Lesson 10 Domino

Scene lead-in

A domino is a rectangular toy made of wood, bone, or plastic. In the video, 275,000 dominoes were pulled down in turn after the first domino was pulled down, and the scene was spectacular. During placing, dominoes will be pulled down again and again by accident, and participants always face a hit from the failure. It not only tests physical power, endurance and willpower, but also develop intelligence, imagination and creativity. Next, let's get together to understand the domino, and face the challenge of how to use machines to place dominoes!

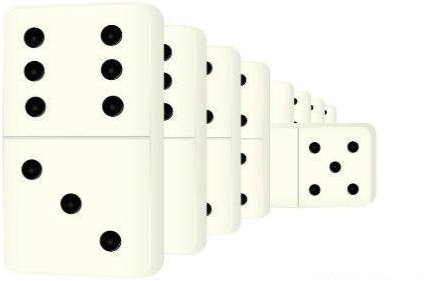
Watch the video and think about it. What are some characteristics of the placement of dominoes?

https://www.youtube.com/watch?v=n9vHtXpygfE

Technology knowledge center

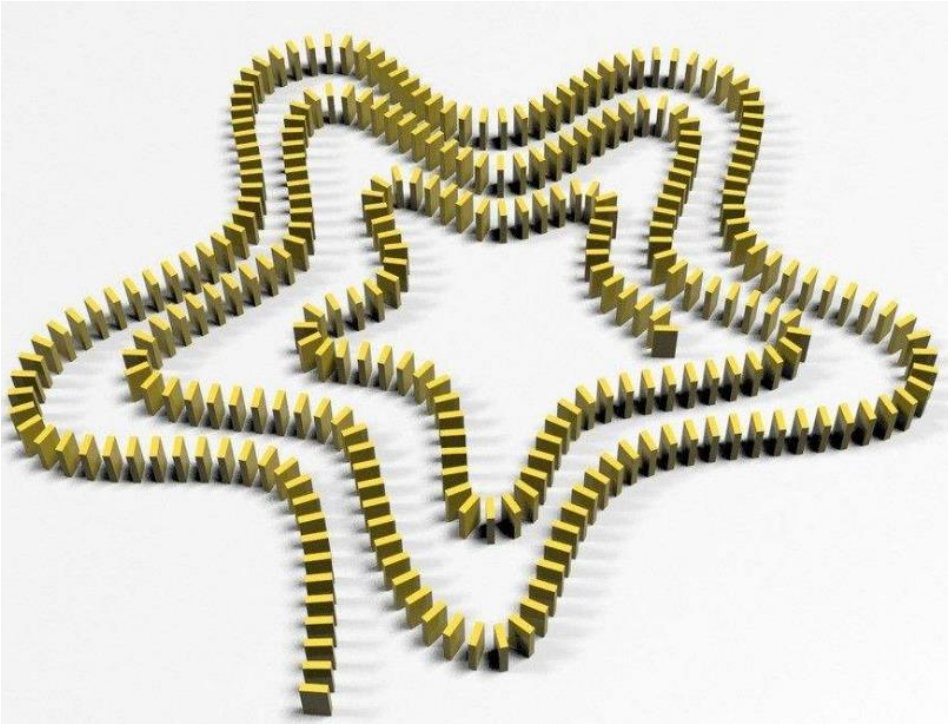
◎ The origin of dominoes

Domino is actually originated from the ancient Chinese "Pai Gow". After it was spread to Italy in the 19th century, people could use the points on it to do some jigsaw puzzles. Later, an Italian named Domino curiously arranged the dominoes vertically, and then the domino was gradually developed into its current form. Now, domino has become a worldwide sport. Out of the non-Olympic sports, it is the sport with the highest popularity, the largest number of participants, and the largest geographical spread.



◎ The rules of the domino game

The rules of the domino game are very simple. To be specific, arrange the dominoes in a single row or rows with a certain dimension of spacing. If the first domino is pulled down, the rest of the dominoes will fall one by one due to the chain reaction. Sometimes, it forms a long dragon or a pattern, and the sound of dominoes impacting is clear and melodic.



The original playing method of dominoes is just linear, to race who can knock down more and further. After that, dominoes began to develop from the line to the plane, and people began to use dominoes to form some characters and patterns. Domino was further developed towards the three-dimensional level, and applied high-tech achievements, with the effect of sound, light and electricity, so that the transmission of power of dominoes has a variety of forms. At the same time, its artistry has also increased.

◎ Domino effect

In an interconnected system, a small initial energy can produce a series of chain reactions, which is known as the "domino effect".

Activity: manual domino building experience

Try to do: Try to set up a "straight" domino structure with 15 dominoes, and the top view (partial) of domino shape is as follows, which requires uniform spacing and placement.

Think about it: What conditions should be met for the distance between the dominoes and the size of dominoes respectively if you want all the dominoes to be pulled down?

_____

_____

Creative design

Students should be able to realize that it is not easy to set up such projects accurately, steadily and quickly by artificially setting up dominoes. If we can use the machine to set up by moving dominoes precisely and steadily, we shall not have to worry about all kinds of accidents.

Project practice: building of dominoes with robotic arm

Project requirements: Build dominoes with robotic arm through DOBOT Blockly programming

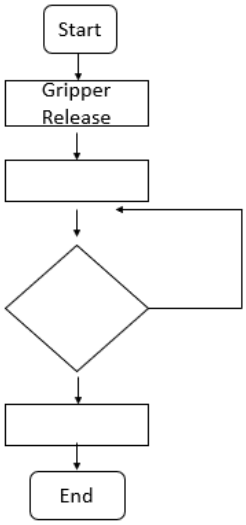
Project score:

- Project completeness (70%)
- Project completion time (15%)
- Independent study and team cooperation (15%)

We can let the robotic arm build dominoes automatically with the gripper kit if a program for gripping and placing dominoes is compiled. Next, we will try to build dominoes with the robotic arm.

1 Drawing of the program implementation flow chart

Which actions and steps do you need to build dominoes by controlling the robotic arm with a program? Please complete the flow chart below.



2 Main operation steps

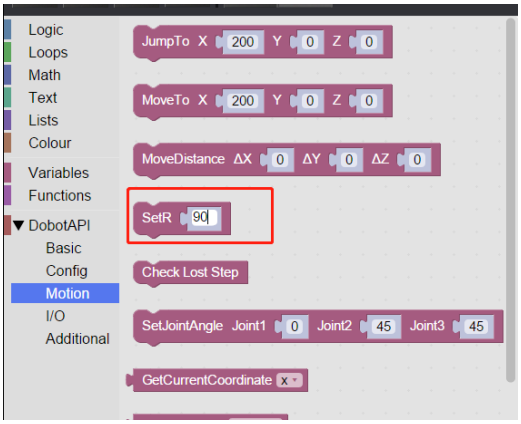
1) Gripping way of gripper and locating place of dominoes

How does the robotic arm grip and move dominoes to ensure they will not be touched by mistake during construction?

Grip the upper narrow edge of vertically placed dominoes. In this case, the opening and closing of the gripper will not affect the front and rear dominoes. Dominoes at the domino storage point and the domino building point shall be placed in the same orientation to facilitate the clamping and placing of dominoes, as shown in the following figure.

As shown in the following figure, select the DobotAPI motion classification and set the end angle module to 90°

during program compilation.



2) Fixation mode of dominoes at domino storage point

How can the robotic arm accurately grip the dominoes every time?

Place a device for fixing the dominoes at the domino storage point, as shown in the following figure. In this way, the dominoes can be vertically and neatly placed in a fixed position. When the program is repeatedly used, the dominoes can be gripped in the same place without adjusting their storage position.

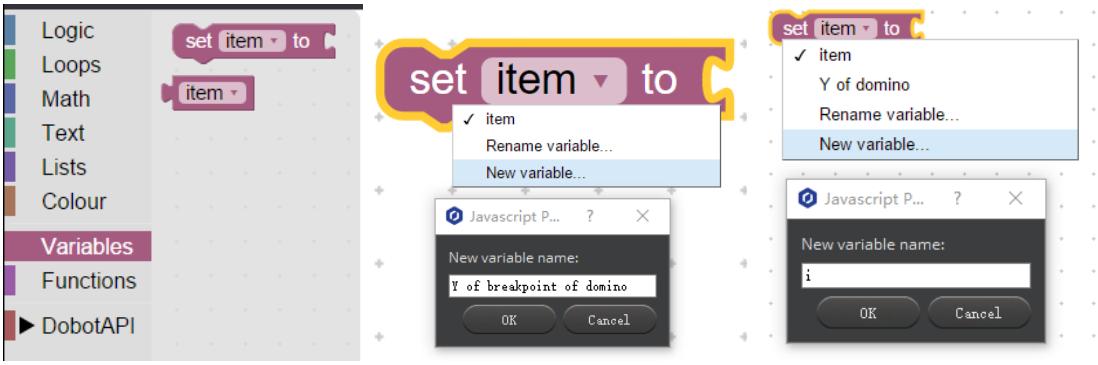
3) Gripping of dominoes by moving to the domino storage point

How can the robotic arm grip the dominoes successively at regular intervals every time?

At the domino storage point, the coordinate values of a row of dominoes show the law of equal difference, with a distance interval of one domino thickness, so the Y-axis coordinate value where the robotic arm grips the dominoes can only be changed; namely, the thickness of a domino can be added (gripping from right to left) or subtracted (gripping from left to right) from the previous one. The specific implementation process is as follows:

The Y coordinate of the target point is constantly changing, and we can introduce a variable to correspond to the Y coordinate, where the assignment module in the variable classification is required.

Select a new variable from the drop-down list of the assignment module and enter the variable name "Y coordinate of domino gripping" (feel free to name the variable yourself). As the Y coordinate shows the law of equal difference with the gripping times, a new variable i needs to be introduced to indicate running times, so as to calculate the "Y coordinate of domino gripping" each time, as shown in the following figure.



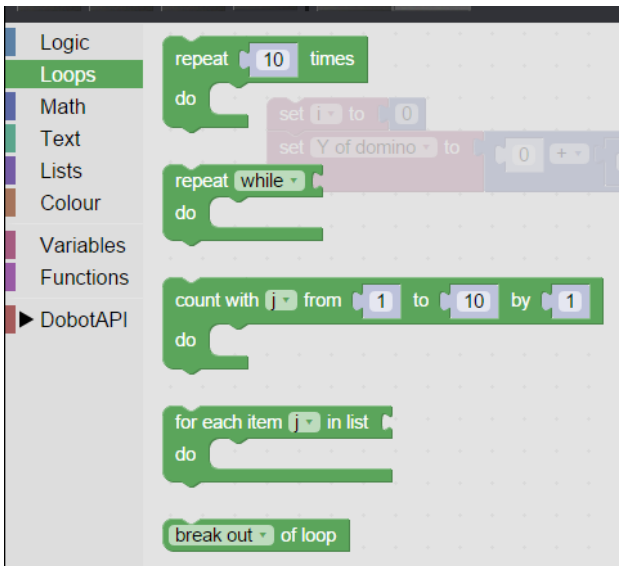
Assign the variable i. Pull out the first digital module from the mathematical classification to connect thereafter and enter 0 in the input box to assign it, as shown in the following figure.

Assign the "Y coordinate of domino gripping" through the second calculation module. Set the Y value of the first domino gripped as 0 and grip dominoes from right to left, namely the Y value is increased by one domino thickness (7 mm) each time. It can be seen that the calculation formula is the initial Y coordinate 0 plus the difference of 7 for each change, so the implementation is as shown in the following figure.

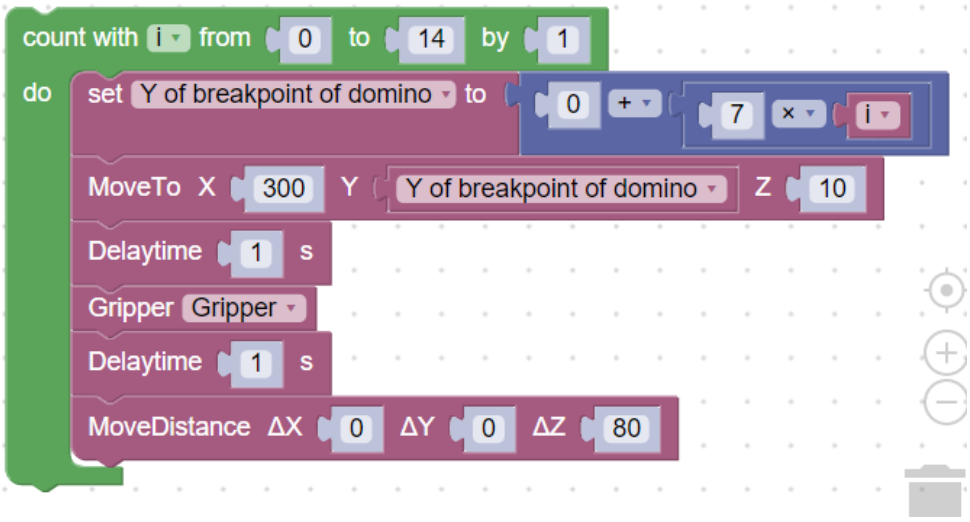
4) Circulating gripping of dominoes

How can the robotic arm grip dominoes repetitively at regular intervals?

Use loop modules - step size loop modules, as shown in the following figure.



The use method is to select the variable i, just defined through the drop-down list, and set the range according to the number of times the dominoes need to be gripped. If we need to build 15 dominoes, set the range from 0 to 14 and fill in 1 after "every interval". The value of i will increase by 1 in turn from 0 to 14 in the circulation. The program is to be executed circularly (namely the corresponding action of gripping dominoes) is pulled into in the execution box, and then once per cycle every specified step size within this range can be taken, and the cycle ends after completing the step size within the range, as shown in the following example.



Design principles of some programming for placing dominoes is accomplished by using variable increments and a cycle module with specified step size.

It shall be noted whether the set coordinate position is within the travel range of the robotic arm during the programming; if not, the program will not run normally.

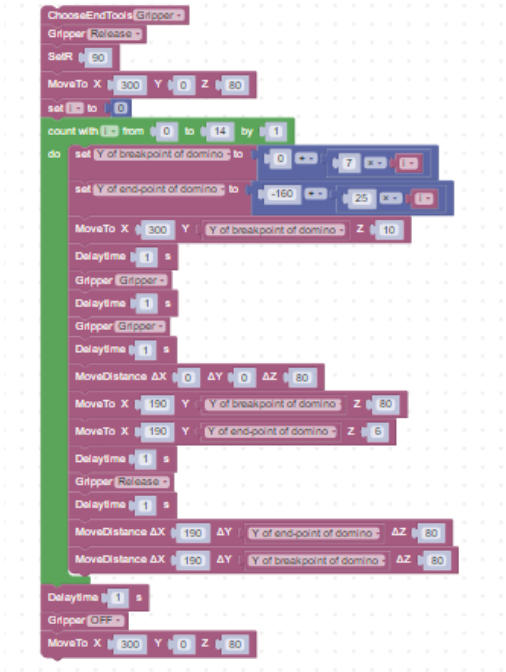
5) Movement mode of the robotic arm

Which way does the robotic arm move in the process of gripping and placing the dominoes?

A door-type movement mode can be adopted, namely moving step by step through the "movement to point" module. The door-type moving points can be treated as separate statements by using multiple "moving to point" modules, so that the robotic arm moves point by point according to the door-type movement mode, thus avoiding the end clamp returning to zero while also achieving the door-type movement of the robotic arm. The program is shown below.

3 Program for building dominoes with the robotic arm

How should a complete program be written? Try to compile a complete program for the building of dominoes with the robotic arm, with reference to the following example.



Organize all groups to participate in the competition concerning building of dominoes, try to build a "single line" structure with 15 dominoes using the robotic arm, set the interval between each domino freely and require all dominoes to fall down at the end.

1) Record the competition completion time of all groups and select the first group in the class to complete the building.

Group	Time
1	
2	

3	
4	
5	
6	

2) How long does it take for 15 dominoes to fall in turn? What if it's 30, 45 … dominoes? Please find out the relationship through the experiment and analyze the reasons. Experimental error can be reduced by strictly controlling the distance between the dominoes with the robotic arm.

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3)What kind of kit can be used besides the gripper in the process of building dominoes? What are the advantages and disadvantages compared with the gripper kit?

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Knowledge sharing

Summarize and reflect on any problems encountered during the competition and how best to cope with them. Sort out knowledge gained through this lesson and your reflections.

Group	
Result	
Problems encountered during the competition	
Reflection on operation during the competition	
Summary of learning gains and thoughts	

Comprehensive evaluation:

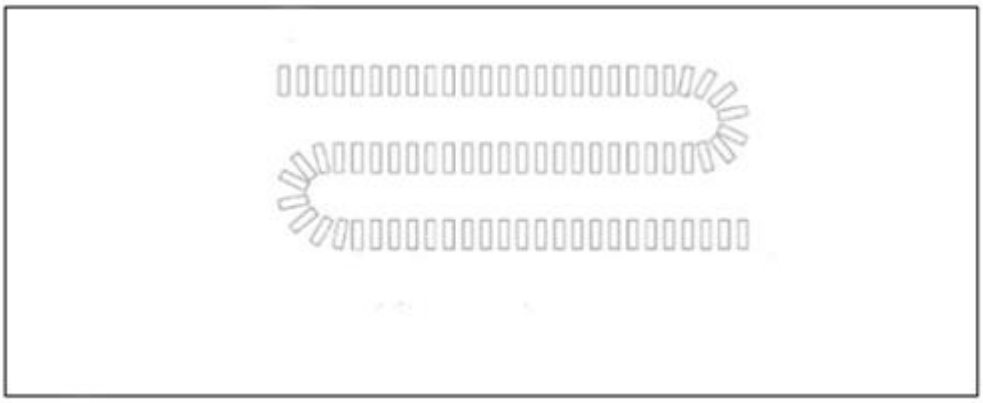
Evaluation method	Evaluation phase	Evaluation contents	Evaluation criteria		
			3 Excellent	2 Good	1 General
Self-evaluation	**Scene lead-in**	• Understand the origin and basic rules of dominoes.			
	Creativity	• Calculate scientific and reasonable dominoes interval.			
	Ability to solve problems	• Grip and move dominoes to successfully complete the competition by operating the robotic arm according to competition 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.			

Skills development: building of dominoes with more complex shapes

Review the dominoes with complex shapes and huge building work in the video from the first part of this lesson. We can find that the second, third and fourth...hundreds of thousands of dominoes fall in turn when the first domino falls, and there are various shapes and patterns.

Now, you have built straight dominoes and have some experience in building dominoes with the robotic arm. If more dominoes are used to build more complex shapes, how should we approach this? Next, each group will try to build more complex dominoes within the operable range of the robotic arm.

1 Design the domino shape the group wants to build.



Domino Shape Design

2 List the difficulties to be solved in building dominoes with the robotic arm; for example, the movement mode of the robotic arm, and discuss how to solve them.

3 Compile programs and test whether the dominoes with complex shapes can be built successfully.

If it is required to build dominoes with more complex shapes, set the corresponding angle of the J4 axis according to the end angle of module to place the dominoes and enter the corresponding angle in the input box.

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