



dexter industries

Using Dexter Industries GPS Sensor and Google Maps



The Dexter Industries GPS is a GPS unit for the Lego Mindstorms NXT. This guide will walk you step by step through using Google Maps, Google Earth, and the Dexter Industries GPS sensor to find and map coordinates.

Version 1.0 Last Modified Sep 2010



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Contents

Introduction:

- The GPS Coordinate System

Google Maps:

- Getting destination coordinates from Google Maps
- Converting coordinates
- Entering coordinates into NXT-G

Google Earth:

- Gathering GPS coordinates with the NXT
- Making a KML file and displaying data on Google Earth

Version 1.0 Last Modified June 1, 2010



The GPS Coordinate System

Understanding the GPS Coordinate Systems: The Basics

Imagine the earth, divided by lines running north and south (latitude) and east and west (longitude). One can describe any place on earth with a pair of latitude and longitude coordinates. Furthermore, the earth is typically divided into North (the northern hemisphere north of the equator) and South (the southern hemisphere south of the equator) and East (the eastern hemisphere east of the Prime Meridian) and West (the western hemisphere west of the Prime Meridian).

These coordinates are traditionally divided into degrees, minutes, and seconds. A position will typically be described in the following format: 77°04' 85.54" W (seventy seven degrees, four minutes, eighty five point five four seconds West).

Positional data from the Dexter Industries GPS is in integer decimal-degree format. Most mapping systems, like Google Maps, run on a format called "decimal degrees" where the output data looks like this: dd.mmmmmm.

Because of NXT-G 1.0's integer math limitations, the Dexter Industries GPS sensor sends and receives data in the format ddmmmmm. Therefore data must be input into the GPS sensor in integer format (no decimals).

- Latitude is represented by an 8-digit integer. If the position is in the northern hemisphere, the number is positive. If the position is in the southern hemisphere, the latitude is negative.
- Longitude is represented by a 9-digit integer. If the position is in the eastern hemisphere, the longitude is positive. If the position is in the western hemisphere, the longitude is negative.



Traditional Format	77°04'85.54" W
Decimal Degrees Format	-77.048554
GPS Sensor Format	-77058554

Condensed Guide

- Draw a quick diagram here.

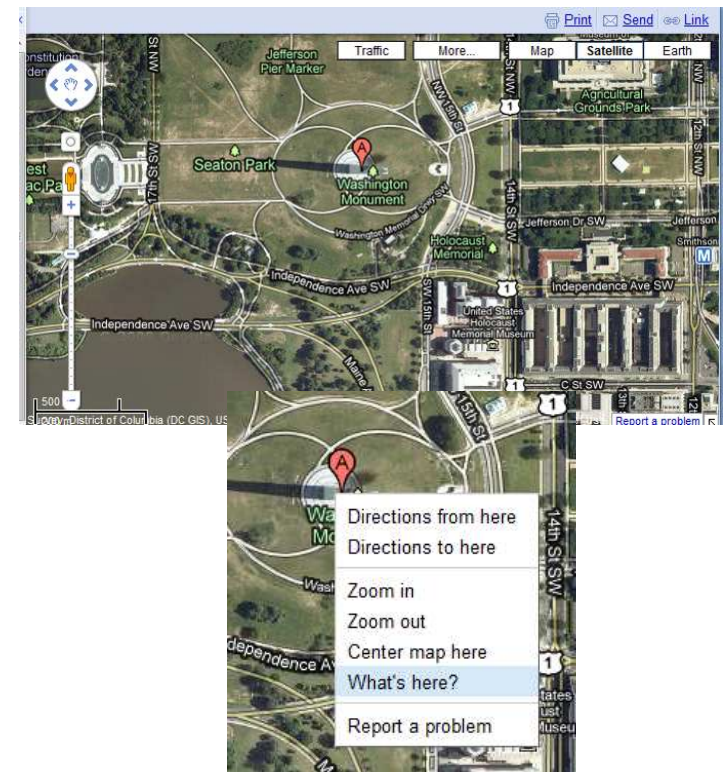


Getting Started: Coordinates from Maps

Understanding the GPS Coordinate Systems: An Example with Google Maps

The NXT-G software can be used to constantly tell the robot where it is, how far it is from its destination, and what angle to travel to. For our example, we'll select a destination we want our robot to navigate to: the Washington Monument in Washington, DC.

1. Using Google maps (maps.google.com), we'll find the Washington Monument. Type in "Washington Monument".
 2. Right-click on the monument and the option "What's Here" shows up. Click on "What's here."
 3. In the search-box on the top of the page, the longitude and latitude of the point you clicked on should appear in decimal-degree format.
 4. You can see the decimal-degree latitude and longitude of the Washington Memorial in the image below and to the right. The latitude is 38.889463, and the longitude is -77.03526. That makes sense because the Washington monument is in the northern hemisphere (latitude is positive), and the western hemisphere (longitude is negative).
1. Before using this as our destination, we have to multiply both numbers by 1,000,000, making them integers. The numbers we will enter into the GPS sensor will be 38889463 and -7703536.



Google maps

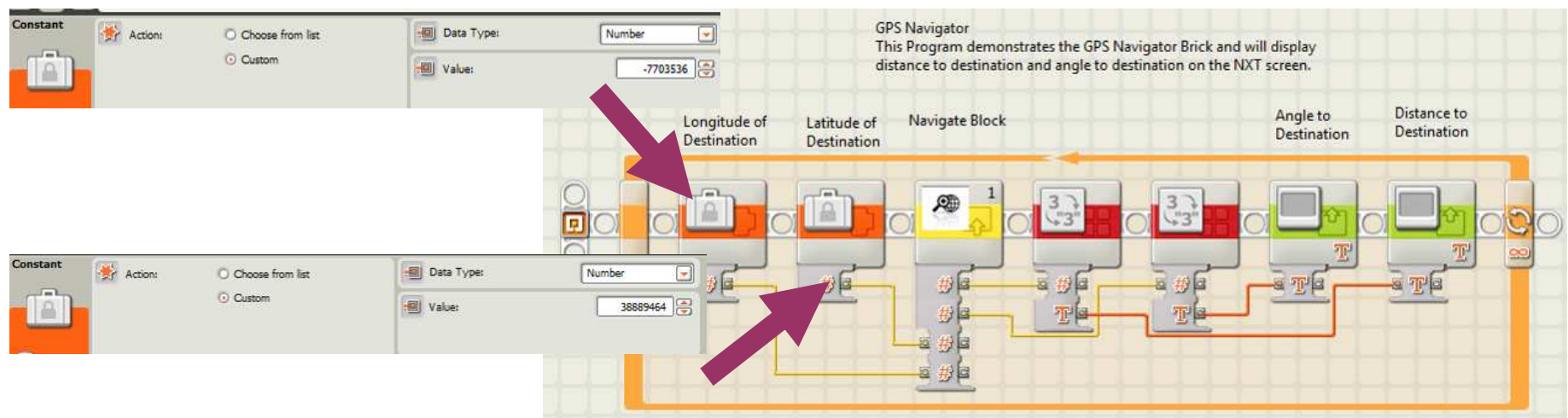
38.889463,-77.03536



Getting Started: Entering Coordinates into NXT-G

Next we'll write a quick program using NXT-G to tell us how far we are from our destination and what angle we have to travel to reach it.

- 1). Open NXT-G
- 2). Download the Program Entering Coordinates into NXT-G or make a program like the one in the picture below.
- 3). In the first constant from the left, enter the Longitude of the destination. For this example it will be -7703536
- 4). In the second constant from the left, enter the Latitude of the destination. For this example it will be 38889464.



After turning this program on and acquiring a signal we should see our angle to destination (the direction we would travel to get to the Washington Monument) and the distance we would have to go (in meters).

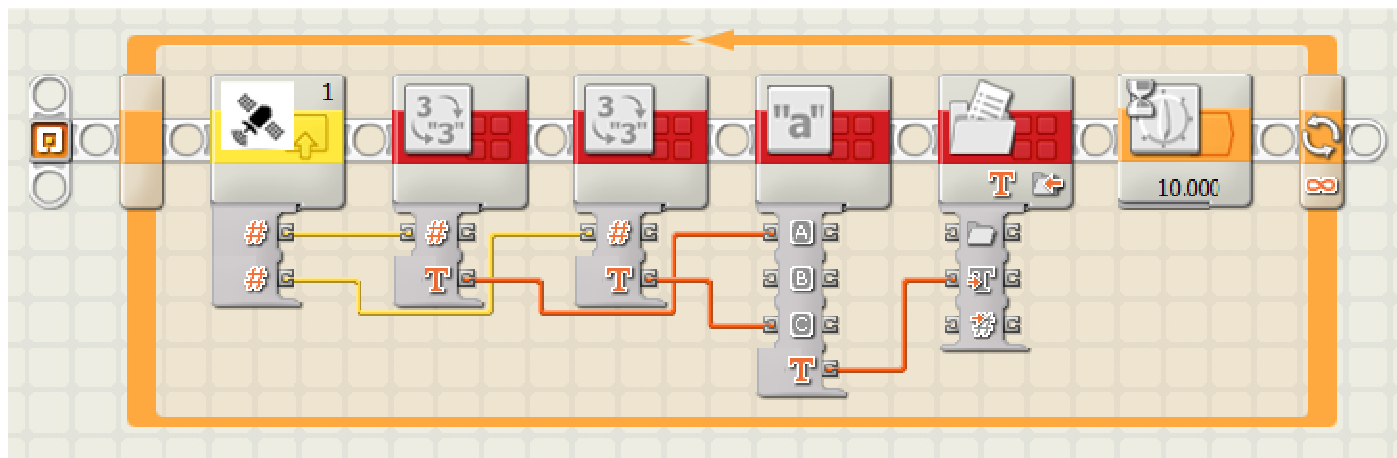


Plotting a Path in Google Earth

Google Earth is the second tool we'll use in this tutorial. It can be found at <http://earth.google.com> You must download and install it to your computer.

With Google Earth we'll plot a path of travel. This could be used to re-create your robot's path over the earth, outline a road-trip, or any number of projects where you want to show where your robot (or you) have been on a map. By recording the Latitude and Longitude of the GPS every few seconds, we can save our positions into a text file. The text file can be modified on a computer into a KML file and loaded into Google Earth to display a path of travel.

The NXT-G Program below uses the GPSRead block to record the latitude and longitude every 10 seconds and save it to file. The data is written so that the latitude is written first, then a comma, then the longitude. The comma will make processing the data in the excel file easier.

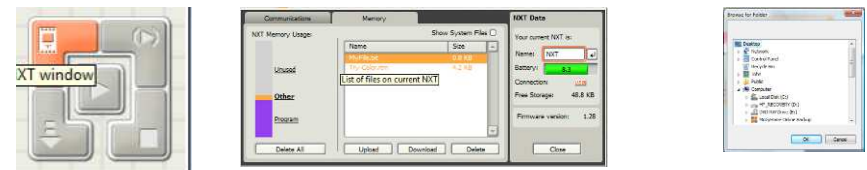




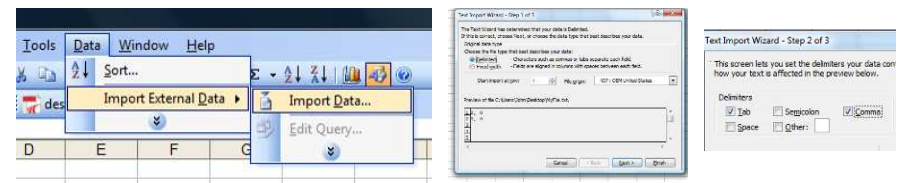
Plotting a Path in Google Earth: Getting the Data

The next step: take it outside and log some data. Start the program and acquire a signal. Then, go for a car ride, bicycle ride, put it in a backpack and hit your favorite trail.

After you finish your journey, stop the program, hook the NXT up to your computer, and start Mindstorms NXT-G. In the program, download the text file you created. In our case, it was “MyFile.txt”.



Next, open Microsoft Excel (This step can also be done in Google Docs). Import the text file from the NXT into Excel. To do this, go to (Data → Import External Data → Import Data). When prompted to select a delimiter, select the comma (“,”).



Divide all numbers by 1,000,000. This will convert the data from integer to decimal-degree format.

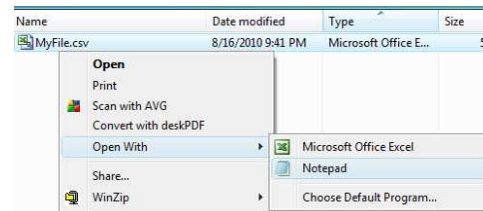
Insert a third column of zeros to the right of the latitude. Save the file as a comma separated values (CSV) file.



Plotting a Path in Google Earth: The KML File

Next we're going to put the data into a KML file. KML stands for Keyhole Markup Language and is the language that Google Earth reads geographic annotation. To put the data into the KML file, do the following:

Open the CSV file with Notepad or another text editor.



Next, copy the template from Appendix I. Paste the template to a text file. Next, past the GPS data from the CSV inside the template where it says “// Data Here”. Delete the text “// Data Here”.

```
File Edit Format View Help
<?xml version="1.0" encoding="utf-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
<doc name="">
<name>KML</name>
<description>Sample of path. Note that the placemark tag is by default
set to 0. If you want to create tessellated lines, they must be authored
or edited directly in the description.
<style is="yellowOutline">
<LineStyle>
<color>#ffff00</color>
<width>4</width>
</LineStyle>
<Placemark>
<name>Extruded</name>
<description>Transparent green wall with yellow outlines</description>
<style>#ffff00</style>
<extrude>1</extrude>
<altitude>100</altitude>
<coordinates>
-71.60436,40.758701,0
-71.60396,40.75939,0
-71.60396,40.75928,0
-71.59848,40.76246,0
-71.59849,40.76098,0
-71.59259,40.76246,0
-71.59274,40.76241,0
</coordinates>
</Placemark>
</doc>
</kml>
```

Save the file with a KML extension (MyFile.KML).



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Plotting a Path in Google Earth: Import and Display

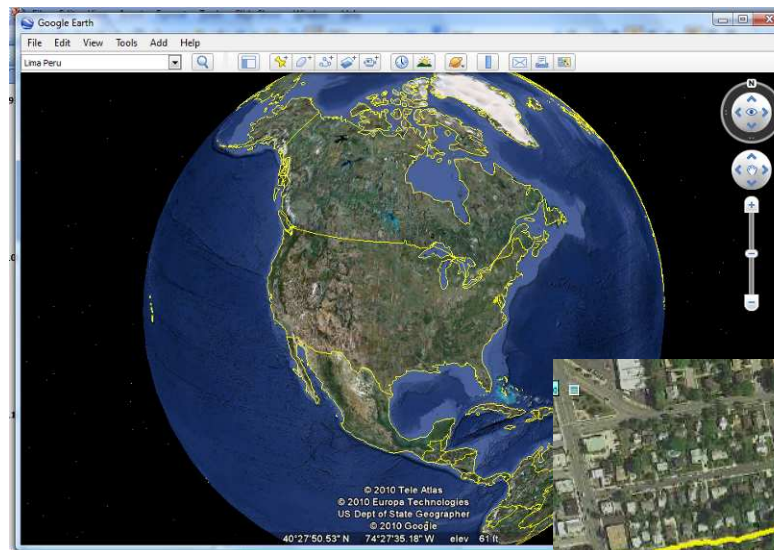
Open Google Earth.

Goto “File → Open →” and select your file.

The path should be displayed!

For more information on KML files and Google Earth see:

<http://code.google.com/apis/kml/documentation/>



Appendix I: Blank KML File

- `<?xml version="1.0" encoding="UTF-8"?>`
- `<kml xmlns="http://www.opengis.net/kml/2.2">`
- `<Document>`
- `<name>Paths</name>`
- `<description>Examples of paths. Note that the tessellate tag is by default`
- `set to 0. If you want to create tessellated lines, they must be authored`
- `(or edited) directly in KML.</description>`
- `<Style id="yellowLineGreenPoly">`
- `<LineStyle>`
- `<color>7f00fff</color>`
- `<width>4</width>`
- `</LineStyle>`
- `<PolyStyle>`
- `<color>7f00ff00</color>`
- `</PolyStyle>`
- `</Style>`
- `<Placemark>`
- `<name>Absolute Extruded</name>`
- `<description>Transparent green wall with yellow outlines</description>`
- `<styleUrl>#yellowLineGreenPoly</styleUrl>`
- `<LineString>`
- `<extrude>10</extrude>`
- `<tessellate>10</tessellate>`
- `<altitudeMode>clampToGround</altitudeMode>`
- `<coordinates>`
- `// DATA HERE`
- `</coordinates>`
- `</LineString>`
- `</Placemark>`
- `</Document>`
- `</kml>`