

Connecting a LEGO SPIKE Prime to Vuforia Spatial Toolbox on MacOS

Estimated time to complete

30-60 minutes

Requirements

LEGO SPIKE Prime Hub & LEGO build
LEGO Education product feedback pamphlet
LEGO Education SPIKE app
Computer with Bluetooth capabilities
Vuforia Spatial Toolbox compatible device
Vuforia Spatial Edge Server download from GitHub
Vuforia Spatial Toolbox app

Before diving into this portion of the project, it would be beneficial to get acquainted with the capabilities and functions of the Vuforia Spatial Toolbox. Starting at the [home page](#), review the following materials:

1. [What is Vuforia Spatial Toolbox?](#) YouTube video
2. [Getting Started with the Vuforia Spatial Toolbox](#)
3. [Getting Started](#) guide for using Vuforia Spatial Toolbox
4. [Spatial Tools](#) page documenting each spatial tool that can be used
5. [Spatial Programming](#) page for using Logic Nodes and each of its related pages for [Logic Blocks](#) and [Example Programs](#)

Feel free to explore the rest of the website as well, but these are the materials that will be critical to completing this part of the project.

Additionally, the LEGO SPIKE Prime Hub will need to be connected to the LEGO Educational SPIKE App to establish an initial connection. Open the app and become familiar with the capabilities of the LEGO SPIKE Prime. Learn how to connect it to Bluetooth with the beginning tutorials within the SPIKE app.

Font Notes:

- All code to be typed in Terminal is designated by `text following this convention`
- All important notes are in ***bold italics***
- All folder names are in *italics*
- All file names are underlined
- All buttons/areas that need to be clicked are in "quotations"
- All section headers are **bold**
- All references to other portions of the project are **bold and underlined**
- Hyperlinks are [blue and underlined](#)

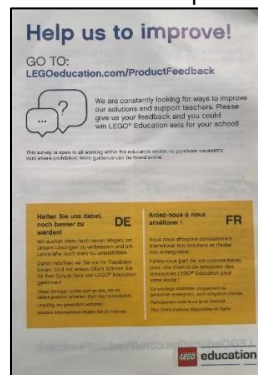
Getting Started

This portion of the project will teach how to connect the LEGO SPIKE Prime set to Vuforia Spatial Toolbox. It will start out by providing steps for connecting the SPIKE Prime to the Vuforia Spatial Edge Server and then move into allowing the SPIKE Prime to be controlled by the Vuforia Spatial Toolbox app with the help of an image target.

Image Target

A key part of using the Vuforia Spatial Toolbox is an image target. This allows the app to scan a predetermined image that will signal the server to display an AR overlay onto the physical world as viewed through a mobile device or tablet. For this project, the feedback pamphlet that comes in each LEGO SPIKE Prime box will be used as the image target. ***This image has already been preconfigured in the Vuforia Spatial Edge Server that has been downloaded. If the pamphlet is not accessible, save the image below as a standalone picture and print it out and use it as the image target.***

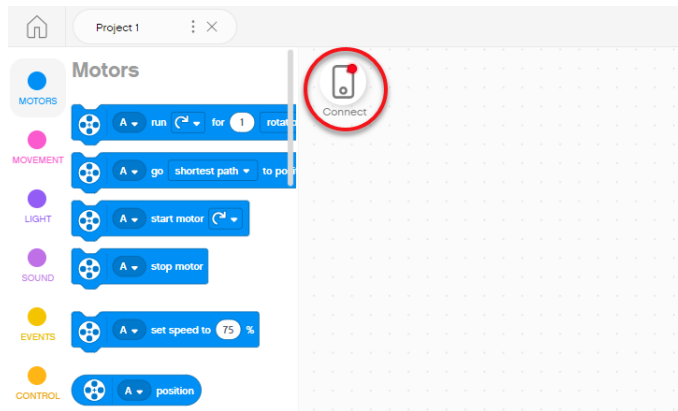
- If printing out the image is not an option, the pamphlet image will also scan off the computer monitor
- Resources for creating new image targets are in the **Appendices and Additional Resources** PDF for this project, though it is recommended that the SPIKE Prime feedback pamphlet is used if possible



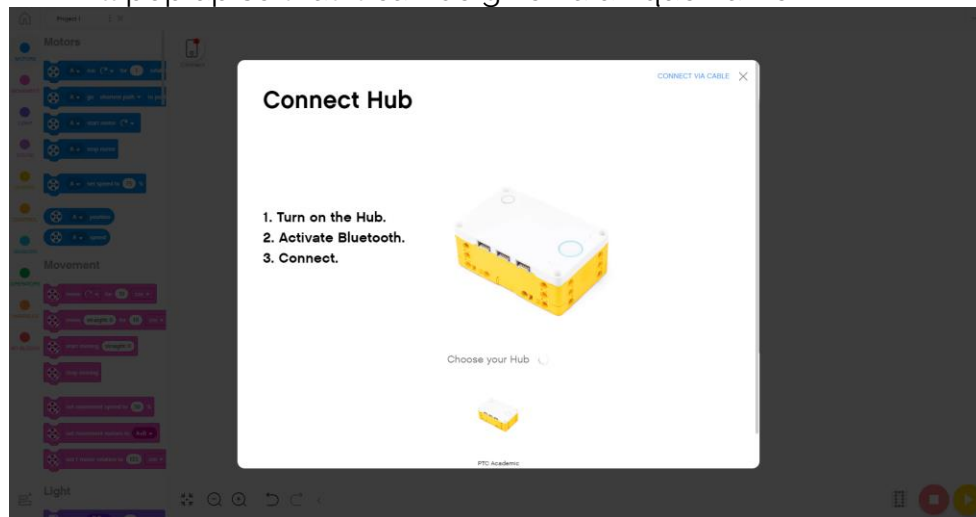
Connecting the LEGO SPIKE Prime Hub to a computer

When using a SPIKE Prime for the first time, it needs to be connected to a computer for it to be named, which plays a key part in connecting it to Vuforia Spatial Toolbox. This section will explain how to start the initial connection of the SPIKE Prime Hub.

1. Open the LEGO Educational SPIKE app and click “New Project” to start a new project. Choose the “Word Blocks” option, even though there will not be any coding inside of this interface.
2. Click the “Connect” button at the top of the page and turn on the SPIKE Prime Hub.



3. Ensure that the computer has Bluetooth enabled and choose the "CONNECT VIA BLUETOOTH" option at the top right-hand corner of the pop-up window
4. Turn on the SPIKE Prime Hub
5. Hold down the Bluetooth button on the corner of the Hub until it starts beeping and lights up
 - Make sure that the SPIKE Prime Hub is within range of the computer, otherwise it will not be able to connect
6. If the SPIKE Prime Hub can connect to the computer, it will show up on the screen as a nearby Hub and will be recognized as a device by the computer
 - If this is the first time that the Hub is connected to the app, a prompt will pop up so that it can be given a unique name



7. ***Once the SPIKE Prime Hub has been connected successfully, close out of the SPIKE app to avoid interference when connecting with Vuforia Spatial Toolbox***

Connecting the LEGO SPIKE Prime to Vuforia Spatial Toolbox

The following steps will describe the procedure of connecting a LEGO SPIKE Prime to Vuforia Spatial Toolbox via the Bluetooth connection on a computer and the Vuforia Spatial Toolbox mobile app. All code will be run in Terminal.

1. Turn on the LEGO SPIKE Prime if it is not already on

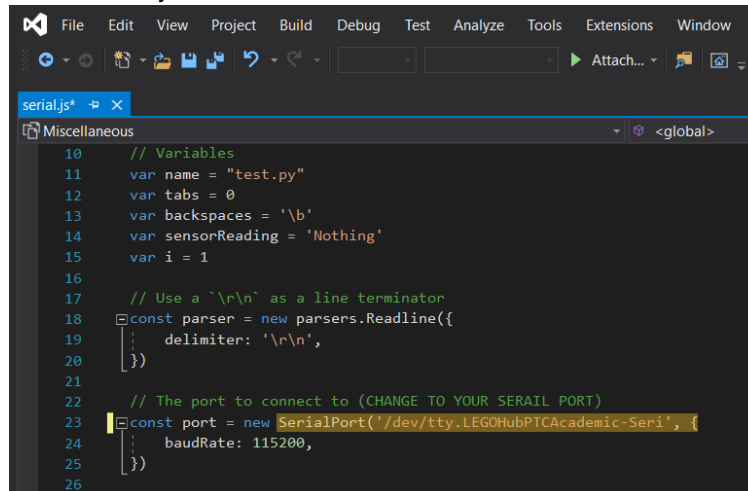
2. Go to "System Preferences" and click on "Bluetooth". Ensure that Bluetooth is turned on. Press down the Bluetooth button on the LEGO SPIKE Prime and wait for the computer to recognize it. Pair the LEGO SPIKE Prime with the computer.
3. Open a new Terminal window. This is where all commands to start the Vuforia Spatial Edge Server will be executed.
4. Type `ls /dev/tty.*` and hit the enter key until the Bluetooth ports that are being used are displayed.
5. Find the serial port that starts with "tty.LEGOHub" and copy the full name of the port.

```
Jacobs-MacBook-Pro:~ jacobdelano$ cd /dev/tty
(Display all 132 possibilities? (y or n)
tty          ttyse
tty.Bluetooth-Incoming-Port  ttysf
tty.LEGOHubPTCAcademic-Seri ←
ttypp0       tttyt1
ttypp1       tttyt2
ttypp2       tttyt3
ttypp3       tttyt4
ttypp4       tttyt5
ttypp5       tttyt6
ttypp6       tttyt7
ttypp7       tttyt8
ttypp8       tttyt9
ttypp9       tttyta
ttyppa       tttytb
ttyppb       tttytc
ttyppc       tttytd
ttyppd       tttyte
ttyppe       tttytf
ttyppf       tttyu0
ttyqq0       tttyu1
ttyqq1       tttyu2
ttyqq2       tttyu3
```

- **Troubleshooting note:** If this serial port cannot be found, open the LEGO Educational SPIKE app.
 - Unplug the LEGO SPIKE Prime from the computer if it is plugged in
 - Turn the SPIKE Prime off and then back on
 - Open a new project and select the "connect" button in the upper left-hand corner of the screen
 - Select "Connect via Bluetooth" in the upper right-hand corner of the window that pops up.
 - Follow the instructions from LEGO for connecting via Bluetooth
 - Be sure to close the LEGO SPIKE Prime from the app after connecting. This will block communication with the server if not disconnected.
 - Repeat the steps above.
- 6. Open the `serial.js` document inside of the folder path `SpatialToolbox-Mac-Interns/vuforia-spatial-edge-server/addons/vuforia-spatial-robotic-addon/interfaces/SPIKE-Prime`.
 - Go to line 23 of `serial.js` and replace the serial port with the one that was just copied that starts with `tty.LEGOHub`. This is the string directly after `SerialPort(`. For example, the code at line 23 that was used when making this tutorial was `const port = new`

`SerialPort('/dev/tty.LEGOHubPTCAcademic-Seri', {`, where `PTCAcademic` is the distinct name that was given to the hub.

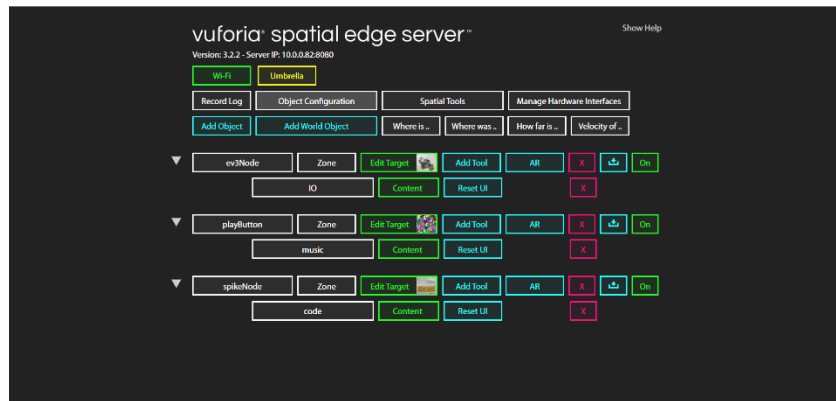
- **Troubleshooting note:** Make sure to keep `/dev/` at the beginning of the line. Also, pay close attention to the syntax of the line. Removing the bracket on the end of the line can cause an error in the system.



```
10 // Variables
11 var name = "test.py"
12 var tabs = 0
13 var backspaces = '\b'
14 var sensorReading = 'Nothing'
15 var i = 1
16
17 // Use a '\r\n' as a line terminator
18 const parser = new parsers.Readline({
19   delimiter: '\r\n',
20 })
21
22 // The port to connect to (CHANGE TO YOUR SERIAL PORT)
23 const port = new SerialPort('/dev/tty.LEGOHubPTCAcademic-Seri', {
24   baudRate: 115200,
25 })
26
```

7. In Terminal, navigate back to `SpatialToolbox-Mac-Interns/vuforia-spatial-edge-server` with the code `cd Documents/SpatialToolbox-Mac-Interns/vuforia-spatial-edge-server`. If the `SpatialToolbox-Mac-Interns` folder is not saved to the `Documents` folder, replace `Documents` in the code above with whatever folder the `SpatialToolbox-Mac-Interns` folder is saved in.
8. Type `node -v` to check which version of Node.js was installed and take note. This will be used in the next step.
9. Run `npm install` while in the `SpatialToolbox-Mac-Interns/vuforia-spatial-edge-server` directory in Terminal
 - **If Node.js is a version other than v12.18.2, use `npm rebuild` to get the folder to work with the current version of Node.js. The server will not start if the without doing this if Node is a version other than v12.18.2.**
10. Navigate to the Spatial Robotic Addon directory using `cd addons/vuforia-spatial-robotic-addon` while in the `SpatialToolbox-Mac-Interns/vuforia-spatial-edge-server` directory and run `npm install` again
 - These two commands will install all necessary packages for this project
 - **As with the step above, if Node.js is a version other than v12.18.2, use `npm rebuild` to get the folder to work with the current version of Node.js. The server will not start if the without doing this if Node is a version other than v12.18.2.**
11. Enter `cd ../../` into Terminal to navigate back to the `SpatialToolbox-Mac-Interns/vuforia-spatial-edge-server` directory

12. Run `node server`. This should start the Vuforia Spatial Edge Server. Type `localhost:8080` into a web browser. If the page does not load, troubleshoot using the methods below. If it does load, it should look like this image:



- **Troubleshooting Note:** the LEGO SPIKE Prime will make a beep shortly after running `node server` and connecting for the first time. This indicates that everything was connected correctly.
- **Troubleshooting Note:** if there is an error like the one below in the Terminal, it is okay. It is expected and this statement alone will not hinder this project. If there are more errors than just this one, refer to the troubleshooting suggestions below.

```
2020-07-10T18:34:04.280Z - error: '(node:904) MaxListenersExceededWarning: Possible EventEmitter memory leak detected. 11 readable listeners added to [SerialPort]. Use emitter.setMaxListeners() to increase limit'
```

13. If the readout in Terminal shows something like the image below, then the server is working! The last two lines in this image describe what type of instrument is connected to the SPIKE Prime and which port that they are in. For example, there is a motor connected to port A and B, a distance sensor at F, and a Color Sensor at E, with the location in the instrument array corresponding to the location of the port that instrument is attached to in the port array.

```
2020-07-10T18:31:33.905Z - debug: 'Port open'
2020-07-10T18:31:34.625Z - debug:
[ 'motor', 'motor', 'none', 'none', 'distance', 'color' ]
2020-07-10T18:31:34.626Z - debug: 'A' 'B' 'none' 'F' 'E' 'none'
```

14. **Troubleshooting Notes:** There is the possibility that there may be issues when starting the server. Do not worry, most of these issues can be solved by restarting either the SPIKE Prime or the Vuforia Spatial Edge Server (`control key + c` and `node server` again in Terminal).
- If there are multiple error statements in the Terminal after running `node server`, like shown below, then the LEGO SPIKE Prime did not connect correctly. Restart the LEGO SPIKE Prime and confirm that the correct serial port is being used.

```

2020-07-10T18:34:04.280Z - error: '(node:904) MaxListenersExceededWarning: Possible EventEmitter memory leak detected. 11 readable listeners added to [SerialPort]. Use emitter.setMaxListeners() to increase limit'
2020-07-10T18:34:13.619Z - error: '(node:904) UnhandledPromiseRejectionWarning: Error: Error: Resource busy, cannot open /dev/tty.LEGOHub40BD3248762A-Ser'
2020-07-10T18:34:13.619Z - error: '(node:904) UnhandledPromiseRejectionWarning: Unhandled promise rejection. This error originated either by throwing inside of an async function without a catch block, or by rejecting a promise which was not handled with .catch(). To terminate the node process on unhandled promise rejection, use the CLI flag `--unhandled-rejections=strict` (see https://nodejs.org/api/cli.html#cli_unhandled_rejections_mode). (rejection id: 1)'
2020-07-10T18:34:13.619Z - error: '(node:904) [DEP0018] DeprecationWarning: Unhandled promise rejections are deprecated. In the future, promise rejections that are not handled will terminate the Node.js process with a non-zero exit code.

```

- If there are errors in the Terminal that do not look like this, or localhost:8080 does not load in the browser, restart the Vuforia Spatial Edge Server by closing out of Terminal or typing **control key + c** and repeating the start up instructions.
- 15. Open the Vuforia Spatial Toolbox mobile app and point the camera at the image target. A light blue box should appear around the image target. If nothing seems to happen, try moving the camera/target or changing the lighting of the room. If the light blue box still isn't visible, then restart the mobile app.

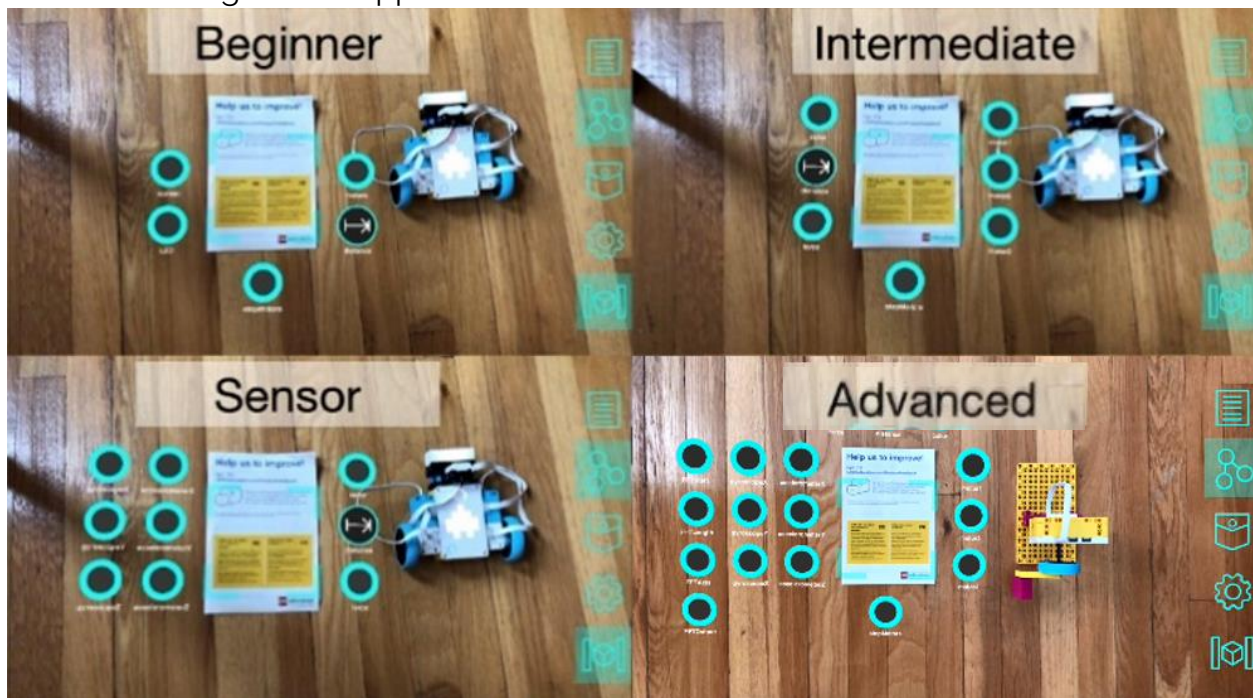


- **Troubleshooting Notes:**
 - ***The iPhone being used needs to be on the same Wi-Fi network as the computer being used to form a connection with the Vuforia Spatial Edge Server***
 - If restarting still does not work, go into the settings tab in the Vuforia Spatial Toolbox app and go into Found Objects. Compare this list to the list of objects in the Vuforia Spatial Edge Server.
 - If objects are missing and the only thing showing up is "_WORLD_local", then there was an issue connecting the app and the Vuforia Spatial Edge Server and the connection process will need to be restarted

- If the list of objects looks like the one below, but all of the font is red, then the app was opened too quickly. Closing out and then reopening the app should solve the issue.

< Back	Name	Version	IP	Nodes	Links
	_WORLD_local	3.2.2	127.0.0.1		
	playButton	3.2.2	10.0.0.199		
	music			1	0
	ev3Node	3.2.2	10.0.0.199		
	IO			12	0
	spikeNode	3.2.2	10.0.0.199		
	code			7	0
	completeXDhfza91nj7i			1	0
	airtablee7i4sju5bjku			1	0
	numberY34jmg17vwyr			1	0

16. When in Programming Mode in the app, a node setup similar to one of the following should appear:



17. Changes to complexity levels can be made within the Vuforia Spatial Edge Server.

- Select "manage hardware interfaces" from the home screen
- Click the gear icon next to Spike-Prime interface to open up settings for the SPIKE Prime.
- Change the setting called "spikeComplexity" by typing in one of the four options shown above (**all configurations should be typed in lower case letters**). For more information about the different nodes and

complexity levels, visit **Appendix D** in **Appendices and Additional Resources**

- When changing complexities, the server will need to be restarted. Go back into Terminal and press **control key + C** to stop the server and then start the process again while running **node server** in the vuforia-spatial-edge-server directory.

