# Bipedinno™
12-DOF Waist-high Robot
Instruction Manual

Version 1.2
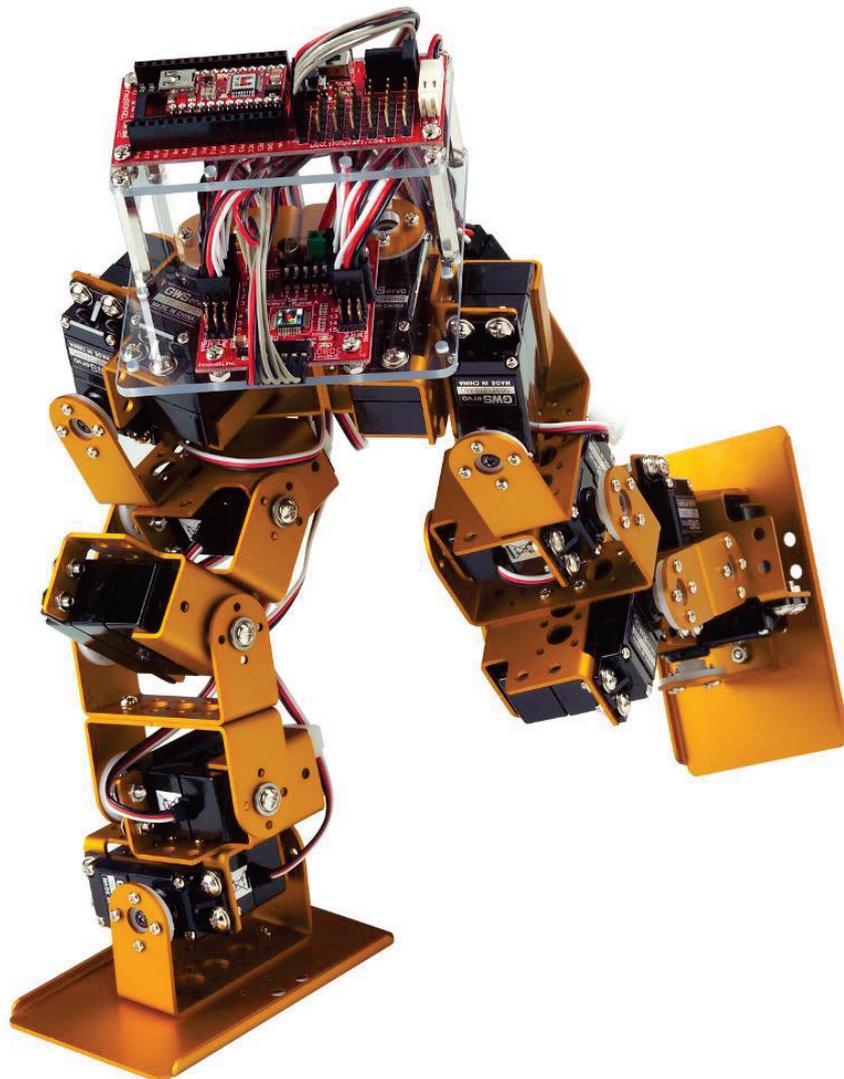
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Errata

We hope the users may regard this document as a lively and practical instruction manual. We have put tremendous efforts in making this instruction manual complete and correct; however, there may be unavoidable missing parts or errors. With a view to providing the user updated and complete information in the instruction manual, we keep improving and supplement the contents of this instruction manual. If you find any error in this manual, please contact us via the e-mail service@innovati.com.tw. Any related update information will be disclosed on our website. Please visit our website http://www.innovati.com.tw for more updated information.

Precautions

- This kit comprises 2 modules, BASIC Commander® and Servo Runner A, each with respective instructions for use and functions. Please refer to these for optimal effects.

- When installing BASIC Commander® to the Command Board, **make sure the input voltage is within the 6-12V range**, otherwise the module may burn.

- The input voltage to the Servo Runner A must correspond to the voltage rating of the servo. **Servos provided in this kit are rated 4.8-6V;** over or under voltage may cause unpredictable results, even burning of the motor. Make absolutely sure of the correct voltage before connecting the power supply.

- The kit provides a total of 12 servos. When operated simultaneously, they consume a large current; make sure the power supply or battery connecting to Servo Runner A is capable of providing **8A of current**, so as to properly operate the kit. Insufficient current may cause unexpected results and damage of the kit.

- When using a battery power supply to the module, the voltage may lower after some while of operation and cause abnormal actions of the kit. In such case, remove and fully charge the battery before using again. If prolonged testing and operation is required, we suggest you use a power supply unit to ensure uniform performance.

- Note that the Servo cables may come in different colors. Pay attention to their polarity when insert them to the ServoRunner board.

Prior to assembling the kit, install InnoBASIC™ Workshop as per the content of the CD; also make sure that the PC communicates with BASIC Commander® via a USB cable connection, so that the entire assembly can be accomplished.

Table of Contents

Part List

Item	Illustration	Qt'y	Specifications and instructions
Assembly Kit Parts			
Main Board for installing module		1	PC installation board for linking robot electronic modules with its leg parts; provides versatile layout of module or power supply accessories.
Top Board for installing module		1	PC board for installing electronic module of the robot and connecting with the main board; provides versatile layout of modules.
Aluminum Foot Bracket		2	For connecting with the Ankel Servo Bracket.
Aluminum Servo Bracket		12	For accommodating and fixing servo; lock holes are provided for connecting with another Servo Bracket or U-shape Bracket.
Aluminum U-shape Bracket, 27mm		4	Provides connection with the Servo Bracket and movement space of the Servo; it also provides connection with two U-shape Brackets for different applications.
Aluminum U-shape Bracket, 22mm		8	Provides connection with the Servo Bracket and movement space of the Servo; it also provides connection with two U-shape Brackets for different applications.
Servo		12	Servos for 180° rotation. Dimensions (LxWxH): 40.6mmx20.0mmx42.8mm Weight: 73 g, Speed: 0.33 sec/60° Torque: 7.4 kg/cm Servo cables may come in different colors "white/red/black" or "orange/red/brown", which stand for signal, power and ground in sequence.
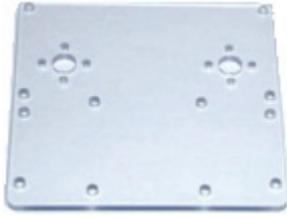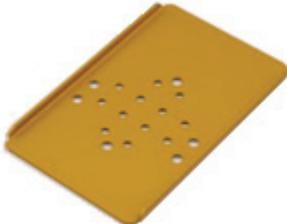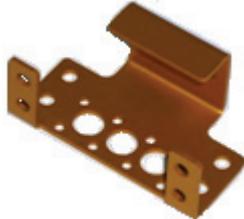
Screw A		48	ISOT 3 x 8 mm
Screw B		10	ISOP 3 x 6 mm
Screw C		20	ISOP 3 x 10 mm
Screw D		32	ISOP 2 x 5 mm
Screw E		40	TP1P 2 x 6 mm
Screw F		8	TP1P 2 x 8 mm
Screw G		4	ISOF 3 x 6 mm
Screw H		8	ISOF 2 x 5 mm
Nut A		90	3 x 5 mm
Nut B		32	2 x 4 mm
Washer A		72	3 x 0.4 x 8 mm
Washer B		12	3 x 1 x 6 mm
Bearing		12	3 x 4 x 8 x 9.5 mm
Hex post, copper		4	30 mm
Module Kits			
BC1		1	Innovati® BASIC Commander®, capable of storing programs and controlling operations of modules
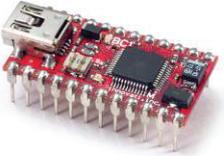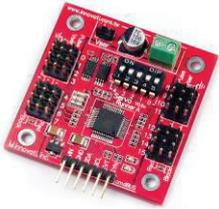
|			
Servo Runner A		1	Innovati® Servo Runner A, for controlling individual servos.
Command Board		1	Used for installing BC1, with spare cmdBUS™ allowing user to connect with Innovati® modules.
Servo Power Line		1	Cable for connecting Servo Runner A with Power Supply Unit.
Command Board Power Line		1	Cable for connecting Command Board with Servo Runner A's Power Supply.
cmdBUS™		1	Signal cable for connecting Command Board with Servo Runner A.
Servo Extension Cable		4	Servo Extending cable, if needed, user may extend the servo cable length for a wider robot operating range.
USB cable		1	Links BC1 with PC, allowing downloading of PC program to BC1, or performing communication in Debug Mode.
Cable Strap		12	Used for fixing wires, so that they do not tangle or affect motions unexpectedly during the operation of the Servo.
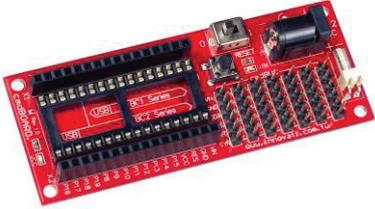
i. Tools

- Cross Screwdriver (2mm and 3 mm).

- Long Nose Pliers

- Screw Glue (selectively used between nut and Bracket joints, to prevent the nut from loosening.)

ii. Assembly Procedure

✤ Calibrating Servos

Before starting installation, verify if the servo horn is at the correct position; if not, calibrate as follows:

◆ Connect servo, Servo Runner A, Command Board, and power supply cable in the sequence as illustrated below.
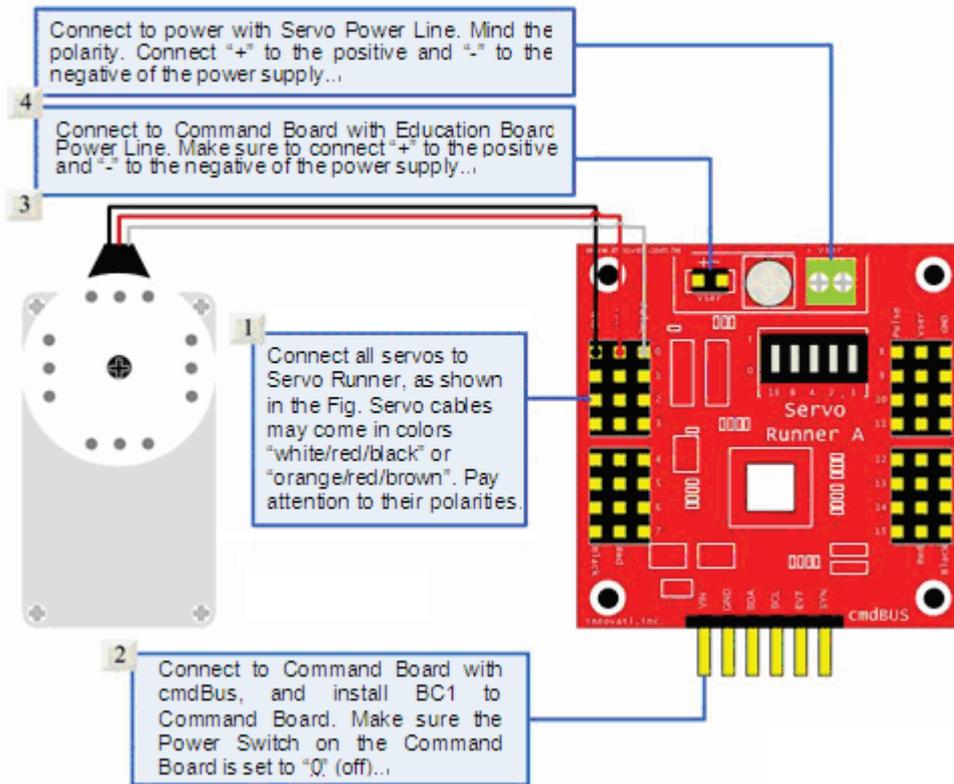

※ When the Command Board or Education Board shares the power supply with Servo Runner A, please notice that the voltage of this kit should be 6V (please refer to Notices). It is recommended to use a voltage regulator to ensure that the voltage is within the safe range.

i. Connect the PC and BASIC Commander® with a USB cable.

ii. Make sure that the DIP switch on the Command Board is set at the 0 position (power off state). If it is not at the 0 position, please poke it to the 0 position.

iii. Connect the power line of the servo to the power supply. (Please make sure that the voltage and current from the power supply are within the ranges required by the servo. After the power line is connected, the servo may make a transient motion due to receiving a switch surge; this is normal. While connecting the power line, please pay attention not to place your hands within the space where the servo may move to avoid being clamped.)

**iv.** **Start the InnoBASIC™ Workshop**

Click the application in the InnoBASIC™ Workshop folder to start the InnoBASIC™ Workshop.

v. **Click the "Tools" item in the menu bar on the top.**

After clicking each item, a pull-down menu with more function items will be displayed. Please click the "Tools" item now.

vi. **Click the "Motion Editor" in the pull-down menu (If a warning window appears, it means that the BASIC Commander® is not correctly connected. Please check if the USB cable is connected or unplug and then plug it again to ensure a correct connection. Exit the Motion Editor and then re-click this button.)**

Click "Motion Editor" to start the Motion Editor.

If this message appears, it means that the USB cable is not connected correctly.

vii. **If the connection is correct, the message "Downloading servo manager..." will be displayed on the PC screen meaning that the program is being downloaded. Please poke the DIP switch on the Command Board to the 1 position and wait a moment.**


The message means that the program is being downloaded. Please do not remove the USB cable.
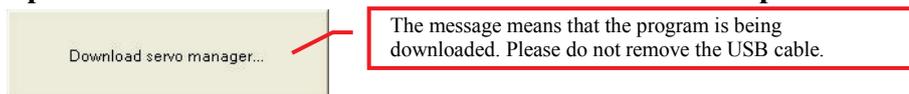
viii. **After the downloading is complete, a notification window will appear. Please make sure that each servo has been connected correctly. After confirming all the connections, please click "OK". (If "Cancel" is clicked, the Motion Editor will be closed. If there is any component is incorrectly connected at this moment, please click "Cancel" to terminate the program.)**

The message appears for notifying the download is complete. Please make sure that each component has been connected correctly.

ix.   **Please pay attention not to place your hands within the space where the servos may move into to avoid being clamped. Please check the checkbox for activating the servos on the left side to move all the servos to their central points. Please note that the number next to it should be 1500. If it is not 1500, please click the number directly, enter the number 1500 and then click "Enter".**
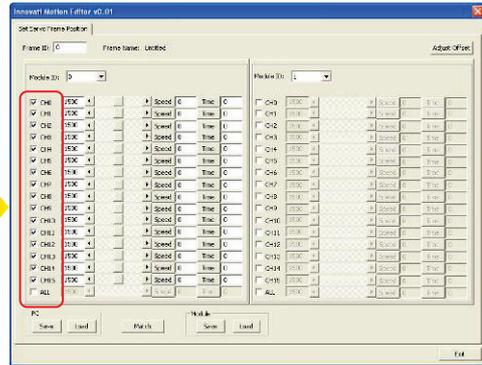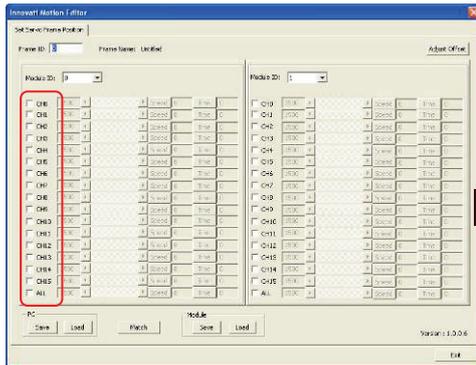
◆   **Check if the disks of all servos are at correct position; in case of any deviation, remove the central screw and pull off the disk, adjust it to the correct angle and re-lock.**

There are 4 sets of 3 holes on the disk of the servo. Verify if the central hole is on the top of the disk in a right angle, as shown in the figure.

If the hole is in an incorrect position, loosen this screw and pull up the disk adjust the disk to the correct position and refit the disk and replace the screw.
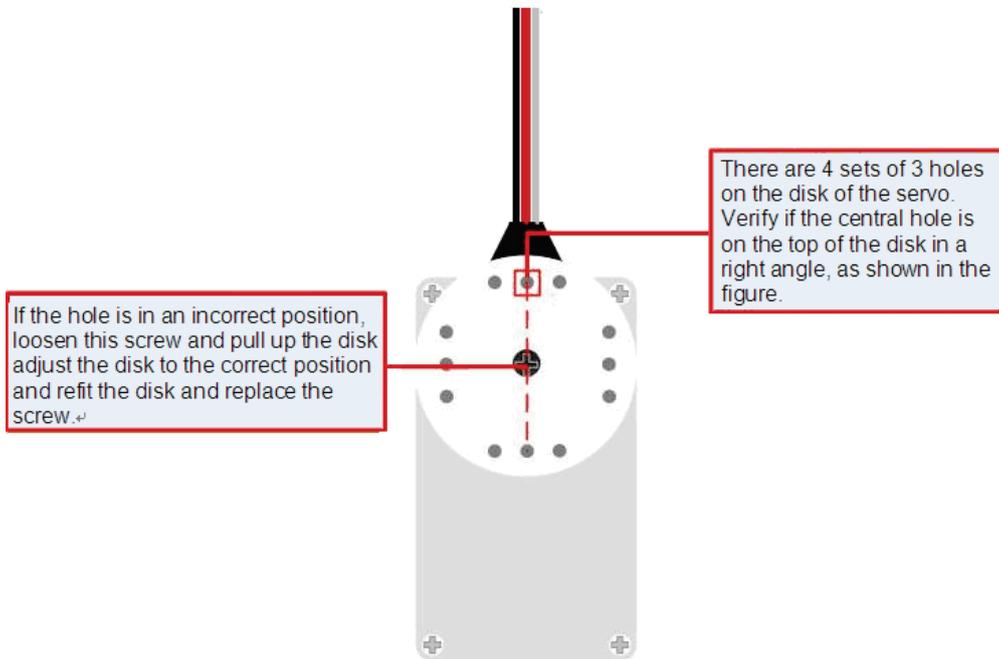
◆   **While making the assembly, before fixing the disk, make sure the disk is maintained at the correct angle. In case the disk is moved, follow this procedure to adjust it, to prevent from any unexpected movement or damage of the parts.**

Installing the bearing (For reference only. Please do not assemble it first.)

Servo Plate

U-shape Bracket

While connecting the Servo Bracket and the U-shape Bracket, the bearing should be used for the joints with the same fixing methods. Pass the Screw C from outside towards the inside through the bearing mounted on the U-shape Bracket, then the Washer B and the Servo Bracket. Finally, fix it with the Nut A at the inner side of the Servo Bracket.

Bearing fixed on U-shape Bracket

Nut A

Washer B

Screw C

Fixing the servo (For reference only. Please do not assemble it first.)

Servo is fixed on the Servo Plate with Screw A passing through Washer A and the square hole on the motor, tightened with Nut A from the lower side of Servo Plate.

Screw A

Washer A

Screw A

After fixing servo, fix U-shape Bracket to secervo horn with Screw E. Make sure the disk is not disturbed.
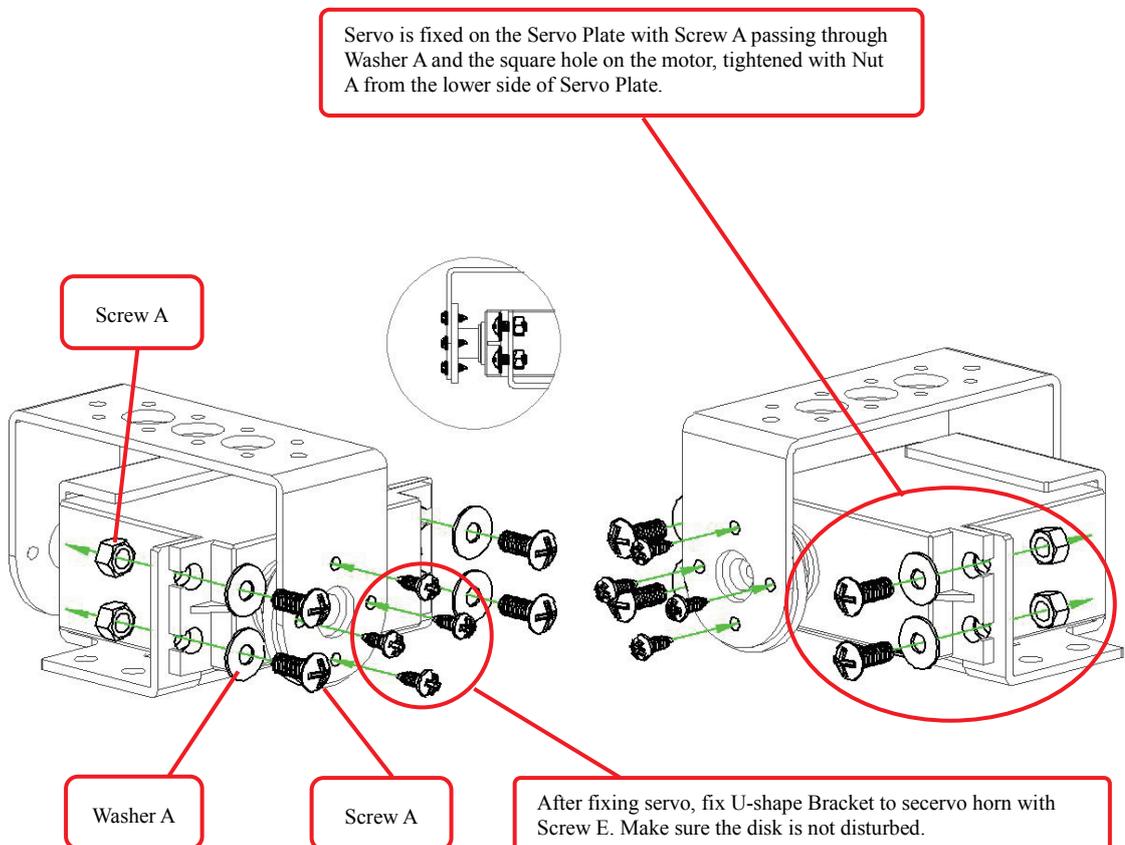
# A. Assemble the leg frames

i.   Assemble the Right Leg Frame

**Part A:** Align two Servo Brackets and fix them with Screw D and Nut B.

Part B: Place 27mm U-shape Bracket together with Servo Bracket as shown, fix them with Screw D and Nut B.

Part C: Place 22mm U-shape Bracket together with Servo Bracket as shown, fix them with Screw D and Nut B.

Part D: Place two 22mm U-shape Brackets back to back as shown, fix them with Screw B and Nut A. Add bearings to each U-shape Bracket on the same side.

Part E: Align two Servo Brackets as shown; fix them with Screw D and Nut B.

Part F: Fix the Foot Bracket to the 27mm U-shape Bracket with Screw G and Nut A. Make sure the screw points upwards.

Connect Part A on top of Part B and fix them with a bearing. The upper-most part is Servo Bracket of Part A. Note the positions of fixing holes on both Part A and Part B.

Connect Part B above with Part C and fix them with a bearing; now that two U-shape Brackets are perpendicular to each other, with the 27mm U-shape Bracket on the top.

Using Part D as the center, connect its lower side to Part E with a bearing, then its upper side to Part C with another bearing, so that a Servo Bracket is at the bottom and a 22mm U-shape Bracket at the top, as shown.

Finally fix the lowest Servo Plate to Part F with a bearing and the Right Leg Frame is complete. Check if the Right Leg Frame conforms to the structure in the illustration.

ii. Assemble Left Leg Frame

Part A: Align two Server Plates as shown; fix them with Screw D and Nut B.
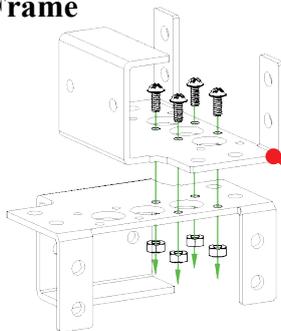
Part B: Place the 27mm U-shape Bracket together with Servo Plate as shown; fix them with Screw D and Nut B.
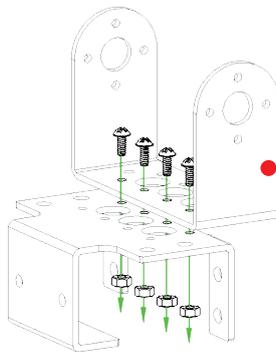
Part C: Place the 22mm U-shape Bracket together with Servo Plate as shown; fix them with Screw D and Nut B.
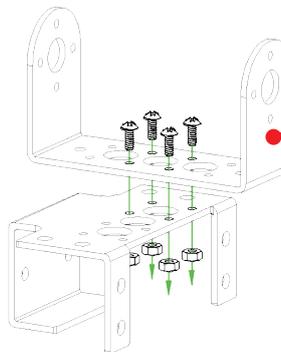
**Part D:** Place two 22mm U-shape Brackets back to back as shown and fix them with Screw B and Nut A. Place bearings on the U-shape Brackets on the same side.
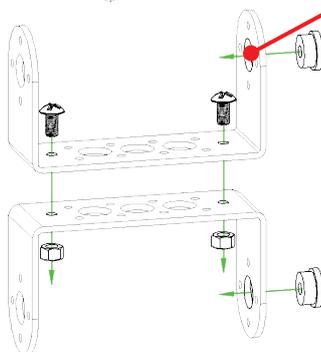
Part E: Align two Servo Plates as shown; fix them with Screw D and Nut B.
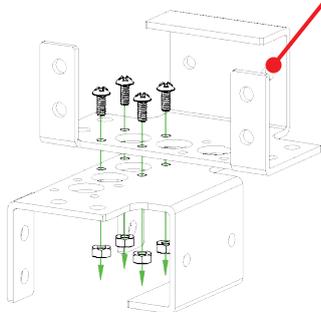
Part F: Fix the Foot Bracket with 27mm U-shape Bracket with Screw G and Nut A. Make sure the screw points upwards.
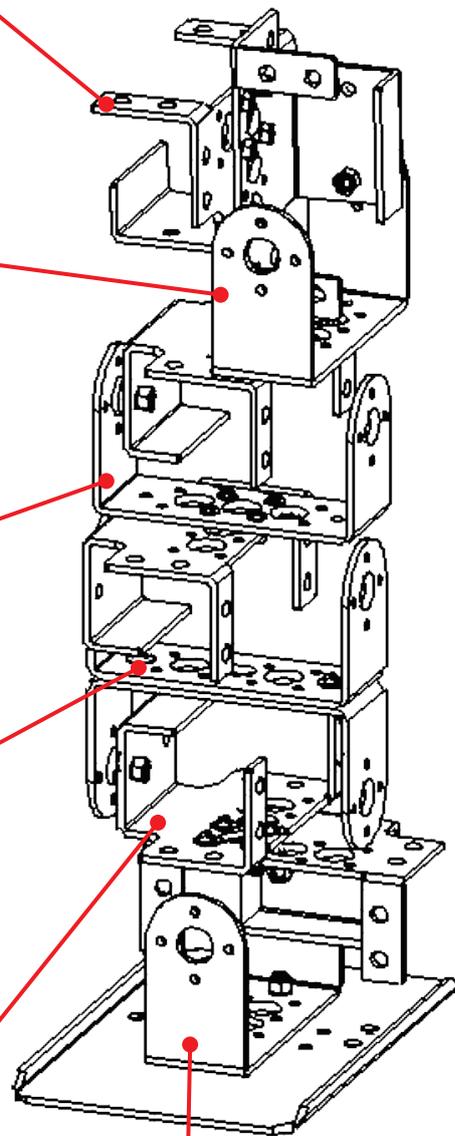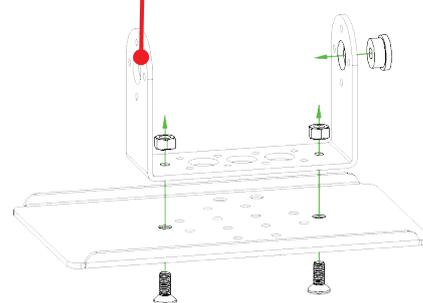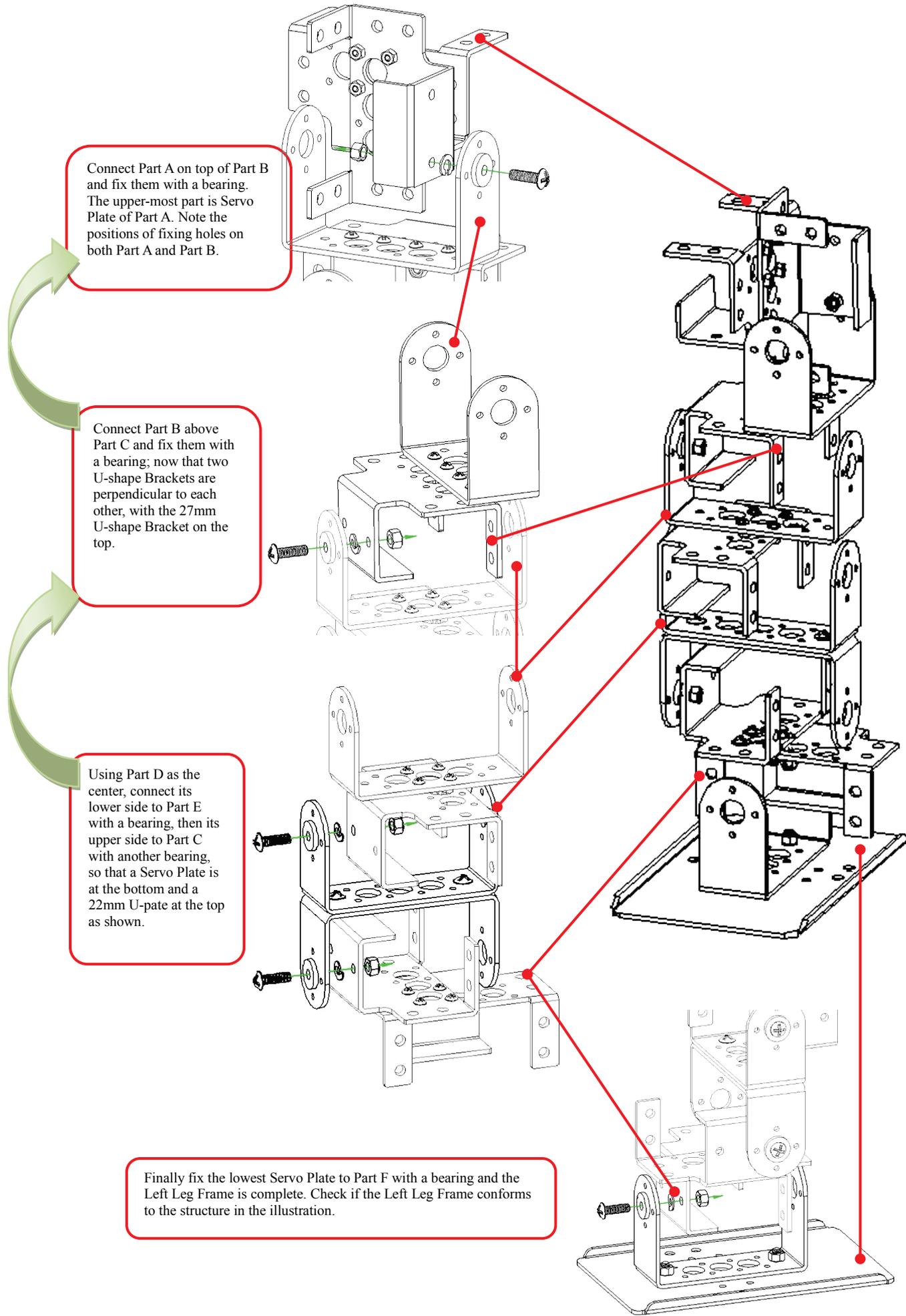
Connect Part A on top of Part B and fix them with a bearing. The upper-most part is Servo Plate of Part A. Note the positions of fixing holes on both Part A and Part B.

Connect Part B above Part C and fix them with a bearing; now that two U-shape Brackets are perpendicular to each other, with the 27mm U-shape Bracket on the top.

Using Part D as the center, connect its lower side to Part E with a bearing, then its upper side to Part C with another bearing, so that a Servo Plate is at the bottom and a 22mm U-pate at the top as shown.

Finally fix the lowest Servo Plate to Part F with a bearing and the Left Leg Frame is complete. Check if the Left Leg Frame conforms to the structure in the illustration.

Confirmation of the Right Leg Frame
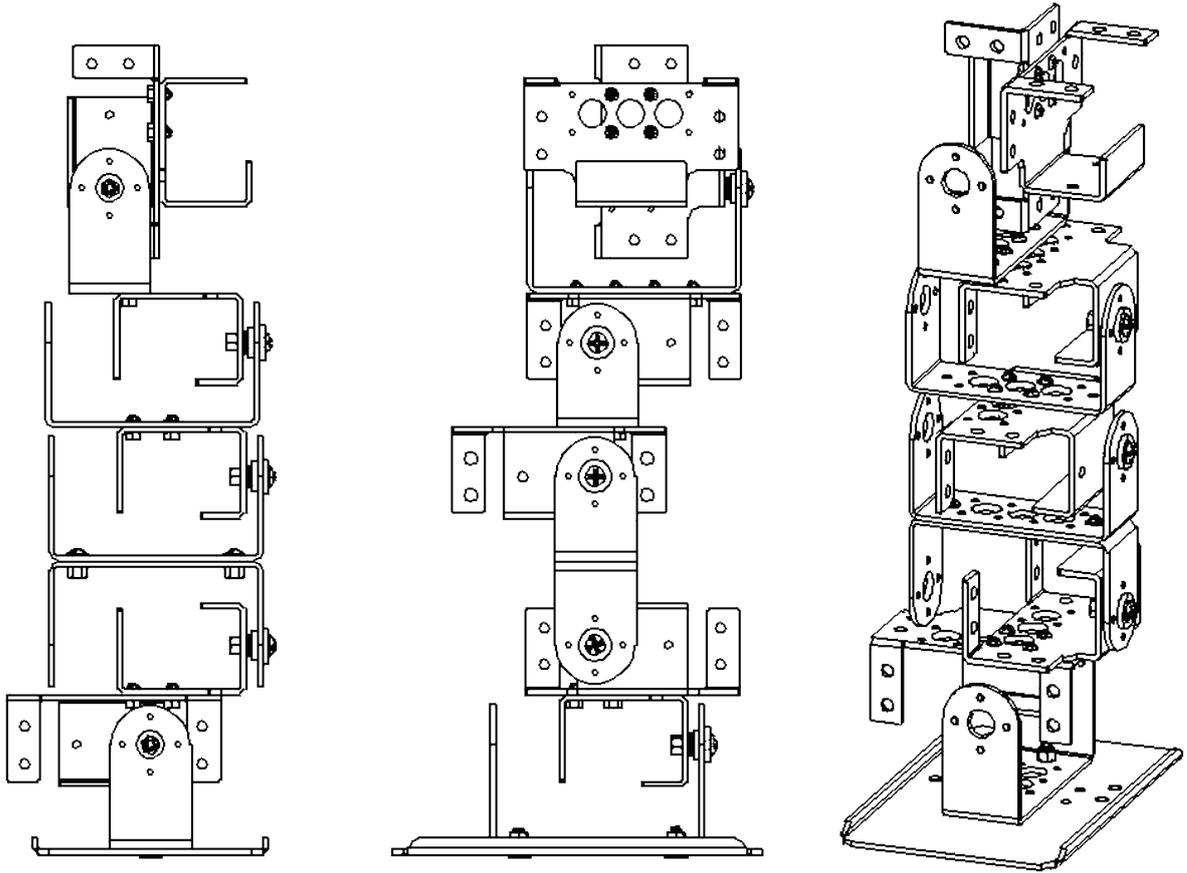
Confirmation of the Left Leg Frame
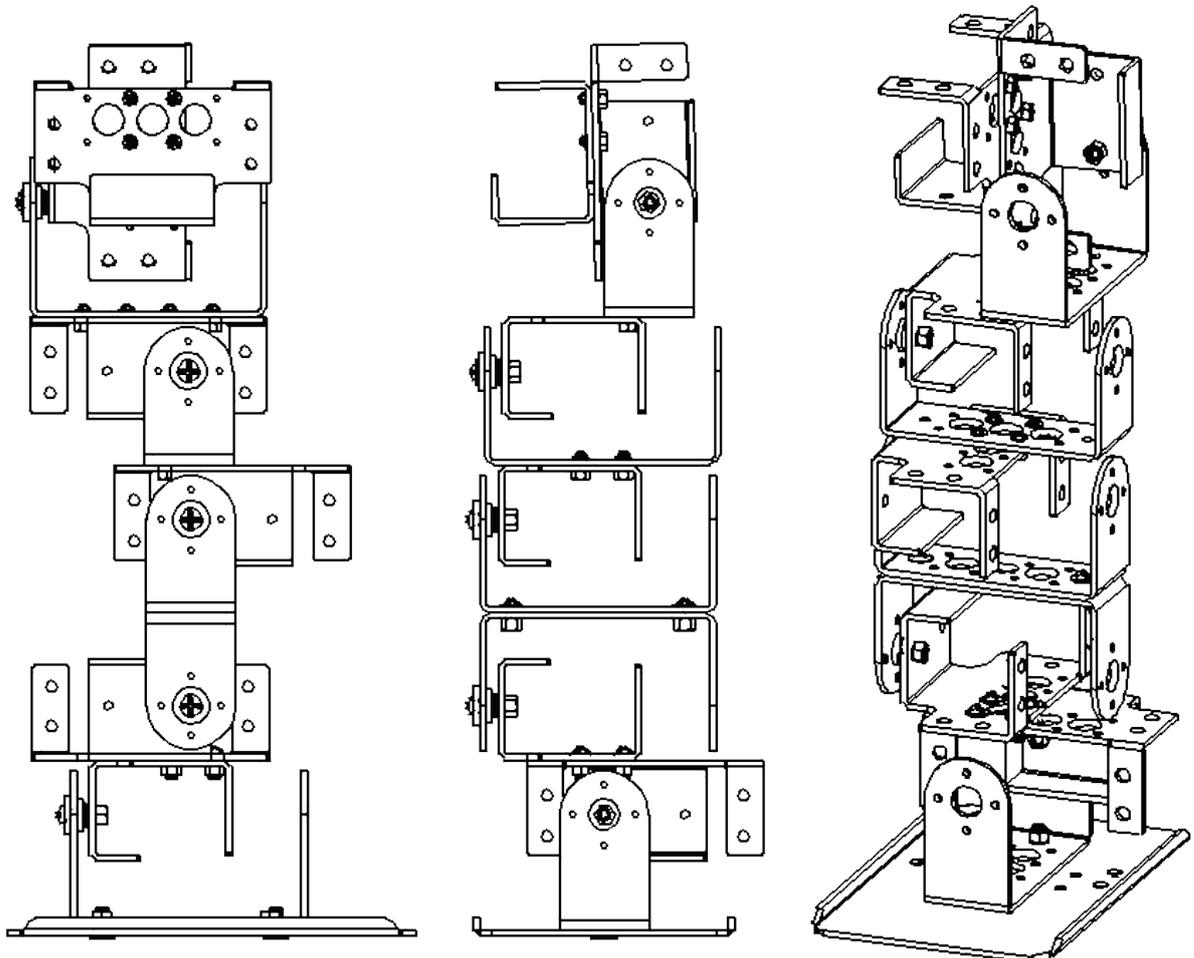
iii.   Connecting the Left and Right Legs
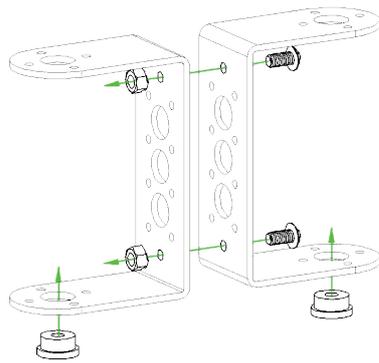
Place two 22mm U-shape Brackets back to back as shown. Then, fix them with Screw B and Nut A and add bearings to each U-shape Bracket on the same side.

Connect the bearing to the Servo Bracket on top of leg frames.
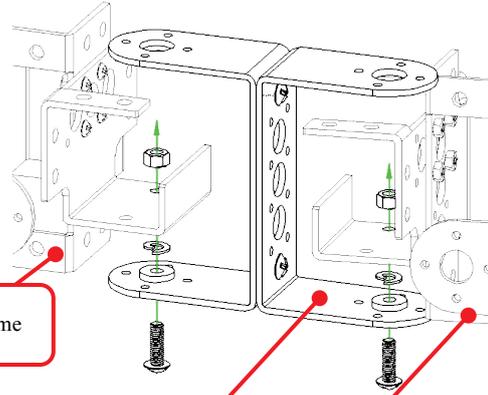
Right Leg Frame

Left Leg Frame
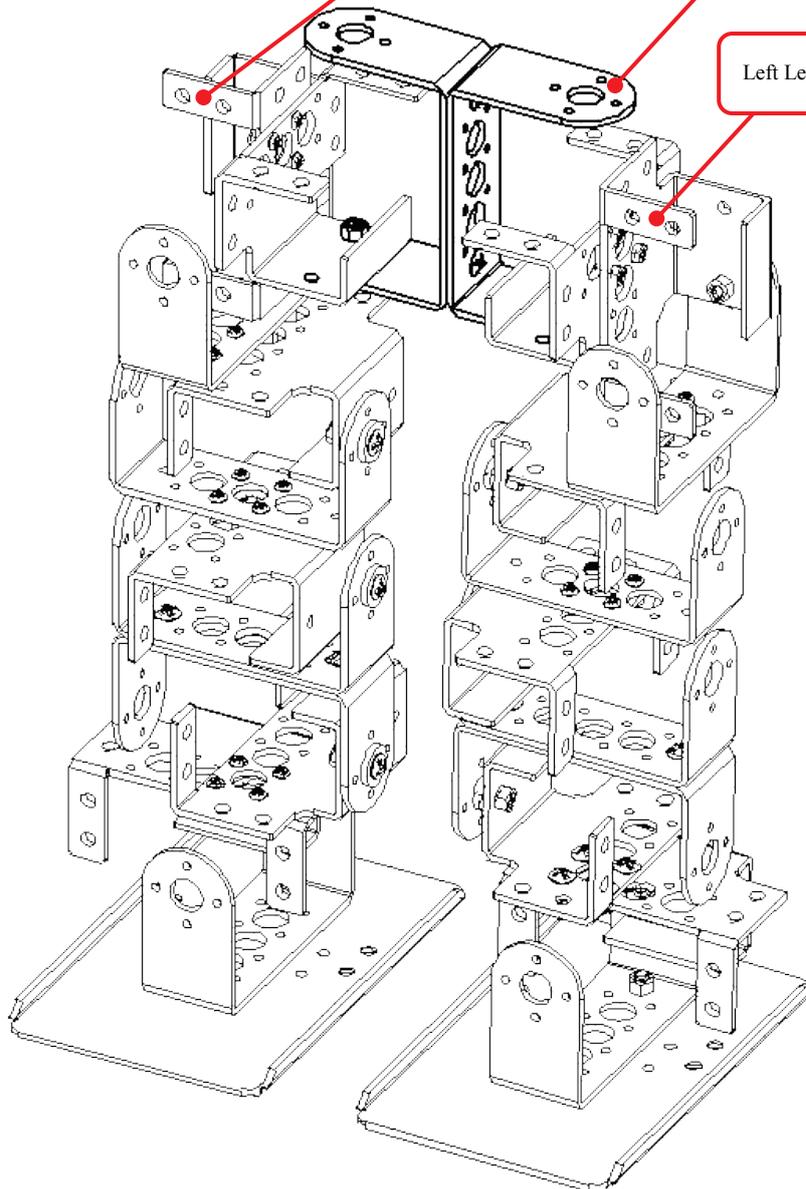
B. Connecting Top Board with Module

i.   Assemble Top Board with Command Board

Insert Screw C into 4 holes of Command Board and fix them with Nut A from below as illustrated.
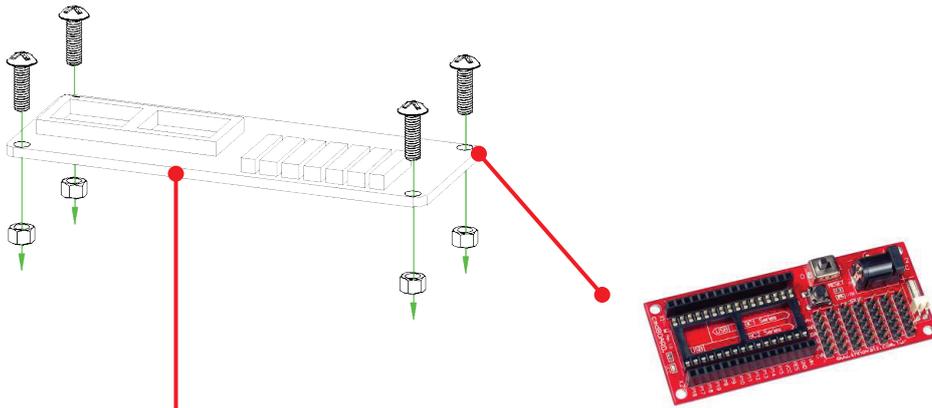
Pass 4 screws through Top Board. Add a Nut A on each of the protruding screws under the Top Board; after turning them up with hand, secure them with long nose pliers.
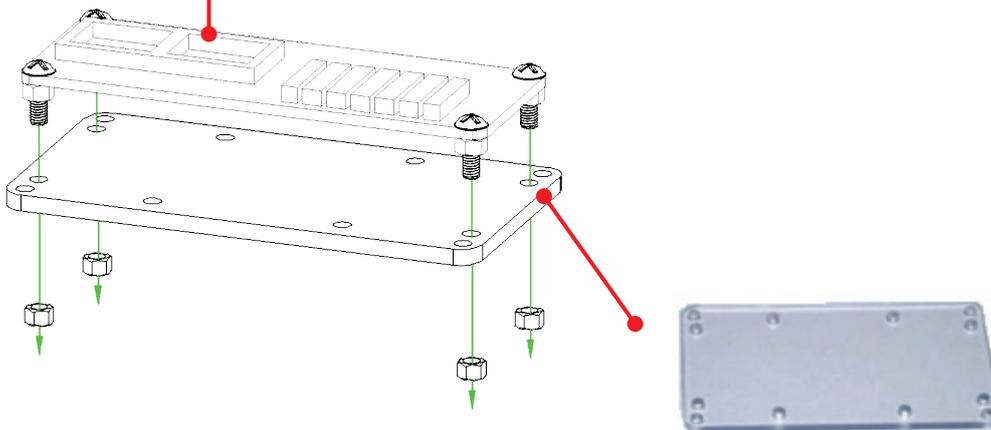
ii.   Assemble Main Board with Servo Runner A

Insert Screw C into 4 holes of Servo Runner A and fix them with Nut A, in the direction as illustrated.

Pass the 4 screws through Top Board. Add a Nut A on each of the protruding screws under the Top Board; after turning them up with hand, secure them with pointed pliers.
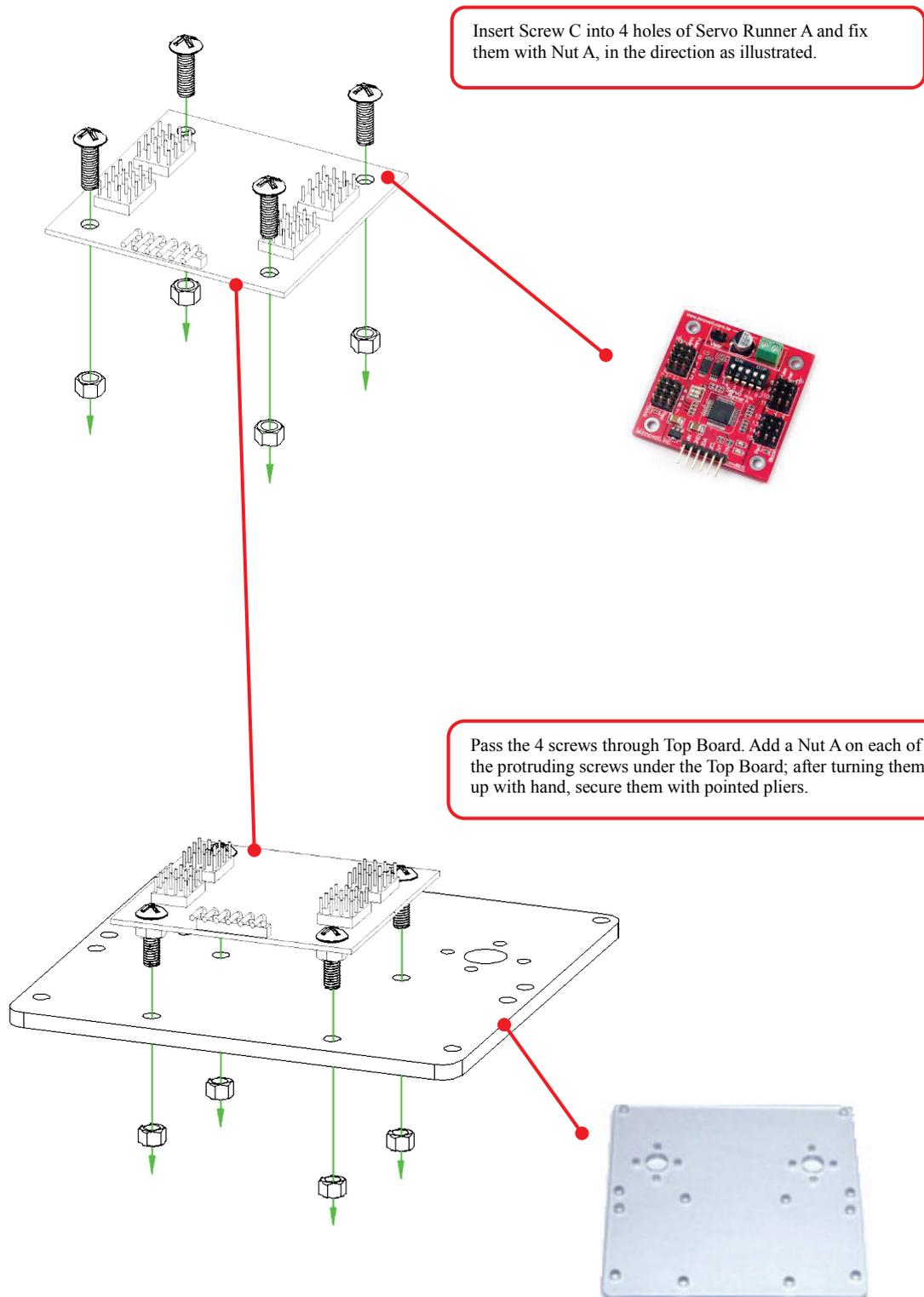
iii.   Install servos and connect with Main Board
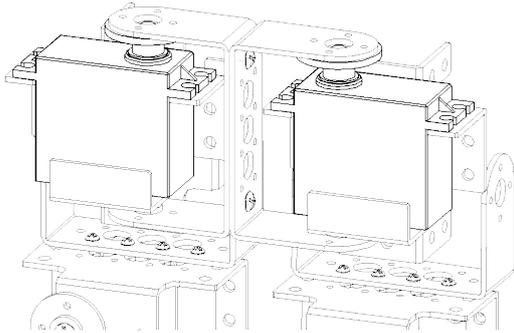
Place a servo in each top Servo Plate of the left and right leg frames. Turn the leg frames outward 90 degrees as shown for easy installation.

Fix servos to respective Servo Plates; insert Screw A with Washer A downwards, passing through servo and then Servo Plate and then fix the screw with a Nut A on the inside of Servo Plate.
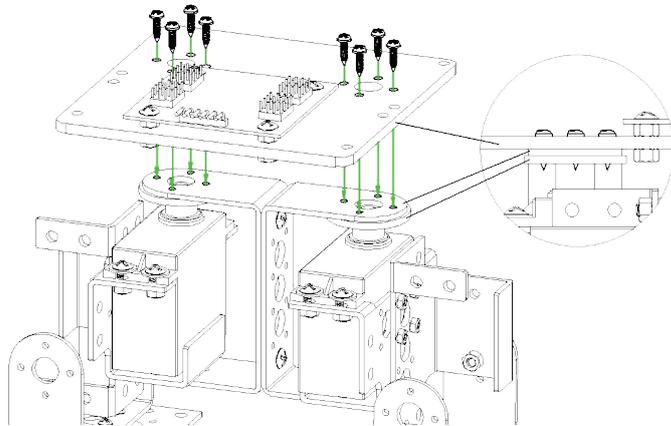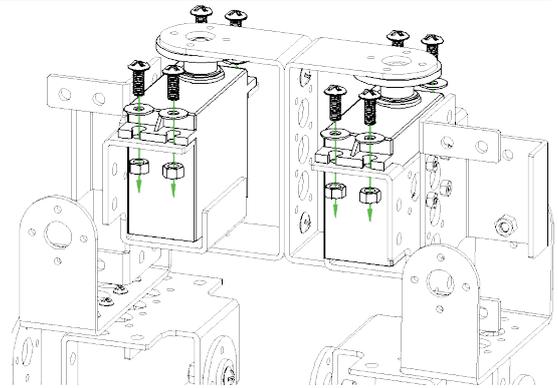
Place Main Board on top of the just assembled servos, and lock with Screws F. Note that Screw F is of self-tapping. Use a lower torque if a powered screwdriver is used. Lock the two diagonal screws first, check the screw hole alignment and then lock another two screws.

Add Screw B to Top Board and lock with the copper post. Place Top Board on top of the 8 screw holes that fix the servos; from lower side of Main Board, secure Nut A with long nose pliers.
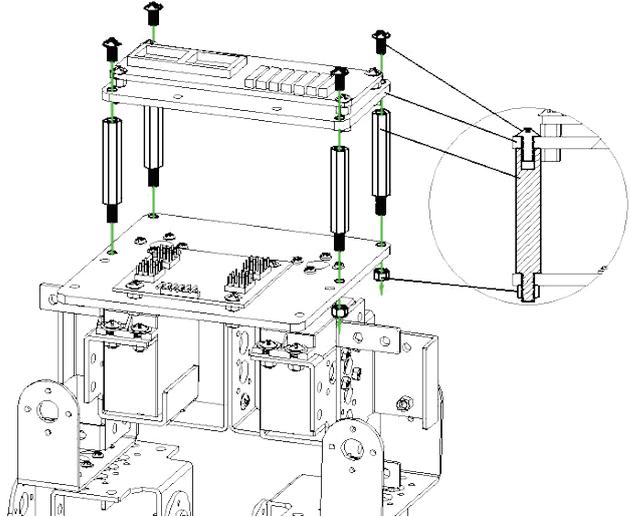
Insert BC1 into Leg Frame according to pin assignment; pull or push it vertically to avoid slanting/damaging pins.

Connect Command Board and Servo Runner A with Command Board Power Line. Make sure red line is connected to + and black to -. Incorrect connection may damage the module.
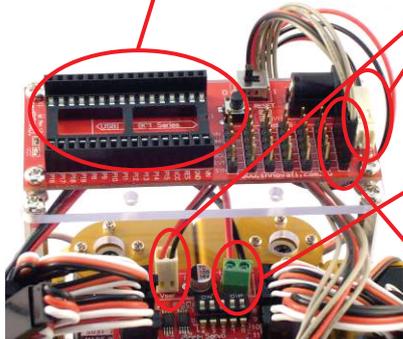
Use correct Servo Power Line to connect with the Servo Board; select corresponding connector for the battery pack. Ensure correct polarity; incorrect connection may damage the module.

Connect cmdBUS™ cable to Command Board and Servo Runner A. Maker the red line connects to "Vin". Incorrect connection may damage the module.

Install the rest 10 servos respectively into each Servo Plate and fix them with Screw A, Washer A and Nut A. Then lock U-shape Bracket onto servo with Screw E. While locking these screws, make sure the each U-shape Bracket is either parallel or perpendicular to the servo. DO NOT disturb the disk before fixing it.
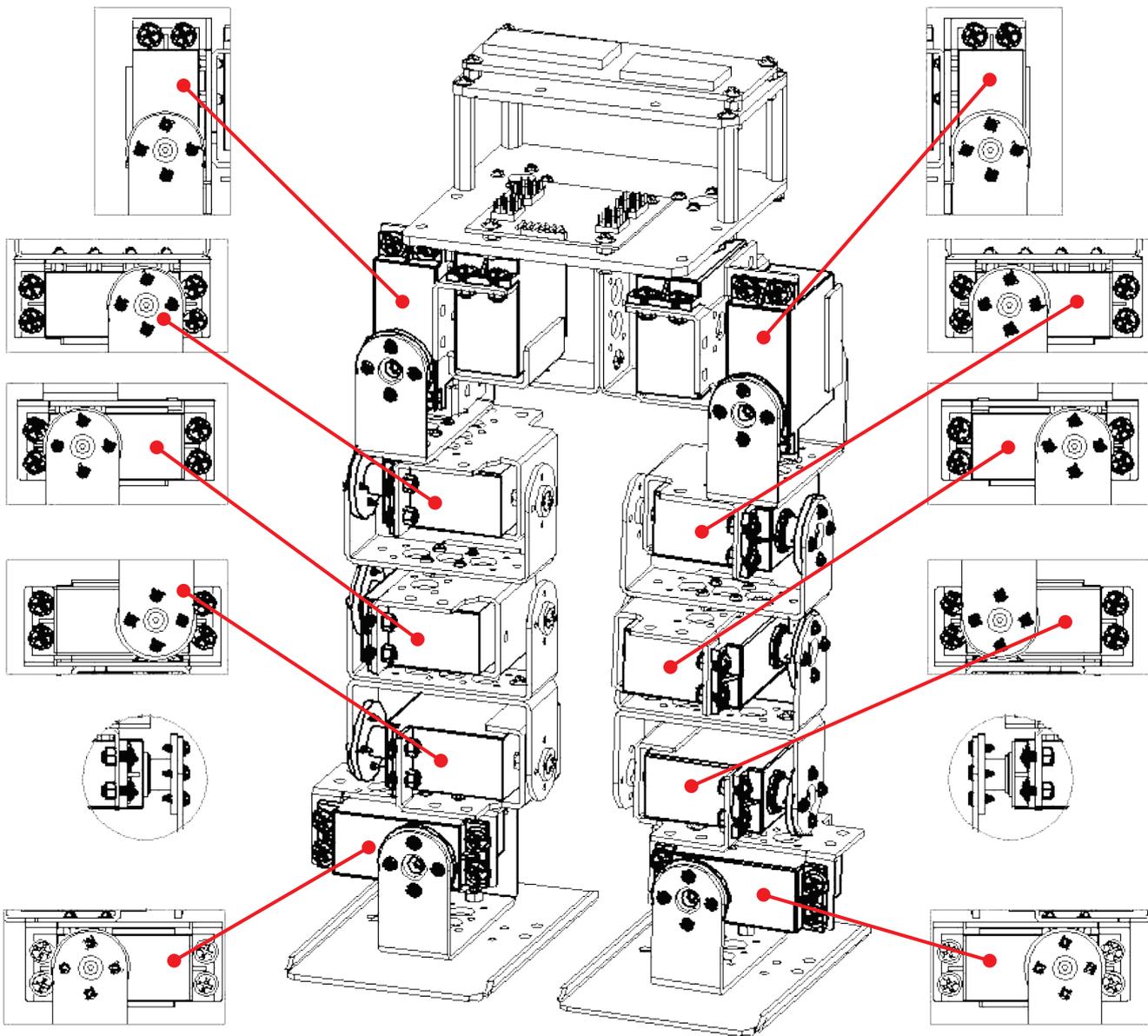
Connect the control line of each servo to the corresponding pins on the Servo Module. Make sure that settings of servo numbers in the program conform to servo numbers on the Servo Module; only the following connection may ensure movements as programmed in the example.
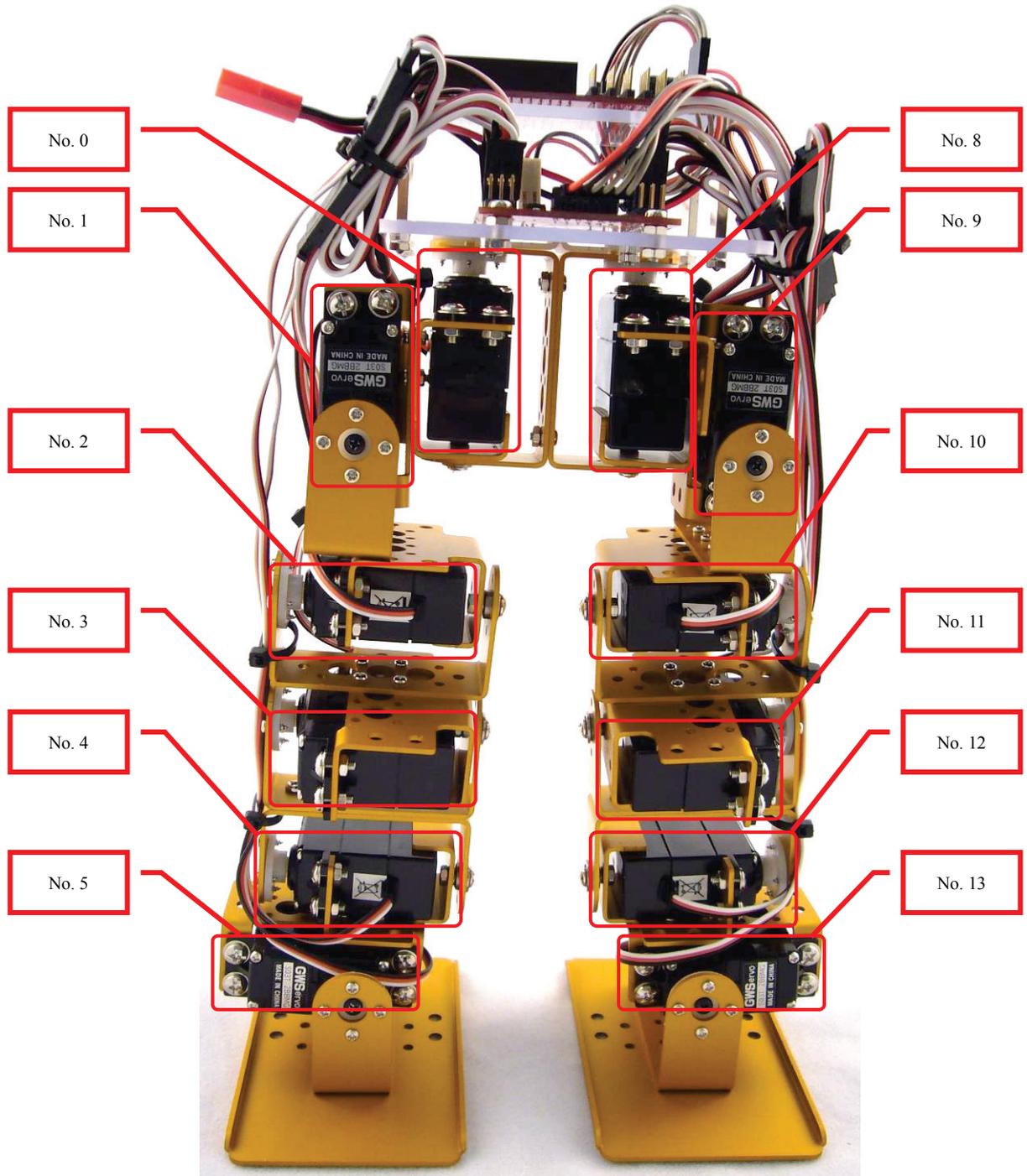
※ *A Servo number is provided beside each Servo Module. Note that the white wire is signal, red the power and black the Ground. Connect them as indicated on the module, to avoid any damage of the module.*

iii.　Fine-tuning initial value of servo

There might be some positioning errors in each servo that are possibly caused by installation or mechanical errors. Therefore, before assembling and installing, it is necessary to perform a two-step adjustment so as to allow the follow-up operations to be positioned correctly.

A.　Structure fine-tuning:

- **Prior to the final step of installation, the disks of all servos are not yet fixed to the structure. You may unscrew the central black screw and adjust position of the disk now.**

- **Connect all servos to the Servo Module and connect to the power supply. Referring to servo calibration procedures, let all servos move to their center point respectively.**

- **Check if all screw holes align with holes on the disk. If not, unscrew the central screw and pull up the disk, align disk holes to holes on the structure and lower the disk.**

※Both the PC and aluminum are flexible to a certain extent. In case hole positions on the PC board misalign with the hole positions of servos, just slightly pull PC board up and adjust the disk, by lifting it up, to a desired angle and replace it.

- **Align holes of all 12 servos one by one, and then proceed with final fixing of the installation.**

B.　Software fine-tuning:

- **After completing structure fine-tuning and fixing disks (the final step of installation), proceed with software fine-tune program.**

- **Enter fine-tune value of each servo respectively and adjust all motors to their desired positions. In case satisfactory result cannot be achieved within the limit range (127~-128), go back to structure fine-tune and readjust the structure.**

※ Make sure all disk screws are tightened and all servos are within the tolerance range while performing software fine-tuning.

B_1. **Connect the PC and the BASIC Commander® on the robot with the USB cable**
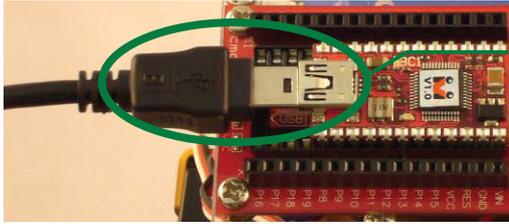

The connectors at the two ends of the USB cable are of different sizes, so please connect the smaller one to the BASIC Commander.

B_2. **Make sure the DIP switch on the Command Board is at the 0 position. If not, please poke it to the 0 position.**
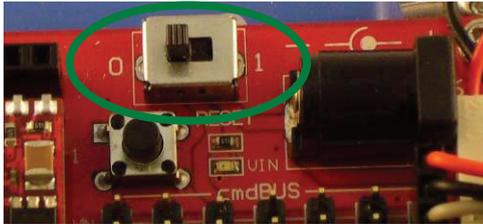

B_3. **Connect the power line of the servo to the power supply (Please make sure that the voltage and current from the power supply are within the range required by the servo. After connecting the power line, the servo will make a transient motion due to receiving the switch surge, which is normal. While connecting the power cord, please pay attention not to place your hands within the space where the servo will move into to avoid being clamped.)**
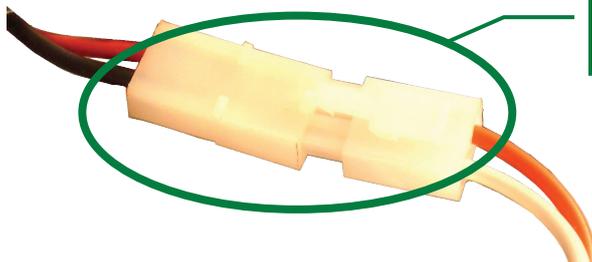
While connecting the power line, please notice the polarity. Connect the two red wires together.

B_4. **Start InnoBASIC™ Workshop**

Click the application under the innoBASIC Workshop folder to start the innoBASIC Workshop.

B_5. **Click "Tools" in the menu bar on the top**
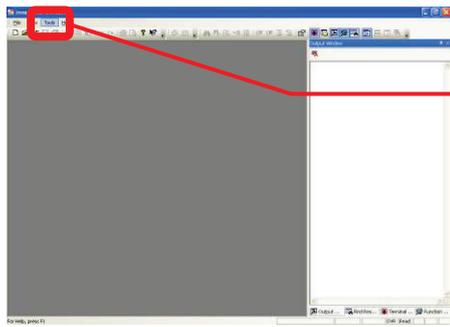
After clicking each item, a pull-down menu with more function items will be displayed. Please click the "Tools" item now.

B_6. **Click the "Motion Editor" in the pull-down menu (If a warning window appears, it means that the BASIC Commander® is not correctly connected. Please check if the USB cable is connected or unplug and then plug it again to ensure a correct connection. Exit the Motion Editor and then re-click this button.)**
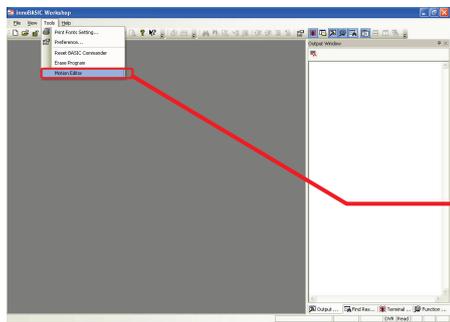

Click "Motion Editor" to start the Motion Editor.
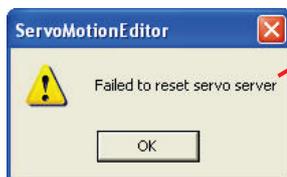
If this message appears, it means that the USB cable is not connected correctly.

B_7. **If the connection is correct, the message "Downloading servo manager..." will be displayed on the PC screen meaning that the program is being downloaded. Please poke the DIP switch on the Command Board to the 1 position and wait a moment.**
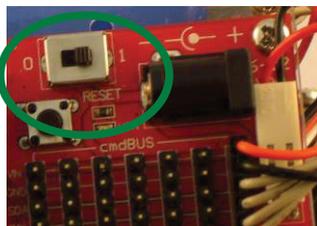
The message means that the program is being downloaded. Please do not remove the USB cable.

B_8. **After the downloading is complete, a notification window will appear. Please make sure that each servo has been connected correctly. After confirming all the connections, please click "OK". (If "Cancel" is clicked, the Motion Editor will be closed. If there is any component is incorrectly connected at this moment, please click "Cancel" to terminate the program.)**

The message appears for notifying the download is complete. Please make sure that the servos have been connected correctly at the specified positions.

B_9. Please pay attention not to place your hands within the space where the servos may move into to avoid being clamped. Please check the checkbox for activating the servos on the left side to move all the servos to their central points. Please note that the number next to it should be 1500. If it is not 1500, please click the number directly, enter the number 1500 and then click "Enter".
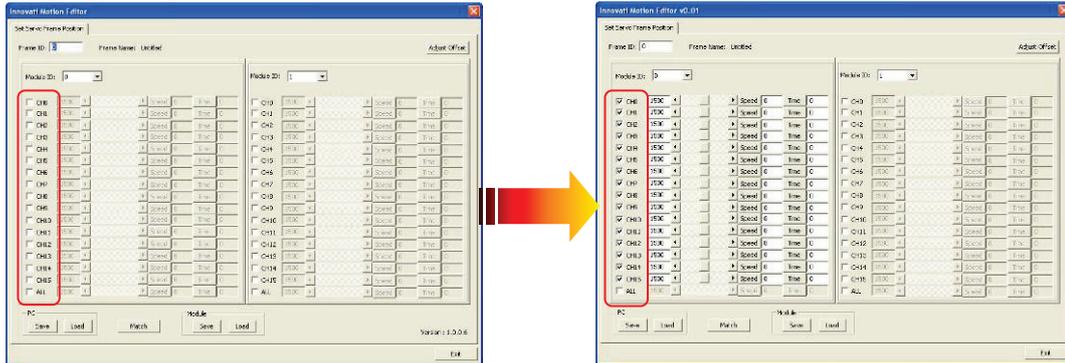
B_10. Click the "Adjust Offset" button at the upper right corner.
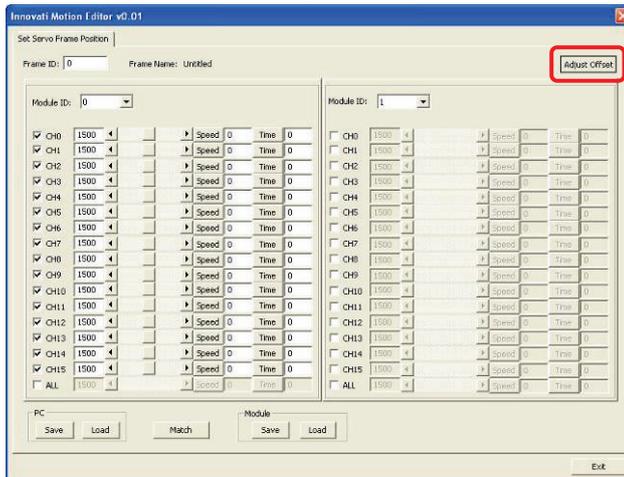
B_11. If the fine tune values are not yet stored, the Filename will be "Untitled". The user can specify a preferred name while storing the file.
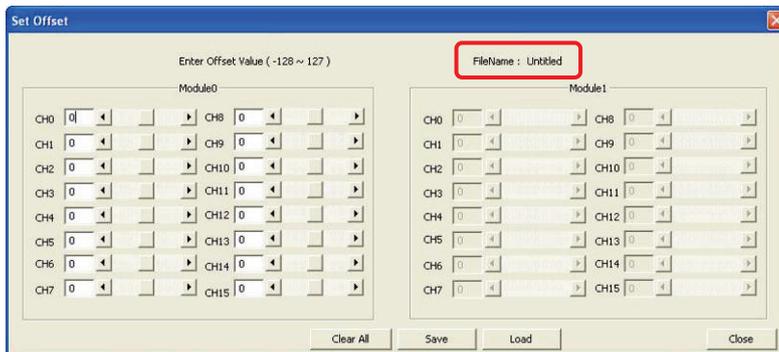
B_12. Observe the servo that requires the fine tune and click the corresponding arrow buttons. The servo will rotate in the selected direction. Please make

sure that the rotation is in the correct direction. If the reverse rotation is required, click the opposite arrow button. Adjust each servo to its central point one by one.
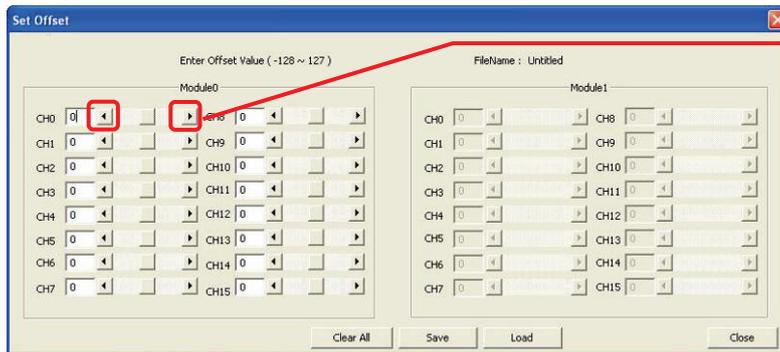
The left/right arrow buttons can be used to rotate the servo clockwise or counterclockwise. Please observe the rotation of the servo to the required central position. Then adjust the next servo.

B_13. **Please note the values after fine tune. Click "Save", select the location for storing the file, enter a preferred filename, and then click OK to save the values in the PC. If it is required to query or download the values, click "Load" to read out the values.**
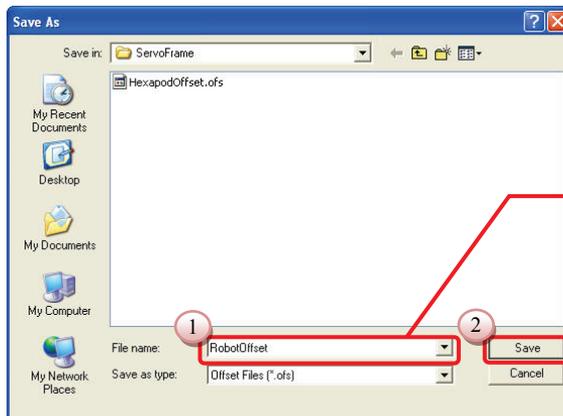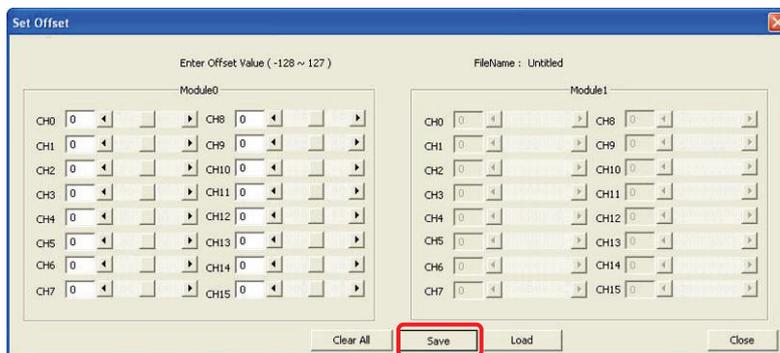
Please enter a preferred name in the "File name" and then click "Save".
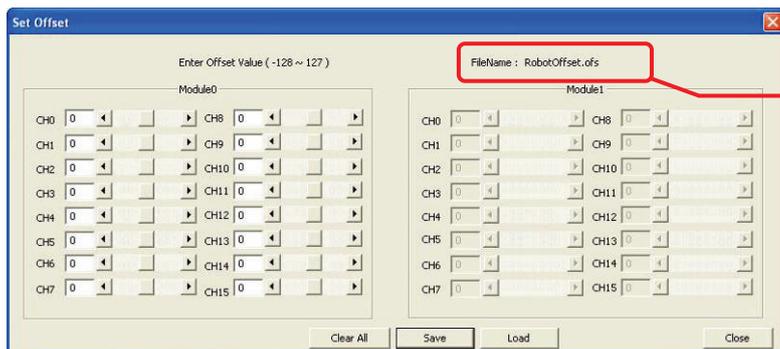
After the file is successfully stored, the filename of the last stored file will be displayed in the "Filename".

B_14. **Click the "Close" button at the lower right corner to close the window.**
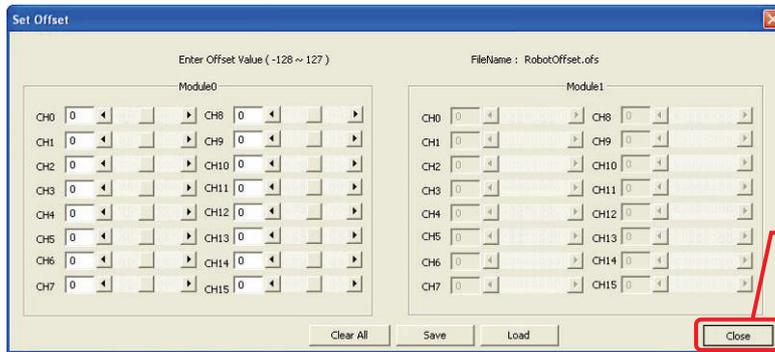
Click the "Close" button to close the window.

B_15. After returning the "Edit Servo Motion" window, click the "Exit" button at the lower right corner to close the fine tune operation.
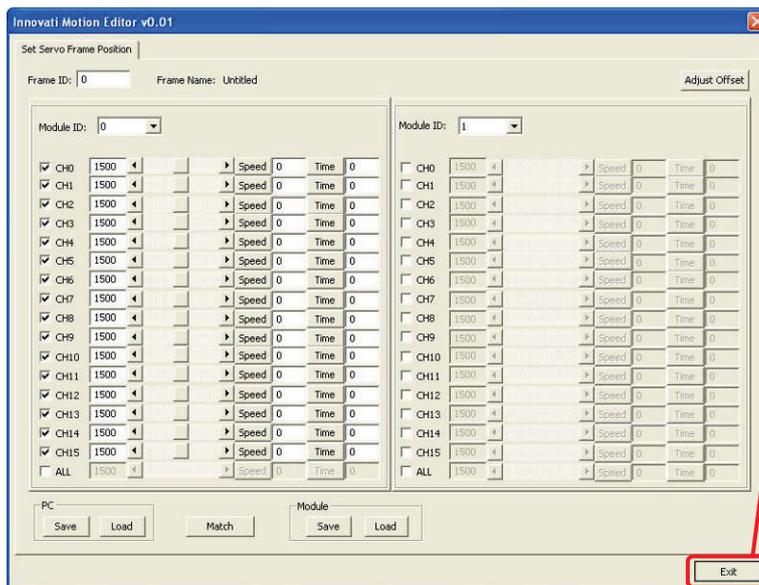
Click the "Exit" button to close the Motion Editor.

iv.   Perform Demonstrative Motions

**4_1. Please copy the folder "12-DOF Bipedinno Doc" to the PC.**

**4_2. In the InnoBASIC™ Workshop, click "Tools" in the menu bar on the top.**
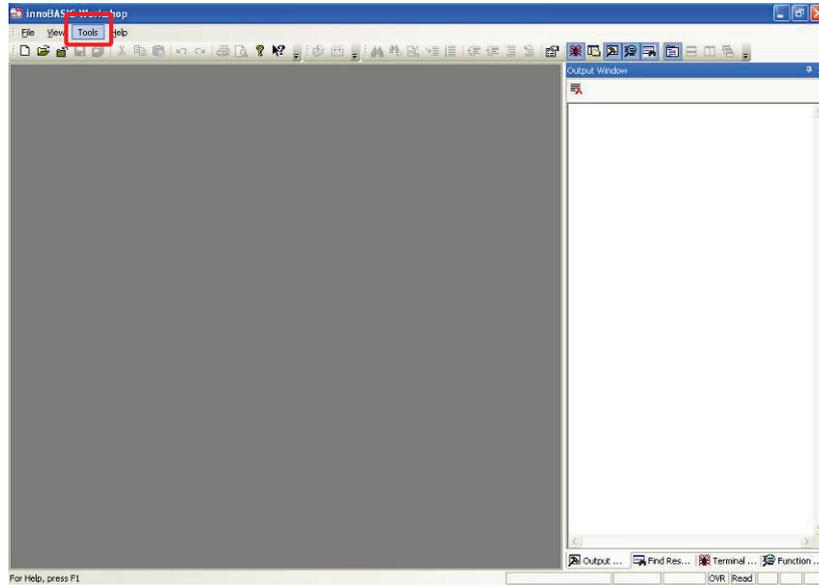

4_3. Click "Motion Editor" in the pull-down menu.
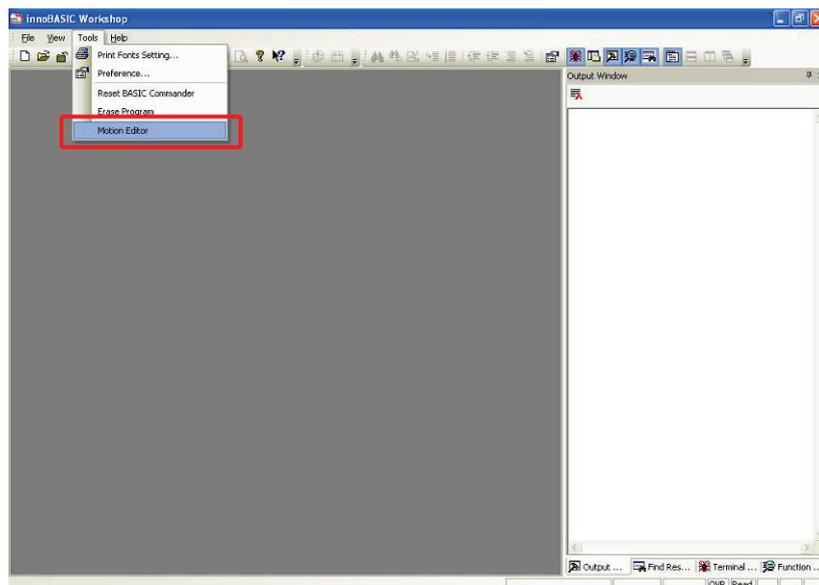
4_4. Click the button "Match" at the bottom of the Motion Editor.
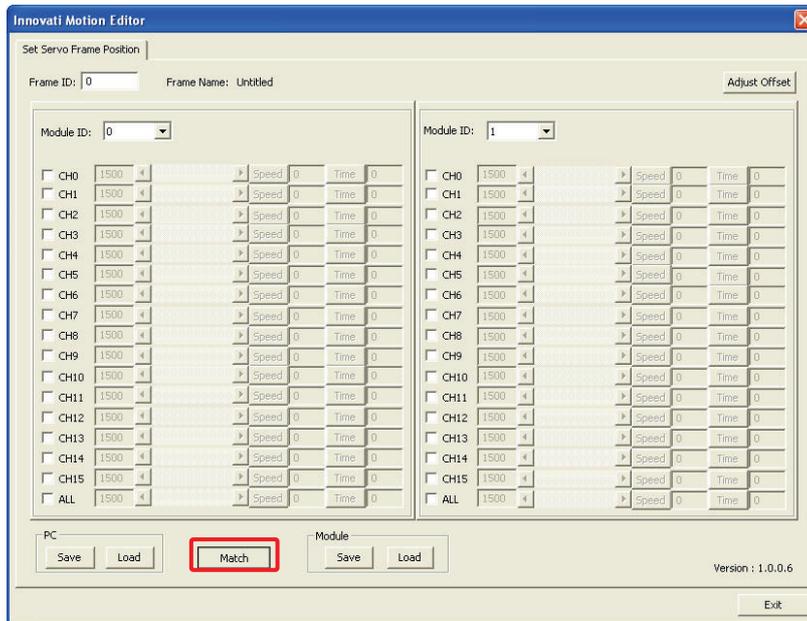
4_5. Click the "Browse" button at the lower left corner.
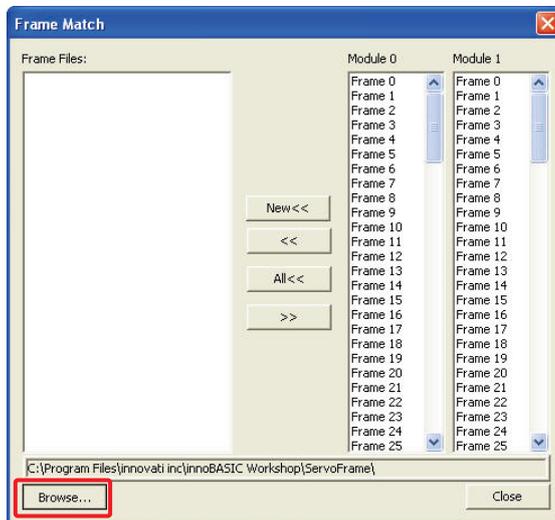
4_6. Set the "Browse for Folder" location to the "12-DOF Bipedinno frame" folder under the "12-DOF Bipedinno Docs" folder and then click the "OK" button.
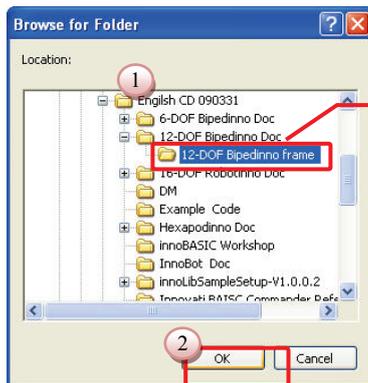
The selected folder will be highlighted. Please make sure that the selected folder is "12-DOF Bipedinno frame".

4_7. Please click the "12-DOF Bipedinno frame0.frm" below the motion files on the left side, click the "Frame 0" under the "Module 0"and then click the ">>" button.
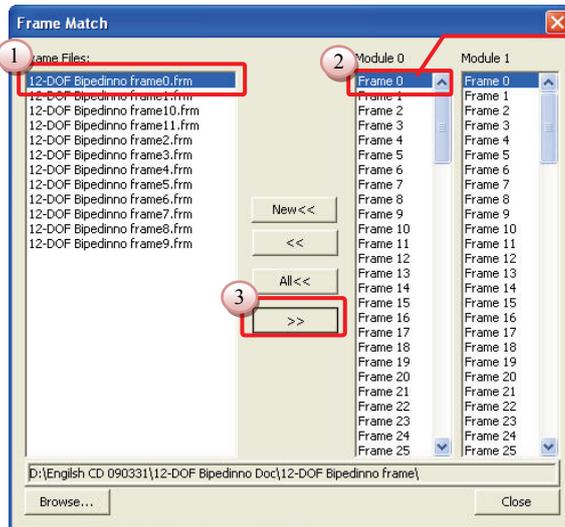
Before clicking the ">>" button to download the motion file into the module, please make sure that the "Frame 0" under the Module 0 has been selected and highlighted.

4_8. Make sure that the "Frame 0" below the Module 0 has become "12-DOF Bipedinno frame0.frm".
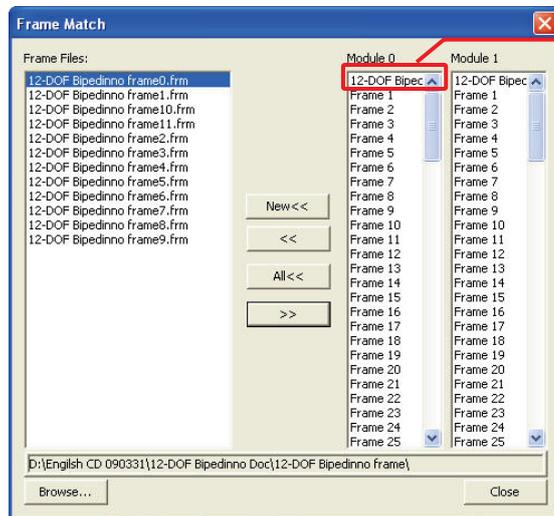
After the download is complete, the original text "Frame 0" will turn into "12-DOF Bipedinno frame0.frm ".

4_9. Now click the "12-DOF Bipedinno frame 1" below the "Frame Files" and "Frame 1" below the "Module 0" as the two steps describe above. Repeat the operation for all the motions till Frames 0-11 have been downloaded to the corresponding frames.
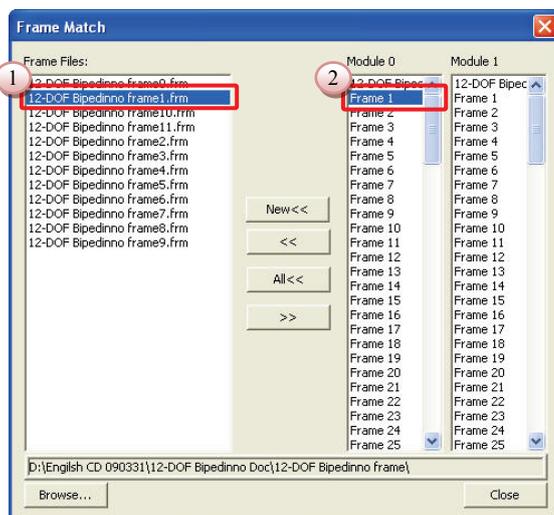
4_10. After all the download operations are complete, it is clear that all the motions above "Motion 12" and below the "Module 0" have been changed to the

corresponding motions.
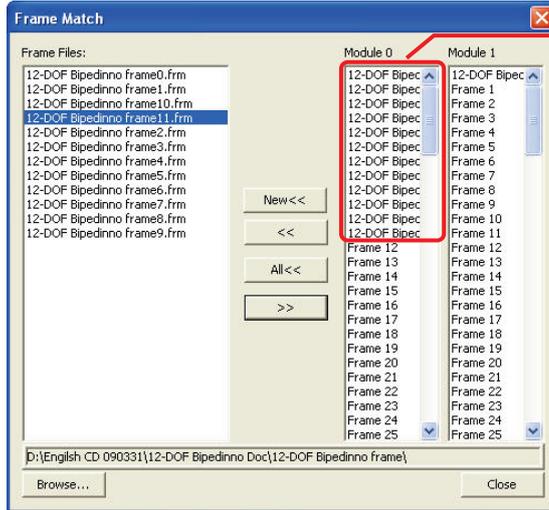
Please make sure that first 12 Frames have been successfully downloaded.

4_11.After the verifying the operations, click the "Close" button at the lower right corner to close the window for setting the corresponding motions.
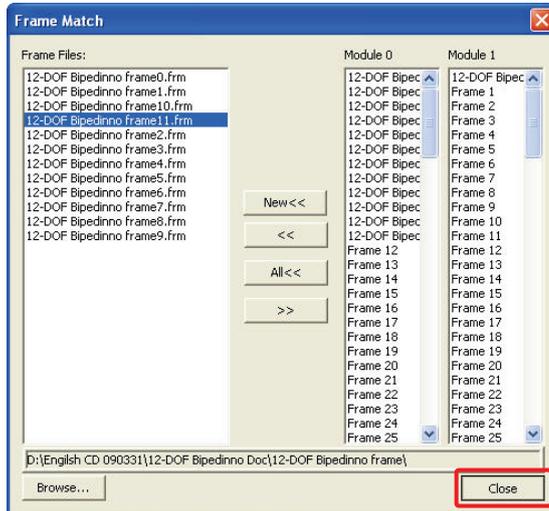

4_12.In the Edit Servo Motions window, click the "Exit" button at the lower right corner to close the Motion Editor.
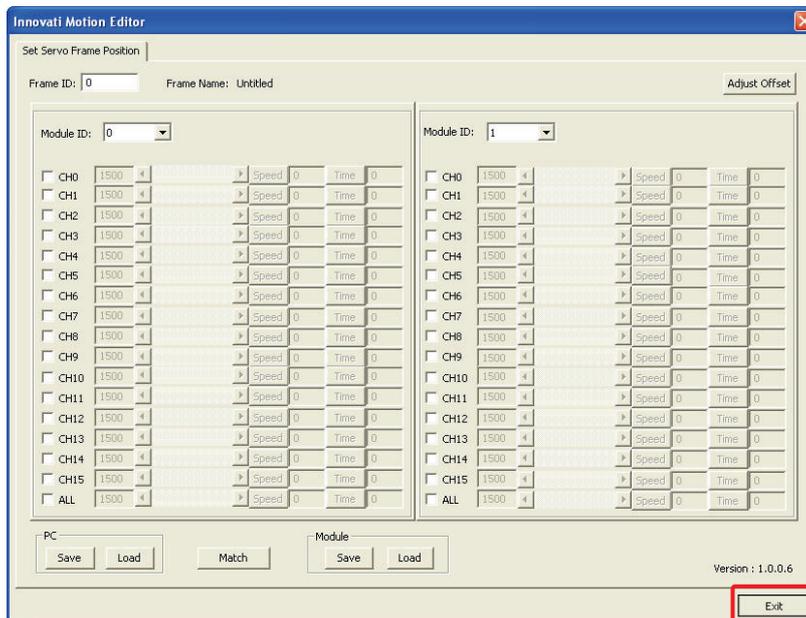
4_13.Click "File" in the menu bar and click "Open".
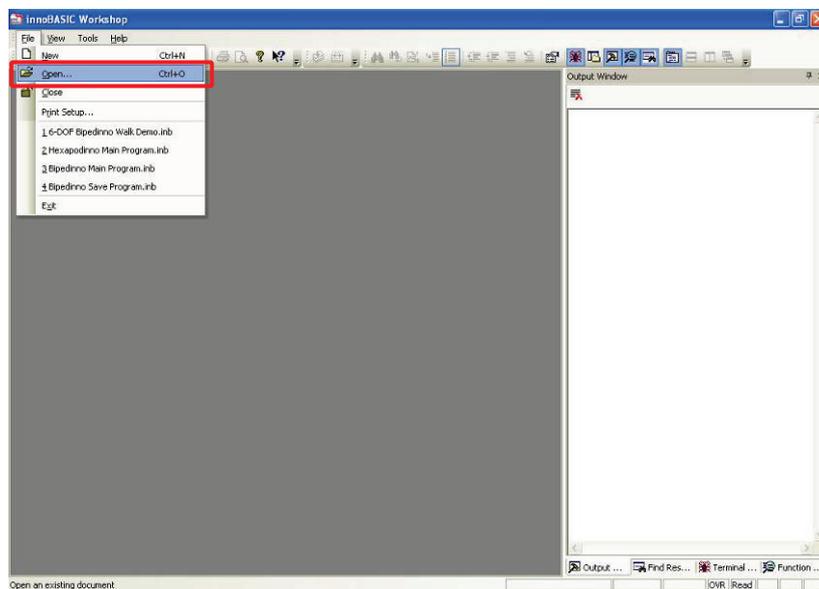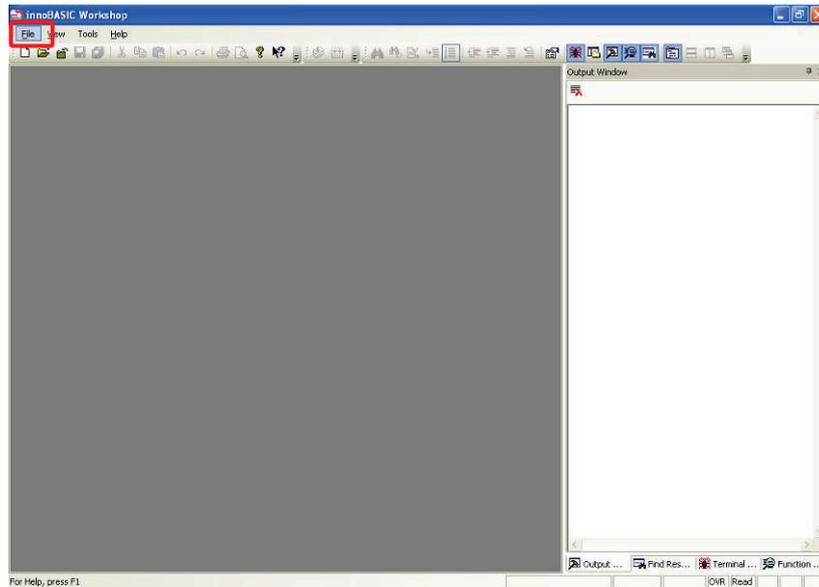
4_14.Please select the "12-DOF Bipedinno Walk Demo" in the folder and click "Open".
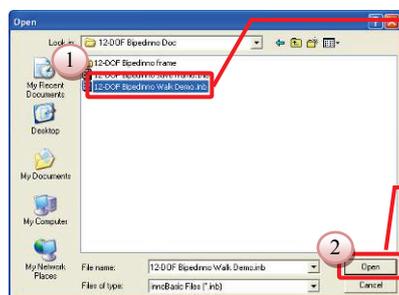
The selected folder will be highlighted. Please make sure that the selected folder is "12-DOF Bipedinno Walk Demo".

Click the "Open" button to download the program into the innoBASIC Workshop for editing or creating motions.

4_15. Move to the 27th line of the program to see the Initial Function. (To move within the program, the user can also click the mouse button at any position in the program and then rotate the mouse wheel to scroll the program page.)

The number on the left side represents the line number of the program. The Function starts at "Sub" and ends at "End Sub" within which the operations are defined to store the fine tune values into the module. At the beginning of each program, it is necessary to set the fine tune values.

4_16. Update the fine tune values, which are recorded during the software fine tune, into the Initial Function to replace the original values of "0".


The SetPosOffset command has two parameters: one is the Servo ID and the other is the fine tune value. Please enter the fine tune value according to the value recorded for each servo ID. The number in the figure is arbitrarily defined, Please do not enter the same number as shown in the figure.

4_17. Poke the DIP switch from the 1 position to the 0 position to prevent the robot from starting the motion directly after the program is successfully created.

4_18. Press the "Build" button and wait until the download is complete.
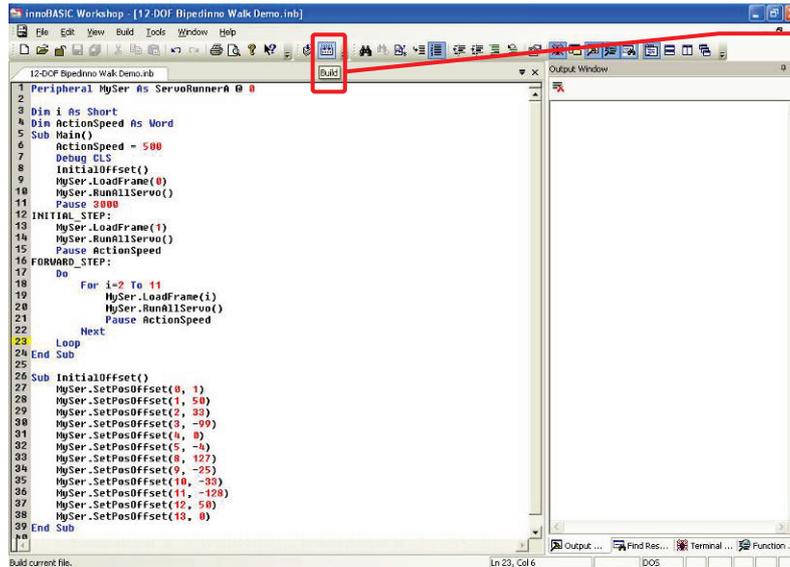
If the user is not sure about the function of each button, the user can move the mouse pointer over the image. After a while, the English name will automatically appear. After click the "Build" button, the program will be downloaded into the BASIC Commander® and stored automatically.

According to the layout, the "Build" button may appear at different position.
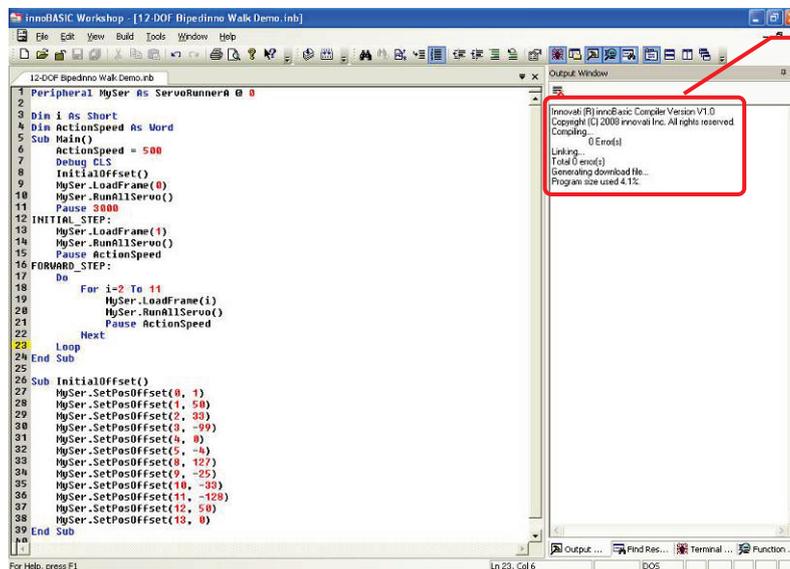
After the download is complete, the output window will display the used memory space. If there is any error, it will be displayed in the output window. Please make sure that no error is displayed in the output window.

4_19. Remove the USB cable that has been connected to the robot and place the robot at a location prepared for performing the motion operations.

4_20. Poke the DIP switch from the 0 position to the 1 position. The robot will perform a forward movement according to the demonstrative program.