WiiGraph User Guide

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Overview

WiiGraph is an interactive software application that leverages Nintendo Wii Remotes ("Wiimotes") to detect and graphically display the location of users as they move along life-size number lines. WiiGraph provides several graph types, challenges, and composite operations for users to individually and collaboratively explore, including shape tracing, maze traversal, and ratio resolution. By grappling with these challenges via collaborative, embodied interactions, users gain meaningful insights into temporospatial mathematical relationships.
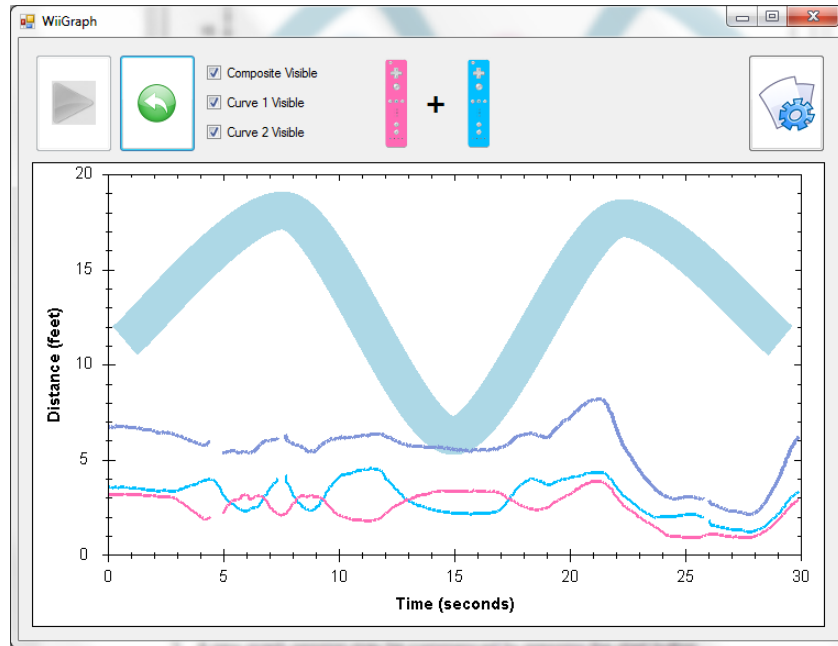
Note: Wiimotes communicate wirelessly over Bluetooth. Although earlier generations of Wiimotes worked well across different Bluetooth implementations, the latest, and only commercially available, Wiimotes work on a subset of providers. As such, we have implemented WiiGraph to work against the seemingly best available: the Toshiba Bluetooth Stack. Installing this Stack is a necessary precondition for using WiiGraph. Fortunately, the installation process is quite simple and can be easily reversed through standard Windows Program management.

Getting Started

This document contains instructions for the setup and use of WiiGraph. If you encounter a problem along the way, consult the Troubleshooting Guide, where you may find a solution to your particular issue. If you still need assistance, you may contact us for support over email.

Assembly

To get started, you will need to assemble the following items:

1.	2.	3.	4.	5.	6.	7.

1. A laptop or desktop computer running a Windows 7, Vista, or XP Operating System.
2. A display area (the computer monitor, a projection screen, etc.).
3. One "Ultra Sensor Bar" for the Nintendo Wii (manufactured by Power A).
4. Two Wii Remote Plus controllers for the Nintendo Wii, ideally in distinct colors.
5. Toshiba Bluetooth Stack and compatible Bluetooth radio adapter (if not built in, we recommend the USB 2.0 Micro Bluetooth Adapter from AZIO).   The Toshiba Bluetooth Stack installer is provided in the application bundle.
6. The WiiGraph software application bundle.
7. A large space for interaction (ideally 5 feet in width and up to 20 feet long, extending from the display area.

Installation

1. Install WiiGraph
2. Install Toshiba Bluetooth Support

Use

1. Set Up WiiGraph Interaction Space
2. Set Up Wiimotes
3. Use WiiGraph!
4. Design Activities
5. Offer Feedback

Install WiiGraph

To Install WiiGraph, assemble the following items:

1.					6.	

1. A laptop or desktop computer running a Windows 7, Vista, or XP Operating System.
6. The WiiGraph software application bundle.

Installation involves unzipping the WiiGraph application bundle and copying the contents to a preferred location on the computer (e.g. C:\Program Files). You may want to create a shortcut to WiiGraph on your Desktop, in the Windows Taskbar, or in the Windows Start Menu, for convenient access.

Install Toshiba Bluetooth Support

Note: This step is optional if you computer already provides the Toshiba Stack and a compatible Bluetooth radio. You can examine your current Bluetooth Radio support through the Windows Device Manager (Control Panel > System > Hardware).

To install Toshiba Bluetooth support, assemble the following items:

1.				5.		

1. A laptop or desktop computer running a Windows 7, Vista, or XP Operating System.
5. Toshiba Bluetooth Stack and compatible Bluetooth radio adapter (if not built in, we recommend the USB 2.0 Micro Bluetooth Adapter from AZIO). The Toshiba Bluetooth Stack installer is provided in the application bundle.

Installation involves unzipping the WiiGraph application bundle and running the Setup.exe program shortcut provided at the root of the bundle. An InstallShield Wizard will appear to guide you through the process:
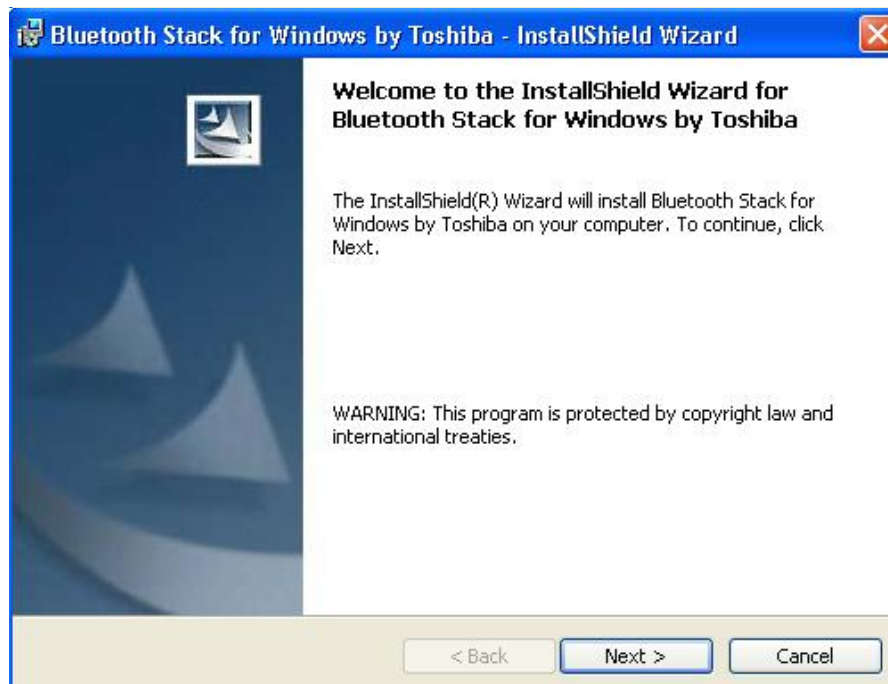
Toward the end of the installation process, a message will appear prompting you to "plug in the Bluetooth device and click OK button." When this occurs, plug the AZIO Bluetooth adapter into a USB port on your computer. After a moment, the installation will continue automatically:
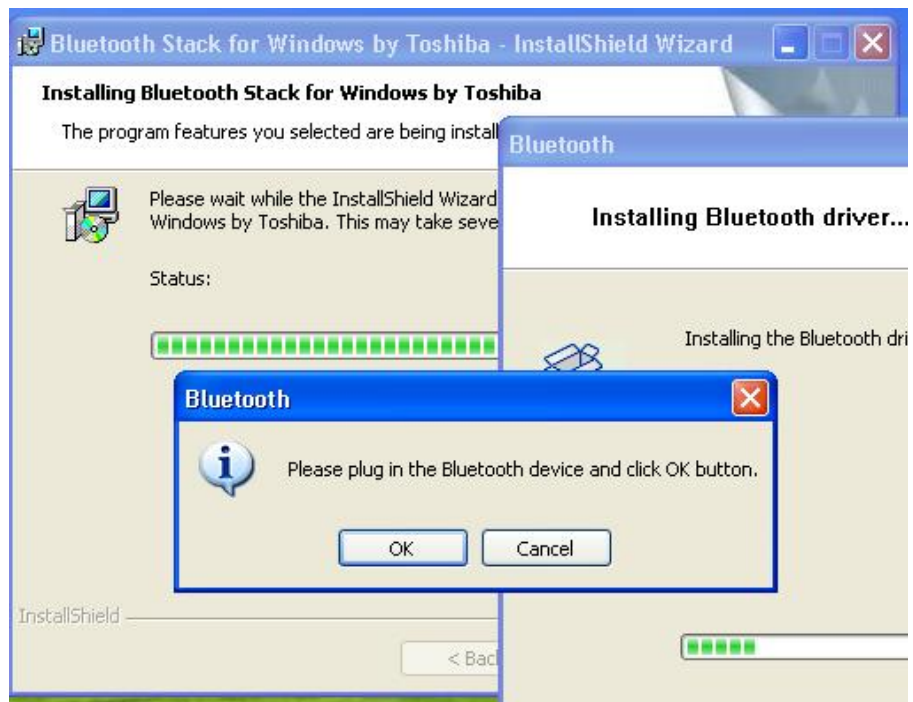
At the end of the installation process, you will be prompted to reboot your computer. After rebooting, the Toshiba Bluetooth Settings Manager will be available in the Windows System Tray:

Set Up WiiGraph Interaction Space

Each time you use WiiGraph, you will have to allocate a sufficient sized space for embodied interactions. To set up the space, you will need:

1.	2.	3.					

1. A laptop or desktop computer running a Windows 7, Vista, or XP Operating System.
2. A display area (the computer monitor, a projection screen, etc.).
3. One "Ultra Sensor Bar" for the Nintendo Wii (manufactured by Power A).

To set up the Wiigraph interaction space, clear out an area approximately 5 feet wide and up to 20 feet in length. **Note: since WiiGraph utilizes the infrared detection capabilities of the Wiimote, it is important to shield the space from direct sunlight, which contains enough infrared to significantly disrupt motion tracking (interior lighting does not have a deleterious effect).**

One one of the narrow ends, set up the display area, and attach it as an output to your computer. Place the Wii Sensor Bar on an approximately waist-high support in front Directly in front of the display area, place the Wii Ultra Sensor Bar. **Be sure to turn on the Sensor Bar and set it to "Wide Range" using the sliders on top.**
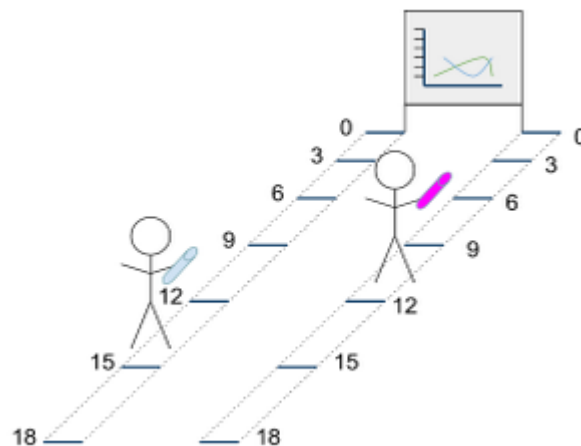
In the space extending away from the display area, you may optionally demarcate one or a set of parallel number lines (the application will work without explicit number lines, but they may prove useful depending on the activity being performed). The number line area should be sufficientlywide such that two users can traverse the line without blocking one another (e.g. 4 feet apart). A good length for the number lines is between 8 and 15 feet, to accommodate significant embodied interactions. **Note that due to limitations of Wiimote hardware profiles, the origins of the number lines need to be located 2 feet away from the Sensor Bar.**
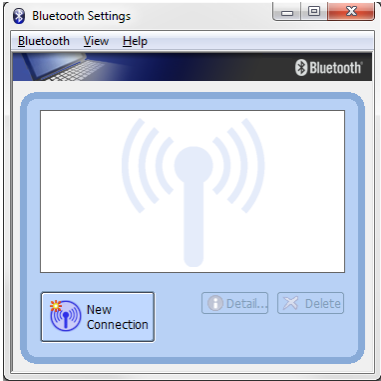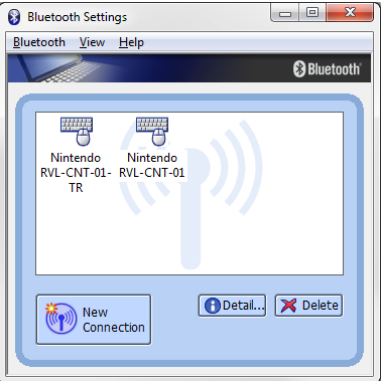
Set Up Wiimotes

To set up wiimotes, you will need to assemble the following items:

1.			4.	5.	6.	

1. A laptop or desktop computer running a Windows 7, Vista, or XP Operating System.
4. Two Wii Remote Plus controllers for the Nintendo Wii, ideally in distinct colors.
5. Toshiba Bluetooth Stack and compatible Bluetooth radio adapter (if not built in, we recommend the USB 2.0 Micro Bluetooth Adapter from AZIO).   The Toshiba Bluetooth Stack installer is provided in the application bundle.
6. The WiiGraph software application bundle.

Each time you use Wiigraph, you may have to perform some number of the following steps to connect to your Wiimotes over Bluetooth and register them with the WiiGraph application. For your initial setup, you will have to perform all of these steps. For subsequent uses of Wiigraph, you may be able to skip all of these steps entirely, or simply reconnect "remembered" Wiimotes.

Double-click the Toshiba Bluetooth icon in the System Tray to launch the Bluetooth Settings window. Depending on a variety of factors, you will see one of several possible configurations of Wiimote devices (with the identifier Nintendo-RVL-CNT-01*) :

No Remembered Wiimotes	1 Remembered Wiimote	2 Remembered Wiimotes

1 Connected Wiimote	1 Remembered Wiimote, 1 Connected Wiimote	2 Connected Wiimotes
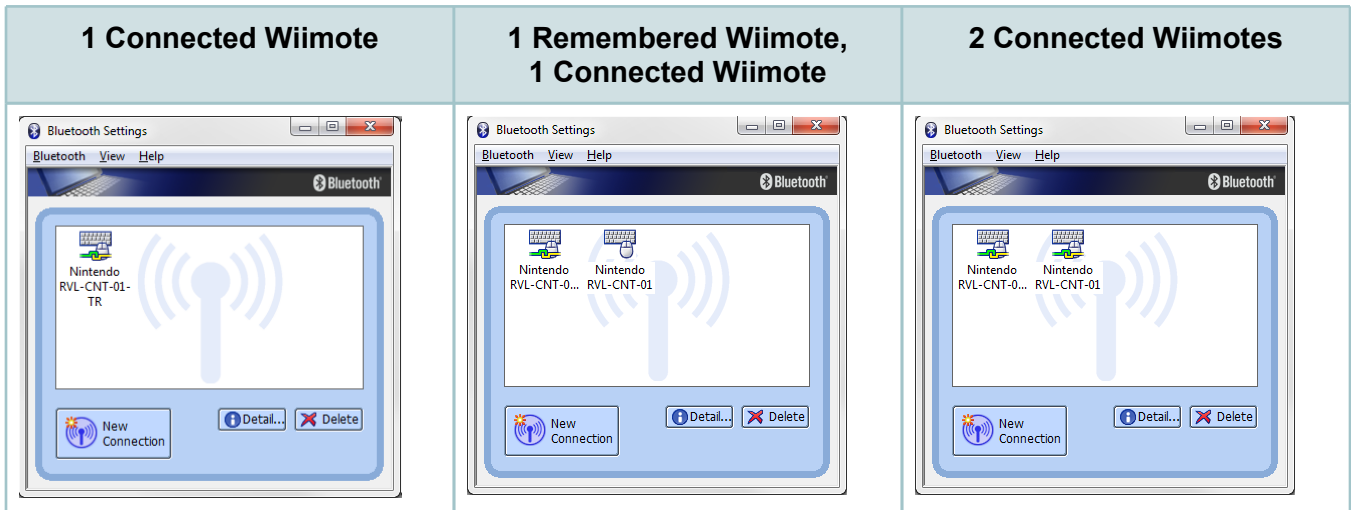
A) If both wiimotes are connected (i.e. they are present and overlaid with green and yellow links), then you can proceed to using WiiGraph. This will only happen if you have not rebooted your computer after establishing Wiimote connections, and the Wiimotes themselves have not lost the connection to the computer (through powering off, etc.).

B) For each Wiimote that is not present (e.g. when you first install, neither Wiimote will be "present"), the following steps need to be performed:

1. Press the "New Connection" button. This will launch the "New Connection" Wizard.
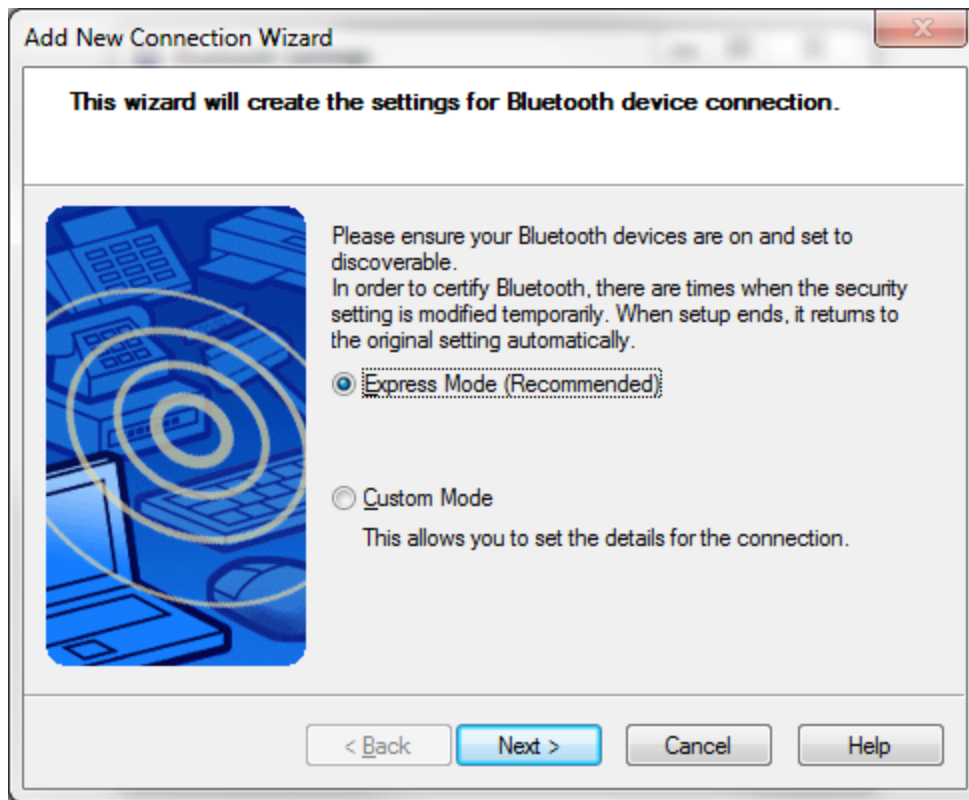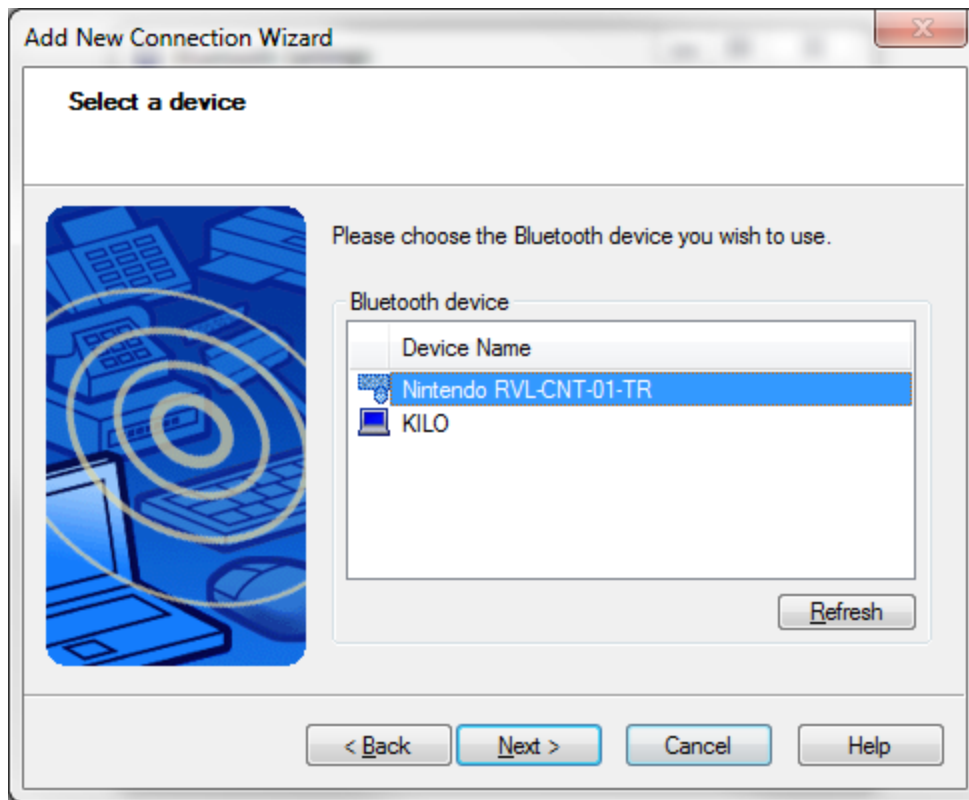

2. Before pressing "Next", you must place your Wiimote into "Discoverable Mode." This is performed by pressing the red "SYNC" button on the back of the Wiimote (for older models,

the battery cover must be removed to expose the button). Once you press the button, the LED lights on the front of the Wiimote will flash.

3. Immediately click "Next" on the Wizard Dialogue, which will initiate a search for the Wiimote. **Note that the Wiimote will only stay in "Discoverable Mode" for approximately 10-15 seconds, so it is important to press "Next" quickly. If the LED lights stop flashing before a connection is made, then you will need to repeat these two steps.**.
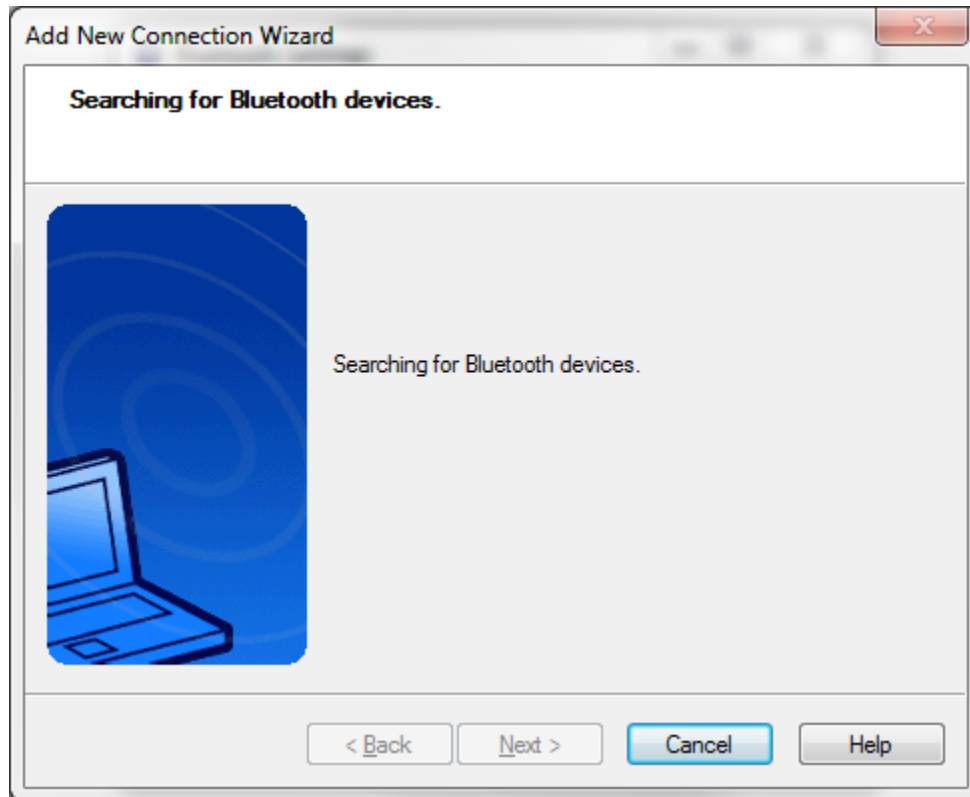

4. Once the Wiimote is discovered, the Bluetooth Device list will be presented in the Wizard:

5. Select the new Nintendo device and click "Next." This will initiate a connection to your Wiimote:

6. If the connection is successful, the Wiimote will appear in the Bluetooth Manager window with a green and yellow link overlay, and the LEDs on the Wiimote will continue to flash without timing out:
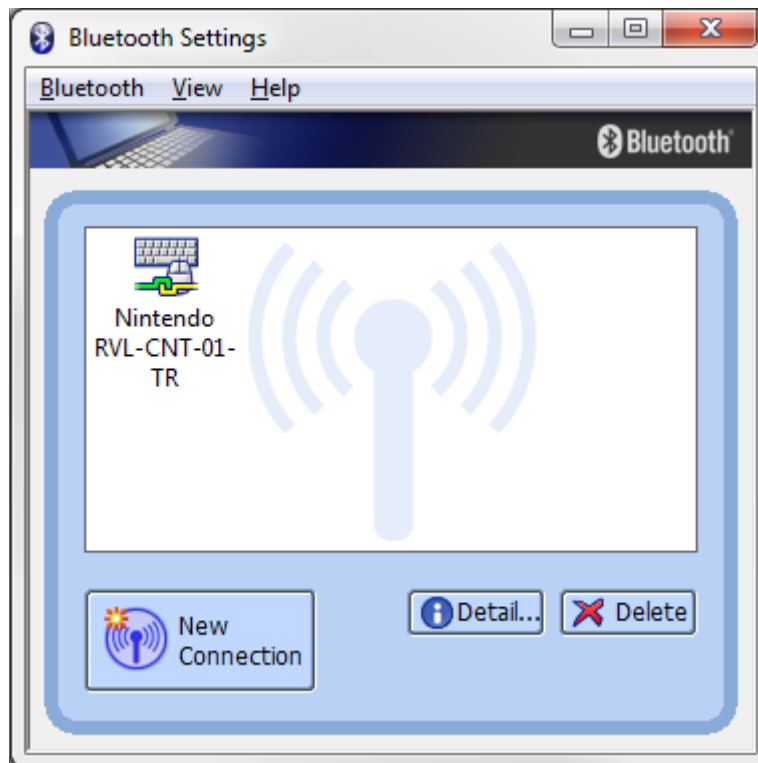
C) For each Wiimote that is remembered by not connected (i.e. it is present but there is not green and yellow link overlay), you can reestablish the connection by right-clicking the device and selecting "Connect," which launches a confirmation Dialog:
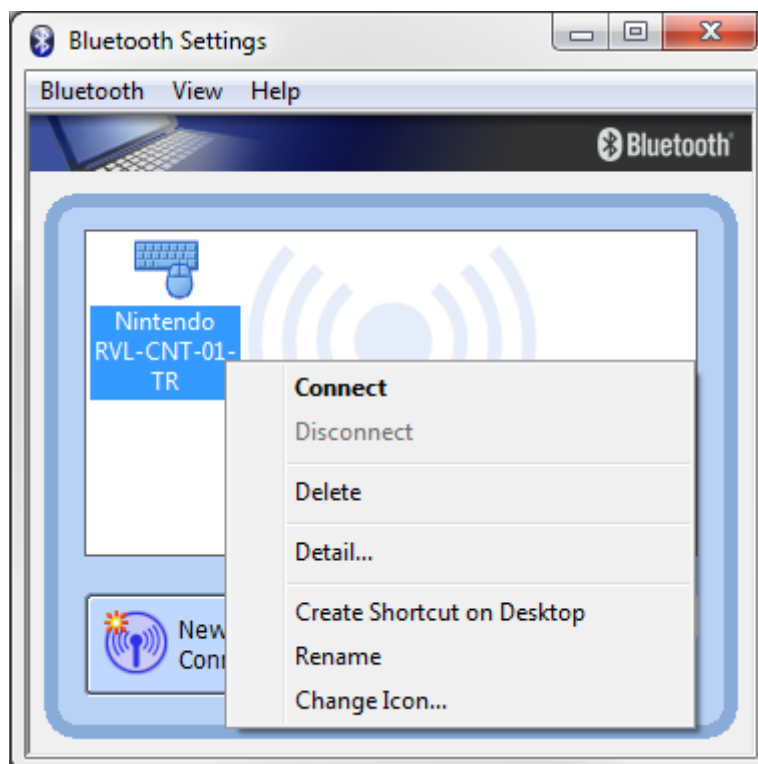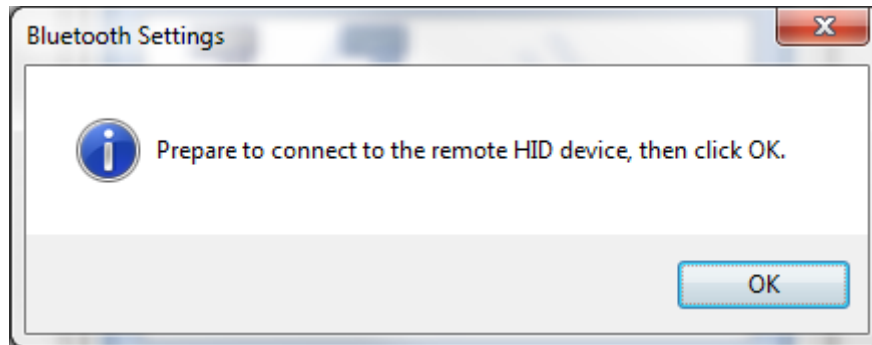
1. Before pressing "OK", you must place your Wiimote into "Discoverable Mode." This is performed by pressing the red "SYNC" button on the back of the Wiimote (for older models, the battery cover must be removed to expose the button). Once you press the button, the LED lights on the front of the Wiimote will flash.

2. Immediately click "OK" on the Wizard Dialogue, which will initiate a connection to the Wiimote. **Note that the Wiimote will only stay in "Discoverable Mode" for approximately 10-15 seconds, so it is important to press "Next" quickly. If the LED lights stop flashing before a connection is made, then you will need to repeat these two steps.**.
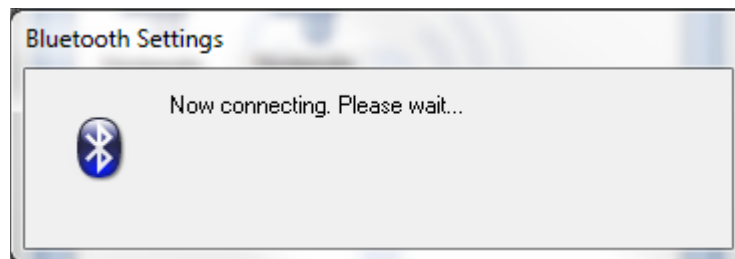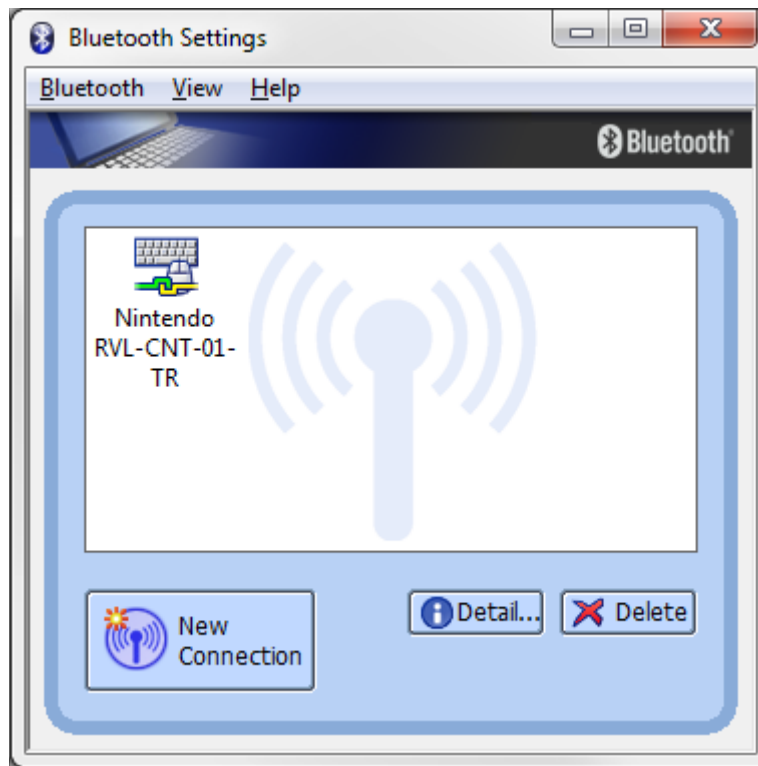

3. If the connection is successful, the Wiimote will appear in the Bluetooth Manager window with a green and yellow link overlay, and the LEDs on the Wiimote will continue to flash without timing out:

Repeat the above steps until both Wiiimotes are connected. Your final step will be to launch WiiGraph from the executable in the application bundle (or from a shortcut). Upon launching WiiGraph, you will see the two connected Wiiimotes presented in the Wiimote Setup window:
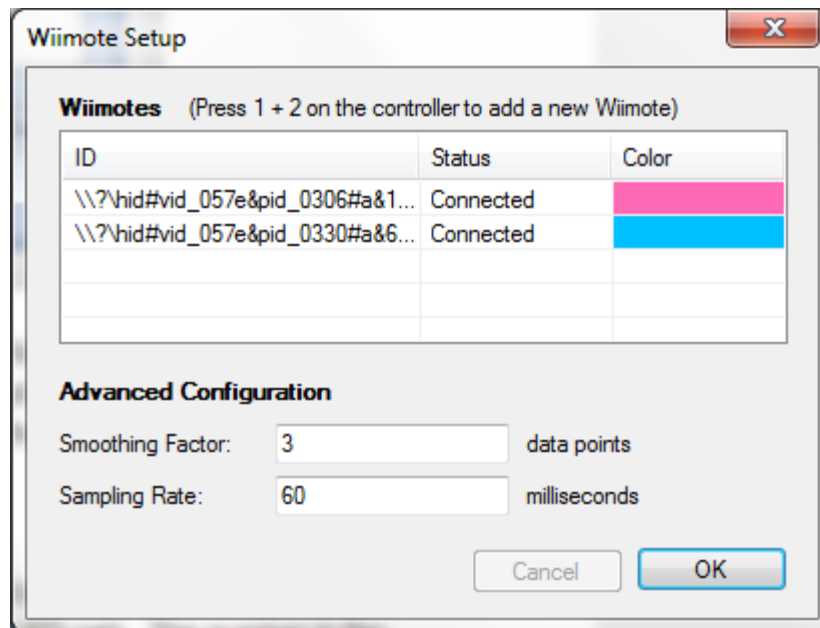
The LEDs on the Wiimotes will stop flashing, and a single LED will be set on each (Wiimote "A" will have the first LED set, while Wiimote "B" will have the second LED set). The order of the Wiimotes in the list corresponds to the specific indicator LED that is set on each device. The color associated with each device may be changed by double-clicking the corresponding row in the list. This is the color that will be used for graphing the distance of the corresponding wiimote. **Note: it is helpful to match the color to that of the physical Wiimote**.

The Smoothing Factor and Sampling Rate fields should not need to be changed unless there is a performance issue (see [Troubleshooting](#)).

Use WiiGraph!

To use Wiigraph, you will need to assemble the following items:

1.	2.	3.	4.	5.	6.	7.

1. A laptop or desktop computer running a Windows 7, Vista, or XP Operating System.
2. A display area (the computer monitor, a projection screen, etc.).
3. One "Ultra Sensor Bar" for the Nintendo Wii (manufactured by Power A).
4. Two Wii Remote Plus controllers for the Nintendo Wii, ideally in distinct colors.
5. Toshiba Bluetooth Stack and compatible Bluetooth radio adapter (if not built in, we recommend the USB 2.0 Micro Bluetooth Adapter from AZIO).   The Toshiba Bluetooth Stack installer is provided in the application bundle.
6. The WiiGraph software application bundle.
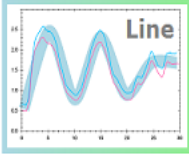7. A large space for interaction (ideally 5 feet in width and up to 20 feet long, extending from the display area.
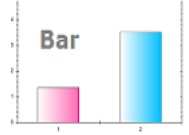
To use WiiGraph, double-click the executable in the application bundle (or from a shortcut). Upon launch, the Wiimote Setup form will appear. If two Wiimotes are not present in the list, then you will need to connect your wiimotes using the steps above. Again, feel free to change the color associated with each Wiimote, which will be used throughout the application, including configuration screens, data visualizations, etc.
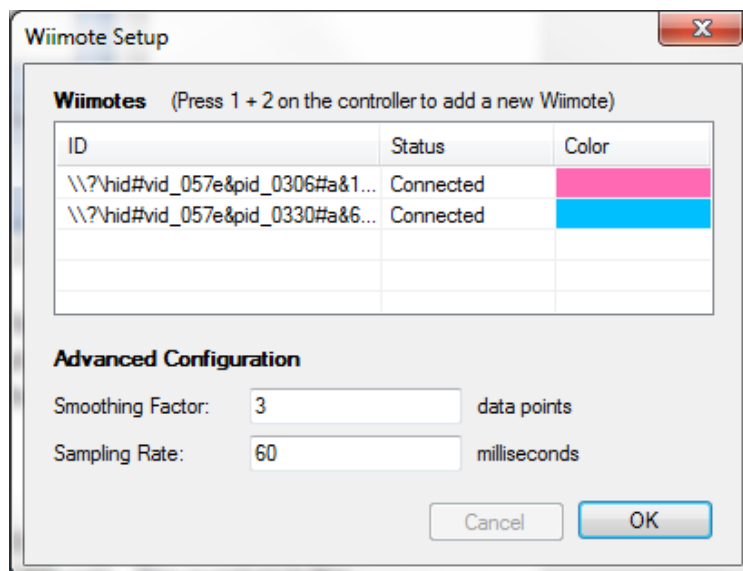
Once two Wiimotes are present in the list, you may click "OK," which launches the Graph Setup Form over the main Graph Form.

Graph Setup

The Graph Setup Form contains options for configuring the graph type (Line, Bar, or Versus), a challenge target (None, Maze, Value), Operation (None, +, -, *, /), a mapping of operands to colors, and number line / graph parameters (Length - the length of the number line, Range - the range of the graph axes, Duration - the length of a graph session). The available Targets, Operations, and Graph parameters differ by Graph Type.

Clicking on the "Make your own Maze!" option launches a Maze Builder form that allows you to create a target challenge for the Line and Versus graph types. Within the Maze Builder, you can select the number of inflection points, width, tension, and layout of the maze. Clicking OK saves the maze as the current challenge target, and returns the user to the Graph Setup Form.
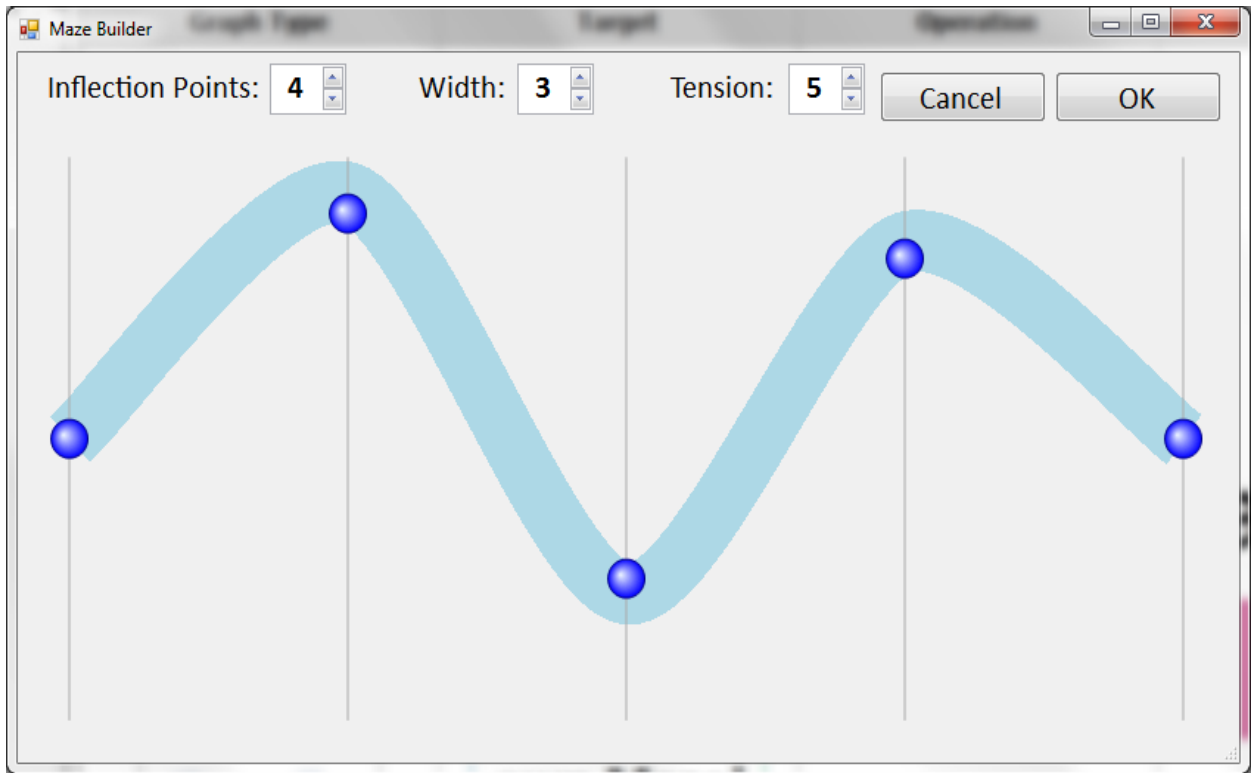
Pressing OK on the Graph Setup Form reveals a Graph Form that is configured according to the setup.

Graphing

The Graph Form consists of a control panel and a graph area. The graph is configured according to selected graph type, ranges, time periods, and targets. The Control Panel contains a Play/Pause button, a Refresh button, graph visibility options (e.g., in the image below, check boxes allow for the hiding and revealing of particular curve), an indicator of the current operation, and a Graph Setup Button. Pressing the Graph Setup button will clear the graph and launch the Graph Setup screen to configure a new session.
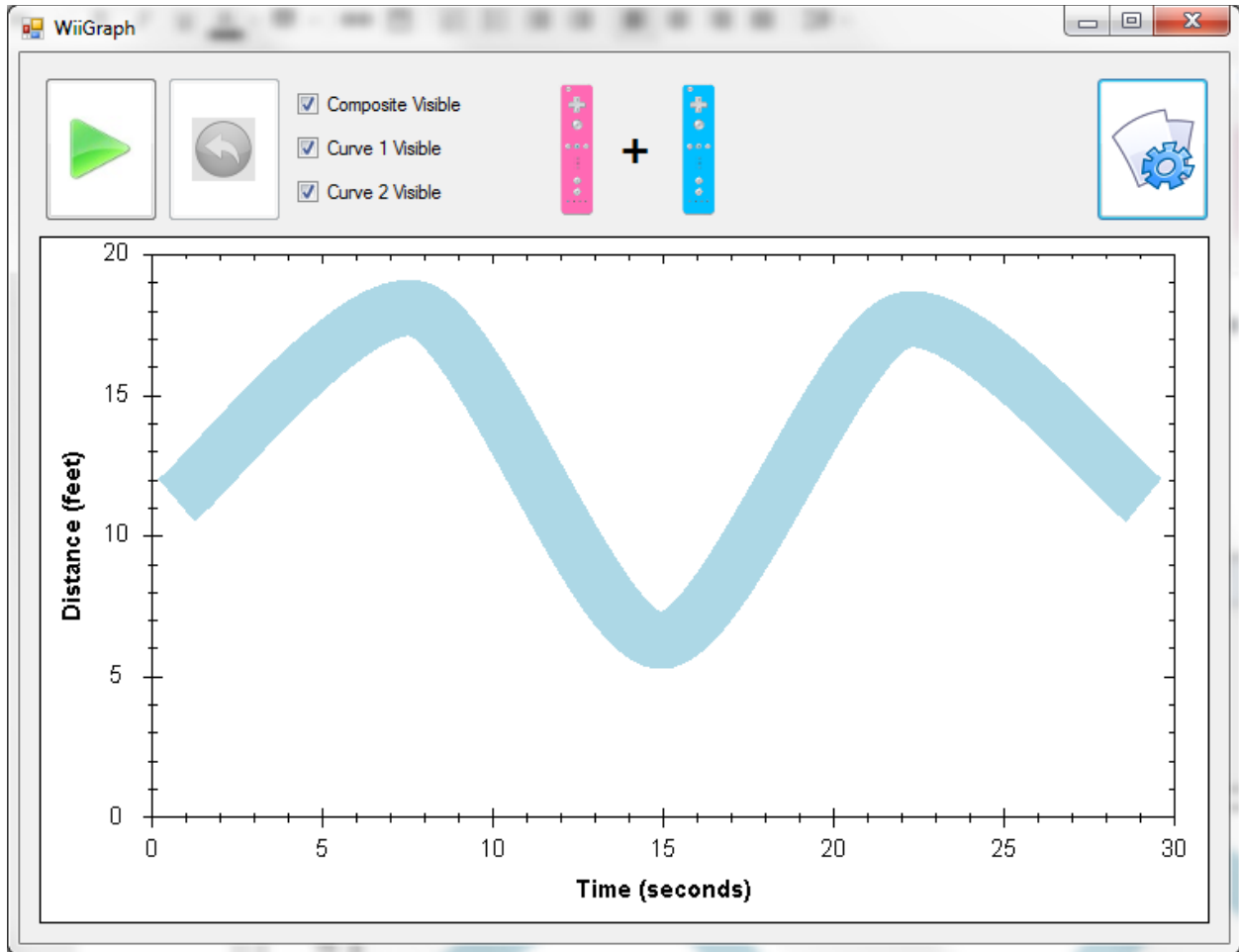
To commence a graphing session, stand on the number line facing the display area, and point the Wiimotes toward the Sensor Bar. If the camera of the Wiimote is directed on the Sensor Bar, then a diffuse circle will appear on the Graph Form, matching the color of the Wiimote. Note that it takes a small amount of practice to reliably direct the wiimote at the sensor bar, particularly at short distances, as the field of view of the camera is narrow. **Remember that the origin of the number line is 2 feet away from the Sensor bar. Recordings attempted at shorter distances will be unreliable.**
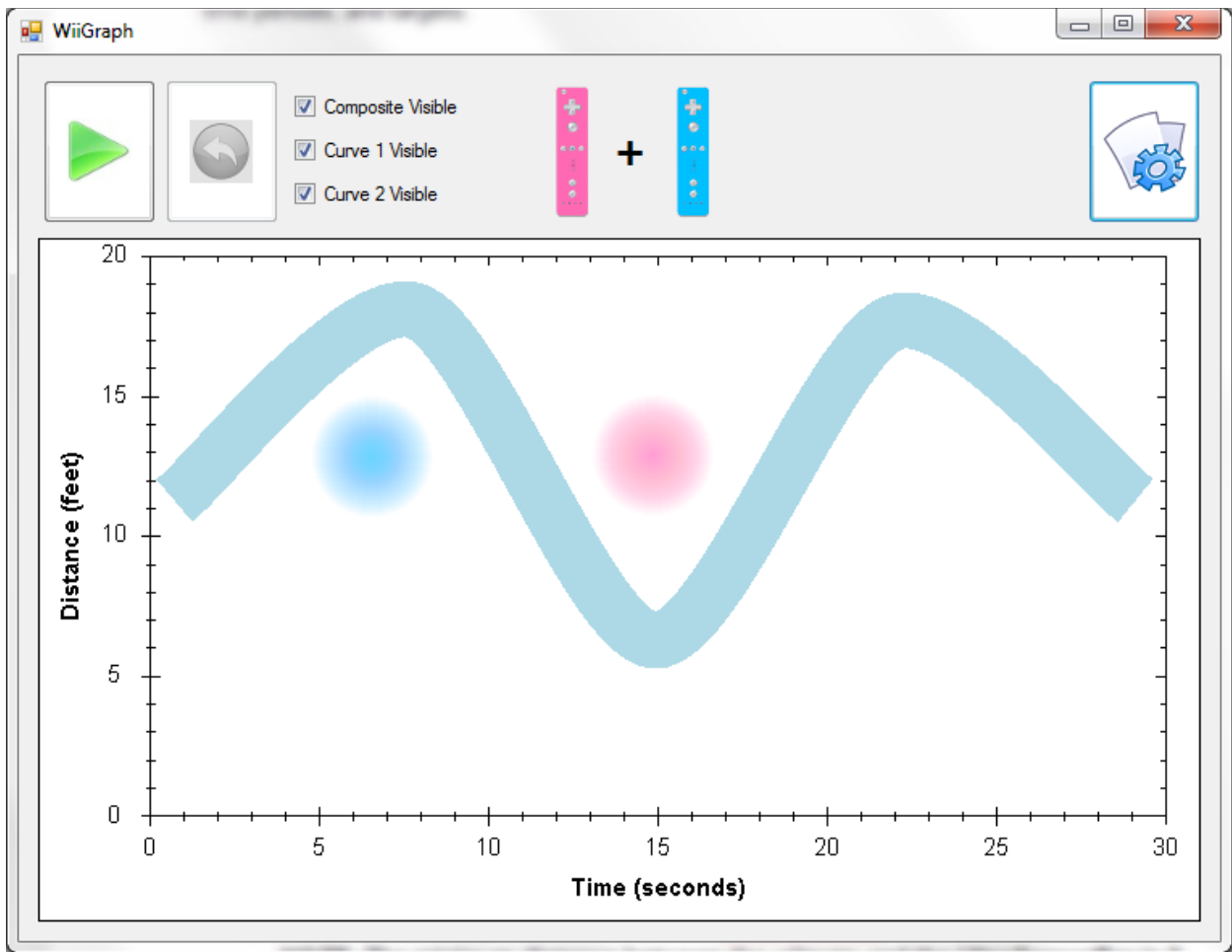
Line Graphs

To commence a Line Graph session, press the Play button. As long as the wiimotes are directed at the Sensor Bar, the distance between the Wiimote and the bar will be plotted on the graph as distance over time. **Note: the graph is controlled by the user holding the Wiimote steady and moving nearer to and farther from the Sensor Bar, not by pivoting the Wiimote vertically or laterally on its own axis.**

The following image shows the result of a Line Graph with a Target Maze using the '+' Operation. The thin pink and blue lines correspond to individual users, and the thicker, darker line is the result of the operation (in this case, adding the two independent values at a given point). The gaps in the graph occurred when a user stopped pointing the Wiimote at the Sensor Bar. Also note that, in this case, the target maze is visible, but the users did not attempt to traverse their curves through the maze.
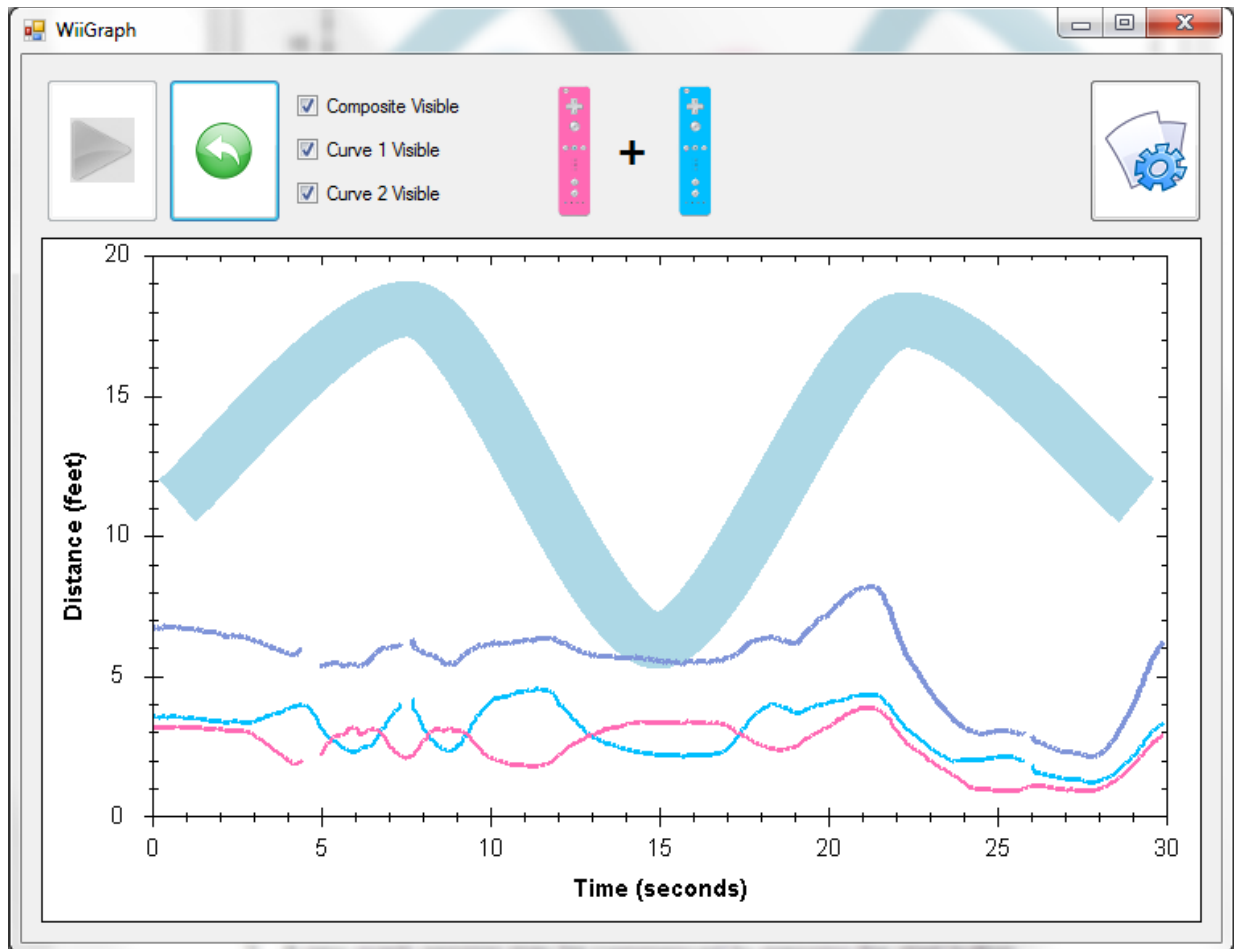
Play and Pause may be toggled at any point during a Line Graph session, and Reset may be used at any time, even after the session, to start anew. The visibility controls can also be toggled during or after the session to selectively hide and reveal specific curves.

Bar Graphs

To commence a Bar Graph session, press the Play button. Although there is no duration for a Bar Graph session, pause may be toggled to freeze processing. As long as the wiimotes are directed at the Sensor Bar, the distance between the Wiimote and the bar will be plotted as vertical bars in the colors of the respective Wiimotes.

The only target that is available for Bar Graphs is a value, and the only available Operation is '/' (ratio). Thus, the goal of the Bar Graph is to work together to achieve the goal ratio. The current ratio of the two distances is shown on a horizontal number line overlaid on the graph, with the target indicated by a box. The image below shows that the two users had momentarily achieved the target ratio of 2.
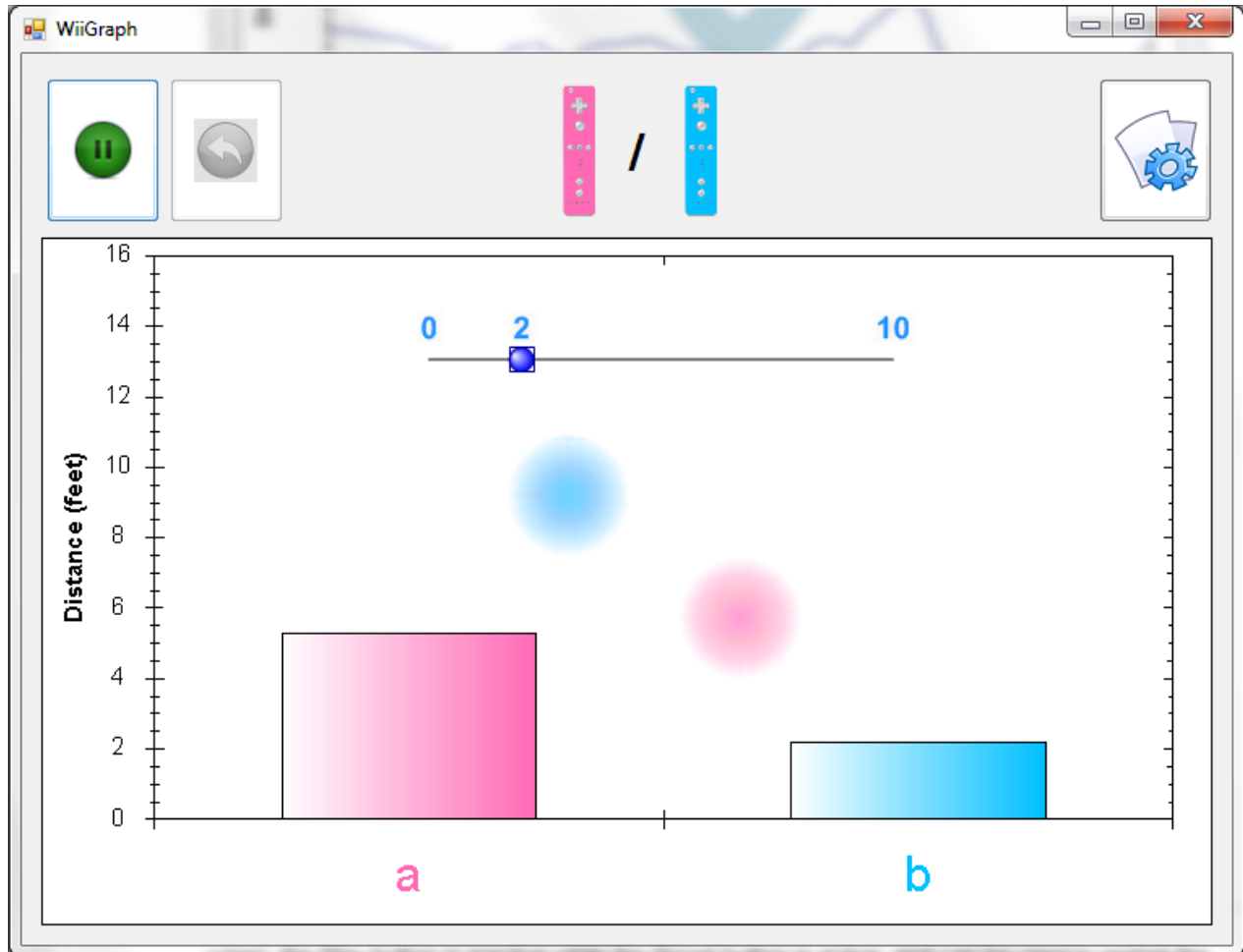
Versus Graphs

To commence a Versus Graph session, press the Play button. Although there is no duration for a Bar Graph session, pause may be toggled to freeze processing. The Versus graph essentially plots an ordered pair of the distances of each user over time.

The Operation of the Versus Graph is implicit (creation of the ordered pair). Although the Maze is available as a target, more interesting challenges for the Versus Graph involve the creation of plane figures. For example, in the following graph, the two users work together to create a Rectangle:
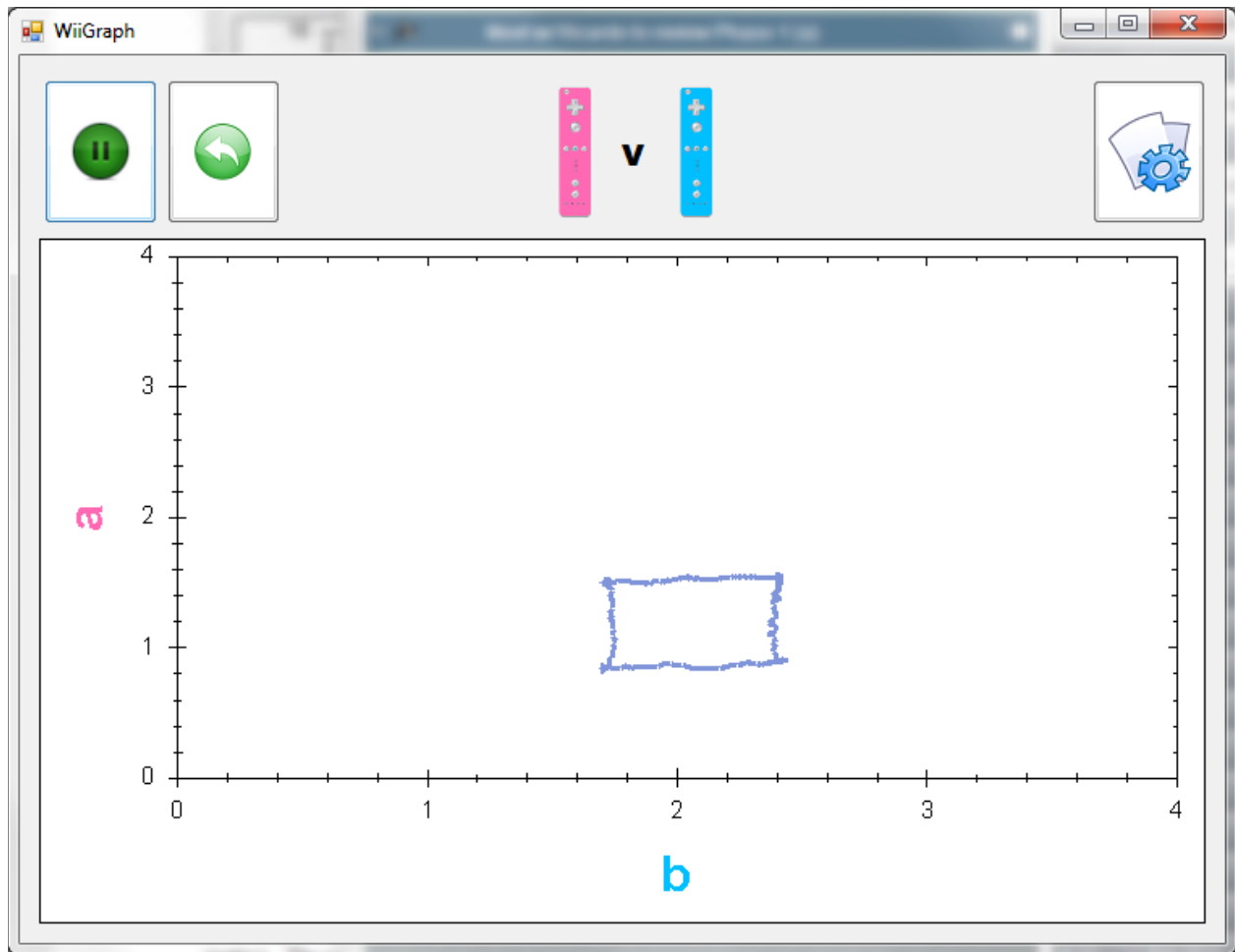
Activities

As described above, simple activities are built into WiiGraph in the form of numerical and maze-like targets. The maze can serve as either an individual or a collective target for the Line Graph (i.e. users can attempt to traverse their own curves through the maze or work collectively to guide the composite curve through the maze). Achieving the target ratio in a Bar Graph or traversing a maze in a composite graph, on the other hand, is necessarily a collective effort.

Still, the provided activities represent a small fraction of potential (and adhocly practiced) interactions with WiiGraph. We encourage you to develop activities to meet the needs or interests of your particular situation, and to share them with us through our feedback channel. Where possible, we will endeavor to augment WiiGraph to better support the activities and needs that arise through use in the field, for the benefit of all users!

Troubleshooting

The following is a non comprehensive list of solutions to issues that might arise during the installation and use of WiiGraph. If your issue is not represented, please email for support so we can address your needs and share the results with future users.

1. **I can't get my Wiimote to connect during the Wiimote Setup process.**

   Unfortunately, establishing bluetooth connections through the process described above is sensitive to timing issues. It is critical to press the SYNC button at the appropriate points in the setup, and immediately proceed with the Connection Wizard so that a connection can be made before the discovery period ends. If the LEDs stop flashing prematurely, repeat the connection steps at an accelerated pace. Also, it appears that Wiimotes running on low battery power (as indicated by the number of flashing LEDs during the discovery period) take longer to connect. If only 1 or 2 of the LEDs flash during this phase, consider swapping out the batteries.

2. **When I launch WiiGraph, the program immediately crashes.**

   This typically indicates an issue in communicating with the Bluetooth Stack. The most likely issue is that a Bluetooth Stack that is incompatible with WiiGraph is still installed. You can see which Bluetooth Stacks are installed by opening the Device Manager (Control Panel->System->Hardware) and expanding the Bluetooth Radios list. Note that we have not seen a conflict with running the built-in Microsoft Bluetooth Stack alongside the Toshiba Stack, although this could be an issue for some users. If Bluetooth is failing, consider disabling the Microsoft Bluetooth device through this interface:
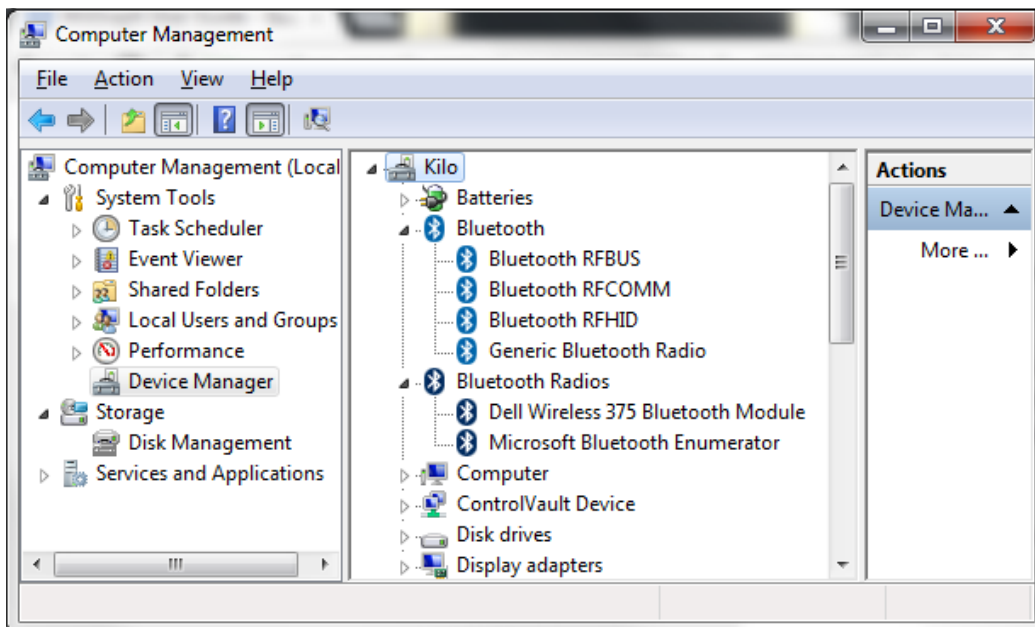
   Another (unlikely) possibility is that the .NET Framework on your computer is out-of-date. WiiGraph assumes that the .NET Framework version is >= 4. Newer versions of the Framework are available for download, here: http://msdn.microsoft.com/en-us/netframework/aa569263.aspx

3. **I am able to run WiiGraph, but when I start a graph session, the graph doesn't update.**

There are numerous reasons why this might be the case. Try the following in order:

    a. Make sure you pressed the Play Button to start the session.
    b. Make sure you are not sitting at the end of the session (Play will be grayed out in this case). You can press Reset to restart the session.
    c. Make sure the Tracker Bar is turned on (a blue light should be visible on the front panel)
    d. Make sure the Wiimotes are still connected (a single LED will be lit on the front)
    e. Make sure you are pointing the Wiimotes at the tracker bar (not necessarily at the display area). You should see a diffuse colored dot on the screen for your Wiimote if it is aimed correctly.
    f. Make sure the space between the Wiimote and the Tracker Bar is not obscured by an object or another person.
    g. Make sure the area is not exposed to larges amounts of direct or reflected sunlight.

4. **The Graph is updating, but the value appear to be way off.**

This suggests an issue with the distance calculation. For the calculation to work properly, you must be facing directly at the tracker bar, not at a severe angle, and the Tracker Bar should be set to "Wide Range" rather than "Short Range." Also, remember that the origin is displaced 2 feet from the end of the Tracker Bar. The measured distance is between the Wiimote and the origin, not the Tracker Bar.

5. **The Graph appears to be updating correctly, but there are lots of gaps**

This occurs because the Wiimote is temporarily pointed away from the Tracker Bar. The ability to keep it pointed at the bar is a minor skill that doesn't take very long to master.

6. **The Graph looks right but the performance is really slow (i.e. the graph appears to update sporadically and sluggishly)**

Graph performance may need to be tuned based on the capabilities of your computer. If you find that the graph repaints too slowly, the program is probably trying to process too much Wiimote data. To reduce the amount of data being processed, restart WiiGraph and change the Sampling Rate on the Graph Setup form to a larger value (e.g. 100). Be aware that if this number is set too high, then the refresh rate of the graph will noticably slow down again, this time because it waits the specified sampling rate interval before adding another data point. As you can see, finding the correct value for your system may require tuning by trial and error.

7. **I am having an issue that isn't described above!**

Please [email for support](mailto:) so we can address your needs and share the results with future users!

Feedback and Support

We welcome your feedback, suggestions, and ideas for improving WiiGraph for you and future users. You can reach us at:

team@motiongraph.us

We can also provided limited troubleshooting support over email. Please allow several days for a response.