

Getting Started with Microsoft Kinect for FRC 2013

2013 Kinect Usage Notes: Per the 2013 FRC Rules, use of a Microsoft Kinect device is a permitted as part of a team's Operator Console. No Kinect and no Kinect Kiosk will be provided on the playing field. Teams are expected to coordinate with their alliance to arrange for any space they may need in the Alliance Station to operate the Kinect.

If you do not have an internet connection on the computer you are installing on you will need to download the Microsoft Kinect for Windows SDK Version 1.6 from here:

<http://go.microsoft.com/fwlink/?LinkID=262831>

The Microsoft Kinect for Windows SDK is only supported on Windows 7. To use the FIRST provided software, you must be using a computer with Windows 7.

Installation

1. Install the 2013 Driver Station software.
2. Go to <http://firstforge.wpi.edu/sf/frs/do/viewSummary/projects.wpilib/frs> and locate the 2013 FRC Kinect Server package.
 - a. Download the most recent version available, unzip the downloaded file and locate FRCKinectServerSetup.exe
 - b. Double click FRCKinectServerSetup.exe to begin the installation, follow the prompts to complete the installation.

Note: On 64-bit machines the FRC Kinect Server will be installed to "C:\Program Files(x86)\Kinect Server" instead of "C:\Program Files\Kinect Server"

3. Additional documentation is installed to the folder Program Files\FRC Kinect Server\docs

Optional – For editing Kinect Server Source only

4. **Non-Classmate PC's only** –The Microsoft Kinect for Windows SDK requires Visual Studio 2010, if you do not already have this, Install Visual C# Express 2010 from this page:
<http://www.microsoft.com/visualstudio/en-us/products/2010-editions/express>
 - a. If you need an offline installer, you can download a Visual Studio Express installer ISO from this page:
<http://www.microsoft.com/visualstudio/en-us/products/2010-editions/express-iso>
5. The FRC Kinect Server source code is installed to Program Files\FRC Kinect Server\Source

Note: Teams not using the Classmate may need to adjust settings on their Antivirus software and/or their power saving settings to get the best performance. Due to the large variance between different AV providers, and manufacturer specific power saving features, FIRST cannot provide detailed information regarding these procedures.

Changes from 2012

The FRC Kinect Server has been heavily modified from the version used in FRC 2012. Teams who are not modifying the FRC Kinect Server Source will see the following differences:

- New Region-of-Interest based skeleton filtering - This means that skeletons will only be detected and tracked in a specified area. In the compiled version, the region of interest is optimized for general use in the FRC Driver Station (between 3 and 11 ft. away from Kinect, +/- 3 ft. off center laterally). Individuals standing outside this region should not result in skeleton data being transmitted from the Kinect Server on to the DS, Dashboard and robot.
- New Debug window - When using the “-debug” command line flag users will see a redesigned debug window. This window is based off one of the Microsoft v1.0 examples. The major functional difference of the new window is that users will be able to dynamically enable and disable the color video feed and change settings on the color and depth feeds.
- Expanded error codes – The set of error codes displayed on the Driver Station Diagnostics tab has been expanded to take advantage of the new Microsoft SDK error codes including an error for insufficient USB bandwidth.

Teams modifying the Kinect Server source code will see that both the Microsoft Kinect SDK and the FRC Kinect Server code have changed drastically since the FRC 2012 version. Custom gesture code which has been created by modifying the FRC Gesture Processor or implementing the IGestureProcessor interface will be portable to the new Kinect Server code with minor modifications. For more details on the new Kinect Server code and porting custom gesture code see the comments embedded in the source code.

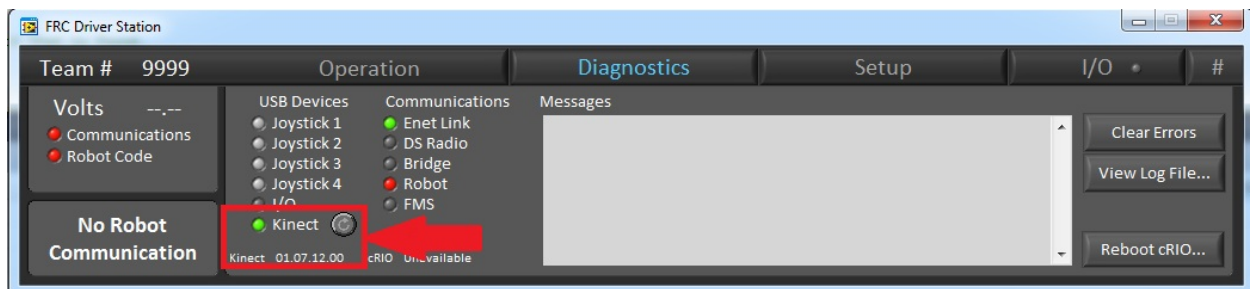


Safety Note: It is highly recommended you secure a sizeable area around the robot and have someone prepared to disable the robot while you are getting used to controlling a robot using the Microsoft Kinect.

Alternatively, put your robot up on blocks so it is unable to move. Until you have some experience using the device it is very possible your robot may move in ways you do not expect.

How to Use the default FIRST Kinect code

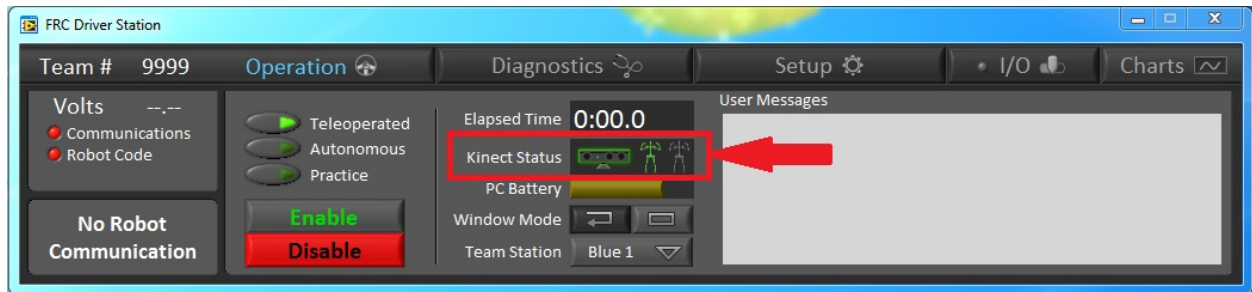
1. Example code is provided for each language which can control a 2-motor robot with Tank drive using the gestures provided by the Kinect Server. Reference “How to Build and Load Programming in LabVIEW, C/C++, and Java” for information on how to open this project in your language. The gestures have been mapped based on tank drive of a typical FRC drive base, and the buttons are activated by actions using your head and legs.
 - a. These joysticks behave like a typical joystick in many ways. The axis values range from -1 to 1 just like a standard joystick and the buttons are all active only when “pressed” using the appropriate gesture just like a typical joystick.
 - b. It may be helpful to scale the joystick values to a fraction of max power when learning to use the Microsoft Kinect. 20%-25% may be a good value to start with.
2. Load the new code onto your robot, again referencing the “How to Build and Load Programming in LabVIEW, C/C++, and Java” document if necessary.
3. Plug your Microsoft Kinect into your Driver Station laptop.
4. Launch the Driver Station and connect to your robot as you normally would.
 - a. At this point, on the **Diagnostics** tab of the Driver Station, the Kinect light should be green and the text below should say **01.05.13.00**



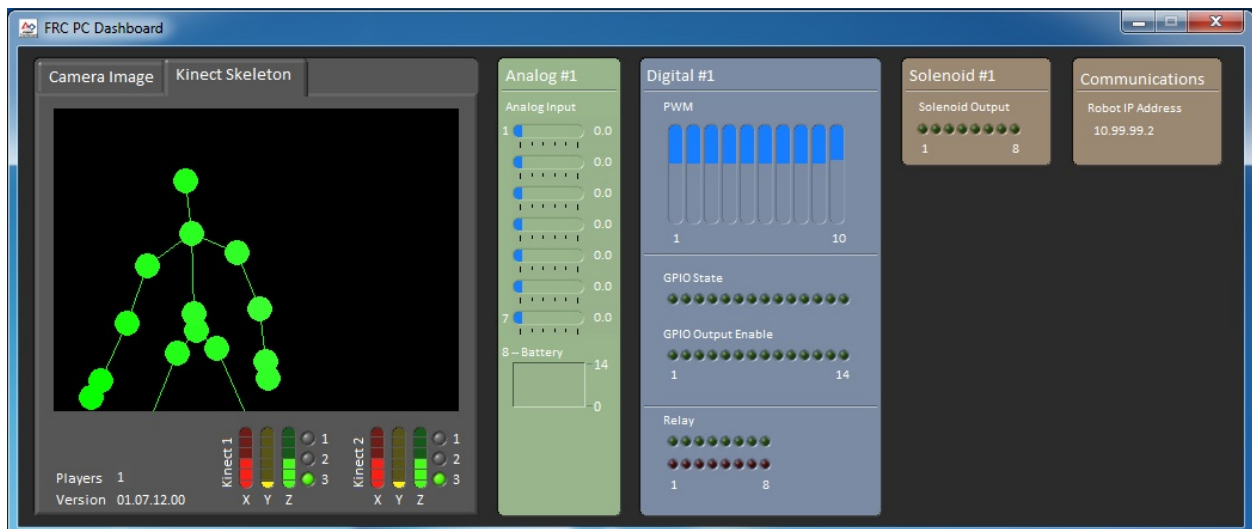
5. Position a single player in the Kinect Playing Area (between 3 and 11 ft. away from Kinect, +/- 3 ft. off center laterally).
6. Before enabling your robot, make sure there is only a single player in the Microsoft Kinect field-of-view and that they are either in a “disabled” position or have their arms out in the neutral

axis position. Enabling the robot while the operator has their hands at their sides will cause the robot to move in an unexpected and potentially unsafe manner.

- a. The Driver Station has an indicator to help you identify how many people are presently recognized by the Microsoft Kinect. This indicator is located on the **Operation** tab between the Elapsed time and the PC Battery. **You should not enable a robot using Microsoft Kinect code if this indicator shows more than 1 person in the field of view.** If two skeletons are in frame, the closest one will be chosen; if more than two people are in frame an arbitrary skeleton is chosen.

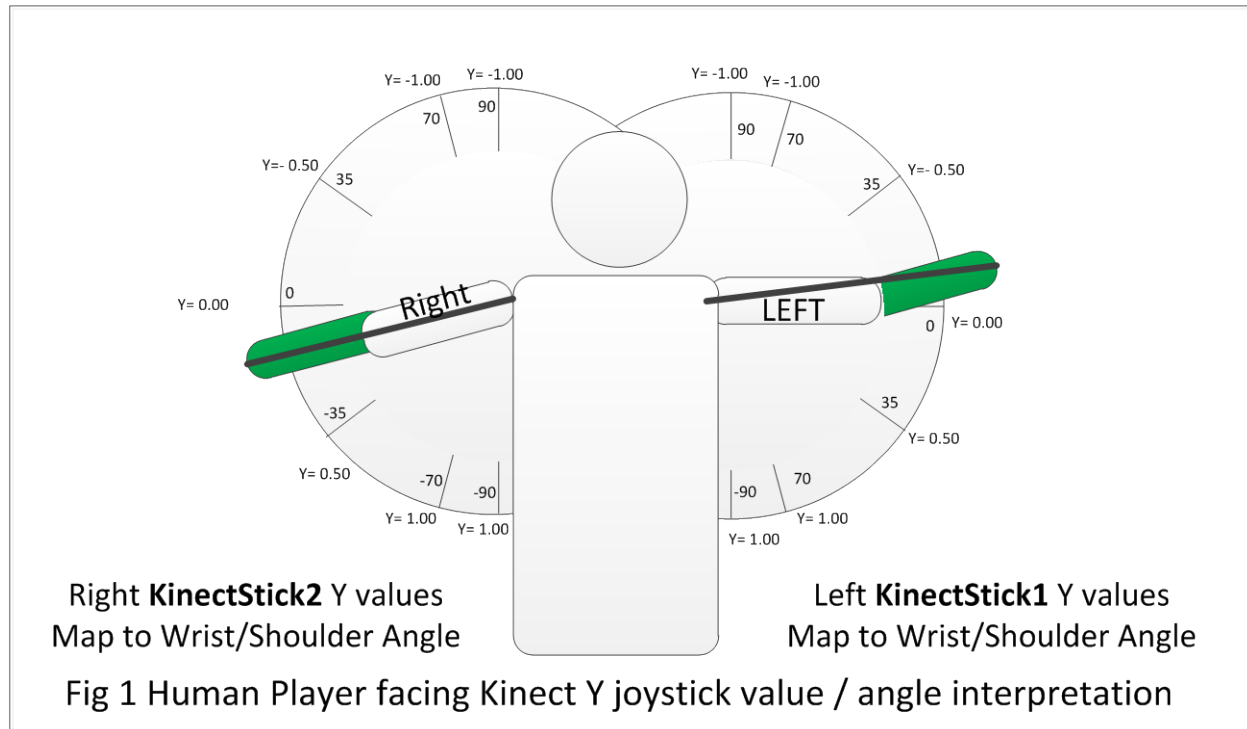


7. You should now be able to control your robot using the pre-programmed gestures. **It is highly recommended you secure the area around the robot and have someone prepared to disable the robot while you are getting used to controlling the robot using the Microsoft Kinect.**
8. The default Dashboard has a **Kinect Skeleton** tab located above the camera image. Selecting this tab will show you a display of the skeleton currently seen by the Microsoft Kinect as well as some joystick diagnostics that may be helpful when learning to drive using the Microsoft Kinect device.



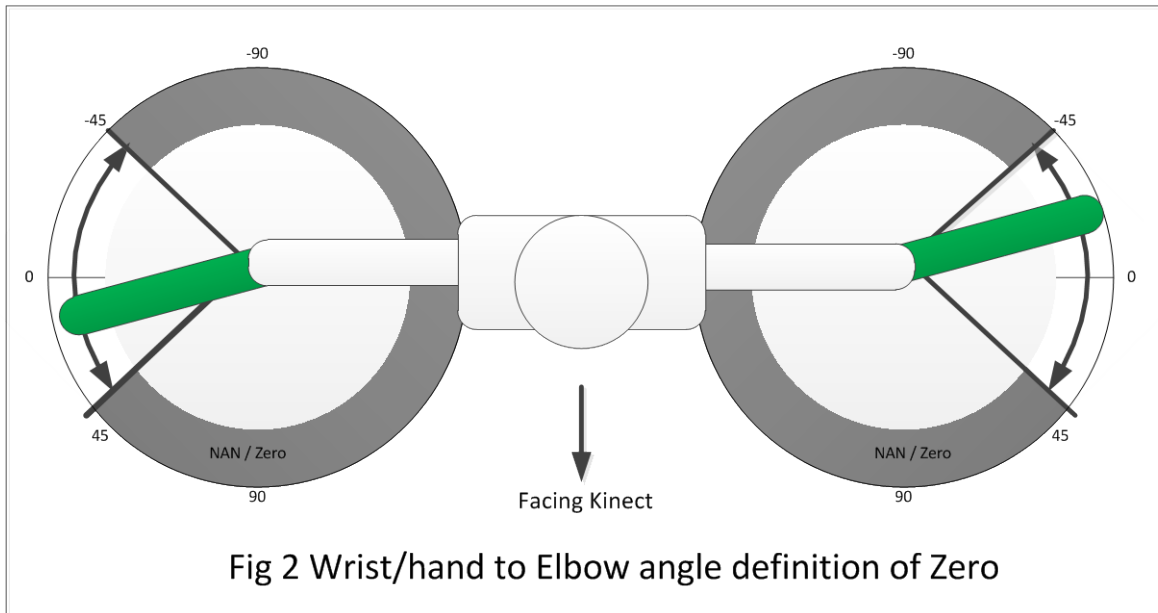
Pre-Programmed Gestures

The wrist/shoulder skeletal data is processed to determine their relative angles for the KinectStick Y data. The resulting angle information is formatted into the Y data field with a range of +1 to -1. The KinectStick data consists of two Y joystick values (KinectStick1-Y and KinectStick2-Y). The diagram below illustrates the mapping of the wrist/shoulder skeletal data into standard joystick format:



Y = -1.00 has been placed at the top with the assumption that up naturally maps to forward and on a joystick, moving a joystick away from you moves Y towards -1.00.

For KinectStick control to be enabled, both arms must be in the same XY plane (see figure 2). In addition, both arms must be within the valid control range (defined as -90 to +110 degrees). If either arm is moved out of plane or out of the valid range, all axes and buttons will return 0/False. **This means the safest way to stop controlling the robot (other than disable or e-stop) is to bring both arms forward and cross them in front of your chest.**



Given that the two arms are used for the two tank drive axes, the remaining body parts potentially available for use as buttons are the head and legs. The following buttons are currently implemented:

- 1) Head to the Right
- 2) Head to the Left
- 3) Right leg out to the right
- 4) Left Leg out to the left
- 5) Right Leg Forward
- 6) Right Leg Back
- 7) Left Leg Forward
- 8) Left Leg Back
- 9) KinectStick control “enable” signal. True if both arms are in-plane and in-range.

Teams should note that the head buttons may trigger accidentally and/or may be difficult to trigger purposefully if one or both arms are near vertical.

The button values are set the same for both KinectStick1 and KinectStick2.

Going beyond the pre-programmed gestures

Option 1 – Modifying the server code

1. Locate the Kinect Server source code in the **FRC Kinect Server\Source** folder located in Program Files. It is recommended to copy the code to another location before editing.
2. Open the Visual Studio Solution file in that folder.
3. You can now see the code for the Kinect Server, make any modifications you would like, and build a new executable. The gesture processing is done in a file called FIRSTGestureProcessor.cs located in the **Source\KinectServer\Kinect** folder.
4. To have the Driver Station launch and close your modified server you can do one of two things
 - a. Rename the existing **Kinect Server.exe** file to **Kinect Server.bak** (as a backup) and place your new Kinect Server in its place.
 - b. Modify the **FRC DS Data Storage** configuration INI file located in **My Documents\FRC** to point at your new version of the Kinect server.

The **Kinect Server Code Walkthrough** document contains further information about editing the existing Kinect Server code to add, modify or replace gestures. This document can be found at C:\Program Files\FRC Kinect Server\docs or at FIRSTForge in the [WPILib project](#)

Option 2 – Performing gesture recognition on the robot

1. Support will be provided to access the raw skeletal data on the robot. All three languages will have access to the same data. The data available on the robot has been made as close to the raw data provided by the SDK as possible, however some items have been trimmed to save space in the DS to robot communications.
2. Sample programs implementing the same gestures programmed into the Kinect Server are provided with all three languages. In LabVIEW, this example can be found by clicking **Support>>Find FRC Examples** from the Splash screen. In Java select **File>>New Project>>Samples>>FRC Java**. In C++ select **File>>New>>Example>>VXWorks Downloadable Kernel Module Sample Project**.
3. Either starting with one of these examples, or on your own, you can program your robot to take the 20 joints from the skeleton data and process them to control robot actions.

Appendix 1 - Language specific information

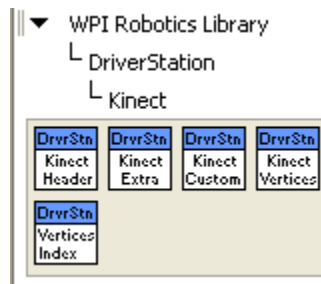
Note for all languages: The autonomous code in LabVIEW and the SimpleRobot based templates in C++ and Java are designed to run once. To read joystick data and update motors throughout the Autonomous period, you will need to add a loop to your code.

Labview

The canned gesture joystick implementation in Labview is accessed using the same interface as a regular Joystick. When using the Joystick Open VI, you now have the option of **Kinect** and **Kinect 2** in addition to the USB ports. After opening the joystick, it should behave the same as a regular USB joystick.



Raw skeletal data is accessible using the VIs in the new Kinect Palette under WPIRobotics Library>>DriverStation.



C/C++

The canned gesture joystick implementation in C/C++ is located in the files **KinectStick.h** and **KinectStick.cpp**. The data from the Kinect gesture processing is made available through a class called KinectStick. There are two KinectSticks available for access, one for each arm. The following code would be used to create a pair of KinectSticks called leftArm and rightArm.

```
KinectStick leftArm(1);
KinectStick rightArm(2);
```

Accessing the Y-axis data can be done using the same methods as a typical joystick. See the WPILib User's Guide for more information. Currently all other axes will return 0 as they are not implemented in the default gesture code.

The available buttons are also accessed the same way you would access the buttons for a joystick. The ordering of the buttons is listed with the gesture documentation above. The Trigger button (Head to the right), Top button (Head to the left) and Bumper (Right leg out to the right) can be accessed using the GetTrigger, GetTop, and GetBumper methods. The same button values will be presented on both KinectSticks.

Java

The canned gesture joystick implementation in Java can be found in the file KinectStick.java. The data from the Kinect gesture processing is made available through a class called KinectStick. There are two KinectSticks available for access, one for each arm. The following example would create a pair of KinectSticks called leftArm and rightArm.

```
KinectStick leftArm;  
KinectStick rightArm;  
.....  
leftArm = new KinectStick(1);  
rightArm = new KinectStick(2);
```

Accessing the Y-axis data can be done using the same methods as a typical joystick. See the WPILib User's Guide for more information. Currently all other axes will return 0 as they are not implemented in the default gesture code.

The available buttons are also accessed the same way you would access the buttons for a joystick. The ordering of the buttons is listed with the gesture documentation above. The Trigger button (Head to the right), Top button (Head to the left) and Bumper (Right leg out to the right) can be accessed using the GetTrigger, GetTop, and GetBumper methods. The same button values will be presented on both KinectSticks.

Appendix 2 – Troubleshooting

The two best tools for debugging the Microsoft Kinect behavior on the Driver Station are the FRC Kinect Server Debugging Mode and the Microsoft Kinect Explorer (bundled with the Developer Toolkit found at the KinectForWindows.org site) Running the Kinect Server in debugging mode will show a display and most importantly show any errors or exceptions. The Microsoft Kinect Skeletal Viewer – WPF example should run on all machines including the Classmate and can verify that the Microsoft Kinect hardware is functional and the SDK is installed and working properly.

Symptom: The Kinect diagnostic light is green and the string shows a version number, but no skeleton is being detected.

1. Make sure the person you are trying to detect is located inside the Region-of-Interest for the FRC Kinect Server code (3-11 ft. from the sensor +/- 3ft. laterally)
2. Occasionally, after coming out of hibernation or other suspended states the Kinect Server will not detect a skeleton. Press the small arrow button next to the Kinect diagnostic light in the Driver Station to restart the Kinect Server.
3. If that does not resolve the issue:
 - a. Close the FRC Driver Station, Kinect Server and any other Kinect enabled applications.
 - b. Open the Kinect Server Debug Mode using the shortcut in the Program Files\FRC Kinect Server folder and verify that the person is clearly located within the field-of-view of the Kinect sensor.
 - c. Open the Microsoft Kinect Explorer (bundled with the Developer Toolkit found at the KinectForWindows.org site). If the Kinect Explorer detects a skeleton, un-install the FRC Kinect server, ensure you have the most recent version, and then re-install.

Symptom: The Kinect diagnostic light is **Red** and the string below reads “No Power”

1. Verify that the power adapter of your Microsoft Kinect device is plugged into a functioning power outlet.
2. If that does not resolve the problem:
 - a. Close the FRC Driver Station, Kinect Server and any other Kinect enabled applications.
 - b. Open the Microsoft Kinect Explorer (bundled with the Developer Toolkit found at the KinectForWindows.org site). If the Kinect Explorer displays data from the Kinect cameras, Uninstall the FRC Kinect server, ensure you have the most recent version, and then re-install.
3. If the Microsoft Kinect Explorer also fails:
 - a. Click Start->Control Panel->System and Security->Device Manager (in the System section)
 - b. Locate the entry “Microsoft Kinect” and click the arrow to the left of it to expand it. You should see 3 entries:
 - i. Microsoft Kinect Audio Array Control
 - ii. Microsoft Kinect Camera

iii. Microsoft Kinect Device

If any of these entries is not present, or has a red 'X' or yellow yield sign, you should uninstall the Microsoft Kinect SDK using Add/Remove programs, reboot with your Kinect unplugged then reinstall the SDK.

If all 3 entries are present, right click on the Microsoft Kinect Camera entry:

- i. If the "Enable" option is available click it and wait for the operation to complete. Your Kinect should now function properly.
- ii. If the "Disable" option is available instead, click it and reboot as prompted. After reboot, navigate back to the same window, right click on the Microsoft Kinect Camera entry and click "Enable".

Symptom: The Kinect diagnostic light is **Red** and the string below reads "In Use"

1. If this string occurs on the Classmate in Driver mode, your Dashboard and the Kinect Server are likely trying to access the same Kinect device, to disable the Kinect Server change the Kinect Server path in C:\Users\Public\Documents\FRC\FRC DS Data Storage.ini to blank quotes.
2. If on a non-Classmate, or in Developer mode, the Kinect is currently being used by another application, close all applications using the Kinect, the Kinect Server should automatically detect that the Kinect is available.
3. If the string still reads "In Use", press the small arrow button next to the Kinect diagnostic light in the Driver Station to restart the Kinect Server.
4. If the problem persists, reboot your PC.

Symptom: The Kinect diagnostic light is **Red** and the string below reads "Eng in Use"

1. The Skeletal Engine on your computer is in use. The most common cause is 2 Kinect devices connected to the same PC. In addition to the single application per Kinect limit, only a single Kinect attached to a PC can be returning skeleton data at any one time. Close any other applications using the Kinect, detach both Kinects, and then reattach one.
2. If you only have a single Kinect, reboot your PC.

Symptom: The Kinect diagnostic light is **Grey** and the string below reads "No Kinect"

1. Make sure the Kinect is securely plugged into the USB port of the computer and that the power supply is plugged into a functioning outlet. Verify that the green light on the front of the Kinect device is blinking (if it is not, find the matching symptom below, and follow the steps there). Press the small arrow button next to the Kinect diagnostic light to attempt to restart the Kinect Server.
2. Unplug the Kinect from the computer. Plug it back in and verify that the green light on the front of the Kinect device is blinking (if it is not, find the matching symptom below, and

- follow the steps there). Press the small arrow button next to the Kinect diagnostic light to attempt to restart the Kinect Server.
3. If the Kinect light does not illuminate after ~30 seconds, restart the computer, leaving the Kinect plugged in. Launch the Driver Station and see if the Kinect light turns on.

Symptom: The Kinect diagnostic light on the Driver Station is **Red** and the string reads “Timeout”

This means that the Kinect Server is not running or not communicating with the Driver Station

- a. Log in to a non-Driver account on your Driver Station Computer
- b. Plug in the Kinect
- c. Launch the Driver Station application. If the Kinect diagnostic light remains unlit:
 1. Navigate to the FRC Kinect Server folder in Program Files and double click the Kinect Server Debug Mode shortcut to launch it.
 - i. **If the Kinect functions properly now**, the Driver Station configuration file does not properly point to the server. Navigate to C:\Users\Public\Public Documents\FRC and open the file “FRC DS Data Storage.ini”. Locate the line beginning with “KinectServerCMDLine” and replace the value in double quotes with the actual location of the server, replacing all ‘\’ characters with ‘\\’.
 - ii. **If the Server does not launch and reports an error with missing .NET Framework 4.0**, you will need to install the Microsoft .NET Framework. The standalone installer is located here:
<http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=17718>
 - iii. **If the Kinect Server launches, then crashes, or launches but Kinect data does not show properly on the default Dashboard**, close the Kinect Server if open. Open the Microsoft Kinect Explorer (bundled with the Developer Toolkit found at the KinectForWindows.org site). A window should pop-up with an image from the Kinect color camera, an image from the depth camera, and a skeleton if one is found in frame.
 1. If the Microsoft Kinect Explorer functions properly, uninstall then reinstall the FRC Kinect Server, making sure you have the latest version.
 2. If the Microsoft Kinect Explorer does not function correctly, uninstall the Microsoft Kinect SDK and reinstall using the steps from this guide.

Symptom: The green LED on the Kinect face is not blinking when plugged into the computer.

1. Restart the computer, leaving the Kinect plugged in.
2. If the Kinect light does not blink after restart your Kinect device is not being properly detected by your PC.

- a. Click Start->Control Panel ->Uninstall a Program (under Programs)
 - b. Locate the entries for the Kinect for Windows SDK, right click each and select Uninstall.
 - c. Make sure you have uninstalled any other Kinect development packages you may have installed (SensorKinect, LibFreenect, cINui, etc.)
 - d. Download and re-install the Microsoft Kinect SDK from kinectforwindows.org
3. Try plugging the Kinect into different USB ports on the computer. The Kinect SDK has known incompatibilities with some USB controllers, particularly some USB 3.0 controllers.
4. If the light on the Kinect face still does not blink when attached to the PC, your Kinect hardware may be damaged. Try the Kinect with another PC to confirm.

Symptom: The Kinect Server crashes or throws an exception.

1. Additional assistance is available by posting to the Operator Console section of the FIRST Forums: <http://forums.usfirst.org/forumdisplay.php?f=1340>

Symptom: The Kinect Server does not launch and reports an error with missing .NET Framework 4.0

1. You will need to install the Microsoft .NET Framework. The standalone installer is located here: <http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=17718>