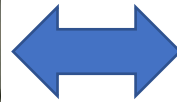
Today's talk will broadly cover our T&L and research activities related to the three aspects of IR 4.0

Picture source Internet

Implementation of IoT based SCADA System for T&L purposes at IIUM

by
Ir. Dr. Tanveer Saleh & Mohammed Banawair

Existing PLC and Pneumatic system

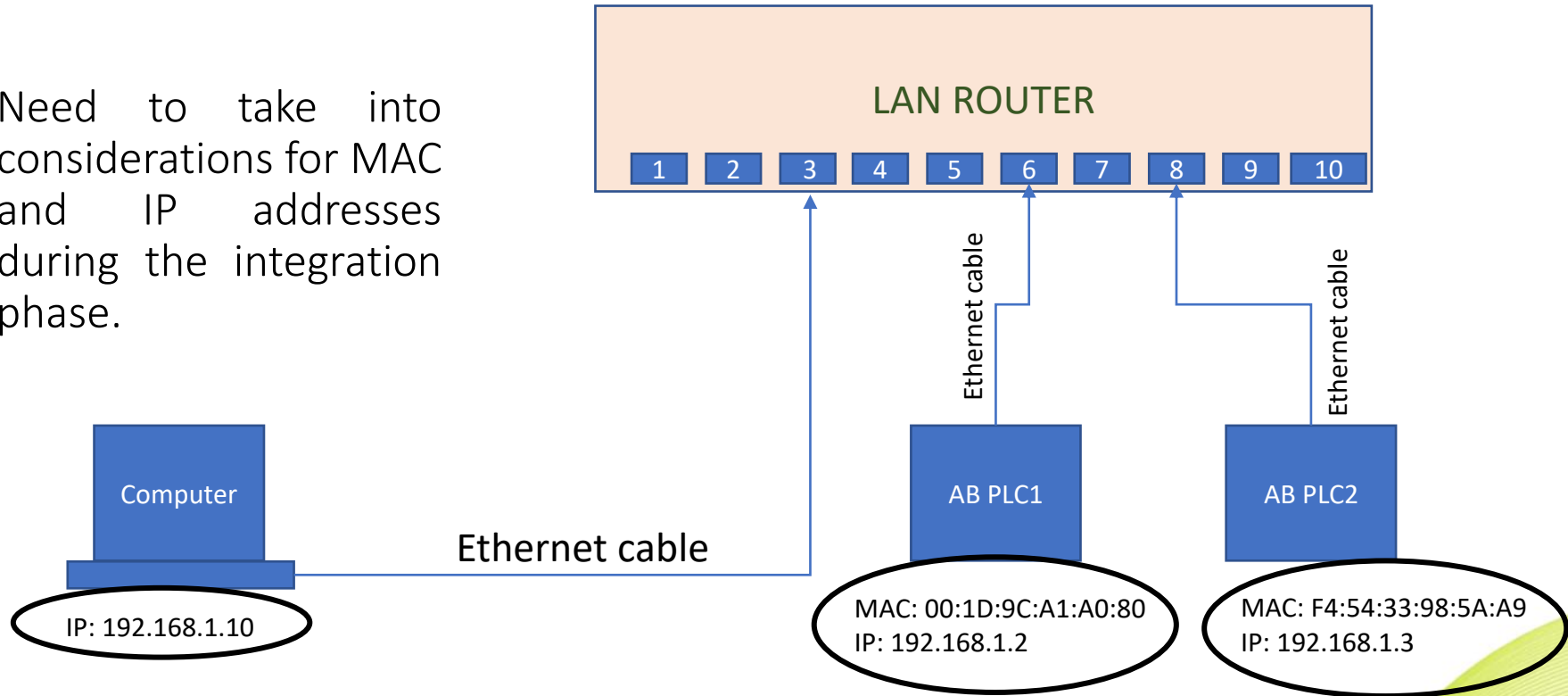


Pneumatic system with cylinder actuator and various types of solenoid valves

PLC controller to program and drive the pneumatic system. PLC is AB from Rockwell automation

Proposed integration between the two PLC field stations

Need to take into considerations for MAC and IP addresses during the integration phase.



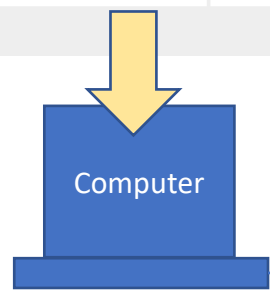
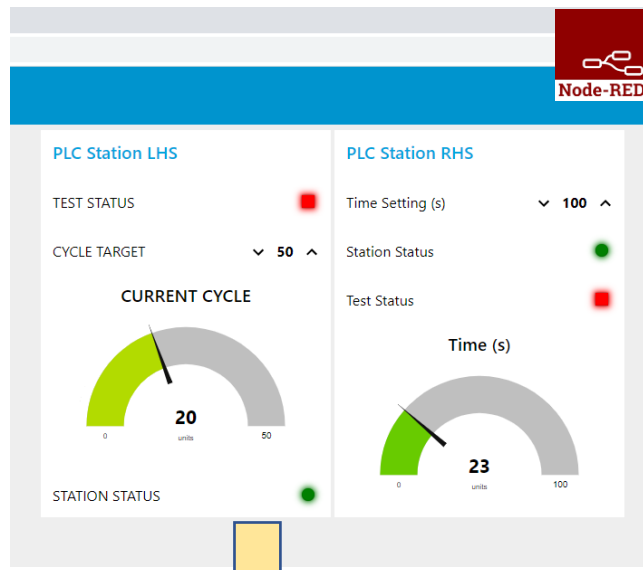
Recliner chair testing simulation



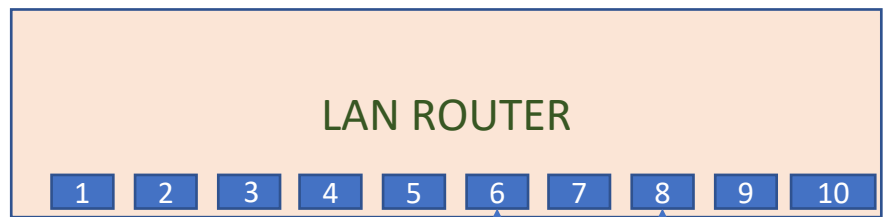
- A reciprocating pneumatic cylinder is used to test the backrest of the chair.
- One of the stations tests based on number of cycle.
- Other station tests based on duration of the reciprocation.

Picture source
Internet

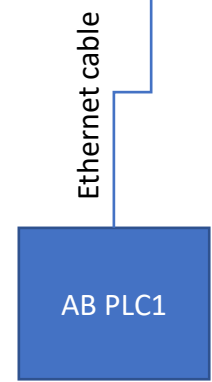
Implementation of Node-Red based WEB SCADA system



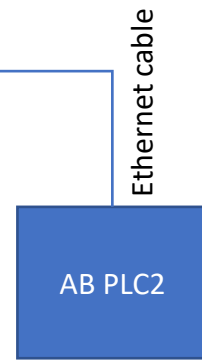
IP: 192.168.1.10



Ethernet cable

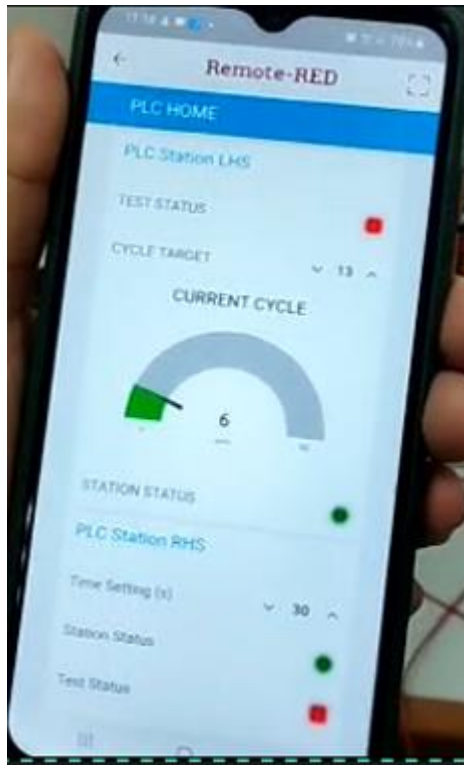


MAC: 00:1D:9C:A1:A0:80
IP: 192.168.1.2

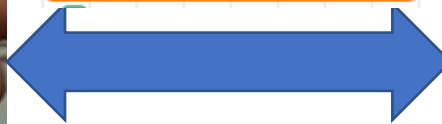


MAC: F4:54:33:98:5A:A9
IP: 192.168.1.3

IIoT integration of the system through Remote access and AWS



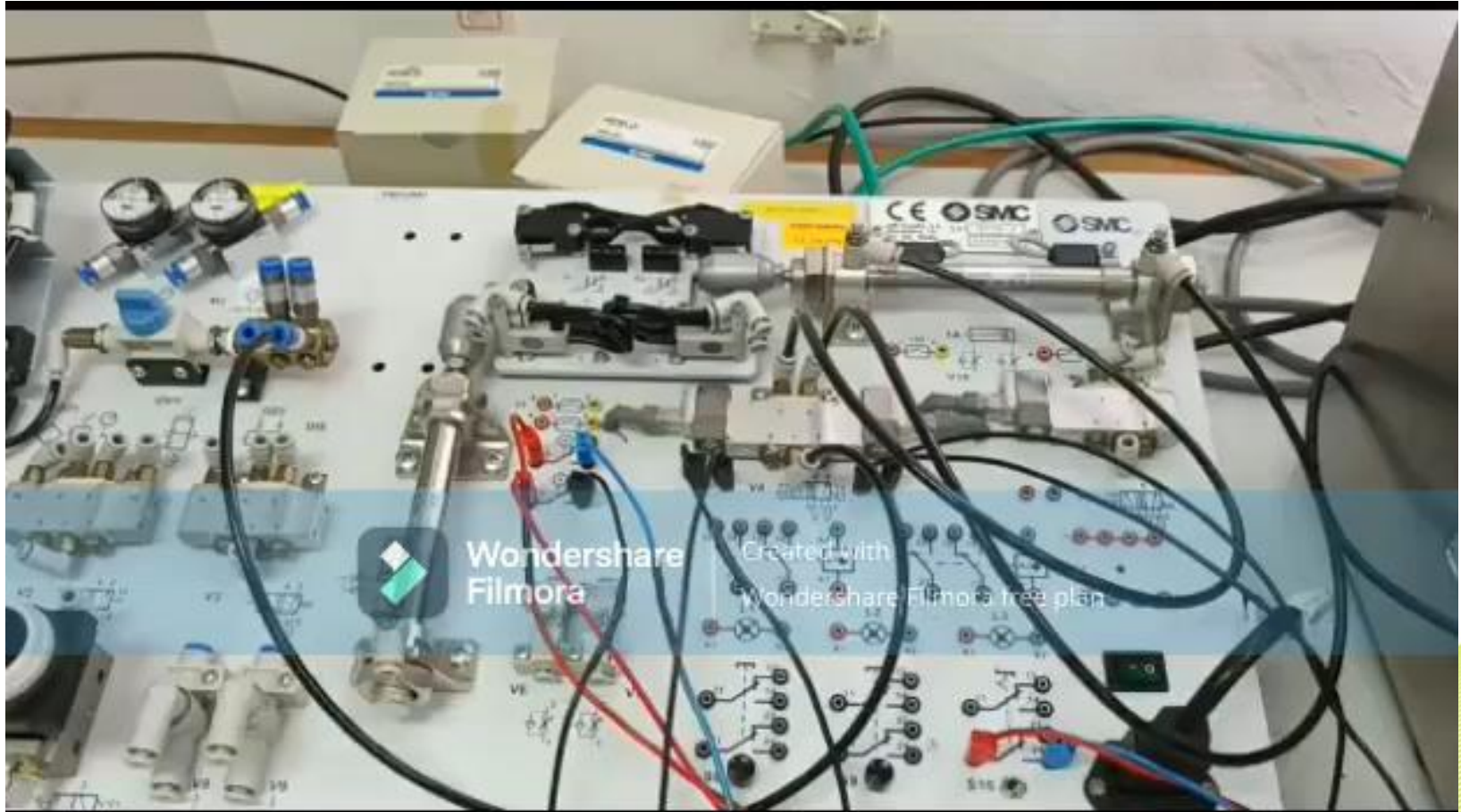
remote access



Computer
IP: 192.168.1.10



Short Demonstration Video



UPGRADING AND VALUE ADDITION TO AN EXISTING 3-AXIS CNC MACHINE FOR TEACHING AND LEARNING

by
Dakhel Abdulrahman & Ir. Dr. Tanveer Saleh

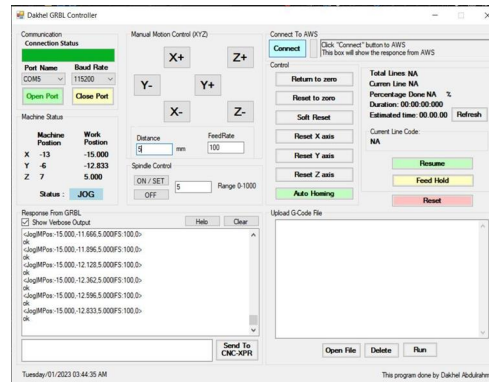
Background

- Programmable CNC machines was one of the key components of IR 3.0. It is widely used for various industries ranging from woodworking to automotive and aerospace.
- In the era of IR 4.0 and IR 5.0 CNC machines are becoming smart (thanks to data driven technology) and IoT compatible.

Research Problem and Objective

- ❑ In many higher learning and vocational institutes we may find many CNC machines are sitting idle because some major elements are spoiled such as the controller or the motors. Hence, the machine ends up occupying space and being a waste of resources. However, the machine's structure is still intact and in a good condition.
- ❑ Hence we aimed to develop a generic GUI software that may help to refurbish stepper motor driven CNC machine with some value addition.

Overview of the project and its significance



Modular Controller

GUI

MECHANICAL
MODIFICATION

Innovation and
Infrastructure:
Increase
Efficiency and
Productivity

9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



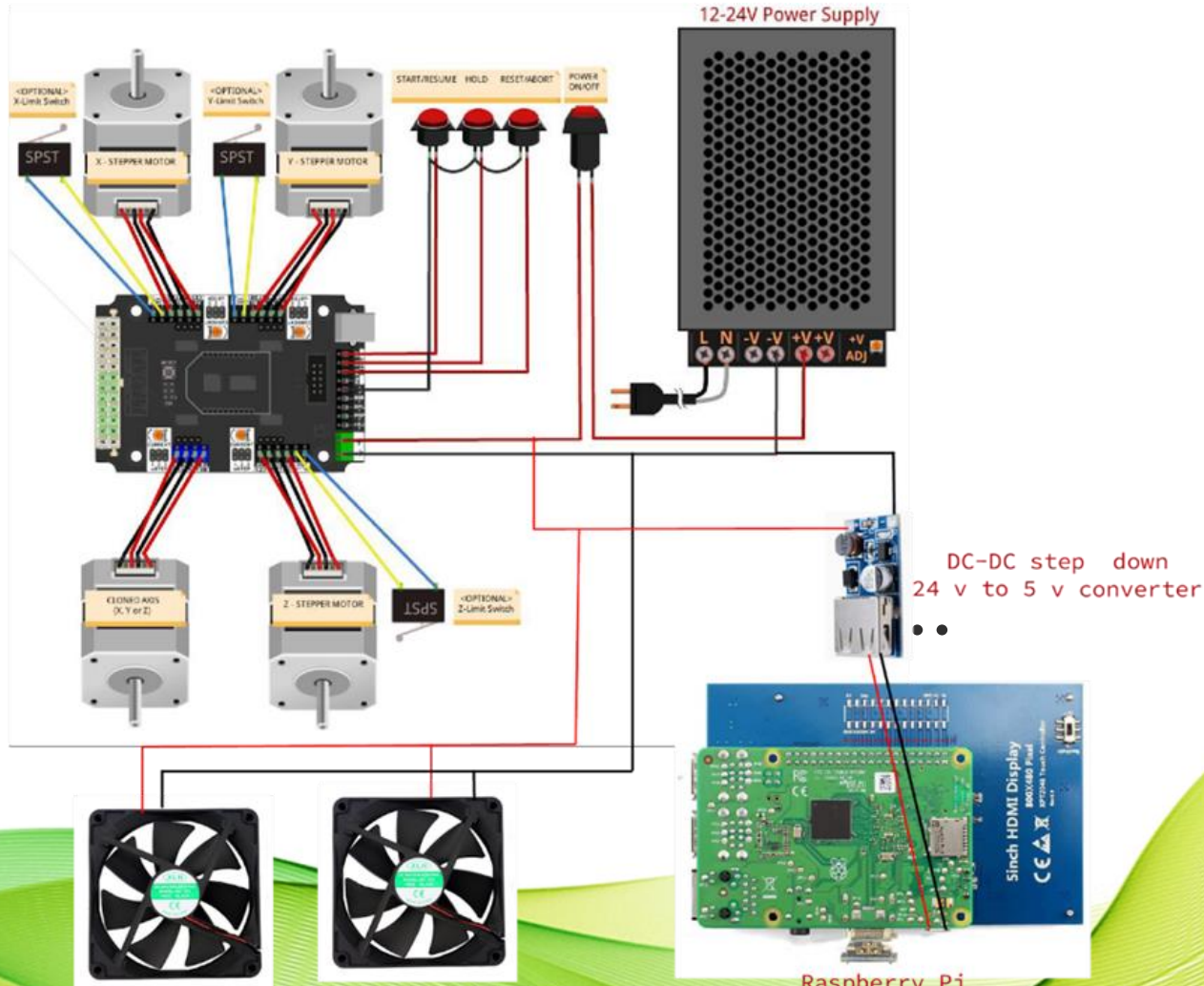
Sustainable Cities
and Communities:
Reduce Resource
Needs.

11 SUSTAINABLE CITIES
AND COMMUNITIES



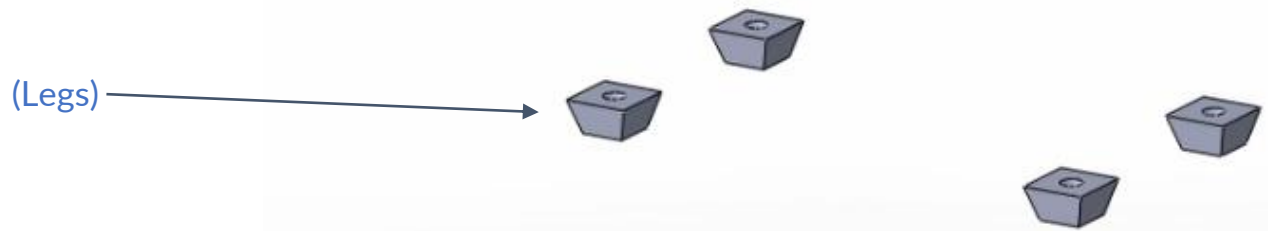
Circuit Design

Powering with 12 - 24V (DC) supply:



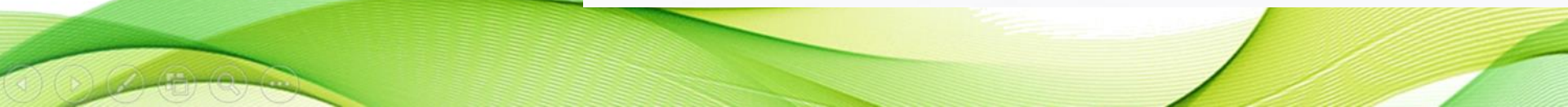
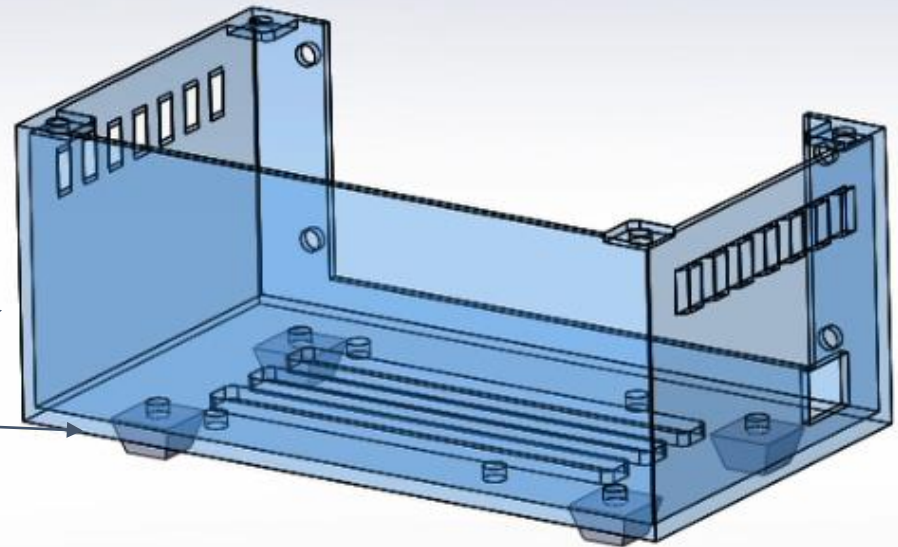
CAD Controller Case Design

(Legs)



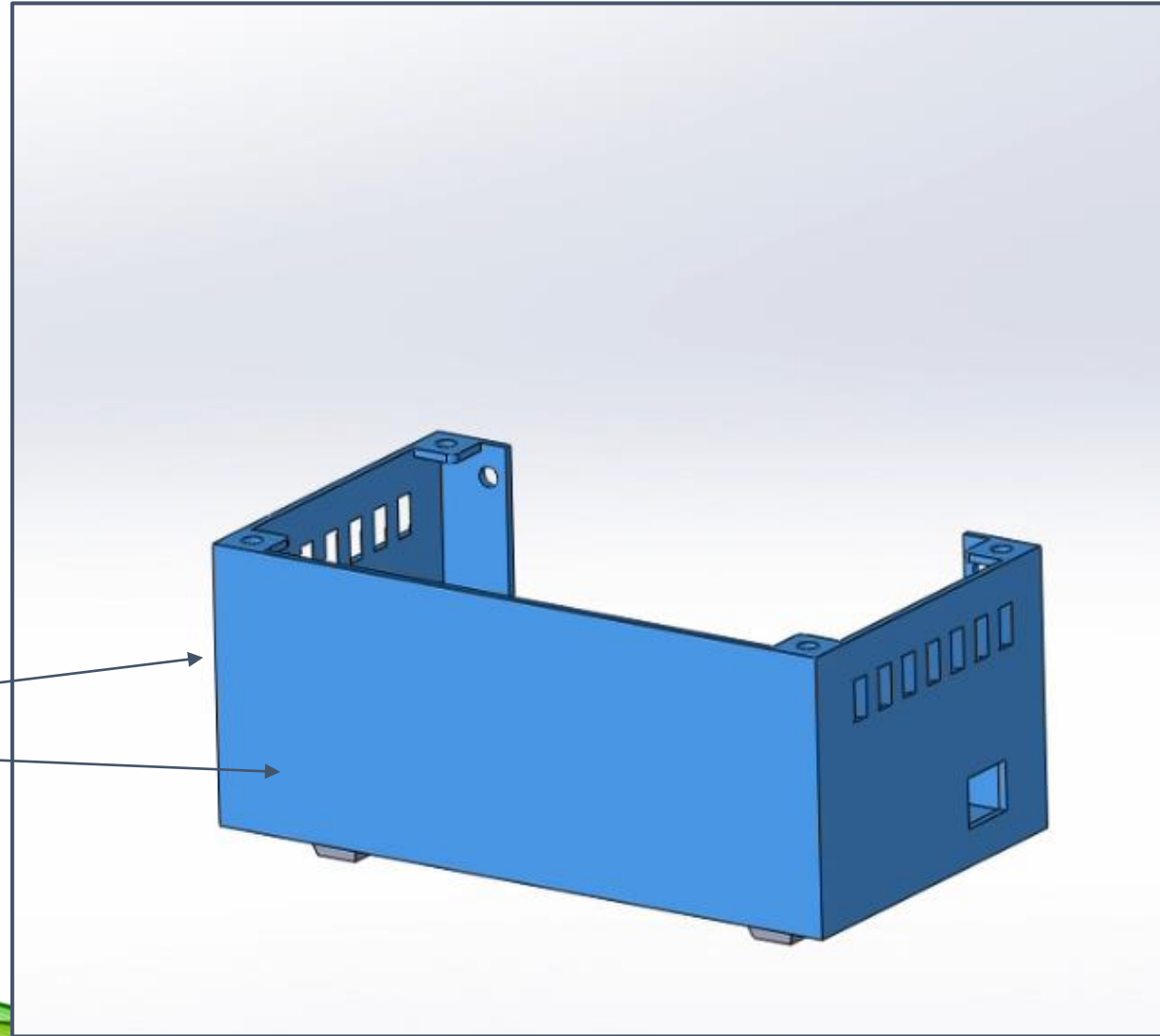
CAD Controller Case Design

(Legs)
(Xpro and Fans casing)



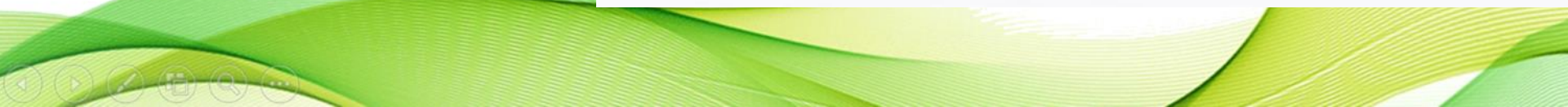
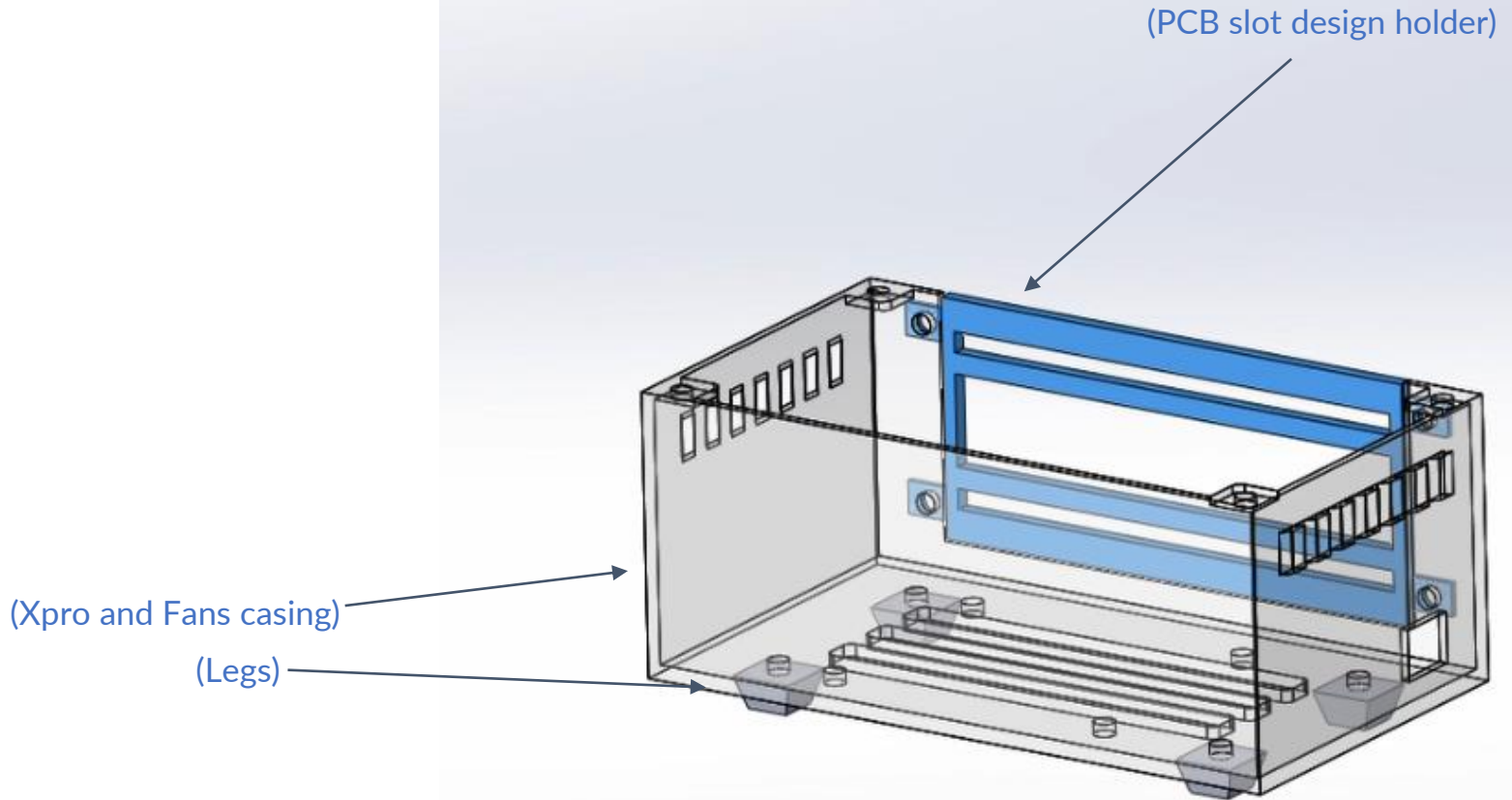


CAD Controller Case Design



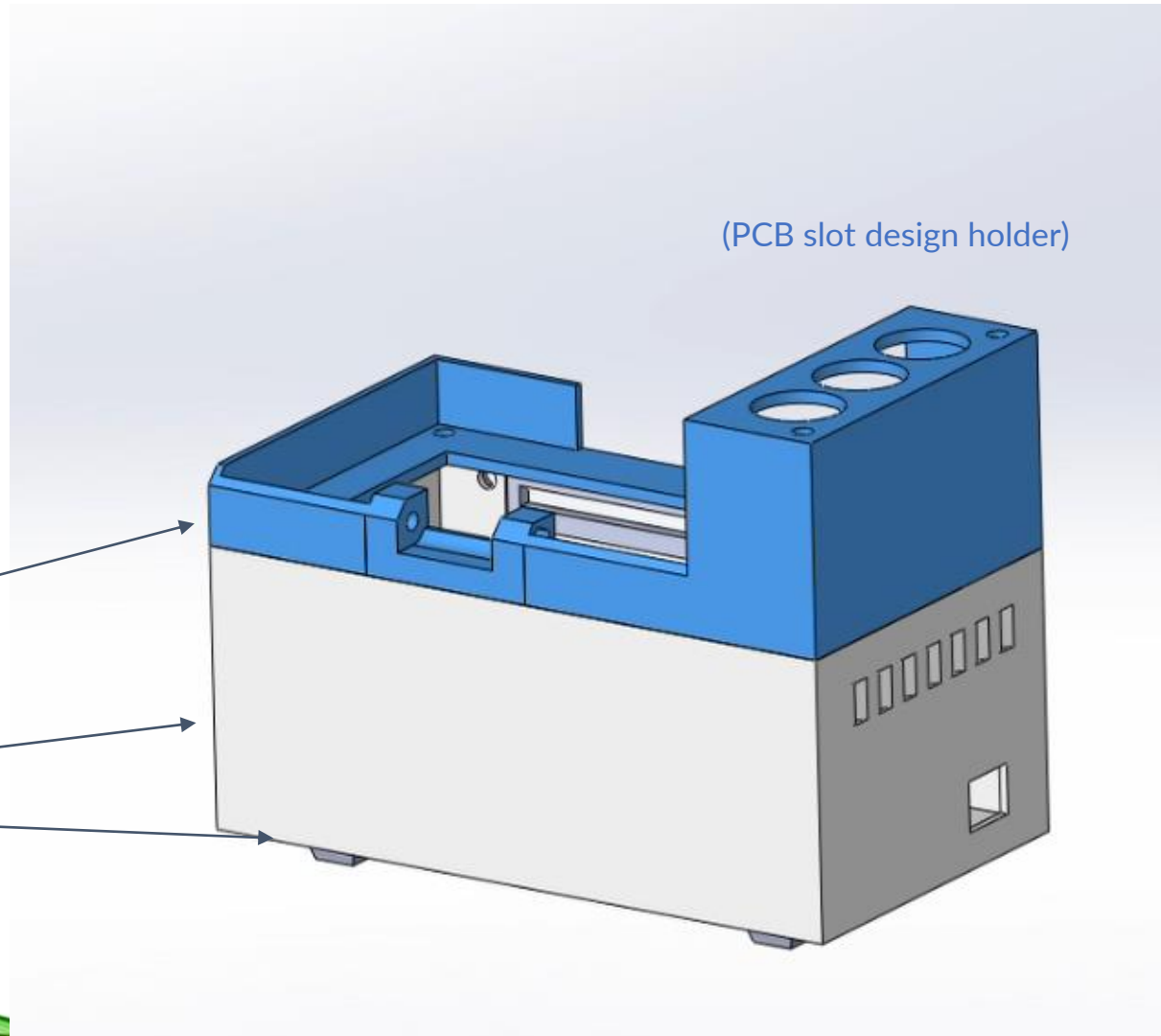


CAD Controller Case Design



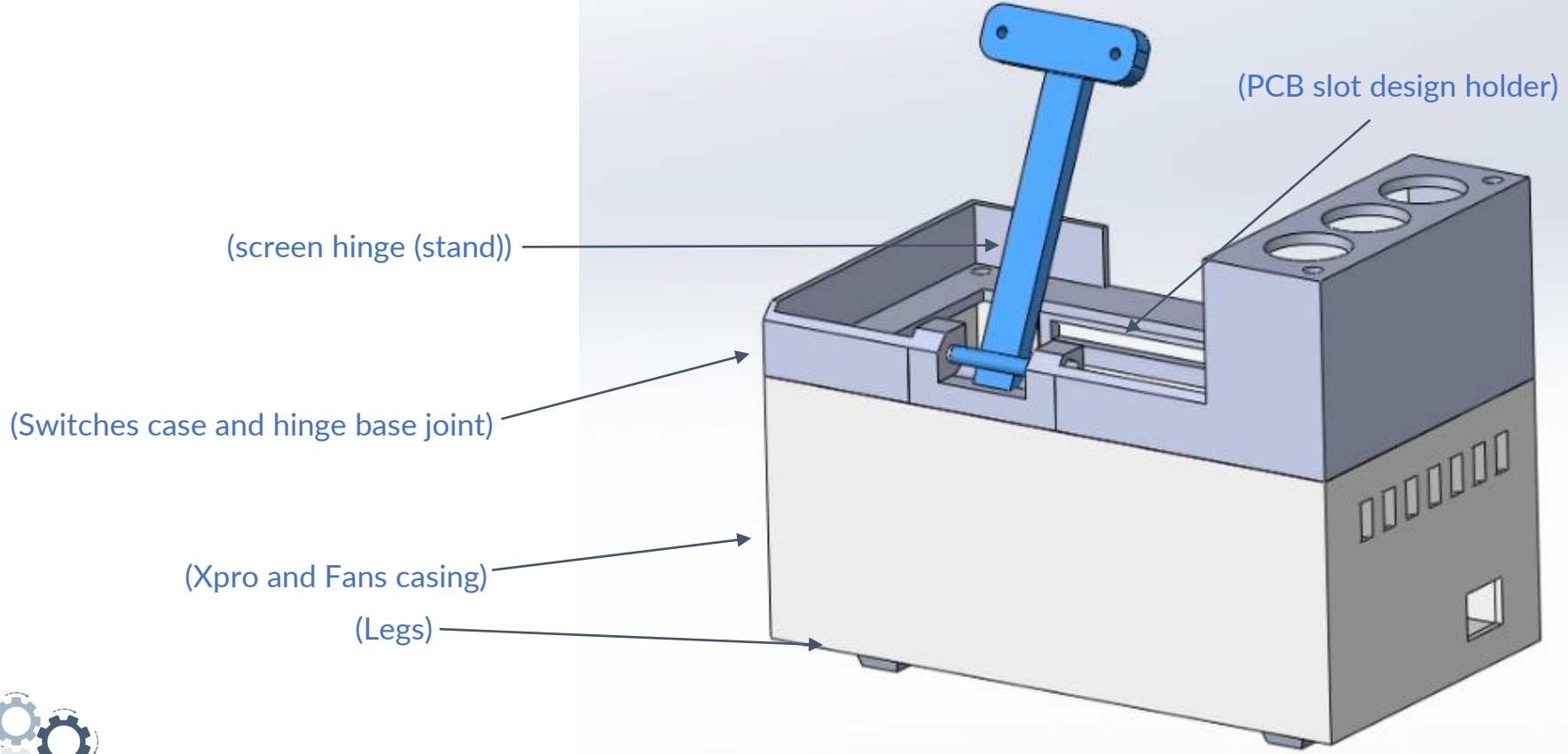


CAD Controller Case Design



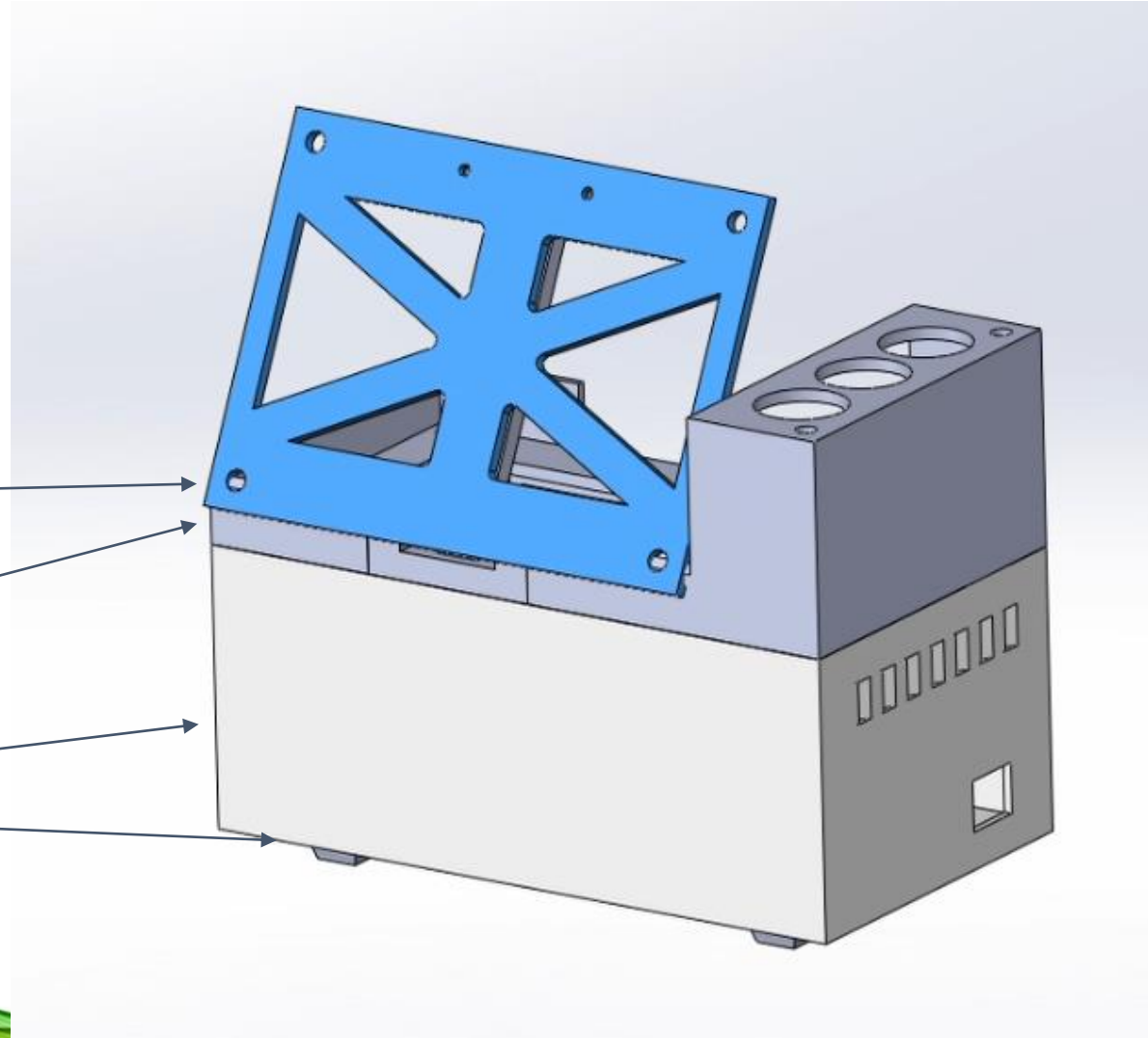


CAD Controller Case Design





CAD Controller Case Design



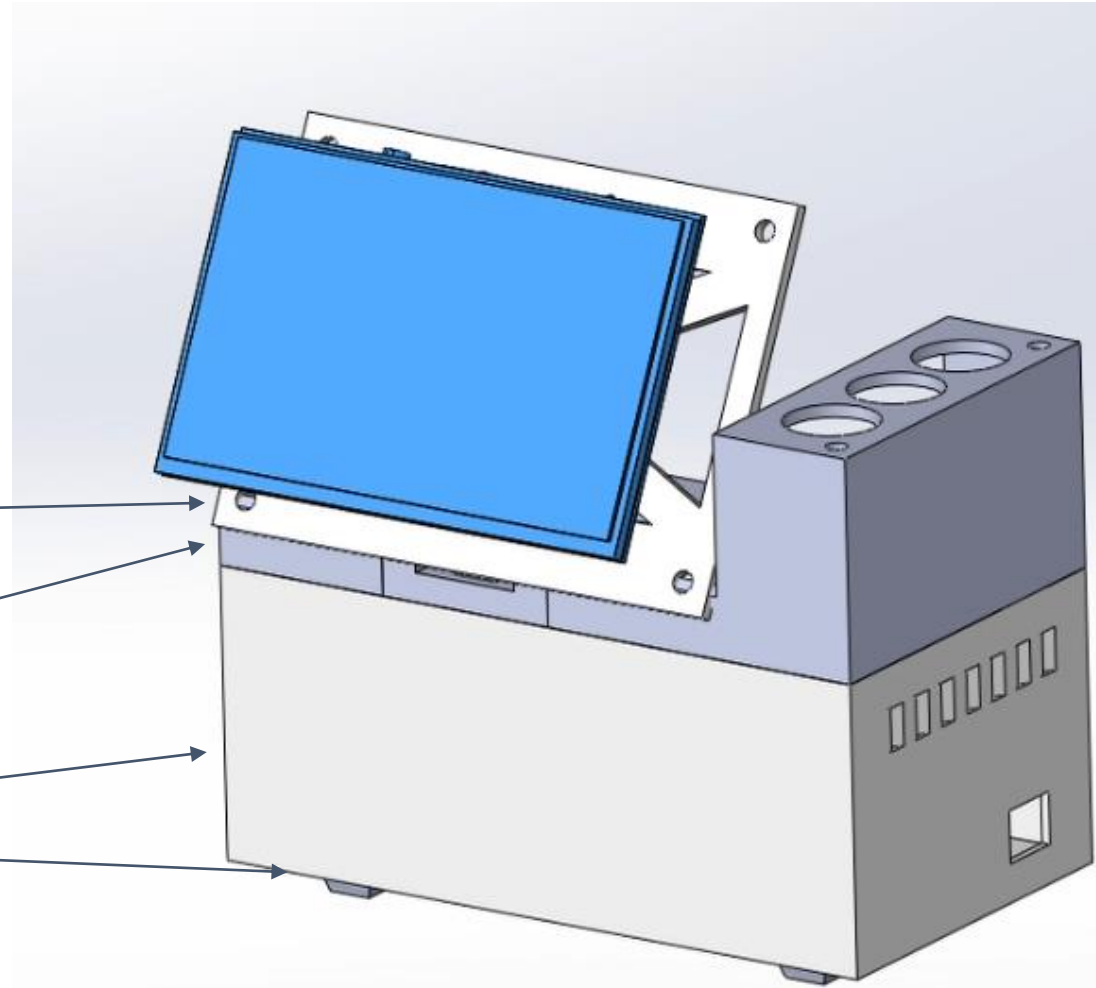
(Screen and Hinge platform)
(Switches case and hinge base joint)

(Xpro and Fans casing)
(Legs)





CAD Controller Case Design





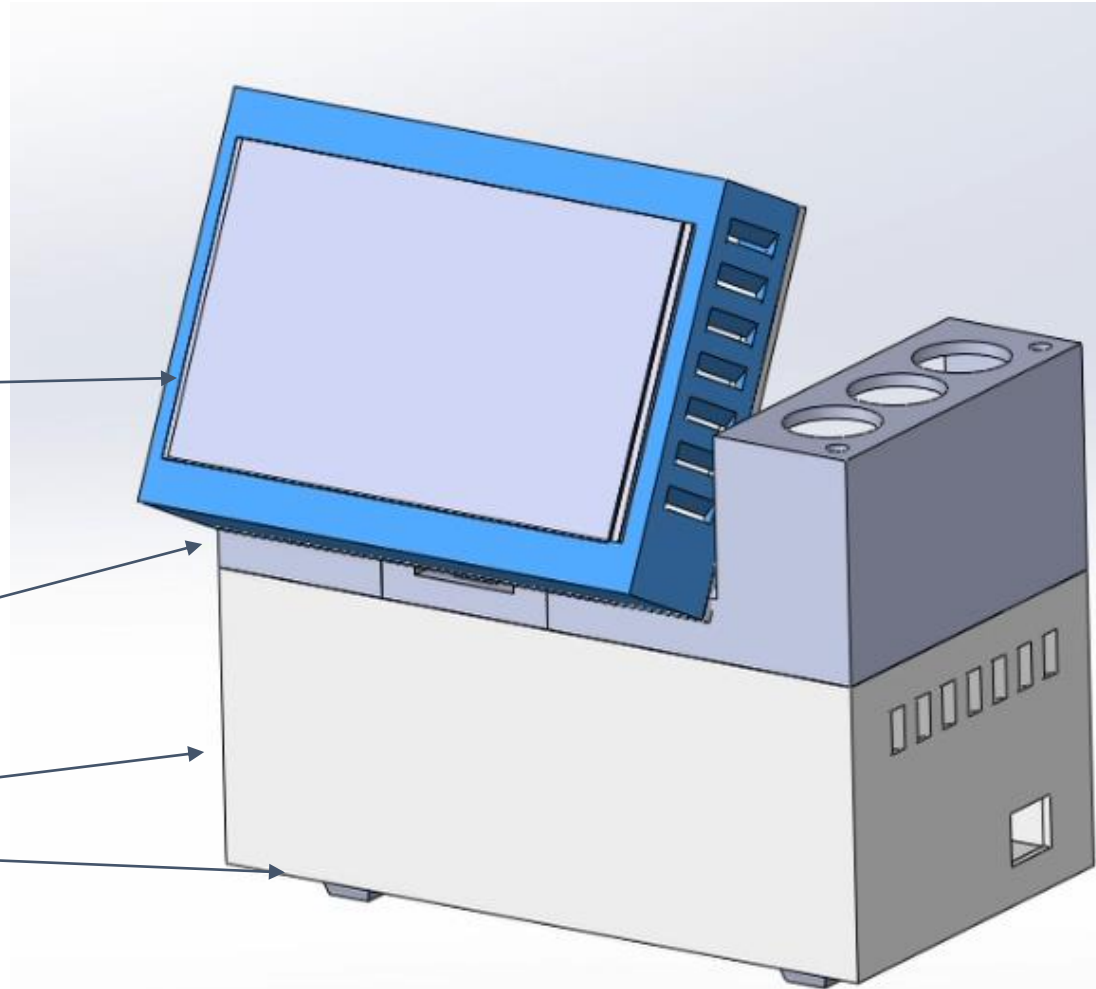
CAD Controller Case Design

(Screen and Raspberry Pi Case)

(Switches case and hinge base joint)

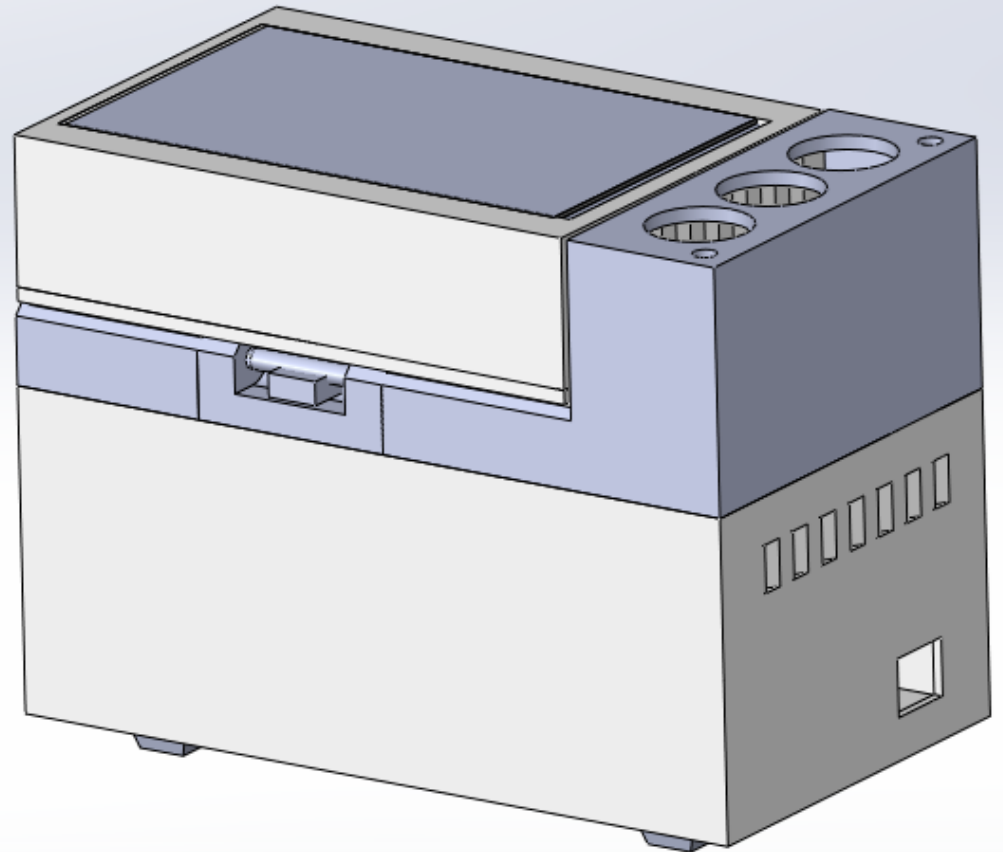
(Xpro and Fans casing)

(Legs)



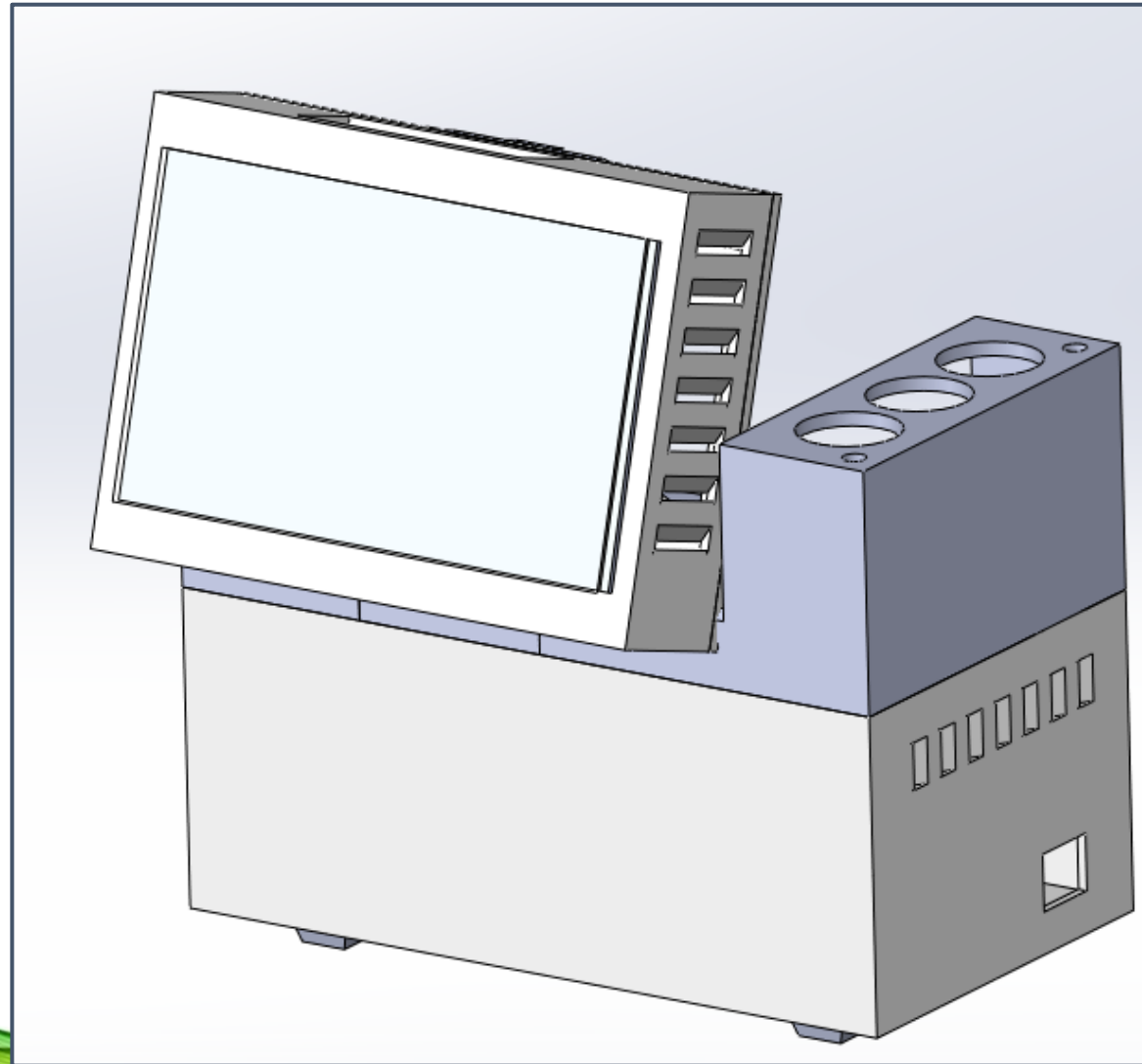


CAD Controller Case Design

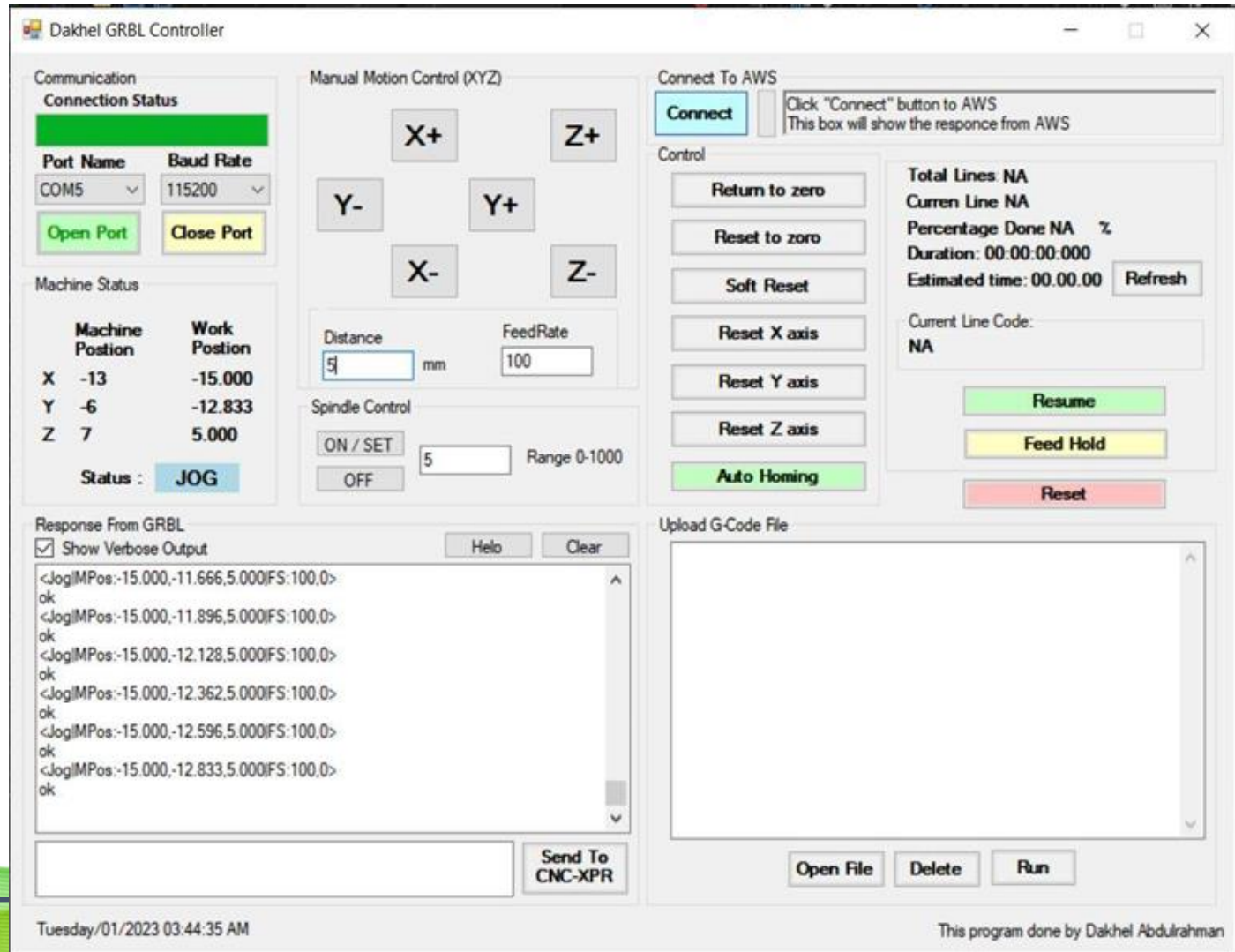




CAD Controller Case Design



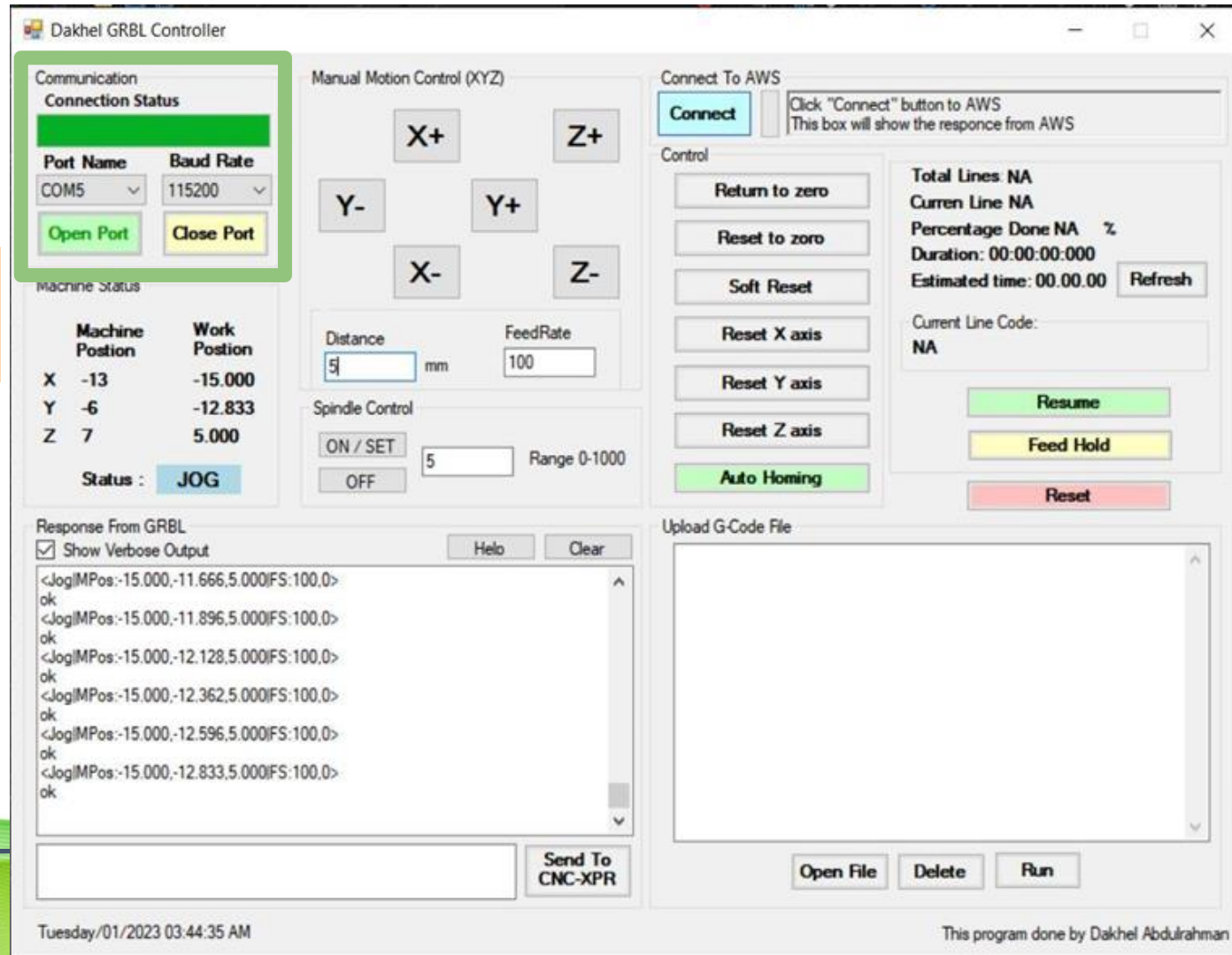
GRAPHICAL USER INTERFACE (GUI)



The screenshot displays the 'Dakhel GRBL Controller' software interface. It is organized into several functional panels:

- Communication:** Shows 'Connection Status' as connected. It includes fields for 'Port Name' (COM5) and 'Baud Rate' (115200), with 'Open Port' and 'Close Port' buttons.
- Machine Status:** A table showing current machine positions: X: -13, Y: -6, Z: 7. Work positions are listed as X: -15.000, Y: -12.833, Z: 5.000. The status is 'JOG'.
- Manual Motion Control (XYZ):** Features directional buttons (X+, X-, Y+, Y-, Z+, Z-) and input fields for 'Distance' (5 mm) and 'FeedRate' (100). It also includes 'Spindle Control' with 'ON / SET' and 'OFF' buttons and a numerical input (5) with a range of 0-1000.
- Control:** A vertical stack of buttons for 'Return to zero', 'Reset to zero', 'Soft Reset', 'Reset X axis', 'Reset Y axis', 'Reset Z axis', and 'Auto Homing'.
- Connect To AWS:** A 'Connect' button and a text box for AWS response.
- Machine Metrics:** Displays 'Total Lines NA', 'Current Line NA', 'Percentage Done NA %', 'Duration: 00:00:00.000', and 'Estimated time: 00:00:00'. It includes a 'Refresh' button and a 'Current Line Code: NA' field.
- Response From GRBL:** A text area with 'Show Verbose Output' checked, displaying a series of 'ok' responses and position updates. It has 'Help' and 'Clear' buttons.
- Upload G-Code File:** A text area for file names with 'Open File', 'Delete', and 'Run' buttons.
- Footer:** Shows the date and time 'Tuesday/01/2023 03:44:35 AM' and the attribution 'This program done by Dakhel Abdulrahman'.

Connection To GRBL



The screenshot shows the 'Dakhel GRBL Controller' software interface. The 'Communication' section is highlighted with a green box, showing 'Port Name' set to 'COM5' and 'Baud Rate' set to '115200'. Below this are 'Open Port' and 'Close Port' buttons. The 'Manual Motion Control (XYZ)' section features directional buttons for X+, X-, Y+, Y-, Z+, and Z-. The 'Machine Status' table is as follows:

Machine Position	Work Position
X -13	-15.000
Y -6	-12.833
Z 7	5.000

The status is 'JOG'. The 'Response From GRBL' section shows a log of 'ok' messages and coordinates. The 'Control' section includes buttons for 'Return to zero', 'Reset to zero', 'Soft Reset', 'Reset X axis', 'Reset Y axis', 'Reset Z axis', and 'Auto Homing'. The 'Connect To AWS' section has a 'Connect' button. The 'Upload G-Code File' section has 'Open File', 'Delete', and 'Run' buttons. The bottom status bar shows 'Tuesday/01/2023 03:44:35 AM' and 'This program done by Dakhel Abdurahman'.

Machine Status

Status : **RUN**

Status : **JOG**

Status : **IDLE**

Status : **Alarm**

Dakhel GRBL Controller

Communication
Connection Status: **Connected**

Port Name: COM5 | Baud Rate: 115200

Open Port | Close Port

Manual Motion Control (XYZ)

X+ | Z+ | Y- | Y+ | X- | Z-

Distance: 5 mm | FeedRate: 100

Spindle Control: ON / SET | OFF | 5 | Range 0-1000

Control: Return to zero, Reset to zero, Soft Reset, Reset X axis, Reset Y axis, Reset Z axis, Auto Homing

Machine Status

Machine Position	Work Position
X -13	-15.000
Y -6	-12.833
Z 7	5.000

Status : **JOG**

Response From GRBL

Show Verbose Output

```
<JogIMPos:-15.000,-11.666,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-11.896,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.128,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.362,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.596,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.833,5.000IFS:100.0>
ok
```

Send To CNC-XPR

Connect To AWS: Connect | Click "Connect" button to AWS | This box will show the response from AWS

Control: Return to zero, Reset to zero, Soft Reset, Reset X axis, Reset Y axis, Reset Z axis, Auto Homing

Total Lines NA
Current Line NA
Percentage Done NA %
Duration: 00:00:00:000
Estimated time: 00.00.00 | Refresh

Current Line Code: NA

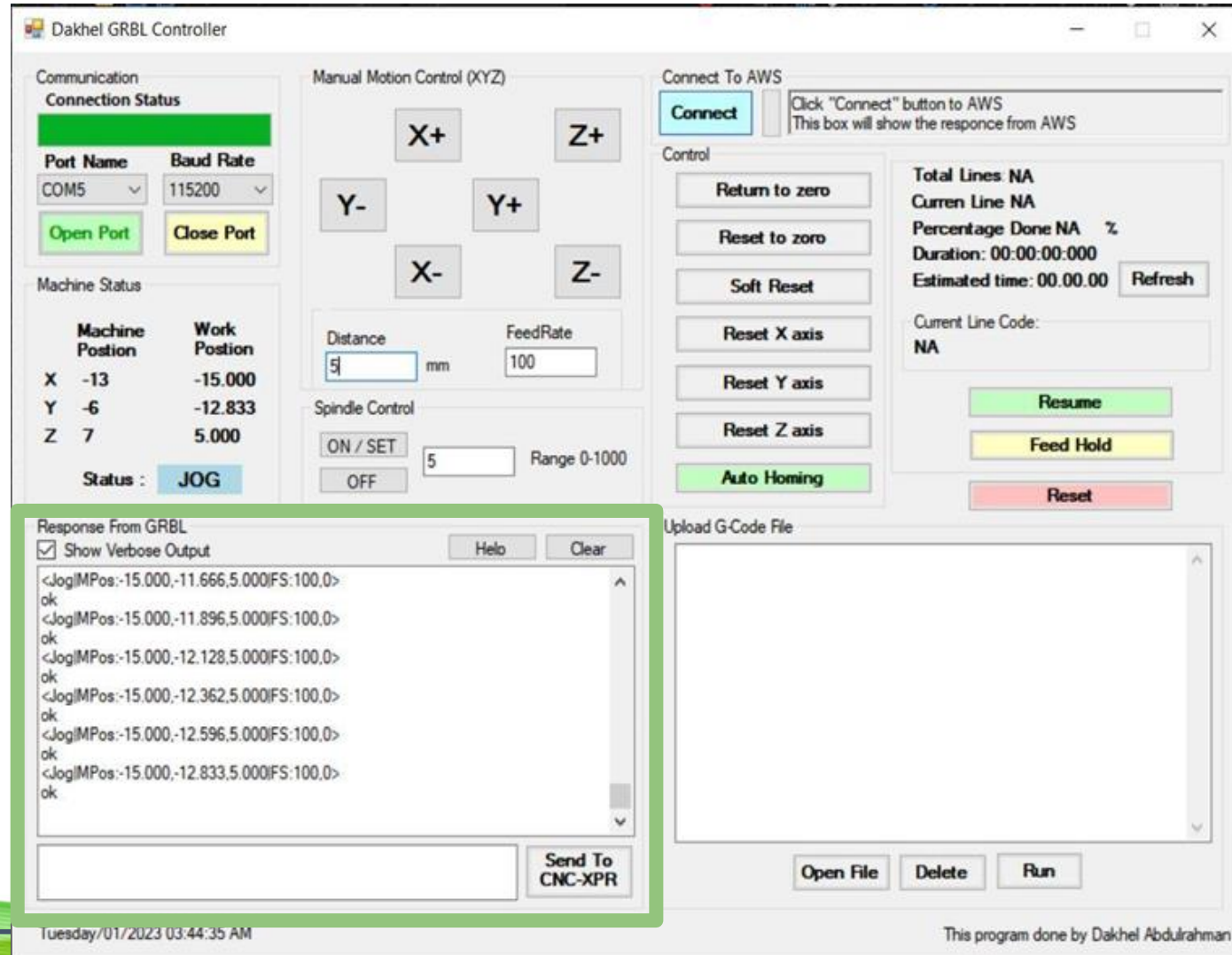
Resume | Feed Hold | Reset

Upload G-Code File: Open File | Delete | Run

Tuesday/01/2023 03:44:35 AM | This program done by Dakhel Abdurahman

GRBL Response

- Send Commands..
- Receive response.

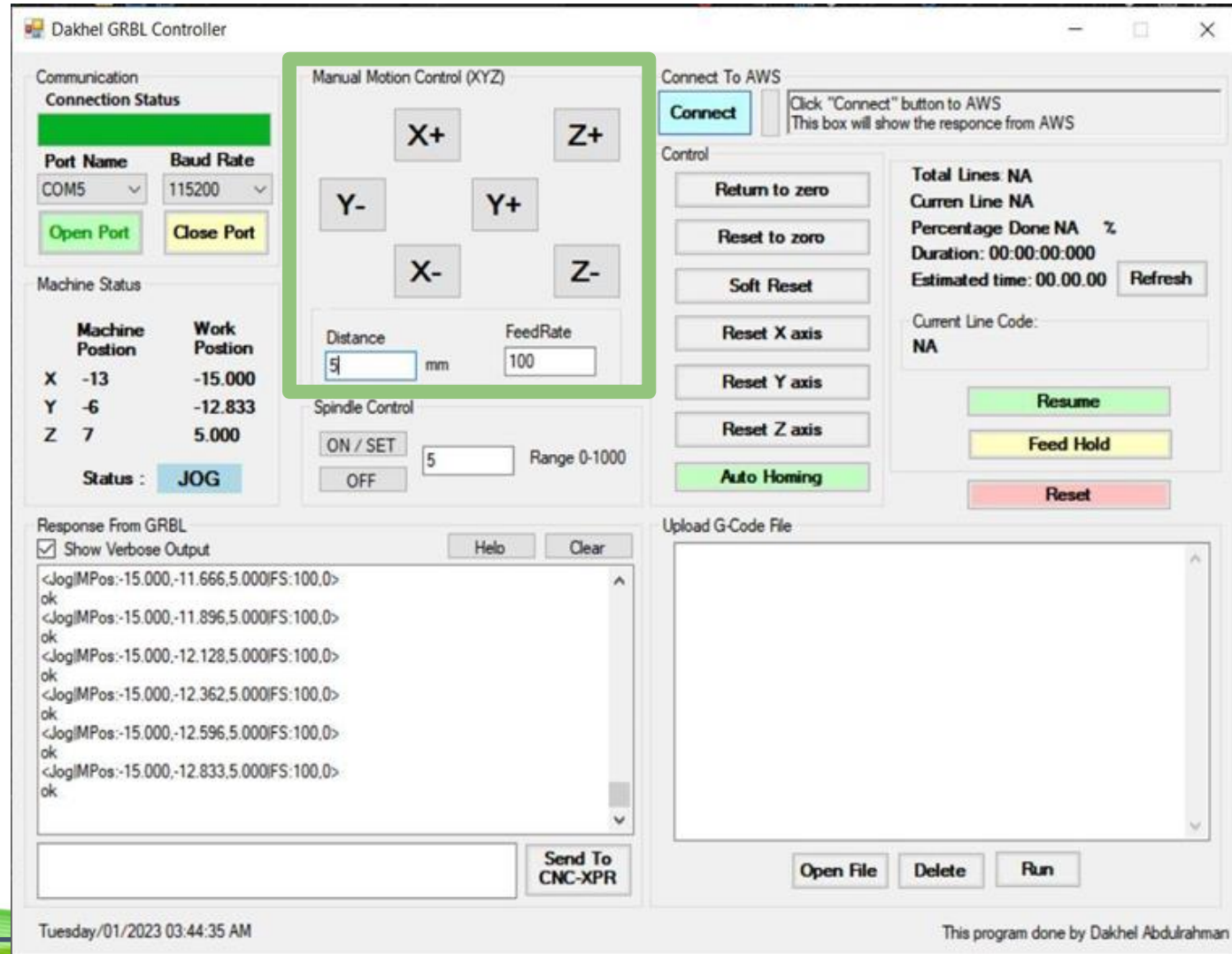


The screenshot shows the Dakhel GRBL Controller software interface. It features several control panels:

- Communication Connection Status:** Shows Port Name (COM5) and Baud Rate (115200). Buttons for Open Port and Close Port are visible.
- Machine Status:** A table showing Machine Position and Work Position for X, Y, and Z axes.
- Manual Motion Control (XYZ):** Includes directional buttons (X+, X-, Y+, Y-, Z+, Z-), Distance (5 mm), and FeedRate (100) controls.
- Spindle Control:** Includes ON/SET and OFF buttons, and a Spindle Speed control (5) with a Range of 0-1000.
- Control Panel:** Includes buttons for Return to zero, Reset to zero, Soft Reset, Reset X axis, Reset Y axis, Reset Z axis, Auto Homing, Resume, Feed Hold, and Reset.
- Response From GRBL:** A text area showing the received response from the GRBL controller, including status reports and position updates.
- Upload G-Code File:** A section for uploading G-code files, with buttons for Open File, Delete, and Run.

The status bar at the bottom indicates the date and time: Tuesday/01/2023 03:44:35 AM. A footer note states: "This program done by Dakhel Abdulrahman".

Manual Motion



The screenshot shows the Dakhel GRBL Controller software interface. The 'Manual Motion Control (XYZ)' section is highlighted with a green box, containing directional buttons (X+, X-, Y+, Y-, Z+, Z-), a 'Distance' input field with the value '5', and a 'FeedRate' input field with the value '100'. The 'Machine Status' table shows the current positions for X, Y, and Z axes. The 'Response From GRBL' section displays a series of status messages indicating successful jogging movements. The interface also includes communication settings, spindle control, and various control buttons like 'Return to zero', 'Reset to zero', and 'Auto Homing'.

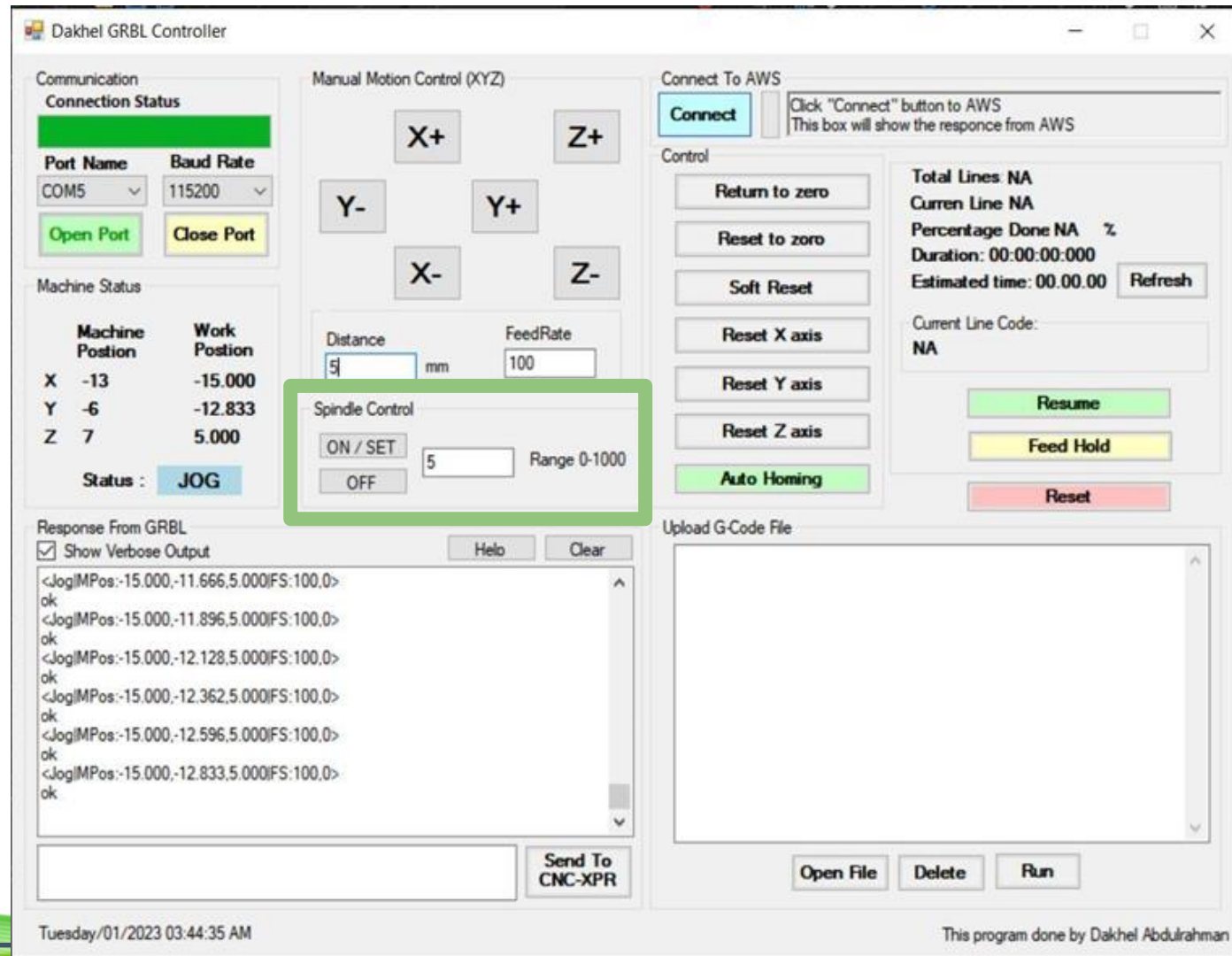
Machine Position	Work Position
X -13	-15.000
Y -6	-12.833
Z 7	5.000

```
<JogIMPos:-15.000,-11.666,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-11.896,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.128,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.362,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.596,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.833,5.000IFS:100.0>
ok
```

Tuesday/01/2023 03:44:35 AM

This program done by Dakhel Abdulrahman

Spindle Control



Dakhel GRBL Controller

Communication
Connection Status

Port Name: COM5 Baud Rate: 115200

Open Port Close Port

Machine Status

Machine Position	Work Position
X -13	-15.000
Y -6	-12.833
Z 7	5.000

Status: JOG

Manual Motion Control (XYZ)

X+ Z+ Y- Y+ X- Z-

Distance: 5 mm FeedRate: 100

Spindle Control

ON / SET OFF 5 Range 0-1000

Connect To AWS

Connect

Control

Return to zero Reset to zero Soft Reset Reset X axis Reset Y axis Reset Z axis Auto Homing

Total Lines NA Curren Line NA Percentage Done NA % Duration: 00:00:00:000 Estimated time: 00.00.00 Refresh

Current Line Code: NA

Resume Feed Hold Reset

Response From GRBL

Show Verbose Output

```
<JogIMPos:-15.000,-11.666,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-11.896,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.128,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.362,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.596,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.833,5.000IFS:100.0>
ok
ok
```

Send To CNC-XPR

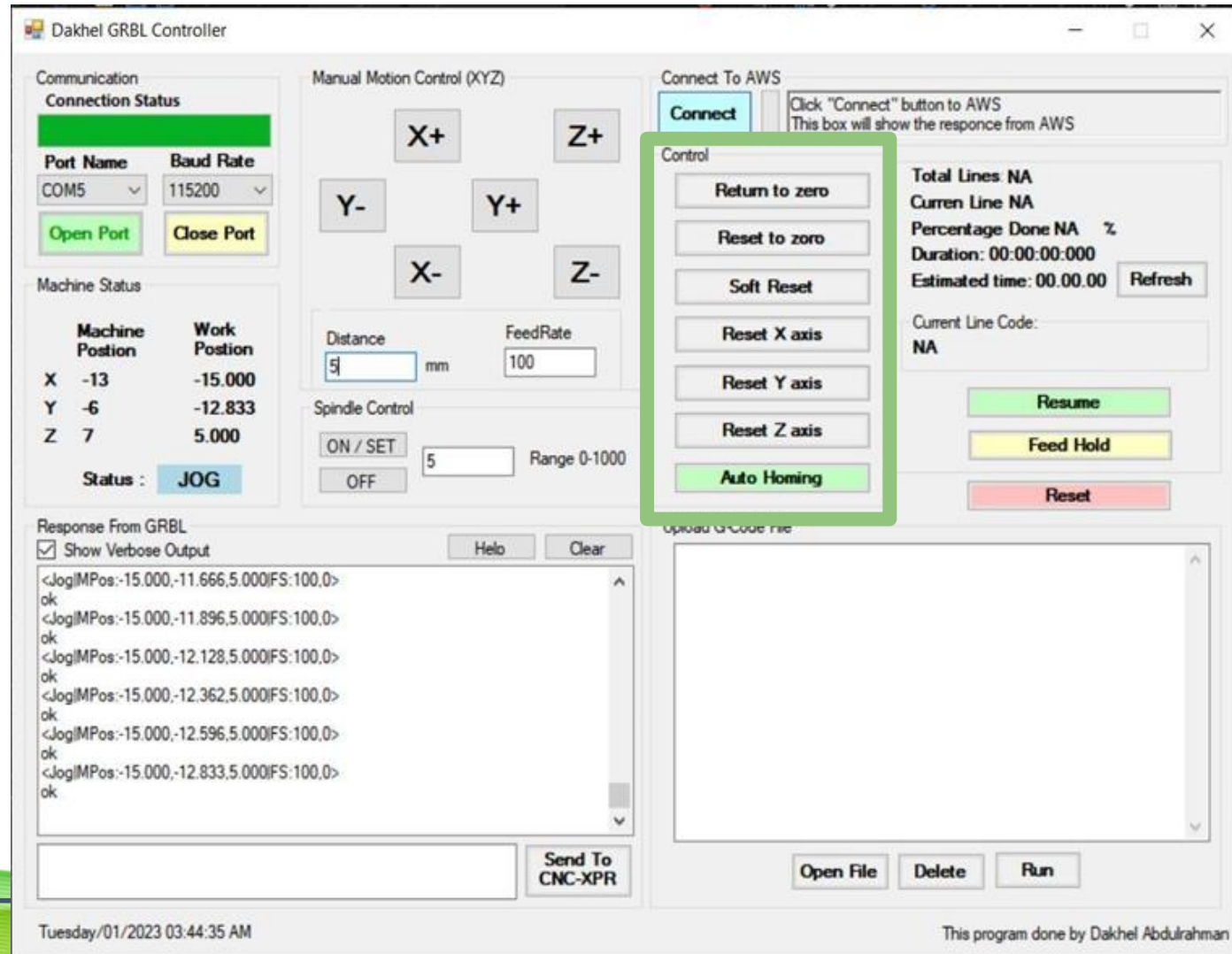
Upload G-Code File

Open File Delete Run

Tuesday/01/2023 03:44:35 AM

This program done by Dakhel Abdurahman

General Control

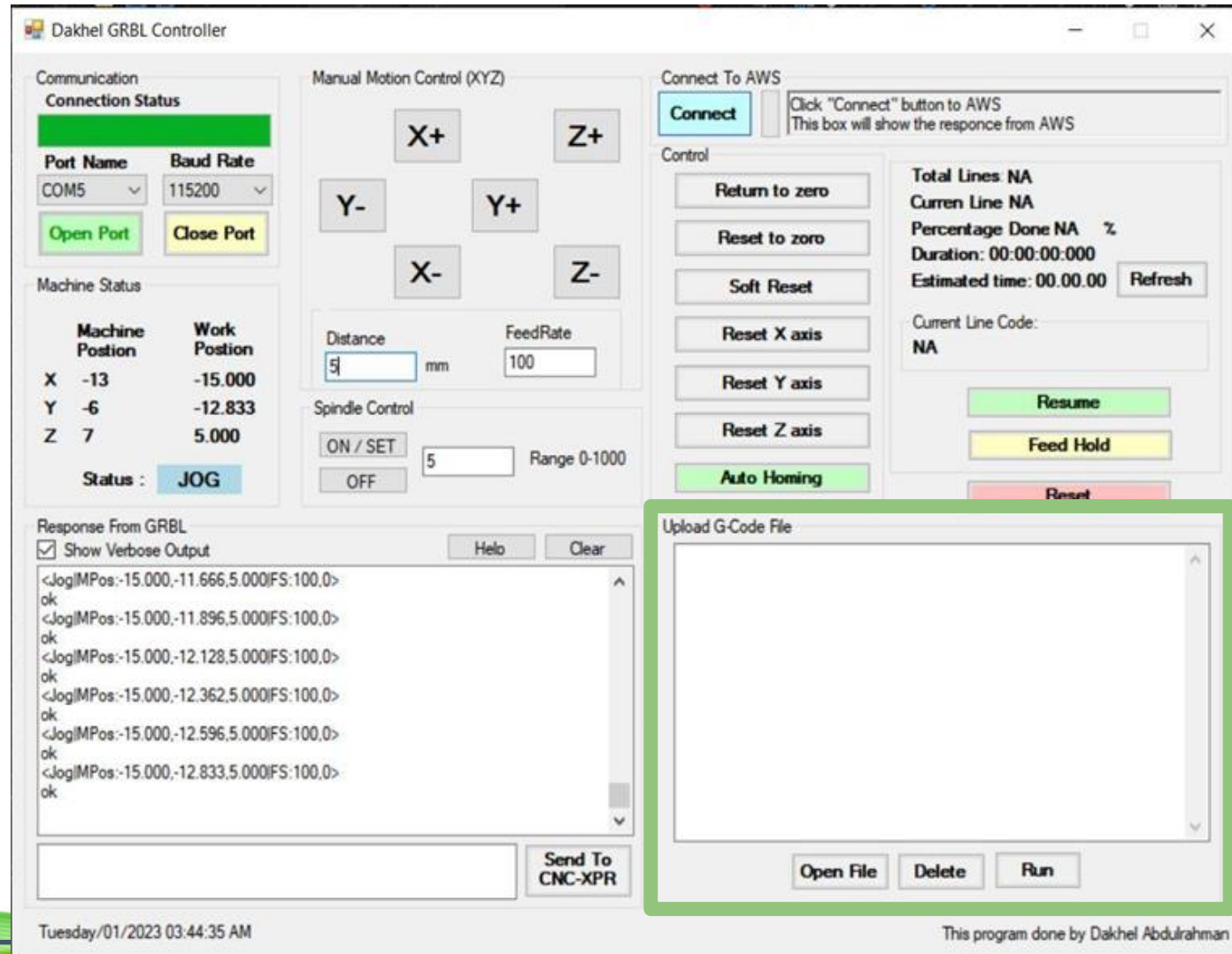


The screenshot shows the Dakhel GRBL Controller software interface. It features several control panels:

- Communication:** Connection Status (green bar), Port Name (COM5), Baud Rate (115200), Open Port (green), Close Port (yellow).
- Machine Status:** Machine Position (X: -13, Y: -6, Z: 7), Work Position (X: -15.000, Y: -12.833, Z: 5.000), Status: JOG (blue).
- Manual Motion Control (XYZ):** X+, X-, Y+, Y-, Z+, Z- buttons, Distance (5 mm), FeedRate (100).
- Spindle Control:** ON / SET (green), OFF (grey), Range 0-1000.
- Control Panel (highlighted in green):** Return to zero, Reset to zero, Soft Reset, Reset X axis, Reset Y axis, Reset Z axis, Auto Homing (green).
- Connect To AWS:** Connect (blue), Click "Connect" button to AWS, This box will show the response from AWS.
- Response From GRBL:** Show Verbose Output (checked), Hello, Clear, Log output showing position updates.
- Upload G-Code File:** Upload G-Code File (grey), Open File (green), Delete (yellow), Run (red).
- Summary:** Total Lines NA, Curren Line NA, Percentage Done NA %, Duration: 00:00:00:000, Estimated time: 00.00.00, Refresh (grey), Current Line Code: NA, Resume (green), Feed Hold (yellow), Reset (red).

Tuesday/01/2023 03:44:35 AM This program done by Dakhel Abdurahman

Upload G-Code



The screenshot shows the Dakhel GRBL Controller software interface. It features several control panels: Communication (Port Name: COM5, Baud Rate: 115200), Manual Motion Control (XYZ axes with X+, X-, Y+, Y-, Z+, Z- buttons), Spindle Control (ON/SET, OFF, Range 0-1000), and a Response From GRBL window showing real-time position updates. A modal window titled "Upload G-Code File" is open, with a text area for the file path and buttons for "Open File", "Delete", and "Run". The status bar at the bottom indicates the date and time: Tuesday/01/2023 03:44:35 AM.

Communication
Connection Status
Port Name: COM5 | Baud Rate: 115200
Open Port | Close Port

Manual Motion Control (XYZ)
X+ | Z+
Y- | Y+
X- | Z-
Distance: 5 mm | FeedRate: 100

Spindle Control
ON / SET | OFF | Range 0-1000

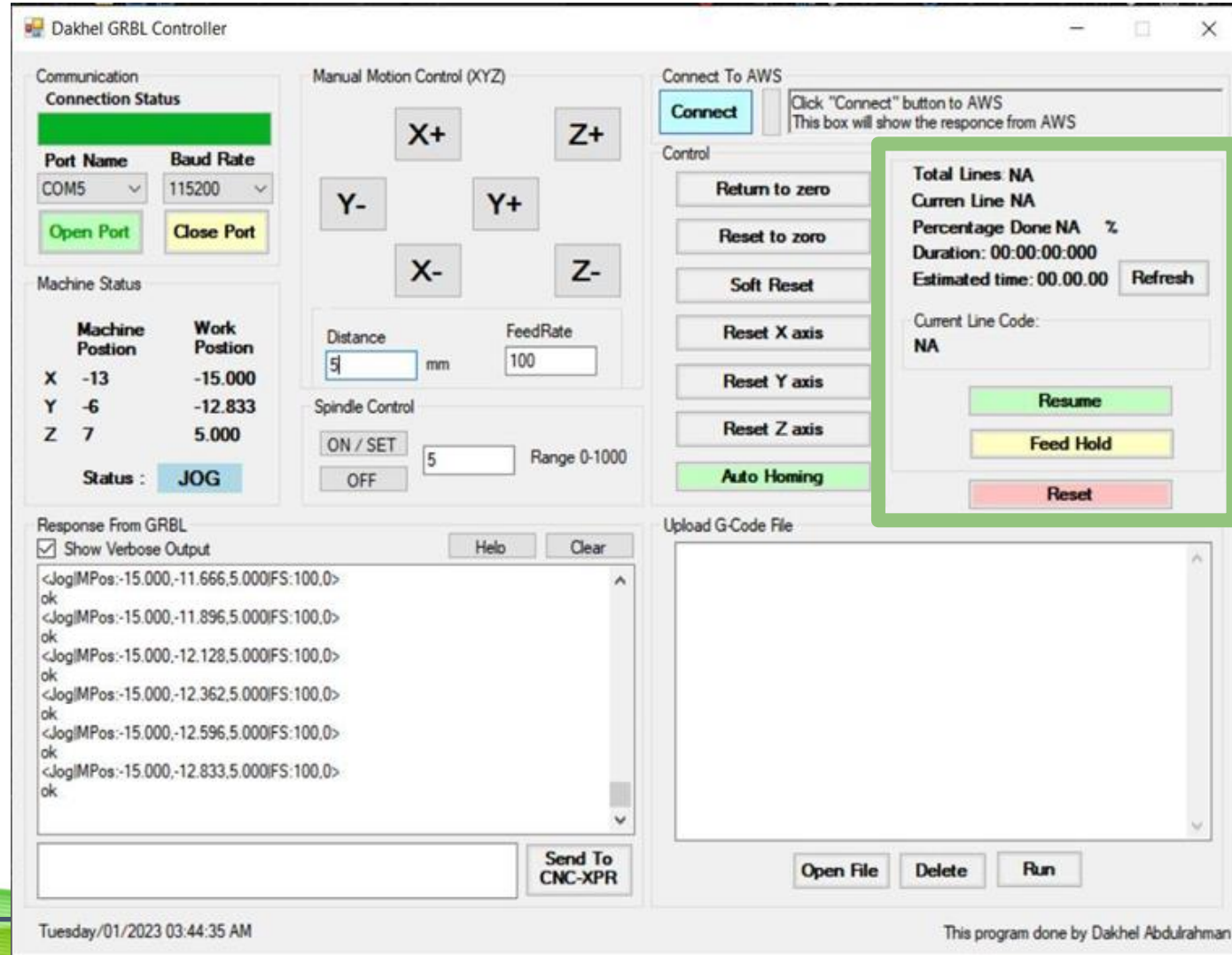
Response From GRBL
Show Verbose Output
<JogIMPos:-15.000,-11.666,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-11.896,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.128,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.362,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.596,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.833,5.000IFS:100.0>
ok

Upload G-Code File
Open File | Delete | Run

Tuesday/01/2023 03:44:35 AM | This program done by Dakhel Abdurahman

Operation Monitor

- Estimated Time.
- Current Line.



Dakhel GRBL Controller

Communication
Connection Status
Port Name: COM5, Baud Rate: 115200
Open Port, Close Port

Machine Status
Machine Position: X: -13, Y: -6, Z: 7
Work Position: X: -15.000, Y: -12.833, Z: 5.000
Status: JOG

Manual Motion Control (XYZ)
X+, X-, Y+, Y-, Z+, Z-
Distance: 5 mm, FeedRate: 100

Spindle Control
ON / SET, OFF, Range 0-1000

Control
Connect To AWS: Connect
Return to zero, Reset to zero, Soft Reset, Reset X axis, Reset Y axis, Reset Z axis, Auto Homing

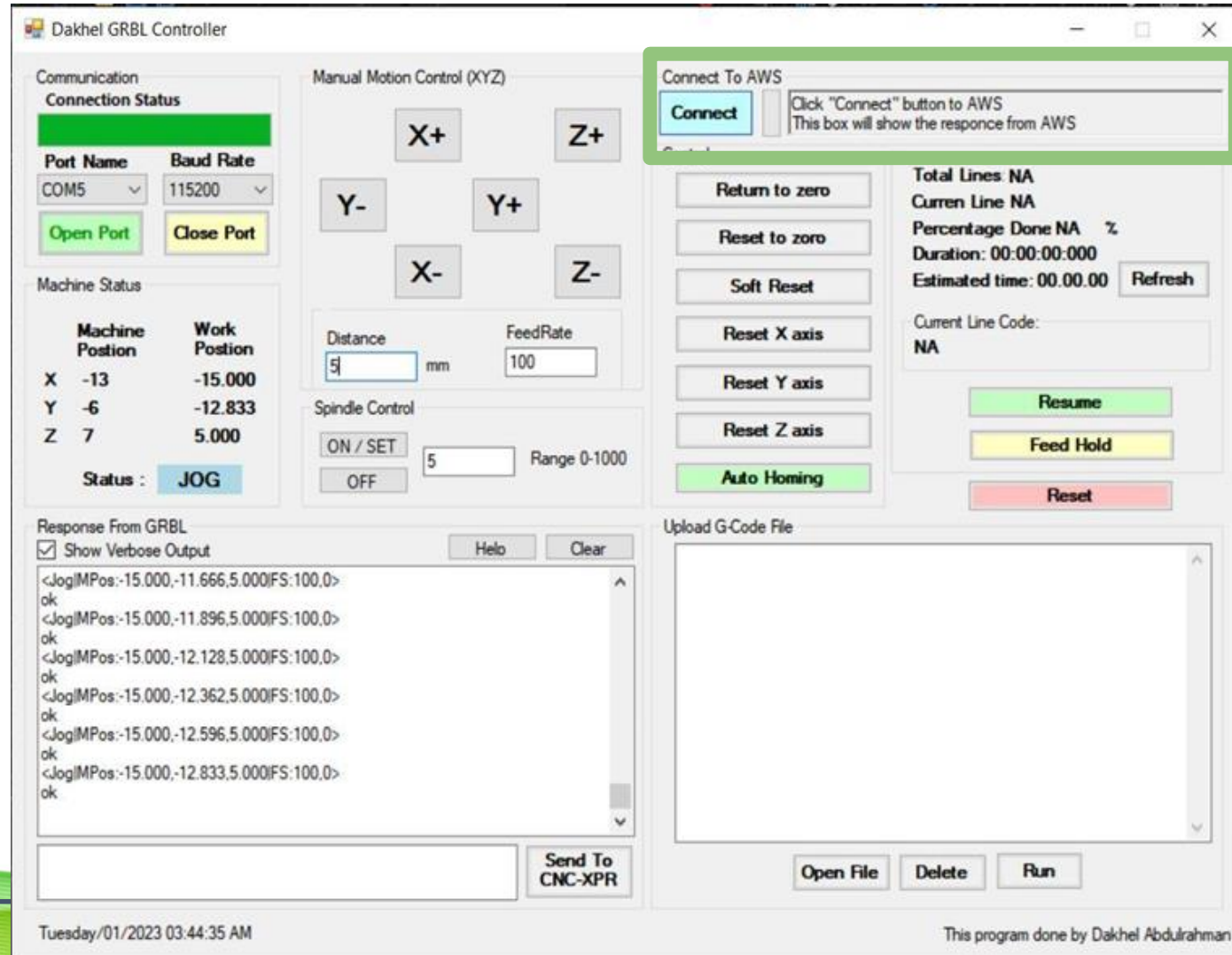
Response From GRBL
Show Verbose Output
<JogIMPos:-15.000,-11.666,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-11.896,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.128,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.362,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.596,5.000IFS:100.0>
ok
<JogIMPos:-15.000,-12.833,5.000IFS:100.0>
ok

Control Panel (highlighted):
Total Lines NA
Current Line NA
Percentage Done NA %
Duration: 00:00:00:000
Estimated time: 00.00.00 Refresh
Current Line Code: NA
Resume, Feed Hold, Reset

Upload G-Code File
Open File, Delete, Run

Tuesday/01/2023 03:44:35 AM
This program done by Dakhel Abdurrahman

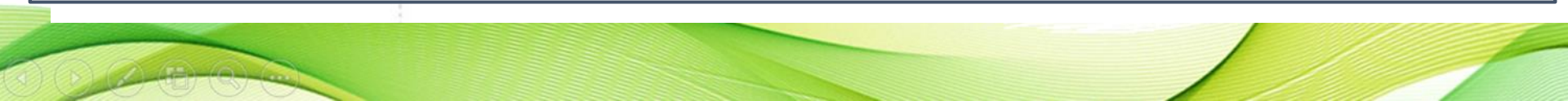
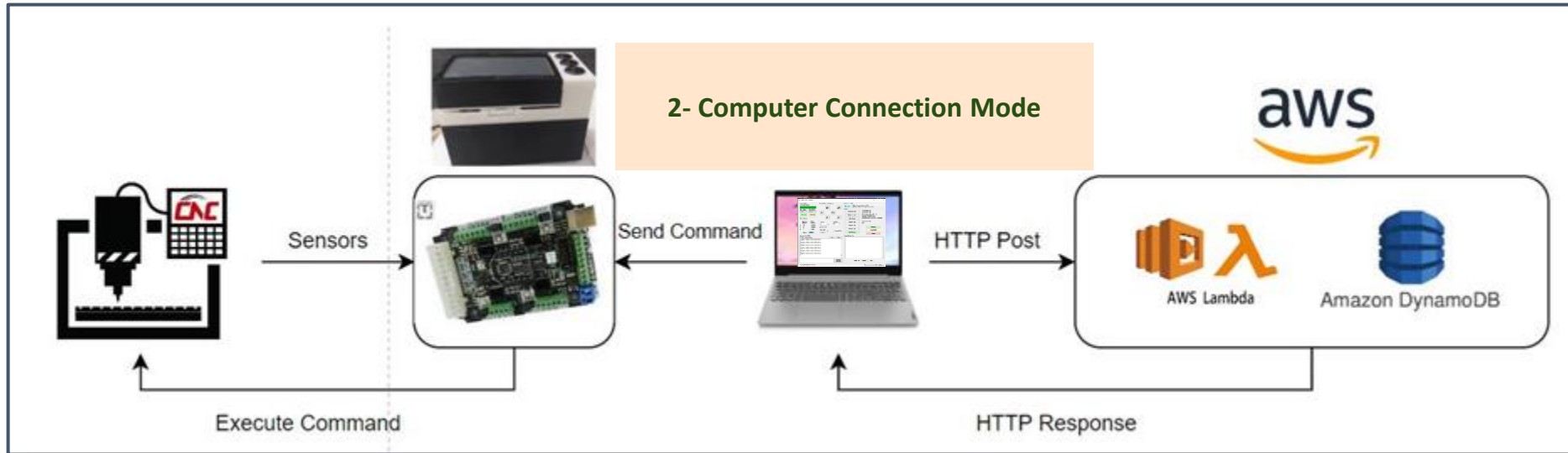
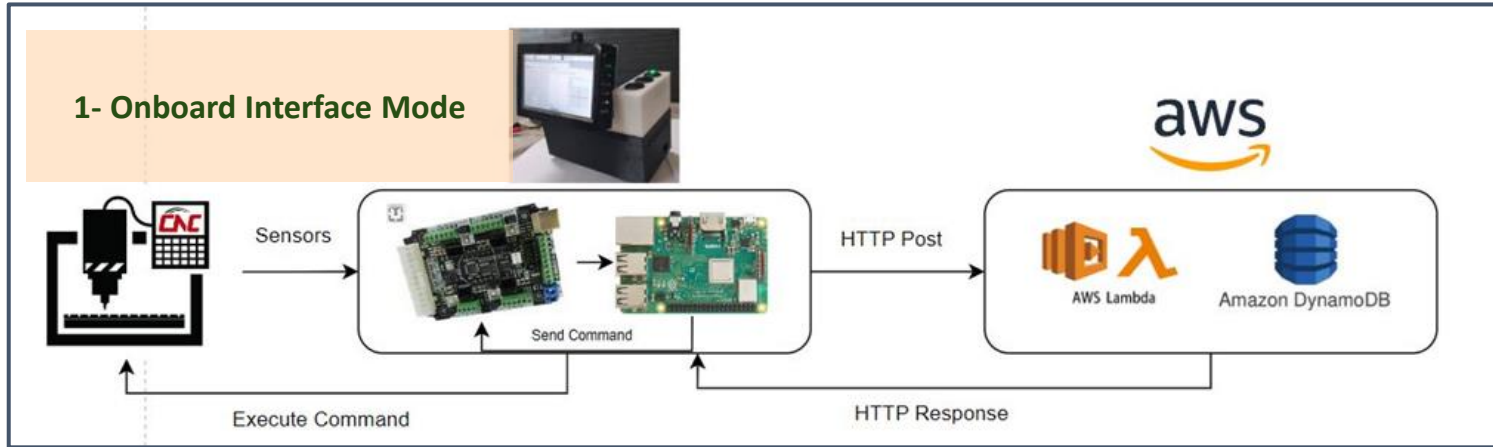
Connect to AWS



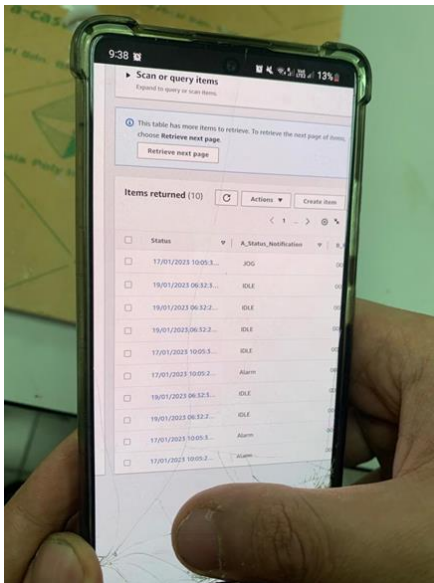
The screenshot shows the Dakhel GRBL Controller software interface. It includes sections for Communication (Connection Status, Port Name: COM5, Baud Rate: 115200), Manual Motion Control (XYZ axes with X+, X-, Y+, Y-, Z+, Z- buttons), Machine Status (Machine Position: X: -13, Y: -6, Z: 7; Work Position: -15.000, -12.833, 5.000), Spindle Control (ON / SET, OFF, Range 0-1000), Response From GRBL (Show Verbose Output checked, displaying G-code responses), and a G-code upload section. A green callout box highlights the 'Connect To AWS' button and the instruction: 'Click "Connect" button to AWS. This box will show the response from AWS'. The status is 'JOG'.

Tuesday/01/2023 03:44:35 AM

This program done by Dakhel Abdurahman



Functionality test



Functionality test



<input type="checkbox"/>	Status	▲	A_Status_Notification	▼	B_Run_Ti...	▼	C_Estimated_Time	▼	D_Percentage_Done	▼
<input type="checkbox"/>	17/01/2023 10:05:26 AM		Alarm		00:00:00:000		00.00.00		NA	
<input type="checkbox"/>	17/01/2023 10:05:28 AM		Alarm		00:00:00:000		00.00.00		NA	
<input type="checkbox"/>	17/01/2023 10:05:30 AM		Alarm		00:00:00:000		00.00.00		NA	
<input type="checkbox"/>	17/01/2023 10:05:32 AM		IDLE		00:00:00:000		00.00.00		NA	
<input type="checkbox"/>	17/01/2023 10:05:34 AM		JOG		00:00:00:000		00.00.00		NA	

Gesture based movement control of industrial robots

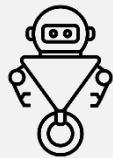
by

Irfan Fikhri bin Iszahar & Ir. Dr. Tanveer Saleh

Target of the research

WHO
1

The Collaborative
robotics industry
community



WHAT
2

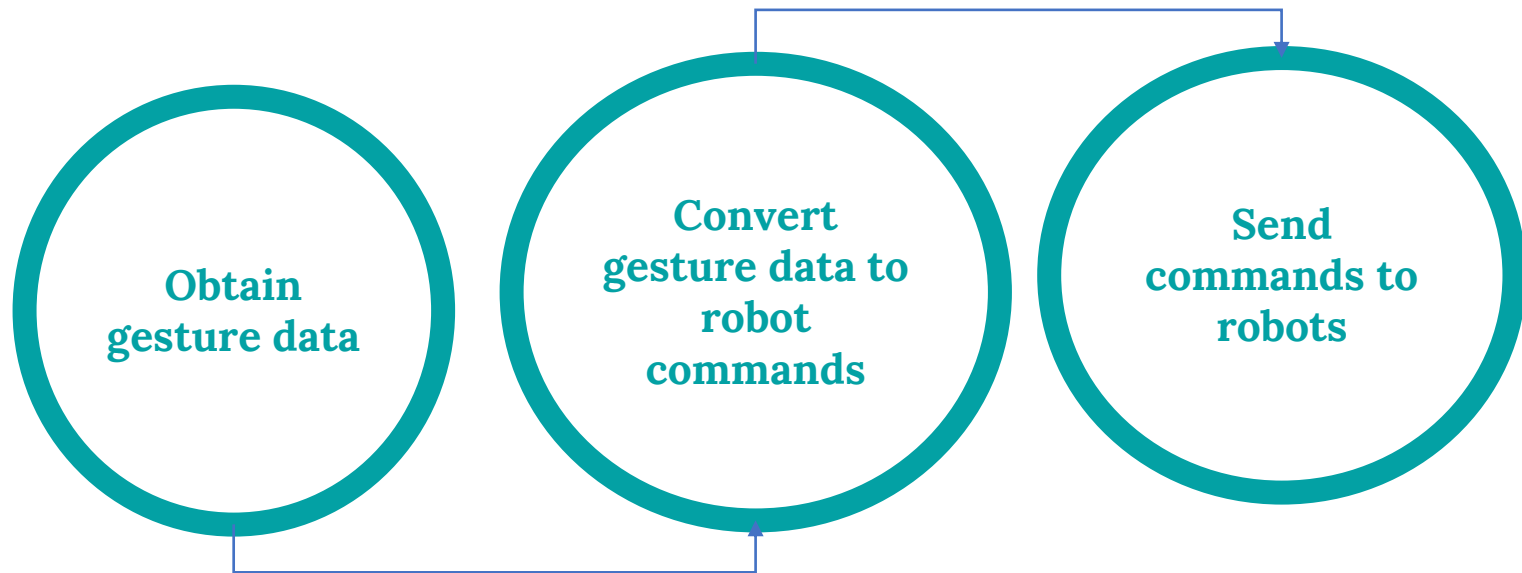
Intuitive
communication
method



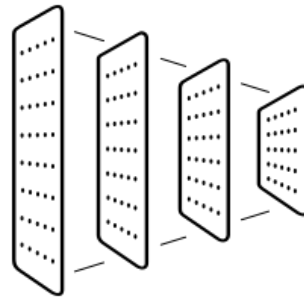
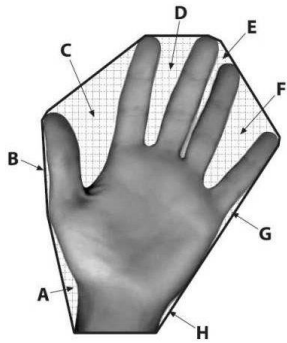
WHY
3

To allow both human
operators and robots to
communicate with each
other in a more natural
way and increase in
speed and efficiency in
completing a task.

System design



Gesture recognition

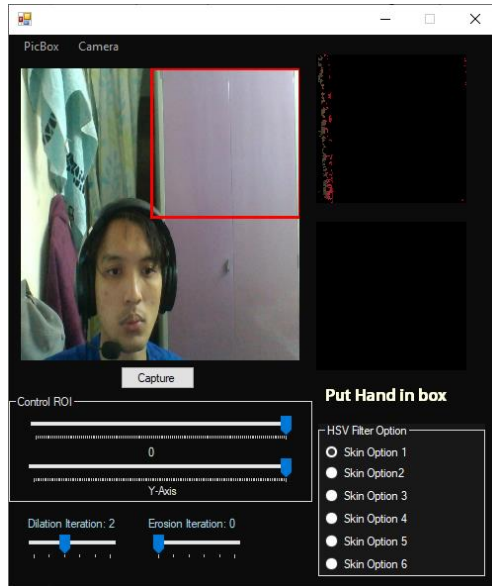


1. Convex hull
algorithm

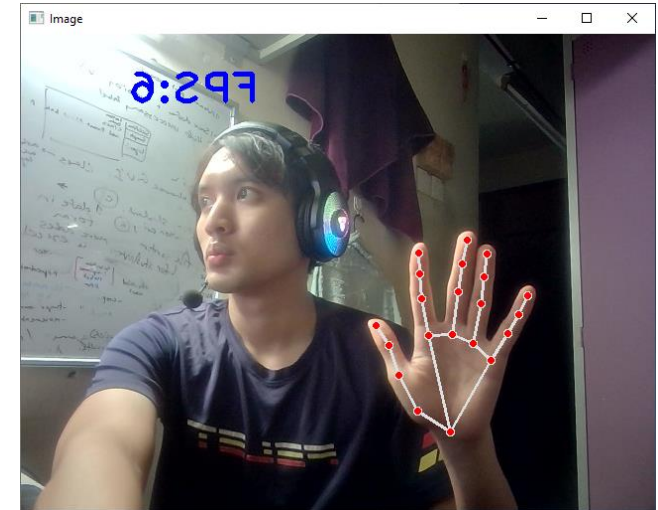
2. CNN



Interface for Gesture recognition



**1. Convex hull
algorithm**

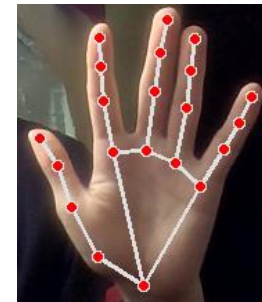


**2. Deep-learning
framework**

Gesture Recognition: Deep-learning framework



Developed in Python
Environment

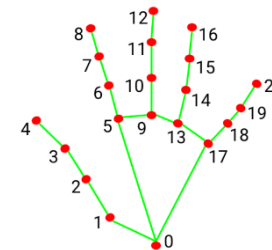


Joints detected from
the framework



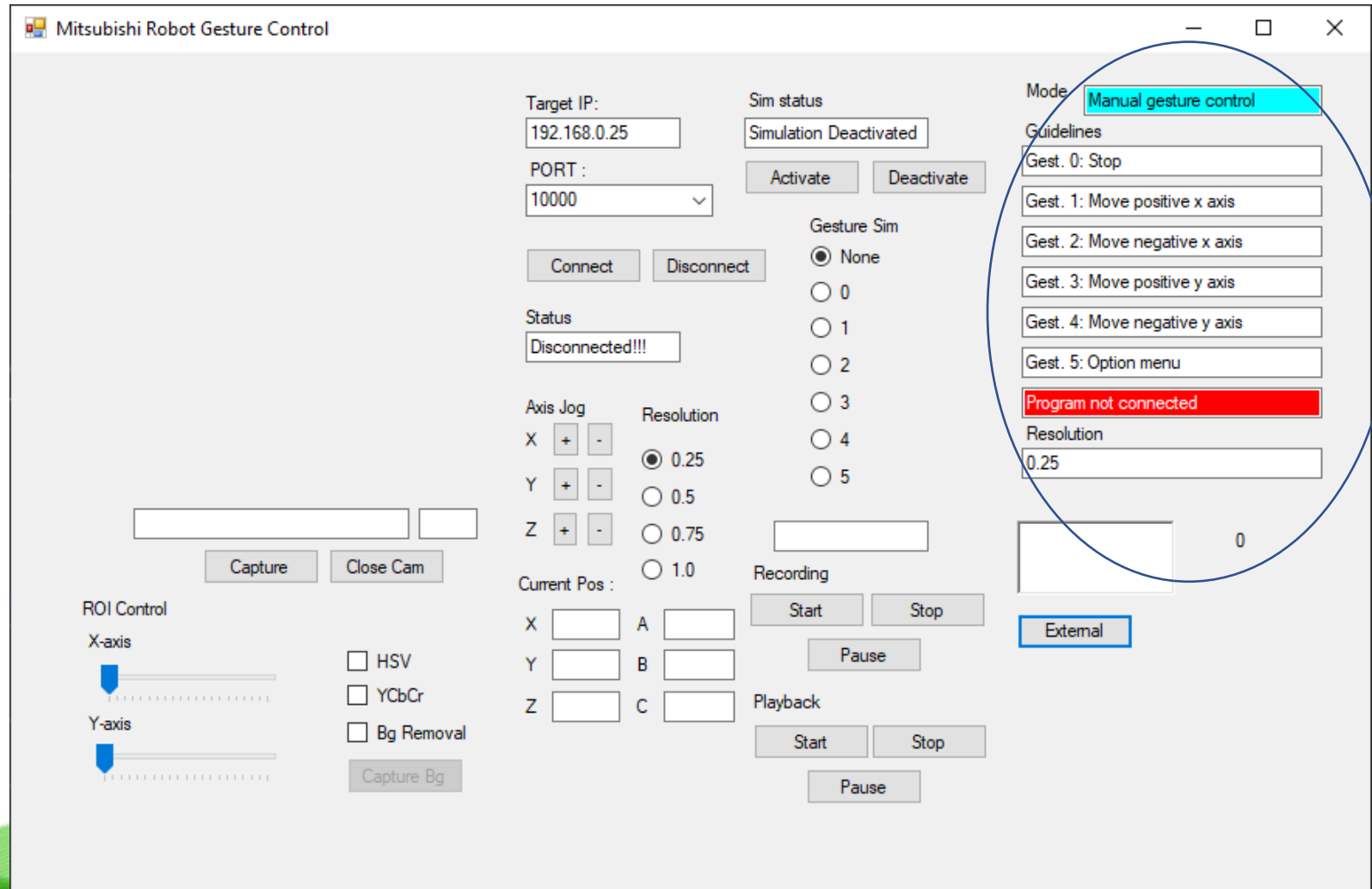
MediaPipe

Using Mediapipe deep-
learning framework



Joints labels

Final GUI design



Experiment 1: System consistency

- Each gestures was shown for 30 seconds.
- Correct gesture detections within 30s period were recorded.

$$Accuracy = 1 - \frac{30 - \text{Correct gesture detection period}(s)}{30} \times 100$$

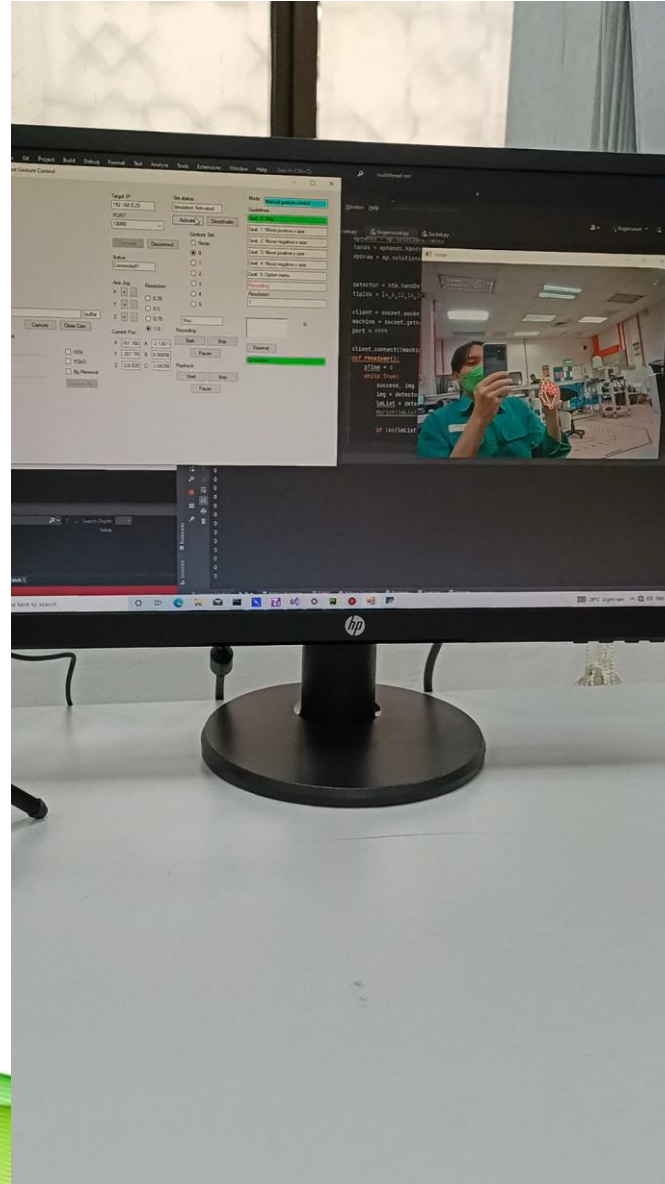
No. of fingers shown (n)	Correct gesture detection period (s)	Accuracy (%)
0	30	100.0
1	30	100.0
2	30	100.0
3	30	100.0
4	30	100.0
5	30	100.0

Experiment 2 : System reliability

- Cycle of gestures from 0 to 6 were repeated for 40 times.
 - First detection were recorded.

		Predicted Gestures						
		0	1	2	3	4	5	
Actual Gestures	0	40	0	0	0	0	0	
	1	0	39	0	0	0	0	
	2	0	1	40	2	0	0	
	3	0	0	0	38	0	0	
	4	0	0	0	0	40	0	
	5	0	0	0	0	0	40	

Experimental demonstration



Thank You.