

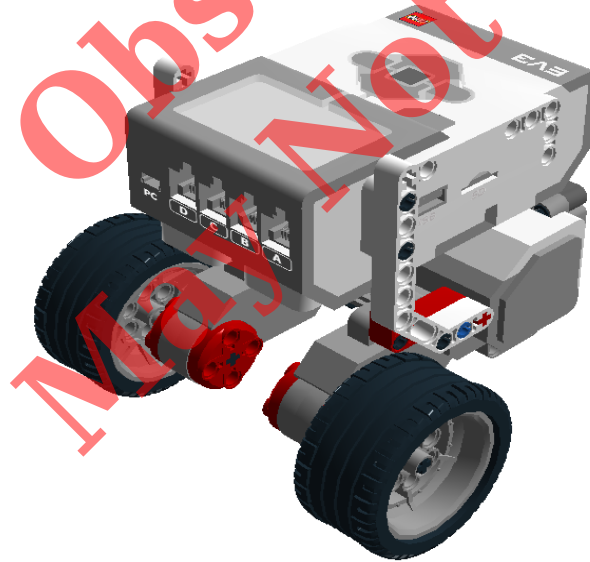
App Inventor + IoT:

Lego EV3 robot Button Control



(including robot assembly)

Level: advanced



## Introduction

This tutorial demonstrates how to control your Lego EV3 robot with buttons, right from your phone. There are five buttons to make the robot move forward, backward, turn right, turn left and stop. You can also drag the slider to adjust motor power.

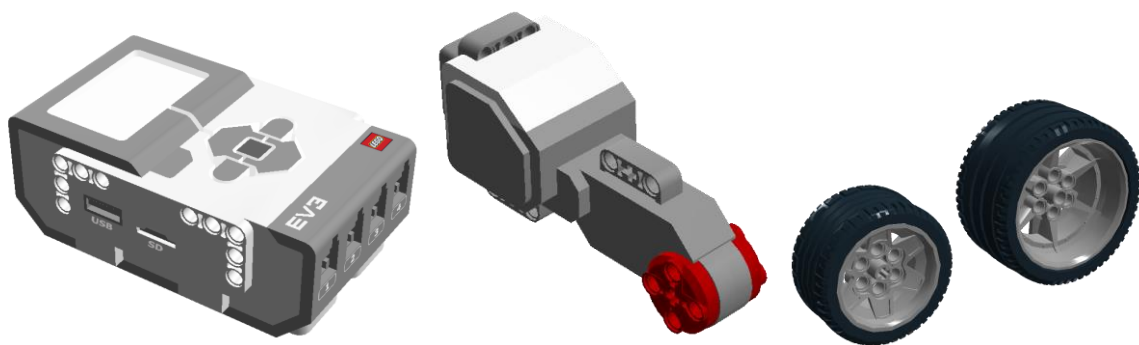
**Notice:** You don't have to write a program for the EV3, just power it on and pair with your Android phone. App Inventor's EV3 components can talk to Lego EV3 brick with a special protocol called [Lego EV3 Direct Command](#). These commands are actually byte arrays which can be executed directly by Lego EV3 bricks. Lego EV3 components were developed by CAVEDU Education and merged to official AI2 in 2016.

- [Source .aia](#)
- Reference: [Sensor Panel of Lego EV3 Robot](#)

## Basic dual-wheel robot platform

Core component of this project:

1. Lego EV3 intelligent brick, x1
2. Lego EV3 motor, x2
3. Wire, x2
4. rubber tires, x2
5. Lego parts



Please assemble your robot like Figure 1, if you are not familiar with Lego brick, [please check this assembly tutorial](#) (use lesser parts) or [Lego Official TRACK3R building tutorial](#) (use far more parts). If your robot looks a little different, that's fine. Just make sure the two motors (attach to port B and C) are on the opposite side of robot. This kind of robot base is called a **differential drive platform** because the robot's behavior can be easily adjusted according to the motor speed. For instance, the robot will go forward with both motors moving at the same speed and will turn right with the left motor moving a little slower than the right motor.

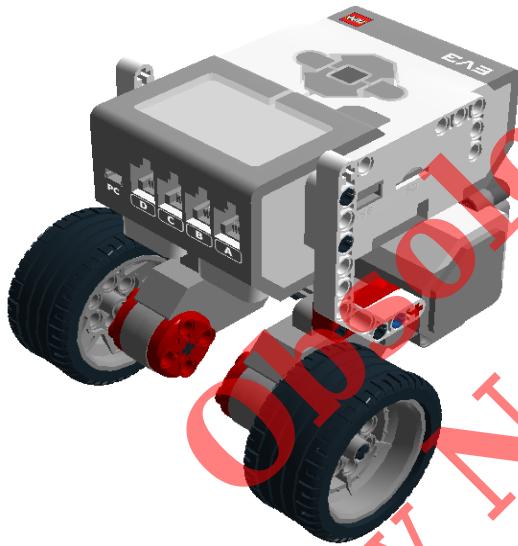


Figure 1a. dual-wheel robot platform



Figure 1b. Use tracks to make your robot cooler (Image source: Lego.com)

Take a look of a real cool Lego robot!

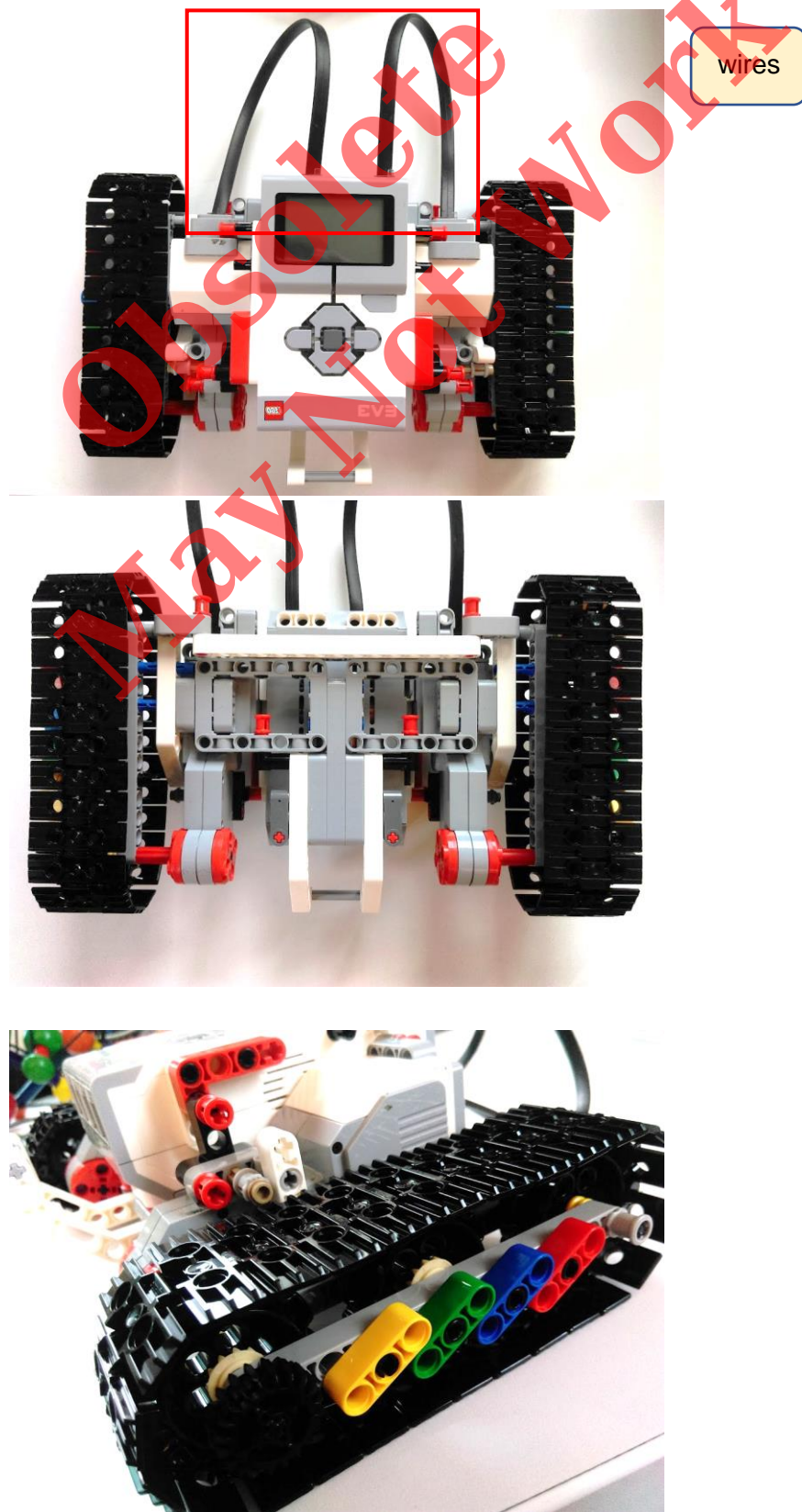


Figure 1c~1e. physical photo of Lego track robot.

This robot does not need any sensors. Power on your EV3 and pair it with your Android phone (default key: **1234**). You can check whether the robot's EV3 is on with the Bluetooth icon at the upper-left screen corner.



Figure 1c, 1d. Check EV3 Bluetooth is turned on.

## App Inventor

Now log into [MIT App Inventor site](https://appinventor.mit.edu/) and create a new project.

## Designer

In the Designer page of App Inventor platform, please add these components and place them as shown in Figure 2. For details, please refer to Table 1.

For connection, the **ListPicker** selects a paired Bluetooth device, your Lego EV3 in this case. A **Disconnect** button closes the Bluetooth connection with Lego EV3.

There are five buttons to make robot move forward, backward, turn left, turn right and stop. We also add a slider to adjust motor power (0~100). Once you have those working, try making up a few of your own!

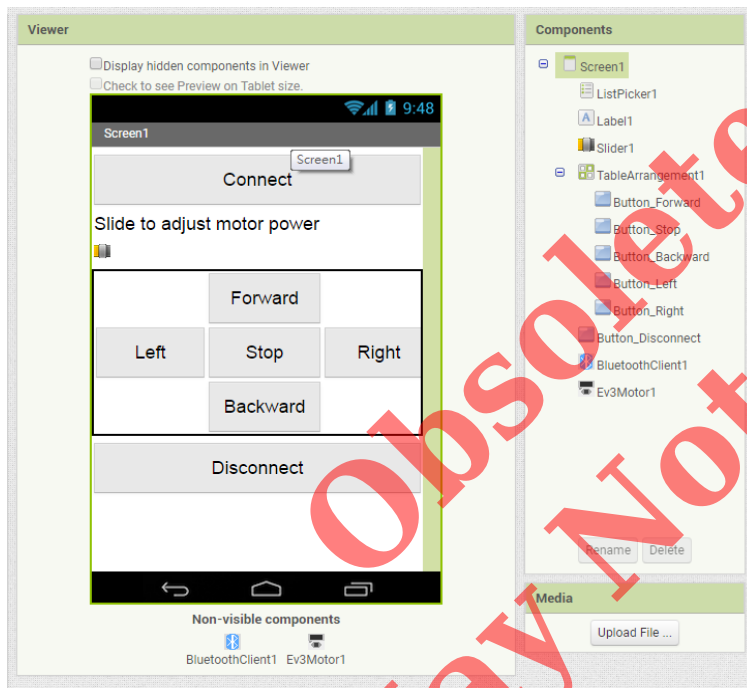


Figure 2. Designer

Table 1. Required components of this project

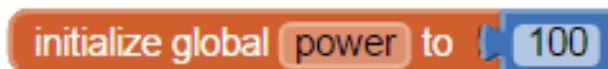
Name	Palette	Settings	Description
ListPicker1	User Interface	set Text to <b>"Choose your EV3"</b>	
Label1	User Interface	set Text to <b>"Slide to adjust motor power"</b>	
Slider1	User Interface		
TableArrangement 1			
Button_Forward	User Interface	set Text to "↑"	Click to make robot go forward.
Button_Backward	User Interface	set Text to "↓"	Click to make robot go backward

Button_Left	User Interface	set Text to "←"	Click to make robot turn left.
Button_Right	User Interface	set Text to "→"	Click to make robot turn right.
Button_Disconnect	User Interface	set Text to "Disconnect"	Click to disconnect from EV3 brick.
Ev3Motor1	LEGO® MINDSTORMS®	set BluetoothClient to <b>BluetoothClient1</b>	Control and get status of Ev3 Motor, MotorPorts is <b>BC</b> .
BluetoothClient1	Connectivity	No need to change	Communication between AI2 and Lego EV3 brick

## Blocks

### STEP1 Initialize variable for motor power:

First we use a variable (give a name of **power**) to represent motor power, with initial value 100. User can adjust its value by dragging slider back and forth to change its value from 0 and 100, and further control motor power.



### STEP2 ListPicker for connecting Lego EV3

We use a ListPicker to show paired devices with your Android device and connect to it by selecting in the Listpicker. This is a better approach and less chance of type error for user to input EV3's bluetooth address in a TextBox.

Before we click the Listpicker, we must set its elements first(**ListPicker1.BeforePicking** event). Here we have to set its element to paired devices (**BluetoothClient1.AddressAndNames**).



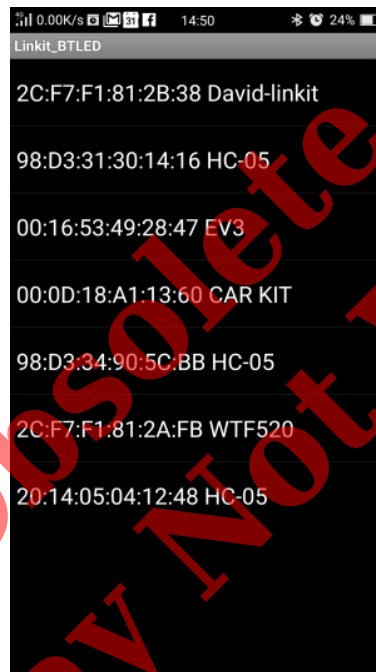


Figure 3a. Initialize and what's inside the ListPicker

Click to open the ListPicker, we are going to connect (**BluetoothClient1.Connect**) our paired EV3 by selecting it (**ListPicker1.AfterPicking**). If connect successfully, **Listpicker** will be disabled, but other buttons will be enabled for the user to operate.

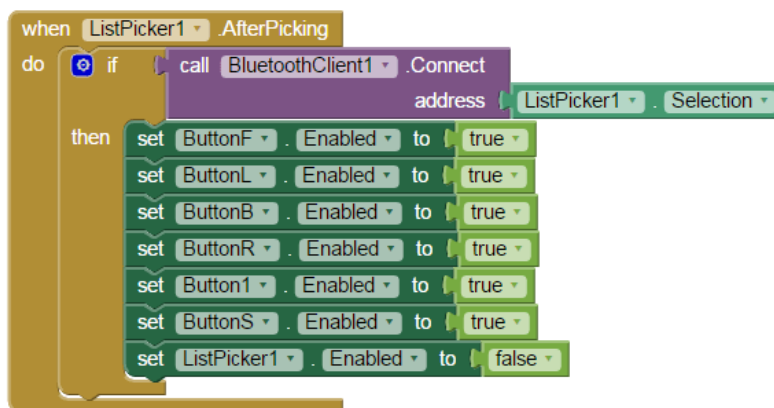


Figure 3b. Select an item to connect to Lego EV3

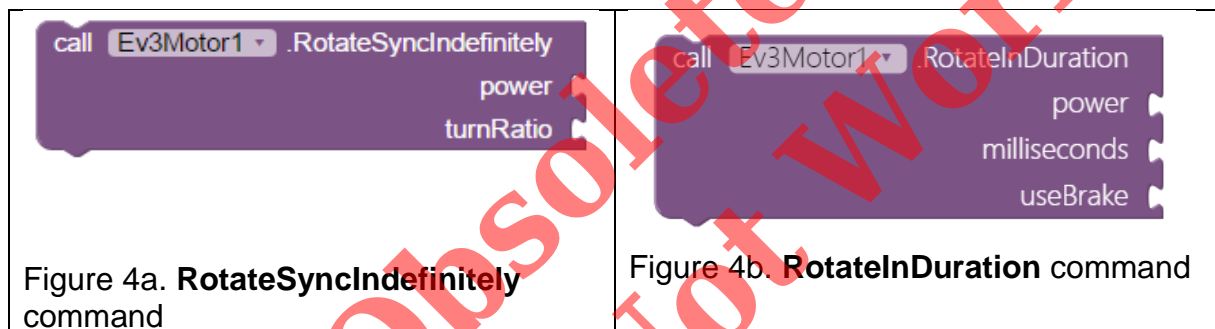
### STEP3 Forward and Backward button:

There are four buttons: Forward, Backward, Left and Right

Except for Button Stop, the buttons call **Ev3Motors1.RotateSyncInDuration** command when clicked, with different **turnRatio** and **power**. Take **Button\_Forward** for instance: we have these parameters: **power** variable, **2000**(millisecond), **0** (means two motor with same speed and **true** (break when execution complete).



Typically, clicking the button activates the robot to do certain action continuously, you can change this command to **RotateSyncIndefinitely** command to ask robot to do something for a certain duration of time (like 2 seconds).



For **Button\_Backward**, we multiply the variable **power** by -1 to make motors turn in the opposite direction (but with the same power level). Your robot will then move backwards (Figure 5).

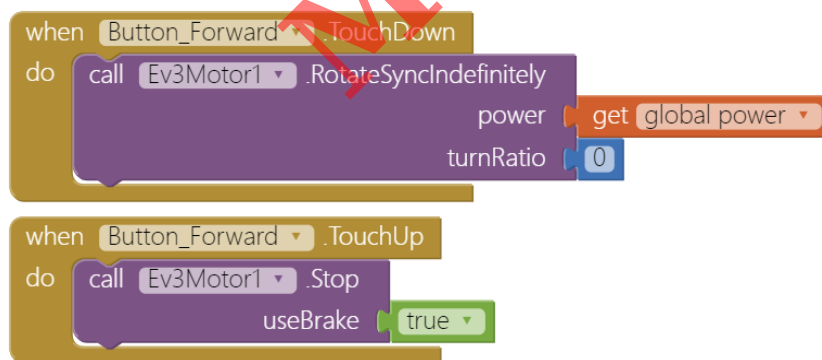


Figure 5a. Forward and backward.

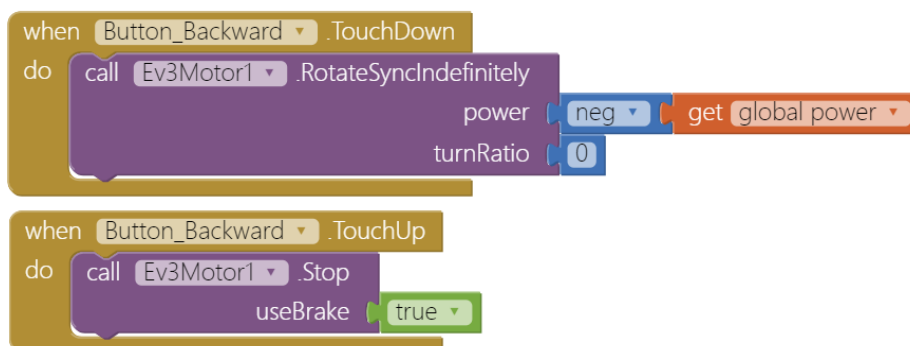


Figure 5a. Forward and backward.

**STEP3 Left, Right turn buttons:**

**Button\_Left** and **Button\_Right** are almost the same, but this time we set **turnRatio** to **-80** (turn left) and **80** (turn right). You can set **turnRatio** to higher value(max is 100) to make a very sharp turn.

Note:An zero **turnRatio** value means go straight.



Figure 6. Turn left, right

#### STEP4 Slider to control motor speed

In **Slider1.positionChanged** event, we set the power variable to the slider's thumb position, therefore the motor power is changed as well (0~100).

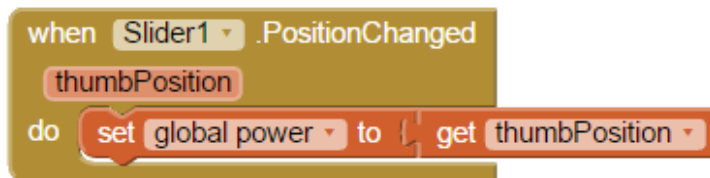


Figure 7. Set power variable to slider's thumb position.

#### STEP5 Disconnect:

When **Button\_Disconnect** is pressed (**Button\_Disconnect.Click** event), we tell **BluetoothClient** to disconnect from EV3 brick and set all buttons and listpicker to original status, ready for the next connection. Like Figure 7.

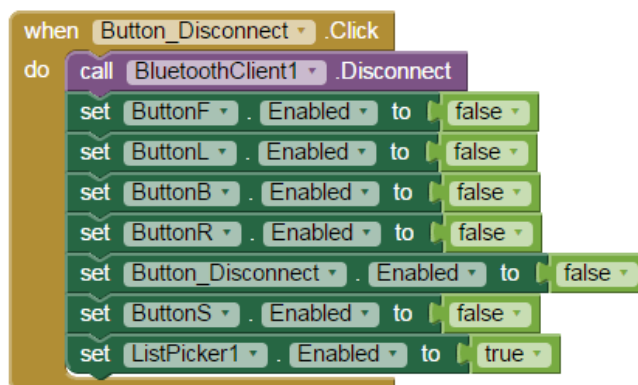


Figure 8. Disconnect from Bluetooth device

## Play

Once you have paired your device with EV3 robot, then press its power button and check that the EV3's BT is switched on. Press the [**Choose your EV3**] listpicker and choose the name of the paired EV3, then all the control buttons will be enabled to click. Please click each button to see how robot moves and also drag the slider to adjust motor power.

## Tips

App starts up like Figure 9, please click **Connect** ListPicker and select your EV3 (figure 10). Click and connect successfully, you can click the five buttons in the middle of the app to control your robot. Enjoy!

Click Disconnect button to close the Bluetooth connection with EV3,

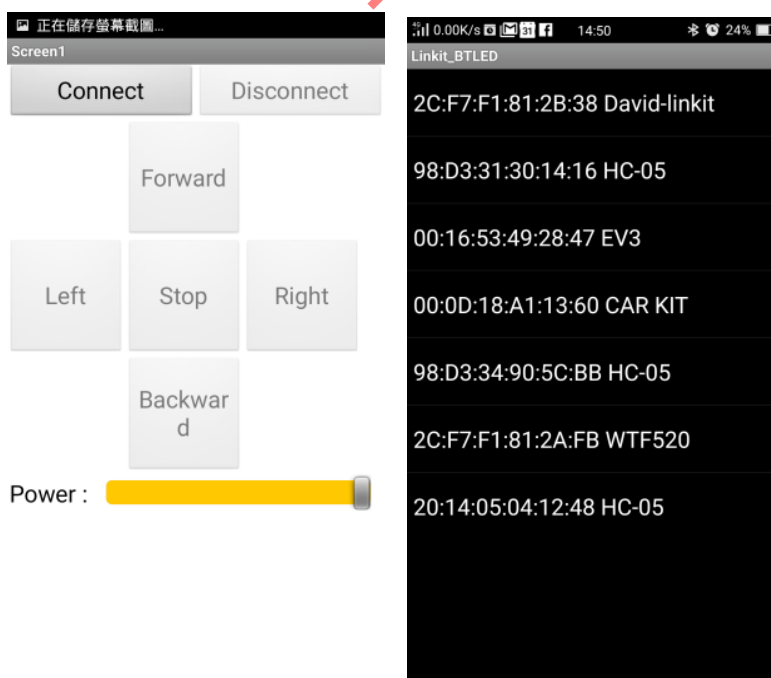


Figure9. 10 Start screen and select EV3

## Brainstorming

1. Build a maze, see if you can drive your robot to conquer the maze.
2. Modify the **turnRatio** parameter and see how robot turns.