Alpha 1S

PC Software Description

V2.0

Available from:

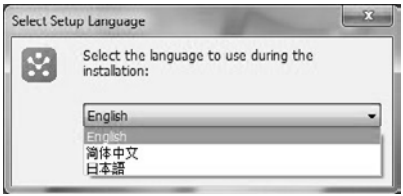
Pullman Learning Group
Better Learning Outcomes

Training Systems Australia
Better Learning Outcomes
A Division of Pullman Learning Group

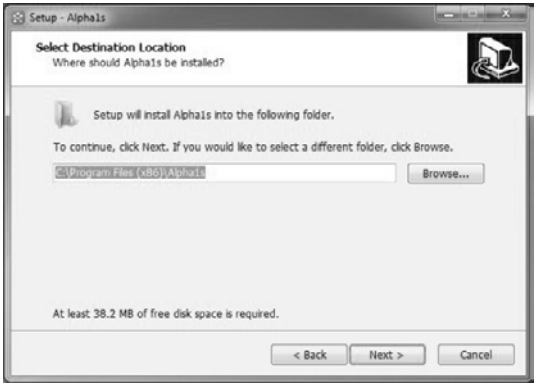
Pullman Academic
Better Learning Outcomes
A Division of Pullman Learning Group

★ Alpha 1S PC Software Installation Instructions

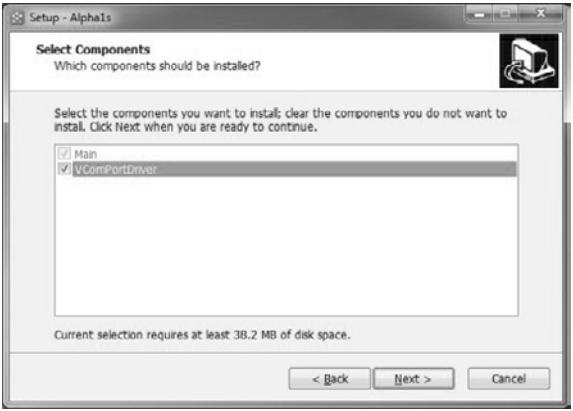
❶ Double-click the package installer to enter UI"Select Setup Language", select the language, click on"OK", as shown below:



❷ Click on "Next" to pop up a prompt box "Select Destination Location", select the installation location of the software. The default location is recommended.



❸ Click on "Next" to pop up a prompt box "Select Components", two alternative components to select:one is required to be installed, another is an opt–in component. But you'd better select the opt–in option for it's the driver connect the robot to the software.

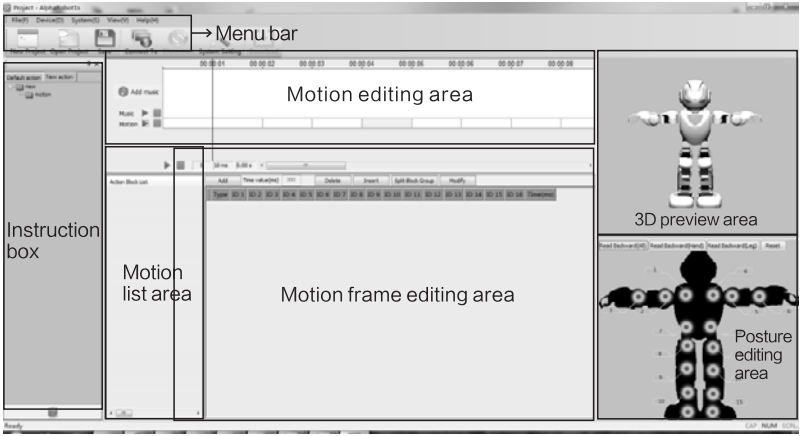


❹ Continue to click on "Next" to pop up a prompt box "Select Start Menu Folder" , next "Select additional tasks", you can select the default way or revise as you need.

❺ Click on "Install" to install the software. If you select the opt-in component at step 3,there will pop up prompt boxes of the installation, as shown below,click on"Next" and "Install" to complete the installation.

★The Software Interface and Operations

The interface is as follows:the sub-menus consists of File,Device,System,View,etc, the interface includes the motion editing area, motion list area, motion frame editing area, posture editing area, 3D preview area and instruction box.



★The menu bar

❶ File

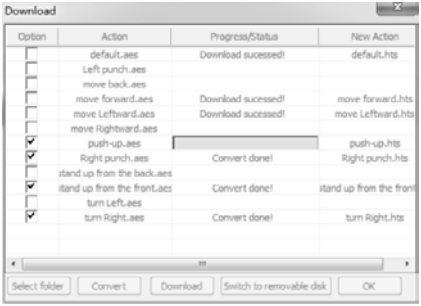
New: A new blank project is to be created.
Open: An AES file that has been edited and its corresponding music file are opened.
Save: When Save is clicked for the first time, the project edited by the user can be saved in the selected folder; when it is clicked for the second time, what is currently edited is saved in the project previously saved.
Save as: The project that has been edited is saved in a new name or a new place.
Exit: Exit the software being operated.

❷ Device

Connect to the robot: The robot is connected to the computer. After the software is installed and opened, the switch of the robot is turned to "On"; when the USB cable is inserted into the USB port of the robot, the computer will automatically recognize the port of the robot and will be connected to the robot; after the connection, the "Connect To" button in the menu bar turns grey, while the "Disconnect" button is lit. If the computer is connected to the robot by the USB cable when the software is closed, the computer can't be automatically connected to the robot when the software is opened again. It can be connected to the robot after the shortcut menu "Connect To" is clicked.

Disconnect: Disconnect the robot from the computer. If the "Disconnect" in the menu bar is clicked or the USB data cable to the robot is just pulled out, the robot will be disconnected from the computer.

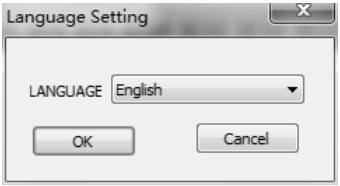
Download: The format of the edited motion file is converted and the file is downloaded into the TF card of the robot. After the robot is connected to the computer, the"Download" in the menu bar will be lit. When Device − Download or the shortcut menu "Download" is clicked, a download prompt box will pop up; when "Select" is clicked, a prompt box will pop up; after the folder is selected for the motion file which needs to be converted and downloaded,tick before the motion file which needs to be converted in the motion list; click"Convert" to convert the file into the format that the robot can recognize; click"Download"to download the project into the motion folder in the TF card of the robot.



Click "Convert" after the motion file is downloaded into the TF card; then the robot will be changed into the USB flash disk mode; the audio file corresponding to the motion file edited can be copied into the music folder in the TF card. After the above operations are finished, click the"Reset"button on the back of the robot, then the robot will be re-connected to the computer.

❸ System

System Setup: If the pull-down menu of System or the shortcut menu"System Setup" is clicked, the Language Setup prompt box as below will pop up;select the desired language and click "Ok". After the language setup is completed, restart the software to complete the language switch.



❹ View

Toolbar: The clicking of its drop-down menu "Standard"can conceal or display the shortcut menu.

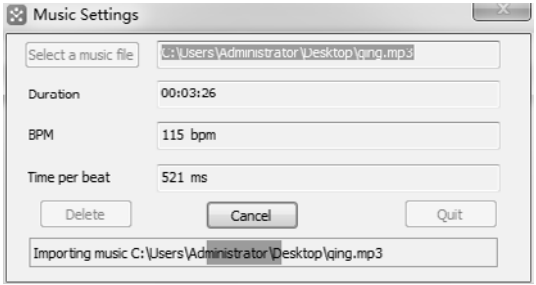
Panel Display: The clicking of the Options in its drop-down menu can conceal or display the "Instruction Box", "3D Robot" ,"Information Output Window (i.e. the posture editing area)."

★ The motion editing area

❶ The music layer

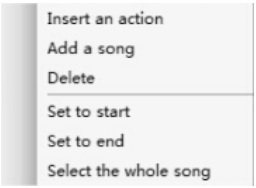
After the music corresponding to the motion that needs to be edited, it can be directly read and played by the software. The user gets a better experience of editing the motion or dance.

Add music:Click on the"Add Music"button in the area or right-click a blank area herein;click"Add Music" and select the music in the pop-up prompt box. Since the music file is big,the loading process might be long. Please wait with patience. During the loading process, if the user wants to cancel, the button can be clicked to cancel the loading;the"Cancel the Adding"button is lit after the music file information is read.



Simulate/Pause: Click the simulation button ▶ in the musical layer to simulate (play) the music, then this button will change to playing mode ❚❚ ; click again when the music is paused.
Stop Simulation: Click the Stop Simulation button ■ in the musical layer, then the music being played will stop and return to the starting position or where is set as the starting position.

The context menu in the music layer: After the music file is loaded, right-click the waveform display area of the music, then a shortcut menu will pop up as below:



Insert Motion: Add a motion group or a motion frame in the motion layer area (the details will be given when the motion layer is introduced).
Add Music: Add music into the software.
Delete: Delete the music that has been added.
Set as the Starting Position: When the music is played,it should sometimes be played from a position; click the "Set as the Starting Position" button and the "Simulate" button, then the music will be played from the selected position.
Set as the End Position: When the music is played, it should sometimes end at a position; click "Set as the End Position", then the music will end at the position, and the cursor will move to the selected starting position;if the starting position is not selected,the cursor will move to the beginning of the music.
Select the Entire Music: If the user wants to cancel the starting position or the end position that has been set, click "Select the Entire Music", then the music is selected.

Notes: 1. If the starting position and the end position are not set, the music will be played from the current position of cursor as the default after the "Simulate" button is clicked.

2. If the starting position and the end position have been set, the music will be played from the starting position after the"Simulate"button is clicked and will stop at the end position,not matter where the cursor is.

❷ The motion layer

Add/insert motion frame: In general,the user edits the dance based on the rhythm of music.When the music is played to a rhythm point and a motion needs to be added,the rhythm point in the music layer is selected by the left mouse button; right-click-Insert Motion(or click the"Add"button in the motion frame editing area), then a motion group which is automatically named as name x(x is a figure:1, 2, 3...)will be generated in the motion layer; meanwhile, a motion group with the same name will be generated in the motion group area, and the angle values of a frame of motions will be generated in the motion frame editing area.

When many motion frames need to be added into a motion group,click any position of the motion group or any position of the musical layer corresponding to the motion group;click either"Add"or"Insert Motion". It is suggested that adjacent motion frames without a major motion difference be added into a motion group to facilitate the editing and the addition into the instruction box for use,which will be introduced later.

Simulate/Pause: Click the simulation button ▶ in the motion layer to simulate the motion, then this button will change to operation mode ▮▮ ; click again when the motion is paused.

Stop Simulation: Click the Stop Simulation button ■ in the motion layer, then the motion in operation will stop and return to the starting position or where is set as the starting position.

During the simulation,if the computer is connected to the robot,the robot will change motions in compliance with the changing motion frames in the motion layer; the robot model in the 3D preview area makes motions in conformity with the actual robot.

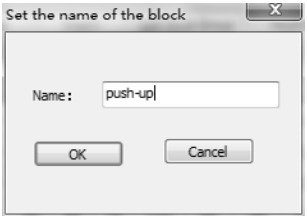
The context menu in the motion layer: When there is a motion group or more in the motion layer, the shortcut menu will pop up as follows if the motion group is right-clicked:

Cut/Copy/Paste: Copy or cut and paste a motion group into the Motions layer. If the position selected to paste is a motion group, what is copied will be pasted to the front of the selected motion group; if a blank area is selected, what is copied will be pasted in the blank area.

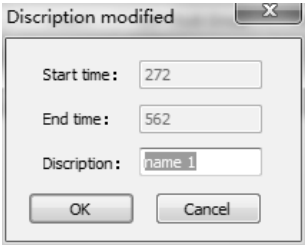
Delete: Delete the selected motion group.

Cancel Simulation: Click to cancel a single-block simulation in operation.
Insert a Blank Frame: Select any frame in a motion group and click "Insert a Blank Frame," then a new motion group will be inserted in front of the selected motion group; and a new motion frame is created in the new motion group.

Save into the Instruction Box: Select a motion group and click "Save into the Instruction Box" in the context menu, then the "Name Setup" prompt box will pop up;enter the name and save the motion group into the instruction box; the instruction block in this name will be displayed in the instruction box. For the functions of instruction box, see the introduction of "Instruction Box".



Modify Group Information: If the"name x"of a motion group automatically named by the software is not satisfying, select the motion group and click"Modify Group Information"in the context menu, then the"Modify Description" prompt box will pop up; enter a name and save, then the changed name will be displayed in the motion layer and the motion group list. The"Starting Time"in the prompt box is the starting time of the selected motion group; the"End Time"is the end time of the selected motion group; the "End Time" minus the "Starting Time" resembles the length of time of the motion group.



❸ Co-simulation

The so-called co-simulation is the simulation of both music and motion. It aims to check whether motion and music are coordinated in the motion editing process.

Co-simulate/Pause: Click the simulation button ▶ at the bottom of the motion editing area to jointly simulate the motion and music, then this button will change to operation mode ❚❚ ; click again when the motion is paused.

Stop Co-simulation: Click the button ■ at the bottom of the motion editing area to stop the co-simulation, then the motion and music in operation stop and return to the initial position.

Timescale: There are a row of time-scale values next to the co-simulation buttons.The first value is the length of time, i.e. the length from the starting position of the motion layer or music layer to the position of mouse cursor; the second value is the resolution of the length of time (10ms); the third value is the time period (the length of time * 10ms).

Note: The simulation process can be paused, if the Pause button is clicked. However, the robot sometimes will still run for some time. The unit of the robot's motions is frame. If the frame before the pause is long, the robot will not be paused until after the motions are completed. This situation is normal.

❹ Other functions of the motion layer

Click: Left-click the motion frame in a motion group in the motion layer, then the block of the frame becomes a different color. All the motion frames of the selected motion group will be displayed in the motion frame editing area, and the angle in the selected motion frame is marked in blue, allowing the user to easily see the selected motion frames. Meanwhile, the robot model in the 3D preview area will make motions in conformity with the angle values of the selected motion frames.

Double-click: When the motion frame in a motion group in the motion layer is double left clicked, in addition to the functions that can be achieved when clicked, the robot can make the corresponding motion simulation in conformity with the angle values of the selected motion frames.

Modify the duration of a motion group: Put the mouse over the end of a motion group, then the mouse will become two arrows in opposite directions. If pulled to the left or the right, the length of time of the motion group can be changed according to certain rules. The mouse can be pulled to shorten the length of a motion group. Note that the prompt box "The adjustment range is too big" will pop up, when the frame length of this motion group is compressed to less than 20ms.

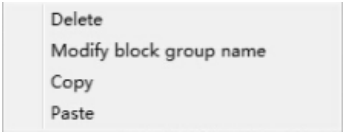
Merge motion groups: How to combine the motion frames of two or more adjacent motion groups into one motion group? Select the first motion group and long press the Shift key; click the final motion group, then the "Merge" prompt box will pop up; click"Ok"to merge the selected motion groups; the combination will automatically be named as the name of the first motion group. The merging process is as follows:

★The motion group list area

The motion frames added into the motions layer will all be saved in the motion group.The motion groups will all be displayed in the motion group list area for easy and efficient edition and processing.

The context menu of the motion group

Select a motion group in the motion group list area; right-click, then the context menu as follows will pop up; its functions are similar with those of the motion layer:



Delete: The selected motion group can be deleted; the motion group in the motion layer in the motion editing area can also be deleted.
Modify the Group Name: It has the same function of renaming a group in the motion layer.
Copy / Paste: Copy and paste a motion group to the top of the selected motion group.

★ 3D preview

Preview the current motions and postures.Click or double-click any motion frame in the motion frame editing area or motion layer, then the robot model displays the robot's posture of this frame. The left mouse button can be used to rotate and view the model from any angle.

★ The posture editing area

The posture editing area has the following major functions:

❶ Readback

Readback the angle values of multiple steering engines: When the robot is connected to the computer and the steering engine is live,all the joints of the robot are locked and can not swing.If the Readback button is clicked, the steering engine will be powered down; the joints will be flexible and can swing freely;adjust the robot to the appropriate posture;click the button again, then the software will read and record the angle values of the robot. If the"Insert"button or"Modify"button in the motion frame editing area is clicked, the angle value can be inserted into the top of the selected position or can replace the angle value of a frame.

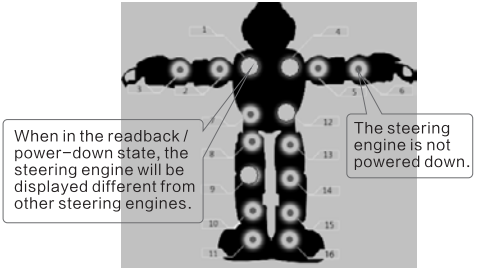
Readback All: When this button is clicked, all the steering engines of the robot will be powered down, and the joints will be flexible. Then the robot can make any posture as expected. When this button is clicked again, the angle values of all steering engines of the robot will be read and recorded.

Arm Readback: When this button is clicked, the 6 steering engines in the arms of the robot will be powered down, and the joints will be flexible. Then the arms can make any posture as expected. When this button is clicked again, the angle values of the steering engines in the arms of the robot will be read and recorded.

Leg Readback: When this button is clicked, the 8 steering engines in the legs of the robot will be powered down, and the joints will be flexible. Then the legs can make any posture as expected. When this button is clicked again, the angle values of the steering engines in the legs of the robot will be read and recorded.

Readback the angle values of a single steering engine: Double-click the button in the middle of the arc buttons above the button which is used to adjust the angle of the steering engine in the posture editing area, then the steering engine will be powered down; when this button is double-clicked again, the angle values of the steering engine will be readback. If the middle button of multiple buttons is double-clicked in this way, multiple steering engines can be powered down, or the angle values of multiple steering engines can be readback.

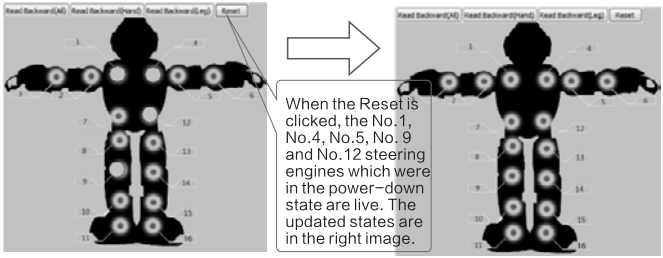
In addition, after the user performs the readback operation of one steering engine (or all steering engines) of the robot, the corresponding steering engine should be powered down. In the robot image in the posture editing area, the readback / power-down state of the steering engine will be displayed in the position marking the steering engine (a circular area different from other areas). The different states are shown below (The No. 1, No. 4, No. 9 and No. 12 steering engines in the figure below are powered down).



Note: When the posture is readback, the joints are rotated in the angle range allowed by the steering engine.

❷ Reset

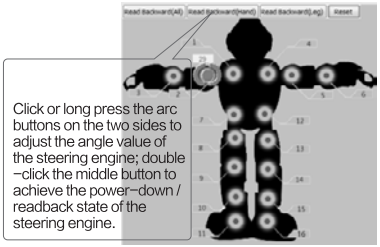
When the robot is connected to the computer, click the "Reset" button in the posture editing area, then the robot and the 3D preview robot will be in the reset state. After reset, all the steering engines of the robot will change from the power-down state to the normal state. The states of the corresponding steering engines in the robot image in the posture editing area will be updated as below.



In addition, some other operations (online simulation, slight angle adjustment, etc.) can result in the switching of steering engine between live state and power-down state. The resulting state change is displayed in the robot image in the posture editing area as shown above, so it is not necessary to repeat here.

❸ The slight change of the angle of the steering engine

The joints numbered in the simulation figure herein are corresponding to the joints of the actual robot. When the mouse is placed on a joint, the button which is used to adjust the joint angle will be shown;click the button to adjust the value of the joint angle of the robot;clicked once, the joint is adjusted one degree; if the mouse is long pressed, the adjustment will go on until reaching the maximum or minimum joint angle, as shown below.

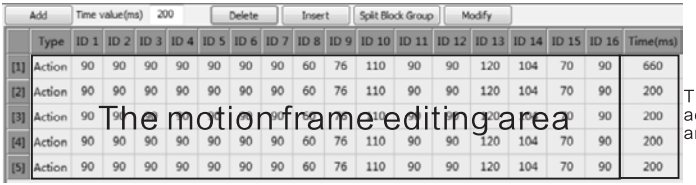


For example, after a frame of motions is completed in the motion frame editing area, there may be a small deviation from the ideal motions. A slight adjustment in the area can achieve the desired effect. The unnecessary angle value can be modified or replaced by means of readback.

The slight change of the angle of the steering engine can change the steering engine from the power-down state to the live state. This change will be shown in the corresponding position in the robot image in the posture editing area.

★The motion frame editing area

The motion frame editing area is used to edit the motions of the robot. Continuous simulation of motion frames in this area can form dance movements. The entire motion frame editing area includes the Tools buttons, serial numbers of steering engines, motion frame area and time adjustment area.



The Tools buttons: The Tools buttons are on the top of the motion frame editing area and can achieve the frame addition, insertion, and other functions.

Add: Add motion frames into the motion frame area. For the detailed operation, see the "Add / insert motion frame" introduction in the motion layer.

Delete: Click the number(s) of a frame or a few frames in the motion frame area to select the frame(s); click the button "Delete" to delete.

Insert: Click the number of a frame in the motion frame area to select the frame; click the Tools button "Insert", then the angle values of a frame obtained by readback can be inserted into the top of the selected position.

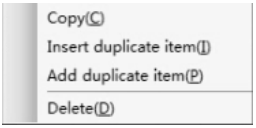
Insert Division: When there is a motion frame in a motion group, the angle values of a frame obtained by readback can be inserted into the top of the selected position by clicking "Insert Division"; while the length of time of the entire motion group remains unchanged, the time is equally divided for all motion frames in the group. It is mainly used to add a motion frame or more, while the length of time of the entire motion group remains unchanged. Note that the time is equally divided when a motion frame is inserted or deleted.
Modify: Select the motion frame that needs to be modified and click the Tools button "Modify", then the angle value of a frame obtained by readback can be replaced by the angle value of the selected motion frame.
Time value (ms): The default time value of the inserted motion frame.

The steering engine numbers: The numbers of the steering engines of the robot are from ID1 to ID16, which are consistent with the numbers of the steering engines of the actual robot.
The motion frame area: The values in this area are the angle values of the steering engines of the robot in a certain state, showing the corresponding angles of the 16 steering engines; a value from 0 to 180 can be entered into a grid of a frame to adjust the corresponding frame and the corresponding joint angle. Click its number to select a frame, then the 3D preview area will display the frame's posture of the robot; double-click its number to select a frame, then the robot will make the motions of the frame.
The time adjustment area: The figures below Time are the time for the robot to make a frame of motions from the beginning to the end. After the robot completes a frame of motions, it sometimes does not need to immediately run the next frame. It takes some time before running the next frame. Thus, two frames of motions with the same angle values but different time are needed as follows:

	Type	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10	ID 11	ID 12	ID 13	ID 14	ID 15	ID 16	Time(ms)
[1]	Action	90	90	90	90	90	90	90	60	76	110	90	90	120	104	70	90	500
[2]	Action	90	90	90	90	90	90	90	60	76	110	90	90	120	104	70	90	200

The 500 (ms) in the figure refers to the time for the robot to run the angle value; the 200 (ms) is the time that the robot maintains the angle value.

The context menu in the motion frame area: Right-click the motion frame area, then the context menu will pop up, as shown below:



Copy: Click its number to select a frame in the motion frame area; click Copy to copy it to the clipboard.
Insert the Copied Item: Select a frame and click the "Insert the Copied Item" to insert the copied item into the top of the selected frame.
Add the Copied Item: Click "Add the Copied Item" to add the copied item to the bottom of the last frame.
Delete: Select a frame and click "Delete" to delete it.

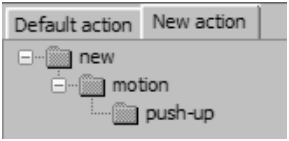
★The instruction box

The instruction box consists of the default motion and new motion. It is mainly to provide the user with a library, by which the user can use the motions in the software or the motions created by the user at any time.

❶ New motion

In the "New Motion" interface, there is a file named"new", in which there is a subfolder named"motion"; the files that the user saves in the instruction box are saved in the two folders. The files are taken therefrom.

Save in the instruction box: When editing dance movements in the motion layer, if the user wants to save a motion group for some reason which may be used when other motions are edited, the user can right-click the motion group and click "Save in the Instruction Box"; enter a name and save; the result is as follows:



"Push-up" is the instruction block saved in the instruction box.

The call of instruction block from the instruction box: After a motion group is saved in the instruction box, even if the software is closed, the instruction block still exists after the software is re-opened. When editing another dance movement, if the user needs to use an instruction block, he only needs to use the mouse to drag the instruction block to the selected position in the motion layer. If the user no longer needs to use an instruction block, he can drag the instruction block into the "Recycle Bin" ( ) at the bottom of the "New Motion" interface to remove it.

❷ Default motion

In the "Default Motion" interface, there is a file named "layer", in which there is a subfolder named "motion". There is a folder in the software before the delivery, in which the instruction blocks of the basic motions are provided for the user to use.

The import of default motion: Click the "Import" ( ) button at the bottom of the "Default Motion" interface, then the "Select the File to Import" prompt box will pop up; select the folder where the file is located, and import the ABC file. If the user needs to import more than one file, he needs to long press the Shift key to select multiple files.

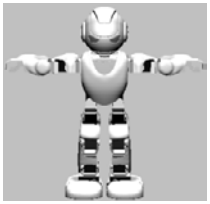
The call of default motion: The method of calling Default Motion is the same as that of calling Instruction Block and thus it is not necessary to repeat it here. However, the "Default Motion" comes with the software and can't be deleted, named, etc.

Steps for editing a complete dance file:

1. Double-click the "Alpha1s" icon to start the software.
2. Insert the data cable into the USB port of the robot and start the robot. At the moment, the robot will automatically be connected to the computer.
3. Press the "Reset" key of the robot or click the "Reset" button in the posture editing area to make the robot in the reset state.
4. Add a piece of music into the music layer in the method described previously.
5. Select the position where the user wants to insert a motion frame and click the "Readback All" button in the posture editing area, then the robot will be flexible. At the moment, within the joint's mechanical limit, the user can freely adjust the robot's posture. When the "Readback All" button is clicked again, the software will read and record the angle values of the robot's current state. Click the"Add"button to write the angle values in the motion frame area; then a motion frame will be generated; a motion group will be generated in the motion group list area too.

6. Adjust the length of time of the motion frame to the optimum state in the forgoing method (by pulling or manual entry).
7. Use the "Add" function to edit multiple motion frames according to the above steps and save them in a motion group or multiple motion groups. In this process, the user can use "Modify," "Delete" and other shortcut keys to change the angle values and delete the frames. The user can also adjust all motions by adjusting the posture editing area to achieve the desired angles.
8. When the "Co-simulation" button in the motion editing area is clicked, the robot will change its motion according to the motion frame in the current branch. Meanwhile, the music will be played, so that the user can check whether the motion and the music are matched.
9. All frames of a complete motion can be saved in a motion group to allow easy modification and re-use. Therefore, a number of motion groups are required to constitute a complete dance. Follow the above steps to create a number of motion groups. If it is necessary to call the library files of the "Default Motion" or "New Motion," the user can user the forgoing method to pull the desired files to the motion layer in the motion editing area.
10. Click the"Co-simulation"button in the motion editing area to make simulation of all motion groups, thereby viewing the overall effect of the motion and the matching of the motion and the music.
11. If the whole motion meets the requirements of the user, click the"Save" button on the menu bar to save the edited motion file into the appropriate folder.
12. Download the motion files into the robot's TF card in the "Download" method described previously; use the"Switch" function to switch the robot to the USB flash disk mode; then copy the corresponding audio files into the music folder (Note: The name of the motion file should be same as that of the audio file; otherwise, the music can't be played).

13. Start the APP application of the mobile phone and connect it to the robot; remotely control the robot to perform motions via the APP application.
    Follow the above steps to create an example: Raise the left arm and then put it down, as shown below:


Motion 1

Motion 2

Motion 3

For the first steps, please refer to the foregoing Step 1, Step 2, Step 3 and Step 4

There are two ways to edit a posture:

Edit the posture directly in the posture editing area: The robot is in the reset state at first as shown in Figure 1. To complete the above motions, it is necessary to complete 3 motions: Put down the arms; raise the left arm; and put the left arm down. Therefore there should be 3 motion frames in the motion group. Upon observation, it is known that the No.5 steering engine is used to control the robot to raise and put down its left arm, which can be achieved by increasing or decreasing the angle value; the No.2 steering engine is used to control the robot to raise and put down its right arm, which can be achieved by decreasing or increasing the angle value. Click the increasing button of the No.5 steering engine with the left mouse button to adjust the joint angle to 180 degrees; click the decreasing button of the No.2 steering engine with the left mouse button to adjust the joint angle to 0 degree, and click the "Add" button to create a new motion frame with the angel values as shown in Figure 2. Then the robot will make the motions as shown in Figure 1.

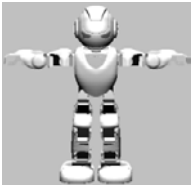


Figure 1

	Type	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10	ID 11	ID 12	ID 13	ID 14	ID 15	ID 16	Time(ms)
[1]	Action	90	90	90	90	90	90	90	60	76	110	90	90	120	104	70	90	500

Figure 2

Follow the above method to add motion frames as shown in Motion 2 and Motion 3 respectively under the first and second row of motion frames.

Edit by the "Readback" function: Click the "Hand Readback" button in the posture editing area to make the hand steering engine be in the power-down state, so that the joints of the robot can be adjusted. At the moment, the user can pose the robot as shown in Action 1. Click this button again, then the software will read and record the angle values of the robot's current state. Then click the "Add" button in the motion frame editing area to insert the recorded angle values into the motion frame area. (Or double-click the middle button to allow the corresponding joints to readback the angle values)

Follow the above method to add motion frames as shown in Motion 2 and Motion 3 respectively under the first and second row of motion frames.

The motion frames edited in the above 2 methods are shown in Figure 3:

	Type	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10	ID 11	ID 12	ID 13	ID 14	ID 15	ID 16	Time(ms)
[1]	Action	90	90	90	90	180	90	90	60	76	110	90	90	120	104	70	90	500
[2]	Action	90	90	90	90	90	90	90	60	76	110	90	90	120	104	70	90	500
[3]	Action	90	90	90	90	180	90	90	60	76	110	90	90	120	104	70	90	500

Figure 3

After the completion of the above motions, the simulation runtime of the 3 motion frames is all 500ms; the total time is 1,500ms. There is no standing time between the 3 motions. In other words, the motions are continuous. When the dance is edited based on the music, sometimes it is necessary to stay for a while before the next motion is performed. Thus, two frames with the same angle values are needed, as shown in Figure 4:

	Type	ID 1	ID 2	ID 3	ID 4	ID 5	ID 6	ID 7	ID 8	ID 9	ID 10	ID 11	ID 12	ID 13	ID 14	ID 15	ID 16	Time(ms)
[1]	Action	90	90	90	90	180	90	90	60	76	110	90	90	120	104	70	90	500
[2]	Action	90	90	90	90	180	90	90	60	76	110	90	90	120	104	70	90	600
[3]	Action	90	90	90	90	90	90	90	60	76	110	90	90	120	104	70	90	500
[4]	Action	90	90	90	90	90	90	90	60	76	110	90	90	120	104	70	90	700
[5]	Action	90	90	90	90	180	90	90	60	76	110	90	90	120	104	70	90	500
[6]	Action	90	90	90	90	180	90	90	60	76	110	90	90	120	104	70	90	800

Figure 4

During the simulation, after the first motion is performed, it stops for 600ms before the second motion is performed; it stops for 700ms before the third motion is performed; then it stops for 800ms before the subsequent motion is performed. The total time is 3,600ms.

❸ The remaining steps can be completed according to the steps 8-13 described previously. Thus, it is not necessary to repeat here.