Lesson 3 The Magic "Hand"

Scene lead-in

At the container terminal, staff transfers containers from ship to dock in an orderly manner. Thousands of pounds or even tons of containers are very "obedient" under staff control. Why? Using handling equipment such as cranes, containers can be easily lifted and transferred to the designated location or transportation machine. So, how does the staff operate the equipment and transfer containers to the designated locations?

Loading and Unloading of Containers

Watch this video and think about how the staff operates the equipment and what devices they use to lift and transfer containers.

https://www.youtube.com/watch?v=2t2cqiQl0BE

Technology knowledge center:

Large equipment controlled by a small handle

Game equipment, wheelchairs, plant trimming machinery, forklifts, heavy machinery, lifting machinery, F-15 jet fighters… all of these pieces of equipment have a device with the same function - operating lever. Using the small operating lever, operators can use both hands to control equipment ranging from game consoles to fighters to perform various actions.

The operating lever is a physical device that converts the motion of a plastic rod into electronic data that can be handled by a computer.

There are many kinds of operating levers; for example, handles. The basic operation principle of various operating levers is approximately the same. They differ mainly as concerns the amount of data transmitted.

Creative design

When the magic handle is used together with the gripper, an extension of human hands, it becomes incredibly skillful. But how can you master this ability? Next, we will go through two activities to learn about the functions of the gripper and handle. During the activity, please think about how to use these tools in our daily life.

Project practice I: Solving the Tower of Hanoi problem using a gripper

Project requirement: Solving the Tower of Hanoi using a gripper kit of the robotic arm.

Project score: The fewer steps taken, the higher the score is.

1 Tower of Hanoi

Tower of Hanoi is an educational toy originated from an ancient Indian legend. When Grand Brahma created the world, he made three diamond pillars and stacked 64 gold discs in order of size from bottom to top on one pillar. Grand Brahma ordered Brahmans to rearrange the discs on another pillar in order of size from below, and stipulated that no large discs can be placed on the small discs, and only one disc can be moved between the three pillars at a time.

How can we solve the Tower of Hanoi problem and how can we accomplish the goal in minimum steps?

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2. Installation of gripper kit

2) Assembly of air pump box and robotic arm

3) Assembly of gripper and robotic arm

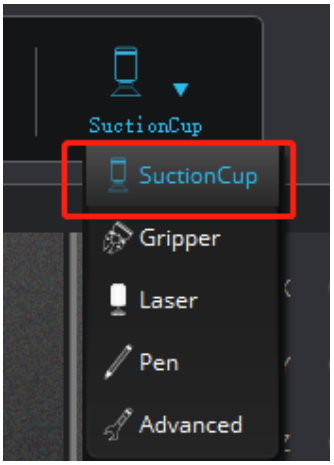
Tighten the gripper kit to the end socket of the robotic arm by means of a butterfly nut, as shown in the following figure.

3) Connection between air pump and gripper

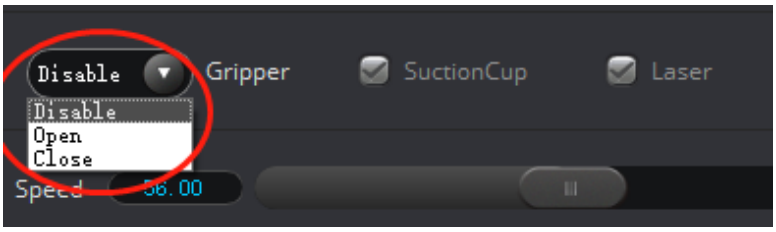
Connect the air pipe of the air pump box to the air pipe joint of the gripper, as shown in the following figure.

4) Connect the Joint4 servo wire GP3 to the little arm interface GP3, as shown in the following figure. Then, installation of the gripper kit system is completed.

2) Set the end clamp as the "Gripper" through the Tools option menu on the main panel, as shown in the following figure.



Open the gripper drop-down list, select the "Open" and "Close" options respectively, and then the air pump will work and drive the gripper to open and close, thus completing the grasping action.



Each group operates the mouse to perform single axis control and gripper control, and to solve the Tower of Hanoi problem on the computer desk. To reduce the difficulty of the game, we select 5 discs.

1) The teacher acts as a referee to record the number of steps required for each group to successfully move the discs as required, and the group with the fewest number of steps shall win the game.

Group	Number of steps
1	
2	
3	
4	
5	
6	

4) The winning group introduces its operation steps and design ideas.

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3) Each group thinks about whether there are any other ways of solving the problem by taking fewer steps.

Technology knowledge center:

Mathematics principles in solving the Tower of Hanoi problem

How many times do you need to stack 64 discs in order again?

Assume that the number of discs is n and the times of motion is f (n),

When n = 1, f (n) = 1; when n = 2, f (n) = 3; when n = 3, f (n) = 7.

When n = 4, f (n) = f (n-1) + 1 + f (n-1) = 2f (n-1) + 1 = 15, then f (n) = 2 * f (n-1) + 1 = 2^n-1,

That is, when n = 64, f (n) = 2^{64} - 1 = 18446744073709551615.

Therefore, it requires at least 18446744073709551615 times of motion to correctly stack the 64 discs again.

Project practice II: Chess game with robotic arm

Project requirement: Control the robotic arm to play a chess game.

Project score: The winner of the chess game shall be the final winner.

The handle kit contains the controller and USB Host module. Before the robotic arm are powered, connect the USB Host module to the communication port 10 pin under the robotic arm base.

2) Connection mode

The controller kit uses wireless connection mode, and the schematic diagram for connection is as follows.

After installment is completed in wireless mode, insert and turn on the main power of the robotic arm. At this time, the green light of the controller module lights up and 4 short sounds can be heard, indicating the completion of initialization. Start the controller by pressing the Home key and the A key at the same time.

Note: The controller is used offline and needs to be disconnected from the computer before use.

3) Hand controller modes

There are generally two control modes for Dobot control by hand controller and software: linear coordinate system mode and Jog mode (single axis mode). The two modes can be switched using the L1/R1 keys on the controller (L1 and R1 represent Jog mode and coordinate system mode respectively). The control mode is specified in the following table.

4) Linear coordinate system mode

Function		Corresponding keys
Starting the controller		Simultaneously press the Home key and the A key for about 2 s.

Closing the controller		Press the Home key for about 2 s.
Robotic arm X+/X-		Frontward/Backward motion of left lever
Robotic arm Y+/Y-		Left/Right motion of left lever
Robotic arm Z+/Z-		Frontward/Backward motion of right lever
Joint4 servo rotation R+/R-		Left/Right motion of right lever
Suction cup ON		X-key
Gripper ON		Y key
Release suction cup/gripper		B key

5) Jog mode (single axis mode)

Function	Corresponding keys
Starting the controller	Simultaneously press the Home key and the A key for about 3 s.
Closing the controller	Press the Home key for about 3 s.
Robotic arm Joint1+/Joint1-	Frontward/Backward motion of left lever
Robotic arm Joint2+/Joint2-	Left/Right motion of left lever
Robotic arm Joint3+/Joint3-	Frontward/Backward motion of right lever
Joint4 servo rotation R+/R-	Left/Right motion of right lever
Suction cup ON	X-key
Gripper ON	Y key
Release suction cup/gripper	B key

Respectively practice the two handle control modes and control the gripper to grip chess pieces. After a simple practice, select the mode with which you are more skilled for the match.

1) The match is played by groups, with two forming a team to play the chess game.

2) The two sides will assign tasks to their respective group members and these two act as the intelligence group and operation group respectively.

Both sides	Intelligence group	Operation group
Black		
White		

3) The teacher will be the referee to preside over the chess match and record the final result.

Knowledge sharing

Summarize and reflect on problems encountered in the match and how to cope with them. Sort out knowledge gained through this lesson and your reflections.

	Solving the Tower of Hanoi problem	Chess match
Result		
Problems encountered during the match		
Reflections on the operation during match		
Gains and reflections		

Comprehensive evaluation

Evaluation method	**Evaluation phase**	**Evaluation contents**	**Evaluation criteria**		
			3 Excellent	**2 Good**	**1 General**
Self-evaluation	**Scene creation lead-in**	• Understand the role of the robotic arm in container transportation.			
	Creativity	• Be able to design a scientific and reasonable building brick arrangement mode.			
	Ability to solve problems	• Be able to operate the robotic arm and complete the match according to requirements.			
	Engagement	• Actively participate in group activities and undertake one's group tasks.			
	Team collaboration	• Be able to cooperate with each other in the match.			

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Fax : 04 77 94 55 14
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