Lesson 12 Vibrant Musical Sound

Scene lead-in

Music is one of humanity's natural hobbies and artistic pursuits. Since ancient times, philosophers have been very interested in how humans create and appreciate art.

Taryn Southern has released an album called "I AM AI" (I'm Artificial Intelligence), which is also the first album in the world created by AI. In creating this AI album, Southern used music-making software developed by a company called Amper Music. During the whole creation, Southern made only small contributions, for example, composing lyrics and vocal melody, while other tasks were completed through artificial intelligence. This simple and rough method seems to challenge the traditional creation approach of the music industry. Perhaps, in the future, humans will just need to enter a simple instruction, and an original song will be created by artificial intelligence immediately.

Activity: echo ranging

In movie and television works, we often find that there will be a series of echoes around the mountain when the leading actor shouts across the mountain. How does sound arise from transmission? What are the functions of echoes?

Conditions required for the production of sound: _____

Conditions required for the transmission of sound: _____

Speed of sound transmission:_____

Think about it. How do you measure the distance between your location and the opposite peak through echo? Talk about your thoughts.

Creative design

Project practice: music performer

Project requirements: Compile the playing program of *Two Tigers*, and control the robotic arm to play as per music score.

Project score: 1 Project completeness (70%)

https://www.youtube.com/watch?v=hgbA4jfDsVU

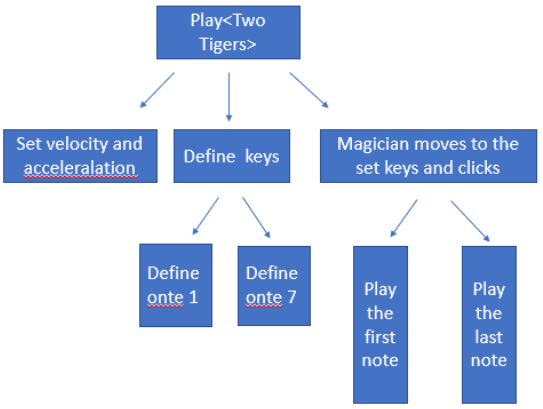
2 Project completion time (15%)

3 Independent study and team cooperation (15%)

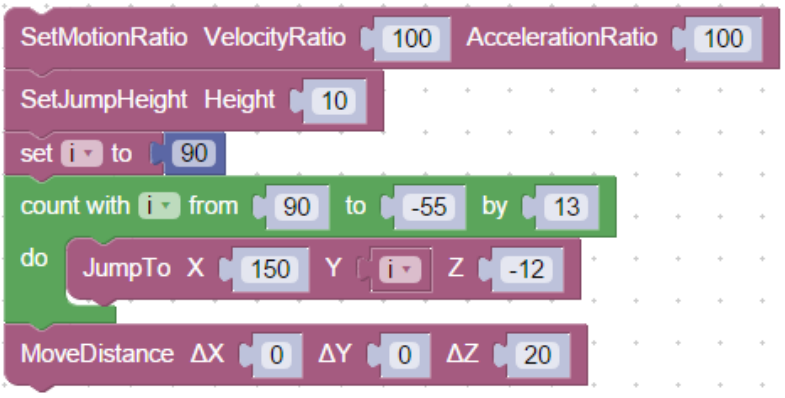
Nigel Stanford, a music artist in New Zealand, lets robotic arms become the leading actors in the MV of *Automatica*, and gives these robotic arms excellent and fluent playing skills through robot animation programming software. Whether it's a piano, a bass, a turntable or a synthesizer, these robot players can easily play it. (Scan the QR code on the right to watch this amazing performance by robotic arms!)

It is a very important way of thinking to divide the program into small parts and solve them one by one during programming. Top-down analysis is a common approach to analyze complex problems.
Through top-down analysis, a large and complex problem is divided into several relatively simple problems, the key points of each problem are found out, and the problem is described qualitatively and quantitatively by accurate thinking. The core essence of top-down analysis is "breaking it down".

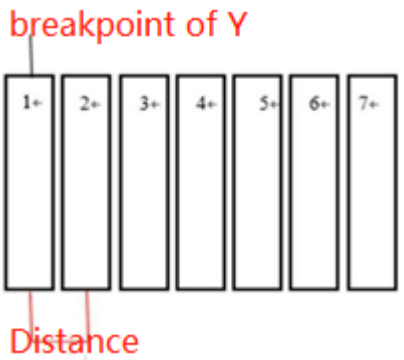
We can try to analyze the programming and playing methods of *Two Tigers* in a top-down way.



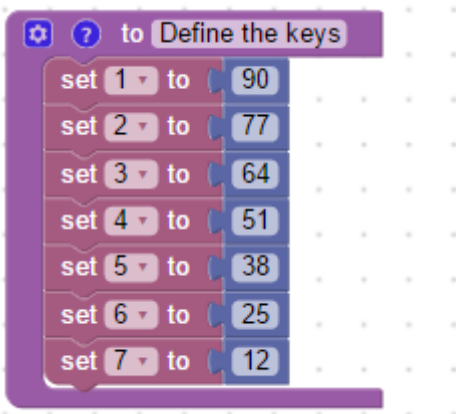
In order to make each hit of the robotic arm correspond to one key in turn, instead of touching the key next to it, we can quickly and conveniently conduct a test using the specified step size loop function. By changing the step size, the most suitable key interval is found, and the specific loop module is shown in the following figure:



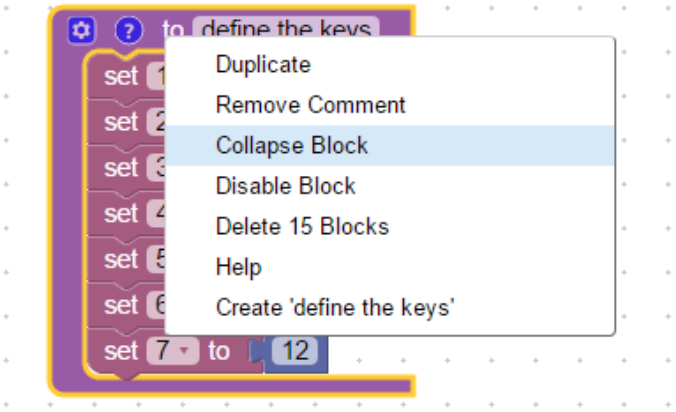
The optimum key interval found in this example is 13. Different optimum key intervals are found as per different placement positions and devices. The most suitable key interval can be found according to your own experimental results.



After the key interval is confirmed, define the key, namely, assign a Y coordinate corresponding to each key to the variable named with note according to the interval. For the sake of simplicity, we will only define seven variables, which are respectively named 1, 2, 3, 4, 5, 6 and 7, adjust the positions of the electronic organ and the robotic arm, find the Y coordinate most suitable for playing Note 1, then successively decrease the Y coordinate by 13 and assign them to the next six notes. Since there are many modules for defining the keys, a function named "Define Key" can be defined to collect these modules.



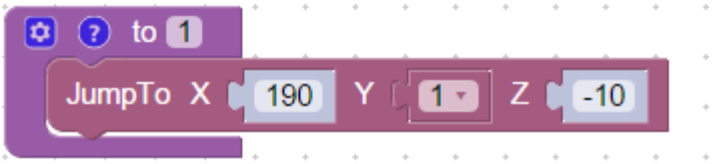
This function is still too long if used in the main program: at this moment, a new function - function folding- can be used. Click this function module on the right, and click the "Folding Block" to access the folding of function module, thereby, the position of one module will be displayed for a function. If a modification is required, the "Unfolding Block" is clicked again.



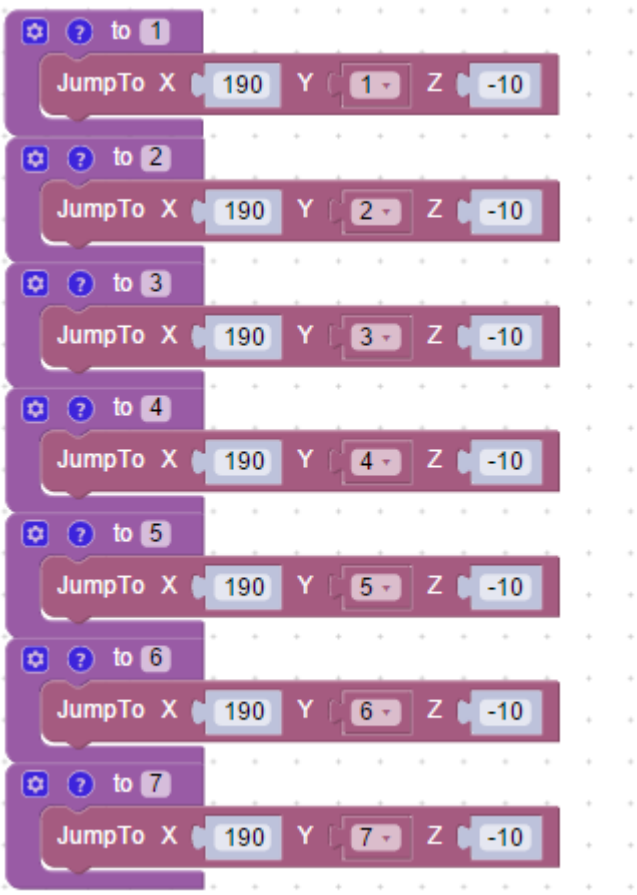
1 Definition of action of playing key

Through the "Define Key" function, the Y coordinate corresponding to each key has been assigned. To make the robotic arm move to the corresponding key and play through certain instructions, the XYZ coordinate corresponding to the key shall be indicated for the robotic arm, and a movement mode is set. The most suitable movement method for playing is door-type movement, so the programming example of movement to the first key and playing in door-type movement mode is as follows:

To facilitate access, simplicity and beauty, we define the functional module for playing Note 1 as a single function (named 1), and play Note 1:

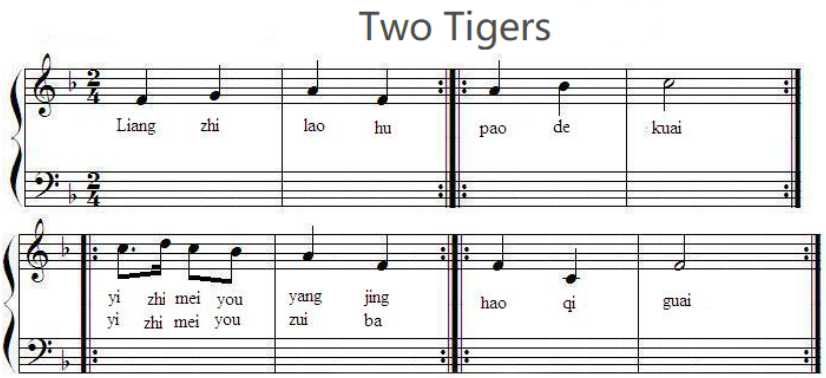


The functions for playing other notes are similar to that for playing Note 1, so the Y coordinate is changed into the corresponding note variable name in turn. The example of respectively defining the functions for playing 7 notes is shown in the following figure:



2 Definition of music score

When playing *Two Tigers*, the DOBOT magician defines the music score of this song as a function, uses "two tigers" (music name) to name this function and then pulls into the defined action functions for playing corresponding keys one by one, according to the musical score. The part between sections of the musical score or requiring two beats shall be properly delayed, to achieve a short pause and delay. In order to simplify procedures, the note for playing a half beat is not generated by changing the speed of the robotic arm temporarily, but is instead handled in one beat directly.



The above figures only show a portion of the “two tigers” function; please set up the complete function modules.

Finally, the defined function modules are spliced together, so that our robotic arms become the performers:

Knowledge sharing

1 In order to ensure a smooth performance, the optimum distance of the keys shall be tested accurately. What measuring tips do you have?

_____

2 Think about it. Can the robotic arm use point-to-point movement instead of door-type movement?

_____

3 How do you generate the note for playing a half beat by changing the speed of the robotic arm?

_____

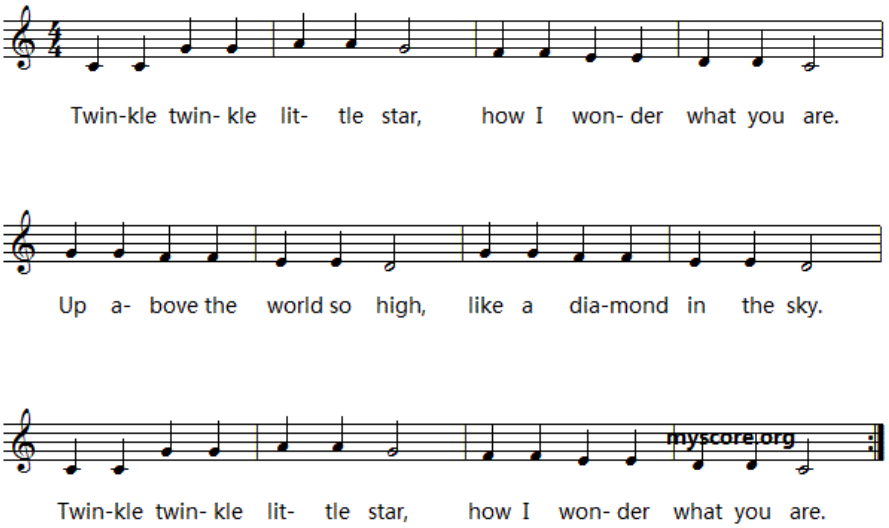
Comprehensive evaluation

Evaluation method	Evaluation phase	Evaluation contents	Evaluation criteria		
			3 Excellent	2 Good	1 General
Self-evaluation	Scene creation lead-in	• Understand the difference between artificial intelligence composition and human composition. • Master the principle of echo ranging.			
	Creativity	• Accurately measure the key position.			
	Ability to solve problems	• Set up simple and available program modules.			
	Engagement	• Actively participate in group activities and undertake one's group tasks.			

	Team collaboration	• Be able to cooperate with each other in the competition.			

Expansion of skills

Using what we learned above, we will try to play *Twinkle, Twinkle, Little Star* with the robotic arm. Put the screenshots of program modules you set up upon printing in the block diagram below, and compare them with your classmates to find whose main program is simpler!



The song *Twinkle, Twinkle, Little Star* is played by robotic arm.

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