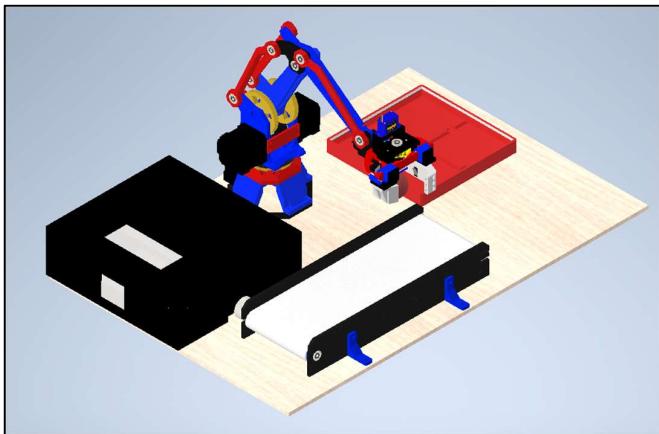


# User Manual

## Choco-Bot v7.4



7<sup>th</sup> Semester – Robotics I  
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## Parts of the Machine

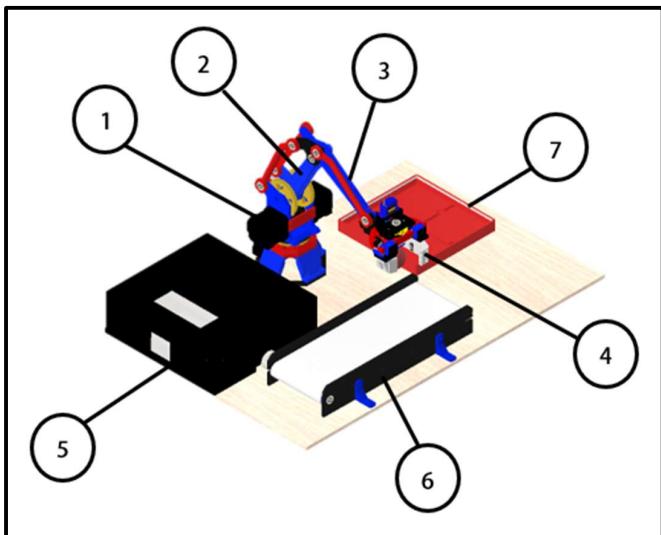


Fig. 1: Parts that compose Choco-Bot v7.4

1. Robot base
2. Robot arm
3. Robot forearm
4. Robot gripper
5. Component enclosure
6. Conveyor belt
7. Chocolate package

## Technical Specifications

### Overall:

- Input voltage: 110 V
- Current: 10 A
- Power: 60 W

### Robot Technical Specifications

- Supply voltage: 12 V
- Microcontroller: Arduino MEGA
- HM communication: Via infrared (IR)
- LCD communication: I2C serial

### Movement:

- Base, arm, forearm, and conveyor: NEMA-17 bipolar stepper motors
- Gripper: 360-degree, SG-90 servomotor
- A4988 drivers (for stepper motors)

## Using Choco-Bot v7.4

The robot is controlled by means of a remote control, which sends instructions to the microcontroller via IR.



Fig. 2: Control used to manipulate Choco-Bot v7.4

- Numbers 1-5: Option selection.
- PREV: Return to previous menu.
- CH-, CH+: Change input mode during manual control.
- CH, EQ: Change step in manual control input.
- PLAY/PAUSE: Confirm value.
- +, -: Increase/decrease value in manual control.

Note: All buttons are depicted in a more detailed way during the interface explanation for the user.

## Choco-Bot v7.4 Interface

Choco-Bot v7.4 has a developed interface so the user can control the robot with total freedom without any complication:

This interface divides the control of Choco-Bot v7.4 in two different ways: automatic control and manual control. The user can select whichever of the control options by pressing the corresponding button in the remote control.

(E.g.: To select automatic control the user has to press button (1).  
The same principle applies in all of Choco-Bot v7.4 menus.)

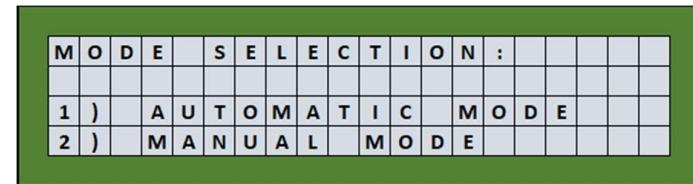


Fig. 3: Mode selection menu

When the user selects an option (either automatic or manual), it is allowed to return to the mode selection menu by pressing the PREV button in the remote control.

## Automatic Mode

In this mode, the user has 3 principal options:

1. Start the routine
2. Actual session stats checking
3. Auto-home function

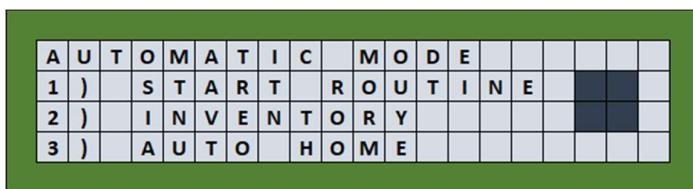


Fig. 4: Automatic mode menu

### Start Routine:

If the user selects this option, Choco-Bot v7.4 will start its purpose: pack a chocolate box.

The chocolate is deposited in the conveyor belt, so it can be moved automatically to a specific position so the robot can pick it up.

The robot will deliver the chocolate to a preset position and repeat the same process for the

remaining chocolates, until the 2x2 box is fully completed.

Before starting this process, the robot will automatically perform an auto-homing function.

Also, the user can visualize which chocolate has been placed by Choco-Bot v7.4 in the screen (in Fig. 4, dark gray squares).

After the box is completely filled, the robot will return to the home position to be ready for the next chocolates to be packaged.

### Inventory

In this screen the user can see how many chocolates have been packaged and how many boxes have been completed.

ACTUAL SESSION STATS
CHOCOLATES :
BOXES :

Fig. 5: Actual session stats (Inventory) information screen

## Auto Home

Auto-home option will open the Choco-Bot v7.4 gripper and also will set all the angles (base, arm, forearm) to 90 degrees.

## Manual Mode

In this mode the user can do three things:

1. Move and control the arm.
2. Open and close the gripper.
3. Move the conveyor motor.

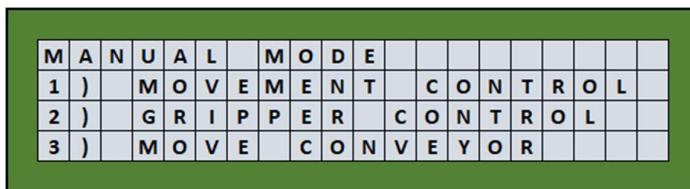


Fig. 6: Manual mode menu

## Movement Control

Choco-Bot v7.4 offers the user to control the robot by using two different types of inputs:

- Angle input (Forward kinematics)
- Coordinate input (Inverse kinematics)

By default, when Choco-Bot v7.4 starts, it will show the user the angle input. The user can change to the coordinate input by pressing the CH+ button in the remote and return to the angle input by pressing the CH- button.

## Angle Input Control

This is the mode that is set by default in Choco-Bot v7.4 programming, so it will be shown any time the machine is turned on.

This mode allows the user to control the angles of the links in the robot, by changing the values to move the base, arm, and forearm motors.

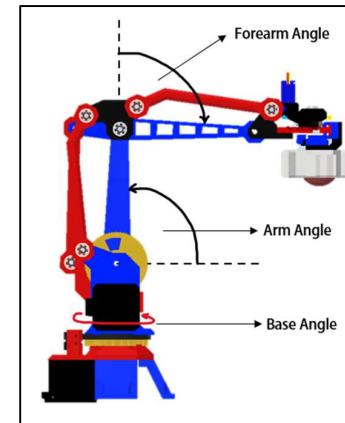


Fig. 7: Angles in Choco-Bot v7.4

In order to control these angles, the user has to select one of the options (1-3) to change the angle value.

1 )	B	A	S	E	A	N	G	L	E	\$	\$	\$	
2 )	A	R	M		A	N	G	L	E	\$	\$	\$	
3 )	F	O	R	E	A	R	M	A	N	G	L	E	
4 )	S	T	A	R	T	M	O	V	E	M	E	N	T

Fig. 8: Angle input control (forward kinematics method)

To change the value of the selected angle, the user has to press the + or – buttons, either to increase or decrease the angle value in one degree. When an option is selected in the bottom right corner a ! will be printed.

To confirm the value, the user has to press the PLAY/PAUSE button on the remote control, and Choco-Bot v7.4 will save the desired value.

When all the values are the ones desired, the user can press the button 4 on the remote to start the movement of the arm.

## Coordinate Input Control

Choco-Bot v7.4 also allows the user to introduce coordinates as inputs to control the movement of the robot.

The principle to input the coordinates is the same as in the angle input, but with some slight differences.

1 )	C	O	O	R	.	X	\$	\$	\$				
2 )	C	O	O	R	.	Y	\$	\$	\$				
3 )	C	O	O	R	.	Z	\$	\$	\$				
4 )	S	T	A	R	T	M	O	V	E	M	E	N	T

Fig. 9: Coordinate input control (inverse kinematics method)

Coordinate input will affect all of the angles in the robot, so when the user confirms a coordinate set, Choco-Bot v7.4 will move every motor to achieve the desired position.

This method is a little bit more precise than the previous one, as it has two different options for steps. The user can modify the coordinate either by 1 or 0.01 to obtain decimal values.

The default step is of 1, but the user can change to the 0.01 step by pressing the CH button on the remote control. To return to the step of 1, the user has to press the EQ button on the control. An indicator (.) in the bottom right corner will appear if the selected step is of 0.01.

It is important to state the direction of the positive X, Y and Z axes of Choco-Bot v7.4 so the user may input the correct values. The directions of the axes are shown in Fig. 10, when the robot is at home position:

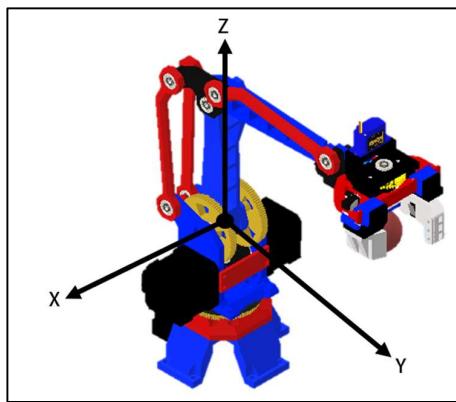


Fig. 10: Coordinate axis of Choco-Bot v7.4 when is set in home position

To make an example, if the user wants to move the gripper to the packaging box (see Fig. 1), the

coordinate in X must be negative, and in Y positive because of the positions.

The Z coordinate works in a slightly different way. It refers to the position of the gripper respect to the reference point, which is the joint of the base and the arm. This means that, for example to pick a chocolate, the user has to input negative values in Z.

If Choco-Bot v7.4 detects an unreachable position and the user wants to move the gripper to that point, the message in Fig. 11 will be displayed in the interface for 3 seconds.

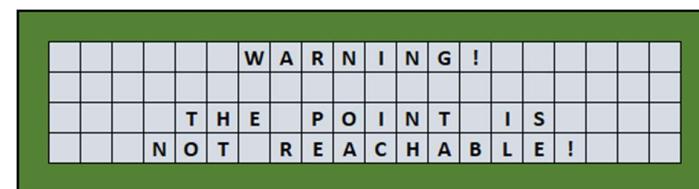


Fig. 11: Unreachable point warning message for coordinate input

By this mean, Choco-Bot v7.4 is protected from going to unwanted positions and damage itself in the process.

## Kinematics Information

In any type of movement input (either angles or coordinates), if the user presses the button 5, the information about the exact position of the robot will be displayed on the screen as shown in Fig. 12.

K I N E M A T I C S				I N F O		
P O S .	X :	\$ \$ \$ \$ \$		%	%	%
P O S .	Y :	\$ \$ \$ \$ \$		%	%	%
P O S .	Z :	\$ \$ \$ \$ \$		%	%	%

Fig. 12: Kinematic info screen. \$ represents coordinates and % angles.

By looking at this information the user can check the position of the robot in coordinates (left values), and also know the values of each of the angles in that specific position (right values).

## Gripper Control

The control of the gripper is quite simple. It has just two options, to open the gripper and to close it (check Fig. 13).

Is it important to note that in order to close the gripper, there must be an object underneath the

gripper itself, otherwise, Choco-Bot v7.4 will fail, because of its design.

G R I P P E R		C O N T R O L		
1 )	O P E N	G R I P P E R		
2 )	C L O S E	G R I P P E R		

Fig. 13: Gripper control menu

## Conveyor Movement

The option of the conveyor movement is the simplest among all the options in the interface.

Whenever the user presses the button to activate the conveyor movement it will just rotate the conveyor motor to translate the chocolate underneath the gripper.