mapnav V.1.5 Geolocation Toolkit

Thank you for purchasing MapNav! We have made a great effort to provide you with a powerful and easy to use geolocation engine and maps implementation for Unity, including GPS navigation, 2D/3D content integration and map/camera controls.
This manual will guide you through each and every step necessary to start building your location-based app or game. Please also have a look to the included Demo Scenes where you can find working examples of basic MapNav configurations and check the inline comments of the included scripts for additional information.

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GETTING STARTED

To start using MapNav you will first need to introduce two basic objects in your scene: a map (usually a plane containing the mapnav.cs script) and a player (user visualization). In the first case, we highly recommend using the “Map” object included in the MapNav's prefabs folder (/MAPNAV/Prefabs). This map object is ready to use and includes all relevant scripts attached. As a player visualization you can also use one of the prefabs provided (2D and 3D pointer), but if you would like to use your own (2d or 3d model, animated character, etc.) this is as easy as setting its Tag property to “Player”. MapNav will then automatically recognize it as the main actor and set all the navigation system around it.

Note that the provided map object uses a diffuse shader for its main material, so any downloaded texture might appear considerably dark unless some kind of light source is being used in your scene (e.g. directional light). The reason for this is to enable the rendering of shadows from 3d objects located on the map, but if you are planning a 2D app/game you might want to use the "unlit/texture" shader instead. Finally, you will need to get a valid AppKey from MapQuest (or your alternative maps provider) and use it in the MapNav main inspector (see "Maps AppKey" on next page).

MAPS IMPLEMENTATION

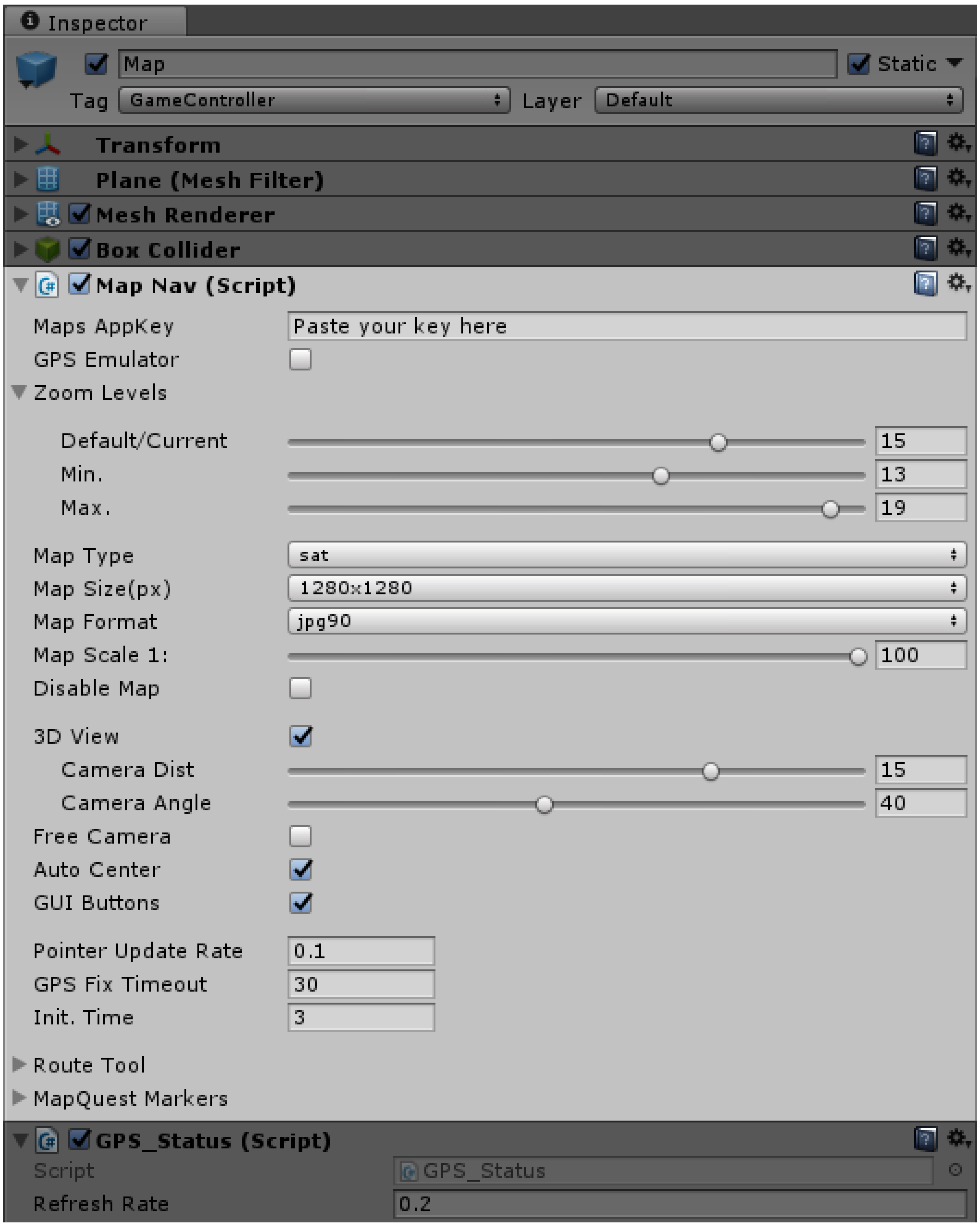
By default, MapNav uses the MapQuest Open Static Maps Service and OpenStreetMap* data to obtain the map tile for your current location. This texture is loaded into the Map object which is automatically scaled according to the tile size and zoom level, so world distances remain constant in your scene. Once the texture is no longer needed, it is properly destroyed to avoid memory leaks. However, since version 1.3 you can also disable the map and still use the MapNav geolocation engine with your own terrain and custom scenery. This is great, for example, if you are planning to build a "parallel world" type of game that can be navigated via GPS with optional AR visualizations.
Alternatively, if you would like to use maps from another tiles provider (e.g. Google Static Maps) you can easily do so by modifying the corresponding url for the http call in the mapnav.cs script. The new url should be compatible with the MapNav geolocation engine as long as it uses the center (lat,lon), size (e.g. 640X640) and zoom syntax to retrieve images from a map tiles server. Also, you might need to populate the maptype array with the new map layers options available from your tiles provider (please see the Maptype property below and visit http://recursivearts.com/mapnav/FAQ.html for additional information).

On early versions, MapNav used a default 1:100 map scale (1 unit in Unity world space equaled 100 m in the real physical world at latitude zero), however, since version 1.4 any map scale value from 1:100 up to 1:1 can be selected via the new inspector option. Please read below for further details.

Please make sure you read and meet the terms of service and usage limitations of any maps provider you intend to implement. The MapQuest Platform Terms of Use are available at https://developer.mapquest.com/legal.

MAIN INSPECTOR PANEL

The core functionality of our geolocation engine is provided by the MapNav script which is included in the "Map" prefab. If you are using any other object to render the map, please make sure that this script (/MAPNAV/Scripts/MapNav.cs) is attached to it. All the options and parameters can then be accessed from the custom Inspector Panel (Figure 1)


Inspector

Map — Static: ✓

Tag: GameController — Layer: Default

Transform

Plane (Mesh Filter)

Mesh Renderer ✓

Box Collider ✓

Map Nav (Script) ✓

Maps AppKey	Paste your key here
GPS Emulator	☐
Zoom Levels	
Default/Current	15
Min.	13
Max.	19
Map Type	sat
Map Size(px)	1280x1280
Map Format	jpg90
Map Scale 1:	100
Disable Map	☐
3D View	✓
Camera Dist	15
Camera Angle	40
Free Camera	☐
Auto Center	✓
GUI Buttons	✓
Pointer Update Rate	0.1
GPS Fix Timeout	30
Init. Time	3
Route Tool	
MapQuest Markers	

GPS_Status (Script) ✓

Script	GPS_Status
Refresh Rate	0.2

Figure 1.MapNav Inspector (3D View)

Maps AppKey. This field allows you to enter an AppKey code (API key) so your application can be identified by the maps servers. This is required in order to use MapQuest Open Static Maps and other maps services (e.g. Google Maps).
App Keys can be requested from your MapQuest developer account. To create a new account please visit: https://developer.mapquest.com/plans

⚠ Please obtain a unique AppKey before you start using MapNav to avoid sharing the default sample key with other developers and reaching possible usage limitations.

GPS Emulator. Check this box if you are building to PC/Mac standalone or using Unity Editor. A GPS Emulator will be enabled to simulate location tracking.
If building for mobile devices (Android/iOS) please disable this option just before you build your project. The real GPS sensor in your device will then be used.

Zoom Levels. Use these controls to set the default, minimum and maximum operative zoom levels for your application. Note that, even if some maps providers accept zoom levels up to 20, this level of detail might not be available in all geographical areas or might differ depending on the type of map used.

Map Type. This drop-down list includes all the possible map types that MapQuest Open Static Maps currently offers, i.e. *map, sat, hyb, light,* and *dark.* Choose the one that better suits your application. If you are using a different maps provider other than MapQuest, you can modify this list by editing the values of the *maptype* (array) variable in the MapNav.cs and MapNavInspector.cs scripts.

Map Size. Size (in pixels) for the map tile request. The resolution of the map on the screen will directly depend on this setting and the available sizes are usually different for each maps provider and license you are using. As an example, Google Static Maps has a maximum tile size of 640x640 for its free license, although using their "scale" property this can be double effectively up to 1280x1280. MapQuest offers tiles as large as 1920x1920, but their servers are generally slower, so it is usually desirable to achieve a balance between download times and image definition.

Map Format. Allows you to select a compression algorithm for the requested map image. Available options are *png*, *jpg90*, *jpg80* and *jpg70*. The png format delivers the best image quality at the cost of larger file sizes and slower download times. On the other end, jpg70 offers the highest compression rate and fastest download times with a slightly reduced image quality.

Map Scale. This setting defines the ratio between real world meters and Unity's world units. For instance, at 1:100 scale, every Unity world unit will correspond to 100 meters in the real world. However, this is only true at the equator (0 degrees latitude), because of the distortion introduced by the map projection as we move toward the poles. In order to measure distances or scale 3D objects in a scene, such a distortion needs to be corrected by calculating the "scale factor" for the current latitude:

```
factor = 1 / cos(latitude)
```

For example, at 60 degrees latitude and a map scale of 1:10, scale factor will be 2, so 1 Unity world unit will correspond to 20 real world meters. <u>This calculation is automatically performed by the SetGeolocation.cs script when the option "Mercator Scale Distortion" is enabled</u> (see page 7 for details).

Disable Map. Tick this box if you do not need to display the base map. MapNav will also stop calling the map tiles service. It has no effect over the geolocation engine as long as the map game object (tagged as GameController) and the MapNav.cs script remain enabled.

3D-View. Enable this option if you are planning to add 3D objects on your map, so the camera can be adjusted to allow a three-dimensional perspective view (*distance* and *angle*). If disabled (2D-view), the camera is switched to orthographic projection and the orthographic size is automatically set depending on the zoom level for an optimal map visualization.
In 3D-view, the camera position can be adjusted using the distance and angle parameters. This distance is measured from the object tagged as "*Player". Please make sure that your camera is also tagged as "*MainCamera".*

Free Camera. By default this option is disabled, so the Main Camera will follow your player (as a child), using the angle and distance settings mentioned earlier. However, enabling this option, it is also possible to use a "free" camera with no constrains or implementing your own custom camera control system. This is a 3D-view-only feature.

Auto Center. When enabled, the map texture will automatically be updated and the camera centered on the new player's position if the following conditions are met:

- 2D mode: The player exits a pre-defined rectangle on the screen. Uses the WorldToViewportPoint method and can be modified using the "rect" variable in the MapNav.cs script.

- 3D mode: The player exits the box collider attached to the Map tile object. The size of the collider can also be changed to set a different auto center boundary.

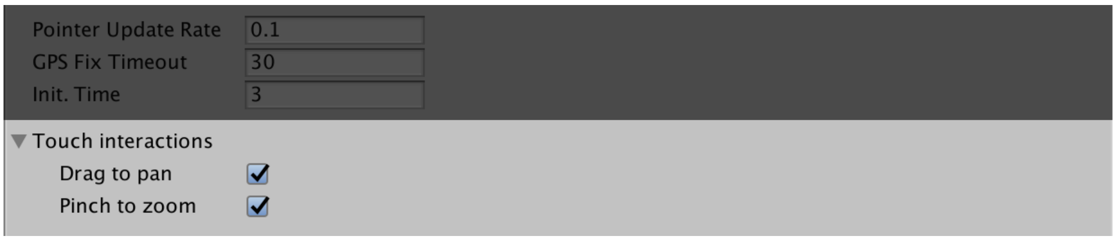
GUI Buttons. Activates a sample graphic user interface to control the following parameters: *maptype, zoom out, zoom in, refresh/center map*, and *info*. The info button enables a GPS status overlay showing geo-location data and console messages. This information will only be available if the "GPS_Status script" (/MAPNAV/Scripts/GPS_Status.cs) is attached to the Map object. Since version 1.5, the "InfoCanvas" prefab (/MAPNAV/Prefabs/InfoCanvas) must also be included in the scene.
This GUI is only provided as a basic functional example. Please feel free to modify or extend it according to your particular needs.

Pointer Update Rate (mobile only). This value sets how often the player's position will be updated using the location data provided by the GPS sensor.

GPS Fix Timeout (mobile only). Maximum time in seconds before the user gets a warning to check if location services are enabled. Allow at least 15-20 seconds so the GPS sensor (if enabled) has enough time to get a GPS fix (it might take longer on some devices).

Init. Time (optional). An initialization time (delay) after a GPS fix has occurred and before the map is displayed, in order to increase the accuracy of the location data (number of satellites).

Touch Interactions (2D-view only). "Drag to Pan" and "Pinch to Zoom" options can be individually activated when targeting touch screen enabled devices.



Pointer Update Rate 0.1
GPS Fix Timeout 30
Init. Time 3
Touch interactions
Drag to pan ✓
Pinch to zoom ✓

Figure 2. Touch Interactions (2D-View)

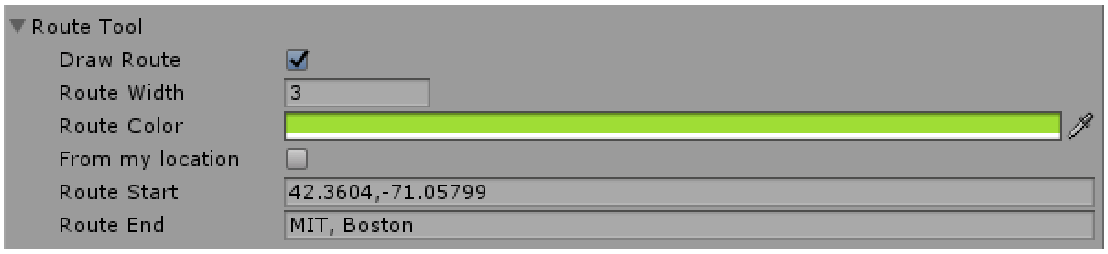
Route Tool. See next section below.
MapQuest Markers. See details below.

MAPQUEST ROUTES AND MARKERS

MapNav 1.5 introduces MapQuest native routes and markers as a simple and effective method to display useful information. This method complements the existing geolocation tools in MapNav (see page 10) and can therefore be combined together.

Drawing a MapQuest Route

Rendering Maquest native routes is now possible using the new **Route Tool** section of the main MapNav inspector (Figure 3).



Route Tool
Draw Route ✓
Route Width 3
Route Color
From my location
Route Start 42.3604,-71.05799
Route End MIT, Boston

Figure 3. Route Tool

This tool will automatically add route parameters to our map queries so the corresponding path is included in the returned image (Figure 4). Available parameters are self-explanatory, however, note that the current user position can also be used as a starting point, instead of providing an actual address or latitude, longitude pair. Simply tick the corresponding option box '*From my location*'.

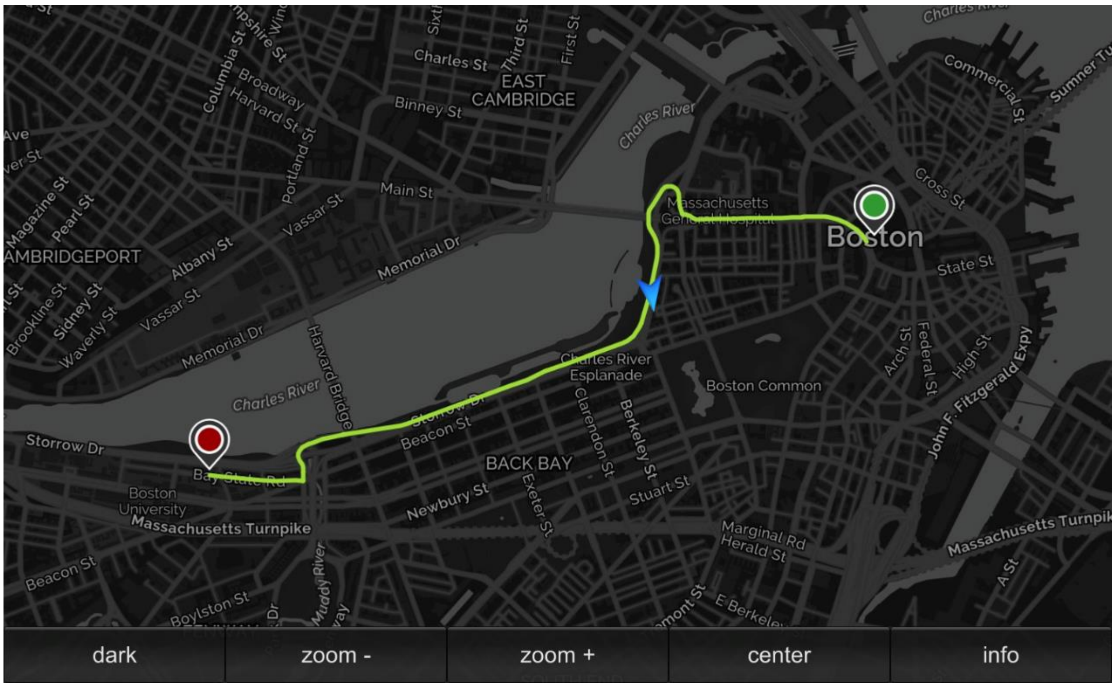


Figure 4. Resulting Route from A to B

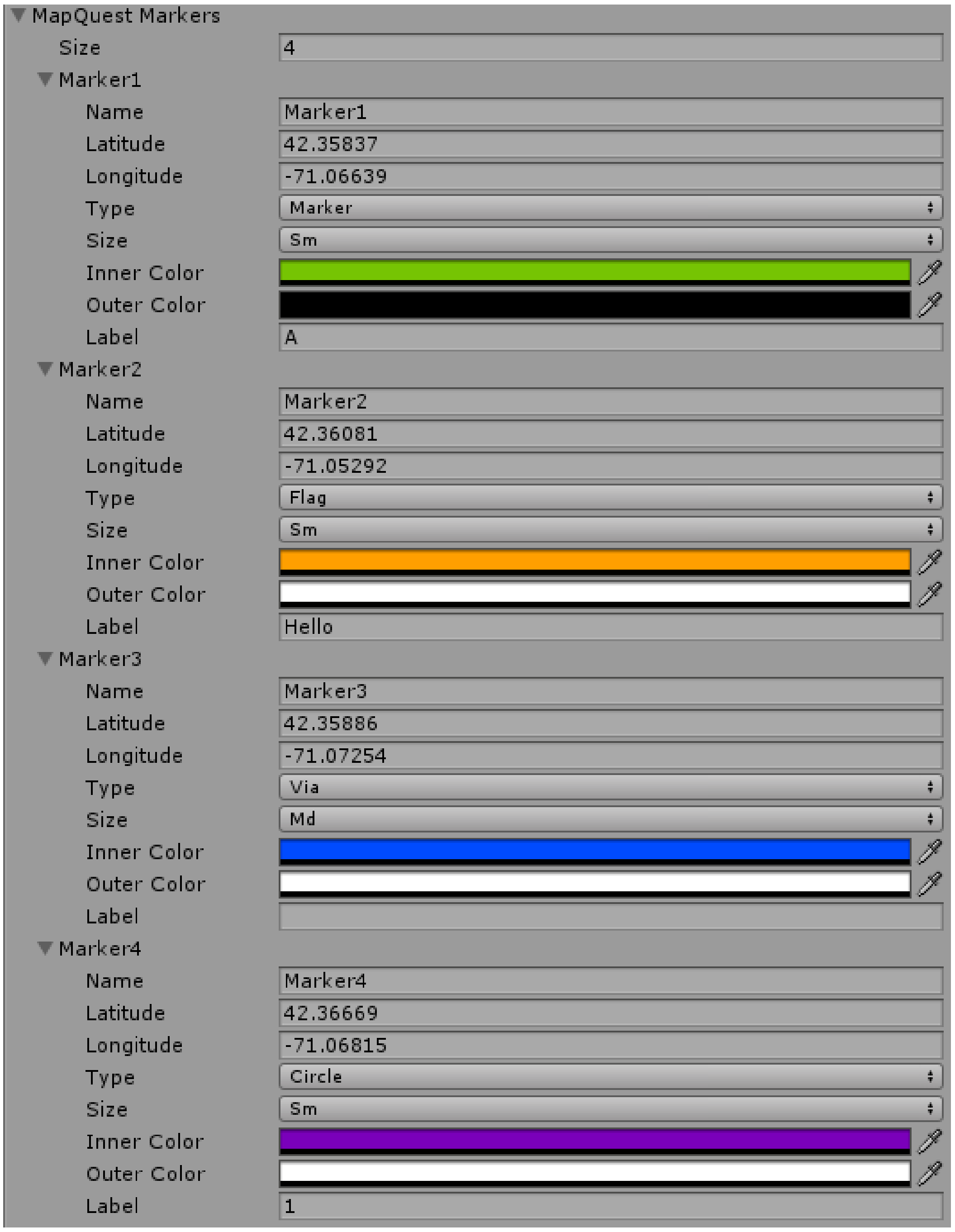
When using addresses, please make sure you are using single-line addresses. For further information and examples of single-line addressed please visit: https://developer.mapquest.com/documentation/common/forming-locations/#singleLineLocations

Adding MapQuest Markers

Similarly to drawing routes, we can also ask the MapQuest server to render native markers onto our map. The number of markers to be included can be set by changing the size of the MapQuest Markers array, either using the inspector or via script.

Each marker can be customized using the following customization parameters (Figure 5):

Name. You can type a name here to identify the current marker.
Latitude. Latitude position as decimal degrees.
Longitude. Longitude position as decimal degrees.
Type. Four marker types (shapes) can be used: *marker* (default), *flag*, *via*, and *circle*.
Size. Determines the size of the marker: small (Sm), medium (Md), or large (Lg).
Inner Color. Selects a color for the inside area of the marker.
Outer Color. Selects a color for the outside area/border of the marker.
Label. You can include up to five letters, numbers, and characters except for "-" and "." (Characters will need to be URL escaped and letters will be capitalized). Not available for 'Via' type markers.



▼ MapQuest Markers	
Size	4
▼ Marker1	
Name	Marker1
Latitude	42.35837
Longitude	-71.06639
Type	Marker
Size	Sm
Inner Color	🟩
Outer Color	⬛
Label	A
▼ Marker2	
Name	Marker2
Latitude	42.36081
Longitude	-71.05292
Type	Flag
Size	Sm
Inner Color	🟧
Outer Color	⬜
Label	Hello
▼ Marker3	
Name	Marker3
Latitude	42.35886
Longitude	-71.07254
Type	Via
Size	Md
Inner Color	🟦
Outer Color	⬜
Label	
▼ Marker4	
Name	Marker4
Latitude	42.36669
Longitude	-71.06815
Type	Circle
Size	Sm
Inner Color	🟪
Outer Color	⬜
Label	1

Figure 5. MapQuest Markers Customization Panel

⚠ If you using an alternative map provider other than MapQuest please contact us for details on implementing native markers (e.g. Google Maps markers)

An example of map including MapQuest native markers is shown in Figure 6.

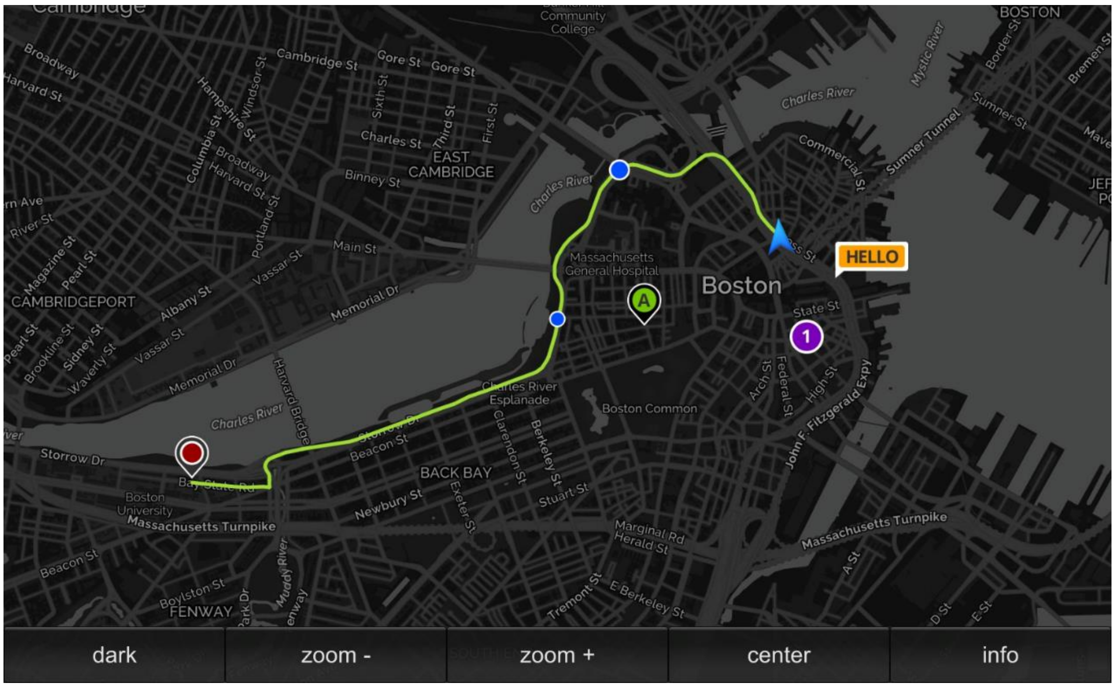
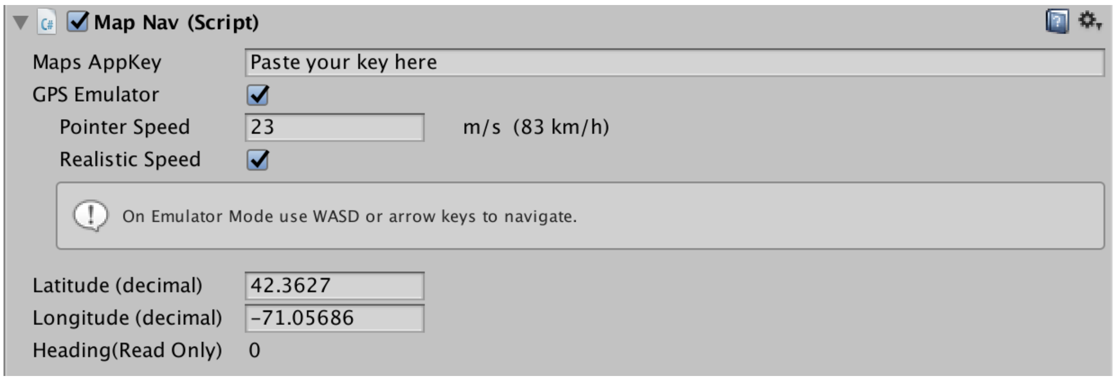


Figure 6. Map including MapQuest Native Markers and Route

USING THE GPS EMULATOR

The GPS emulator allows us to implement the MAPNAV navigation system even if the target hardware/platform does not feature a GPS sensor (e.g. PC/MAC standalone). Therefore, the user position and movement is simulated using the keyboard input (WASD and arrow keys), and location data (latitude, longitude, etc.) is calculated according to our position on the map.



Map Nav (Script)

Maps AppKey	Paste your key here
GPS Emulator	✓
Pointer Speed	23 m/s (83 km/h)
Realistic Speed	✓

On Emulator Mode use WASD or arrow keys to navigate.

Latitude (decimal)	42.3627
Longitude (decimal)	-71.05686
Heading(Read Only)	0

Figure 7. GPS Emulator

A number of additional options are shown in the inspector when the GPS Emulator is enabled:

Pointer Speed. This value sets how fast the player moves on the map when using the keyboard input. Speed units are in m/s, but also displayed as km/h.

Realistic Speed. If disabled, the perceived pointer/player speed is independent of the selected zoom level (unrealistic behavior). On the other hand, if this option is enabled, the player will seem to move slower on the screen when the zoom level is lower, and faster when we zoom in (realistic behavior).

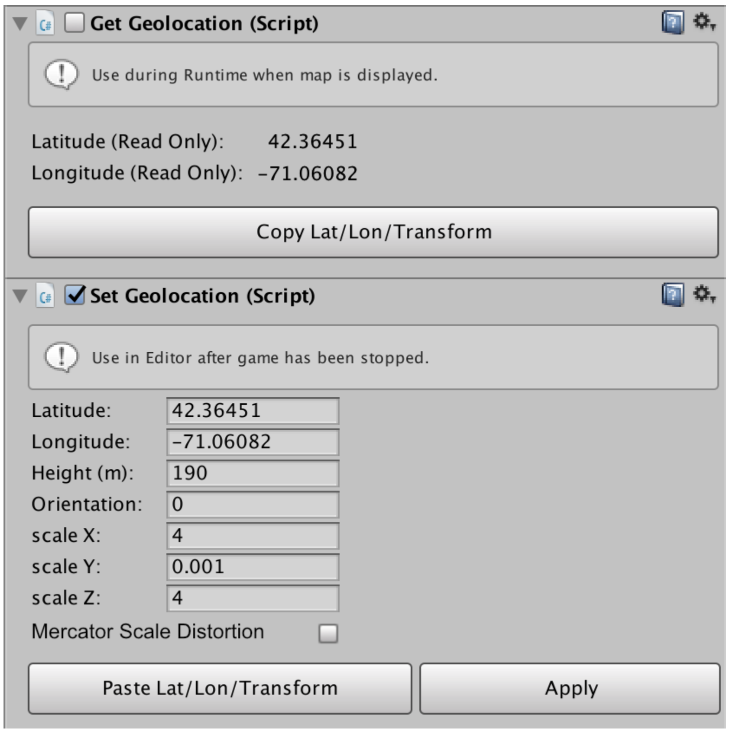
Latitude/Longitude. When using the GPS Emulator you can provide initial Latitude and Longitude values to set the location where your game/app will start. This fields will also read the current user position as geographical coordinates (WGS84) while the game/app is running.

Heading (Read Only). The current user heading provided by the magnetometer sensor. When the GPS emulator is enabled, it takes its value from the user's transform.eulerAngles.y.

Even <u>if your target platform is mobile</u> (Android, iOS or Windows Phone), the GPS Emulator is also extremely useful while working in the Unity Editor, so you can geolocate your content on the map. Just <u>remember to disable the emulator mode before the final build</u>, so the actual GPS sensor in your mobile device can be used.

GEO-LOCATING 2D/3D GAME OBJECTS ON THE MAP

In order to populate the map with your own 3D or 2D content, simply drop any game object into your scene and attach the GetGeolocation and SetGeolocation scripts to it.



Get Geolocation (Script)

Use during Runtime when map is displayed.

Latitude (Read Only): 42.36451
Longitude (Read Only): -71.06082

Set Geolocation (Script)

Use in Editor after game has been stopped.

Latitude:	42.36451
Longitude:	-71.06082
Height (m):	190
Orientation:	0
scale X:	4
scale Y:	0.001
scale Z:	4
Mercator Scale Distortion	☐

Figure 8. Geolocation of Game Object

The GetGeolocation script will allow you to adjust the position (x,y,z), orientation (y-axis only) and scale of your objects on the map while the scene is running, and temporally store these values for later use. This is necessary as the map texture for the current location can only be visualized while the scene is playing and the Unity editor does not keep any changes made during runtime.

After the scene is stopped, you can then use the SetGeolocation script to restore this data.

We can summarize this process in six simple steps:

> *Step 1.* Drag a 2D/3D model into your scene and attach the GetGeolocation and SetGeolocation scripts to it. Enable the GetGeolocation script and check that SetGeolocation is disabled.
> *Step 2.* Start playing the scene.
> *Step 3.* Once the map is visible, adjust the scale, orientation and position of your game object on the map and click on the "Copy Lat/Lon/Transform" button (GetGeolocation inspector). The console will print a message when the data has been successfully copied.
> *Step 4***.** Stop playing the scene.
> *Step 5.* Click on the "Paste Lat/Lon/Transform" button in the SetGeolocation inspector and press "Apply" if you want to visualize the new values now while the scene is still stopped.
> *Step 6.* Disable or delete the GetGeolocation script, and make sure that the SetGeolocation script is now enabled before you play the scene again. Everything should now be in the right location, no matter what the initial location of the player is.

Alternatively, if you already know the latitude, longitude and orientation for a particular object, you can also omit the GetGeolocation step and directly insert these values into the SetGeolocation inspector. In such a case, you might want to enable the new **Mercator Scale Distortion** option so your object's scale is automatically adjusted to match the Mercator projection scale factor corresponding to the selected latitude.

GEO-LOCATING DYNAMIC (ANIMATED) OBJECTS

It is also possible to geolocate non-static game objects using the Get/Set-Geolocation method described in the previous section. An example of this can be found in the 3D Demo Scene included with MapNav (/MAPNAV/Demo Scenes/3D Scene/MapNav_3D_Demo) where the 3D bus model is animated to drive along a particular street. As you can see, the only difference is that we have created an empty **parent** object for this animated object, so the movement of our model is now relative to the position and orientation of its parent's transform. Therefore, the GetGeolocation/SetGeolocation scripts can be used normally on the parent object, ensuring that our animated model is perfectly positioned within that street.

FIXING THE ASPECT OF 2D OBJECTS

A frequently desirable feature of 2D content when displayed on an online map (e.g. markers icons, labels, etc.), is the ability to maintain their aspect constant regardless of the selected zoom level. We are using here the term ‘aspect’ to refer to the apparent size of the object (not to be confused with ‘aspect radio’).

See the following MapNav screenshots as an example:

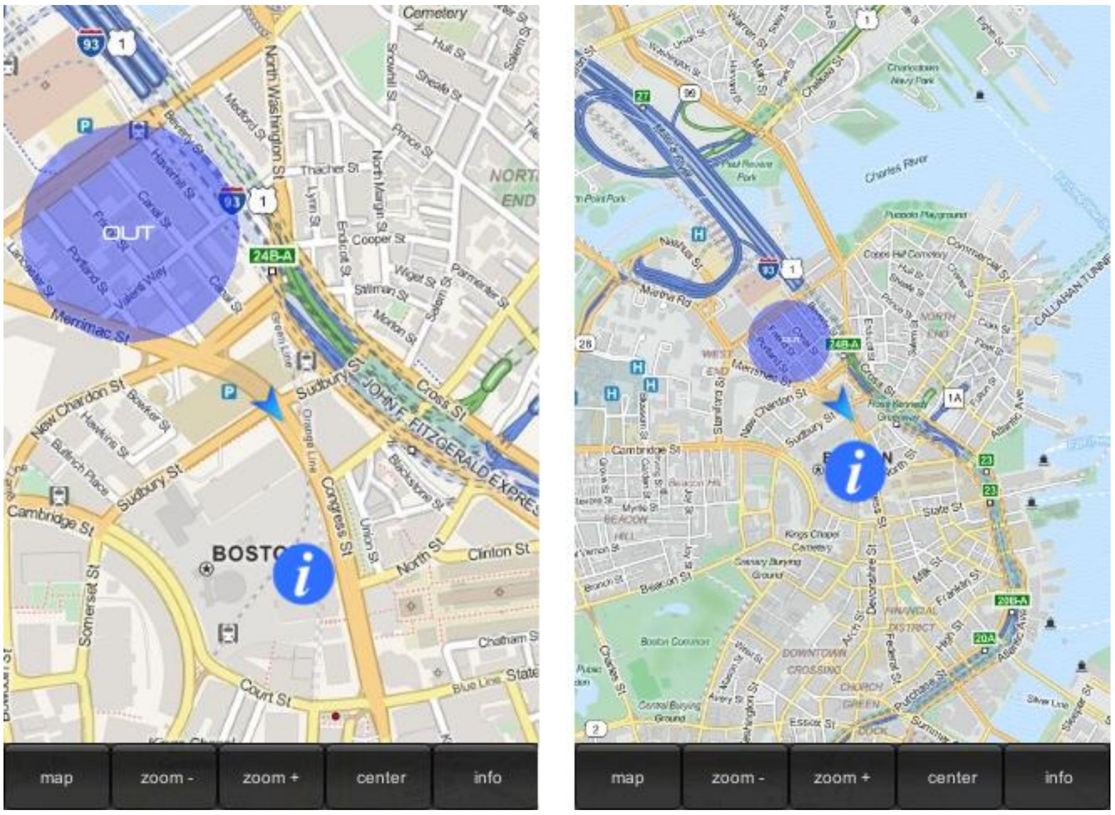


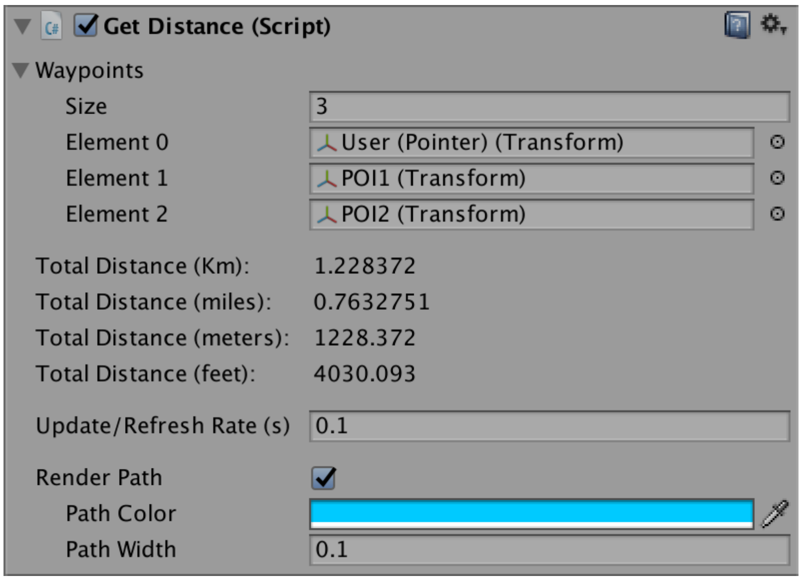
Figure 9. Fixing the size of a 2D game object regardless of zoom level

The image on the left has a higher zoom level than the image on the right, which shows a much larger area of central Boston. However, notice how the user pointer and the information icon maintain their size on the screen, despite the operative zoom level of each map. In contrast, the transparent circular area looks much smaller on the right image given that it has not been re-scaled and maintains its world-space proportions.

In order to get this fixed aspect effect, MapNav includes two separate scripts: **FixPlaneAspect.cs** and **FixQuadAspect.cs** (depending on the type of mesh that your 2D object is using). Just add the corresponding script to the object where you want to achieve this behavior, and it will automatically be re-sized whenever the zoom level is changed, maintaining a constant aspect on the screen while preserving its location on the map.

CALCULATING REAL-WORLD DISTANCES

Automatic distance calculations are now possible thanks to the new GetDistance.cs script (/MAPNAV/Scripts/GetDistance.cs) available since version 1.3.3.



Get Distance (Script)	
Waypoints	
Size	3
Element 0	User (Pointer) (Transform)
Element 1	POI1 (Transform)
Element 2	POI2 (Transform)
Total Distance (Km):	1.228372
Total Distance (miles):	0.7632751
Total Distance (meters):	1228.372
Total Distance (feet):	4030.093
Update/Refresh Rate (s)	0.1
Render Path	✓
Path Color	🟦
Path Width	0.1

Figure 10. Measuring real-world distances between game objects

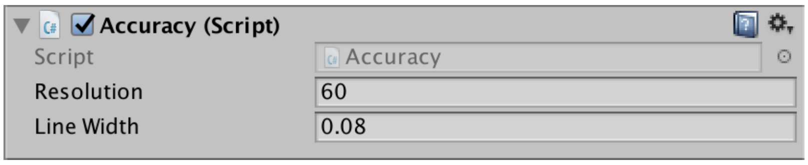
Given the unavoidable distortion introduced by the modified Mercator projection used by most online maps providers (Google, Bing, MapQuest, etc.), it is not possible to measure distances directly on the map using Vector3.Distance and Unity world units. If you try to do so, you will notice that the obtained values differ considerably from the real ones depending on your latitude (see “Map Scale” above). However, the new GetDistance.cs tool implements spherical trigonometry that takes into account the curvature of the Earth and the effects of latitude in distance calculations with a minimal error.

To use the GetDistance.cs tool, you just need to add this script into any game object in your scene (e.g. an empty object) and provide at least two locations using the inspector (Figure 10). You can also increase the size of the Transform type array if your path/route includes more than two locations/waypoints. The total distance between these locations will then be calculated and displayed using multiple units (kilometers, miles, meters and feet). Additionally, the GetDistance.cs tool includes a basic LineRenderer implementation that can be enabled in order to visualize the resulting path. Choose a color and path width to customize this visualization. Distance values are updated in runtime according to the “Update/Refresh Rate” property in the inspector, so dynamic objects (e.g. the Player’s position) can also be used as waypoints.

ADDITIONAL TOOLS

Accuracy.cs

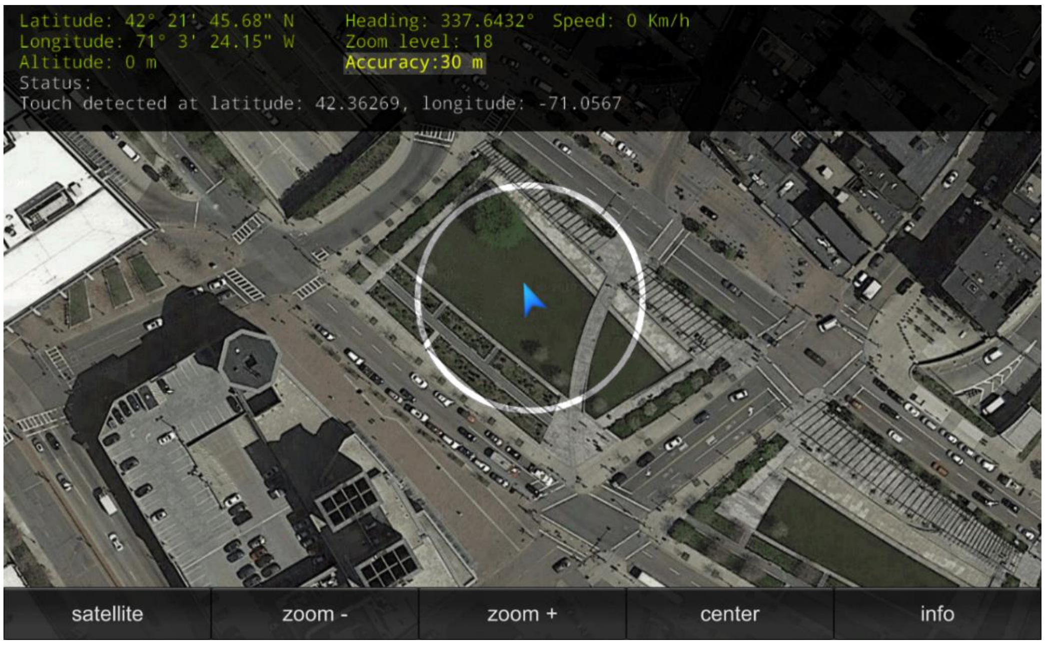
This tool displays the horizontal accuracy of the GPS sensor, both graphically (as a variable radius circle around the user) and numerically (via the GPS_Status.cs info button). In order to function, this script needs to be attached to the “Player” game object.



Accuracy (Script)

Script	Accuracy
Resolution	60
Line Width	0.08

Figure 11. Accuracy script inspector

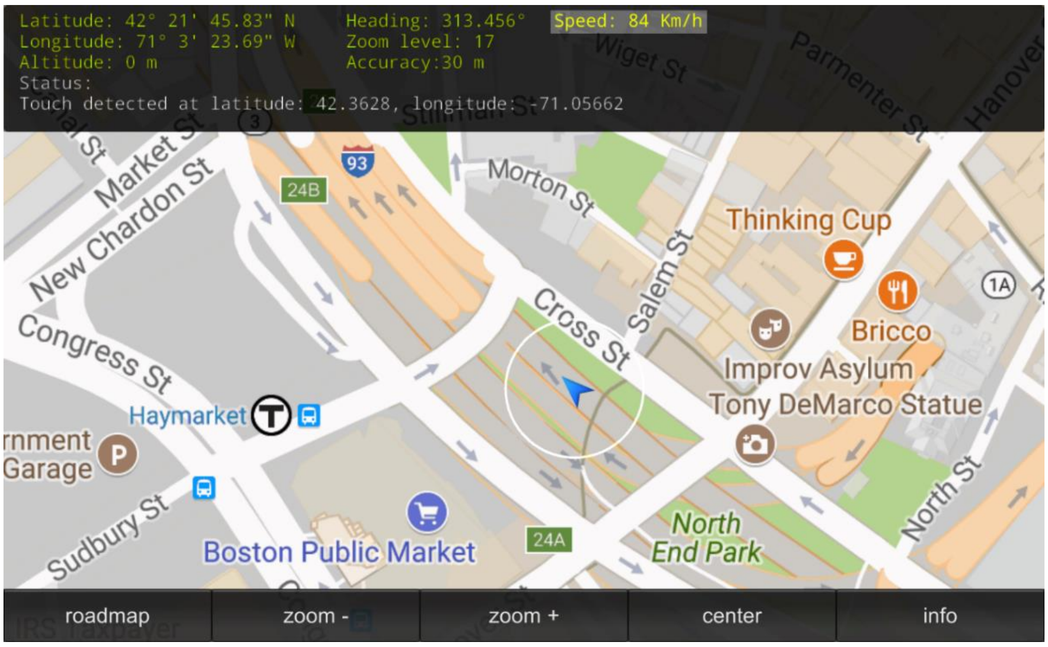


```
Latitude: 42° 21' 45.68" N      Heading: 337.6432°  Speed: 0 Km/h
Longitude: 71° 3' 24.15" W      Zoom level: 18
Altitude: 0 m                   Accuracy:30 m
Status:
Touch detected at latitude: 42.36269, longitude: -71.0567
```

Figure 12. Horizontal accuracy graphical representation

InstantVelocity.cs

Attach this script to any game object in your scene (e.g. the Main Camera or an empty gameobject) in order to calculate the current user speed. The resulting value will automatically be displayed via the GPS_Status.cs script info button (Figure 13).

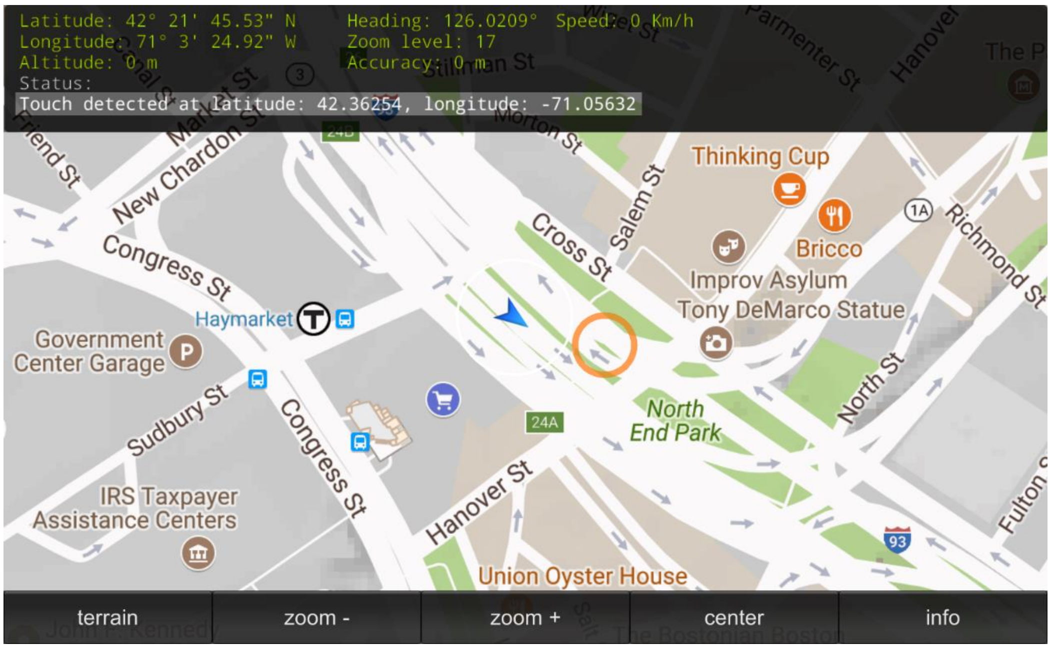


```
Latitude: 42° 21' 45.83" N     Heading: 313.456°   Speed: 84 Km/h
Longitude: 71° 3' 23.69" W     Zoom level: 17
Altitude: 0 m                  Accuracy:30 m
Status:
Touch detected at latitude: 42.3628, longitude: -71.05662
```

Figure 13. Instant Velocity calculation using MapNav

GetTapLocation.cs

When attached to the “Main Camera”, this new tool detects if a user has tapped the screen and returns the exact location (latitude/longitude in decimal degrees) of the touch position on the map. These coordinates will be displayed via the GPS_Status.cs info button, and can be used to instantiate custom content at that location (e.g. POIs). This tool also works on Unity Editor using the mouse. An animated circle around the detected location is also shown on the map.



```
Latitude: 42° 21' 45.53" N     Heading: 126.0209°   Speed: 0 Km/h
Longitude: 71° 3' 24.92" W     Zoom level: 17
Altitude: 0 m                  Accuracy: 0 m
Status:
Touch detected at latitude: 42.36254, longitude: -71.05632
```

Figure 14. Obtaining GPS coordinates of a point on the map

MapNav - Geolocation Toolkit

For support or further information please contact:
support@recursivearts.com