BiDaE Technology

Seeing-I-Go (a Waypoint-Based Anywhere Navigator) at a Glance

June 2023

Overview In this note, the term *navigator* refers to a mobile positioning and navigation application that runs on smart phones and is used by people to guide them as they travel on foot or in wheelchairs to destinations within a building or a complex of buildings. Today, different buildings in a building complex or parts of a large building may deploy indoor positioning systems based on different technologies. An *anywhere navigator* is so named because it provides component positioning modules so that it can work anywhere, switching seamlessly and transparently to the user between different underlying indoor positioning systems deployed within buildings and outdoor spaces around the buildings.

Seeing-I-Go is the anywhere navigator offered by BiDaE. It is designed for use within large and often crowded buildings. Its graphical user interface (GUI) is simple and easy to use and does not require the user to look at the screen for long and frequently. As its name implies, Seeing-I-Go[1] also makes use of accessibility features of modern smartphones and provides audio navigation directions for vision impaired users.

Seeing-I-Go is *waypoint-based.* A *waypoint i*s a point/location with known coordinates on routes of travel. Each waypoint is selected by design to reflect functions and locations of human navigation process[2]: It may be located at a possible starting point or destination, or an easily recognizable landmark, or a place where a human is likely to require a decision or assurance, and so on. The route from any starting point to any destination used by a *waypoint-based navigator* is made up of path segments connected by waypoints.

Navigation Graph The input used by Seeing-I-Go for the purposes of selecting routes and navigation instructions is a *navigation graph* of the coverage area. Nodes in the graph represent waypoints. Each edge, also called a *connection,* between two waypoints represent a path from one waypoint to the other traversable by people on foot, on wheelchair, and so on. As examples, a connection may be a corridor or a stretch of sidewalk, a path in the middle of an open space, an elevator, and so on. Such a two-way connection is represented in the graph by an undirected edge. One-way connections are represented by directed edges. Examples are down-escalators, up-escalators and moving pavements.

[1] The word "Go" has the same sound as "dog" in Chinese. So, Seeing-I-Go would be how a person in US call a guide dog using both English and Chinese.

[2] L. Yang and M. F. Worboys, “Generation of navigation graph for indoor space,” *International Journal of Geographical Information Science*, 17:16, May 2015, pp. 1737-1756.

When given by the user a starting point and destination pair, together with constraints (e.g., no stairs) and preferences (e.g., easy-to-follow route and stay indoors), the user's Seeing-I-Go selects a route containing the starting point and destination based on the navigation graph. It then guides the user from waypoint to waypoint, and typically provides a navigation directive (e.g., turn right at the intersection) or assurance statement (e.g., continue to go straight) as the user approaches each waypoint along the route.

Two-level Navigation Graph Structure In general, the coverage area is partitioned into disjoint regions. The term *region* refers to a contiguous area. Below are reasons for doing so:

- The area is in fact physically partitioned (e.g., containing multiple floors within a building or multiple parts on each floor);
- Different regions may use different positioning technologies (e.g., proximity detection using Lbeacons or ibeacons, trilateration and fingerprint indoors and GPS outdoor); and
- The navigation graph of multiple regions can be downloaded and created incrementally.

Accordingly, the navigation graph of the coverage area is structured hierarchically with two levels. The graph at the top level is called the *region graph*. The region graph of a coverage area with multiple regions contains a *region node* for each region. Edges between two region nodes represent pathways connecting the regions. Properties of each region node include a list (or dictionary) of names/ids of all terminal nodes in the region. *Terminal nodes* are waypoints that are possible destinations in the region. Once this list is downloaded and accessible along with the region graph structure, the user interface can present to the user the start up page, enabling the user to select the starting point and the destination of a navigation session.

Figure 1 presents an illustrative example. The use scenario assumes that visual and audio instructions are issued at waypoints by Seeing-I-Go to guide the user within a medical building and outside the building along sidewalks to and from the stop of the user's public bus.

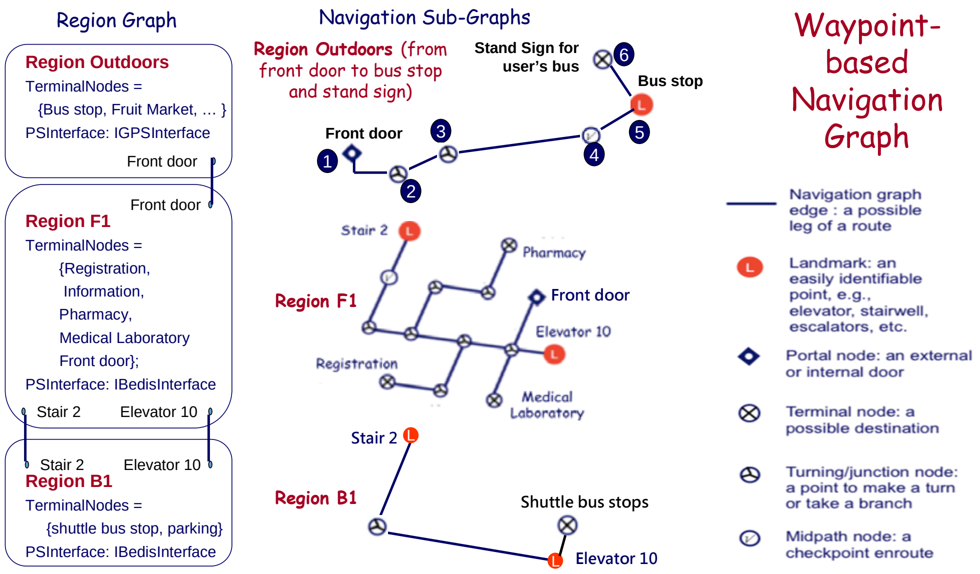

Region Graph
Region Outdoors
TerminalNodes =
{Bus stop, Fruit Market, … }
PSInterface: IGPSInterface
Front door
Front door
Region F1
TerminalNodes =
{Registration,
Information,
Pharmacy,
Medical Laboratory
Front door};
PSInterface: IBedisInterface
Stair 2
Elevator 10
Stair 2
Elevator 10
Region B1
TerminalNodes =
{shuttle bus stop, parking}
PSInterface: IBedisInterface
Navigation Sub-Graphs
Region Outdoors (from front door to bus stop and stand sign)
Stand Sign for user's bus
6
Bus stop
L
5
4
3
Front door
1
2
Stair 2
L
Pharmacy
Region F1
Front door
Elevator 10
L
Registration
Medical Laboratory
Stair 2
L
Region B1
Shuttle bus stops
L
Elevator 10
Waypoint-based Navigation Graph
Navigation graph edge : a possible leg of a route
L
Landmark: an easily identifiable point, e.g., elevator, stairwell, escalators, etc.
Portal node: an external or internal door
Terminal node: a possible destination
Turning/junction node: a point to make a turn or take a branch
Midpath node: a checkpoint enroute

Figure 1 An example of two-level navigation graph.

Specifically, the coverage area in this example has three regions: They are represented by the region graph in the left part of Figure 1: The outdoor regions contain all destinations of interest to the user, including stops for public buses. Inside the building, the region F1 contains destinations on the first floor where the user as an outpatient may visit during the day. The region B1 in the basement contains shuttle bus stops.

At the lower level of the navigation graph, there is a navigation sub-graph for each region: The sub-graph contains nodes that represent waypoints in the region and connections between those waypoints. It provides the data needed for selecting routes within the region. The middle part of Figure 1 depicts the sub-graphs of the three regions. In this case, all connections happen to be two-way. So, all edges are undirected. The list on the right provides names of common node (waypoint) types. A node can be of multiple types. For example a portal node or a landmark may also be a terminal node; a midway node where the navigator may provide assurance may also be a portal.

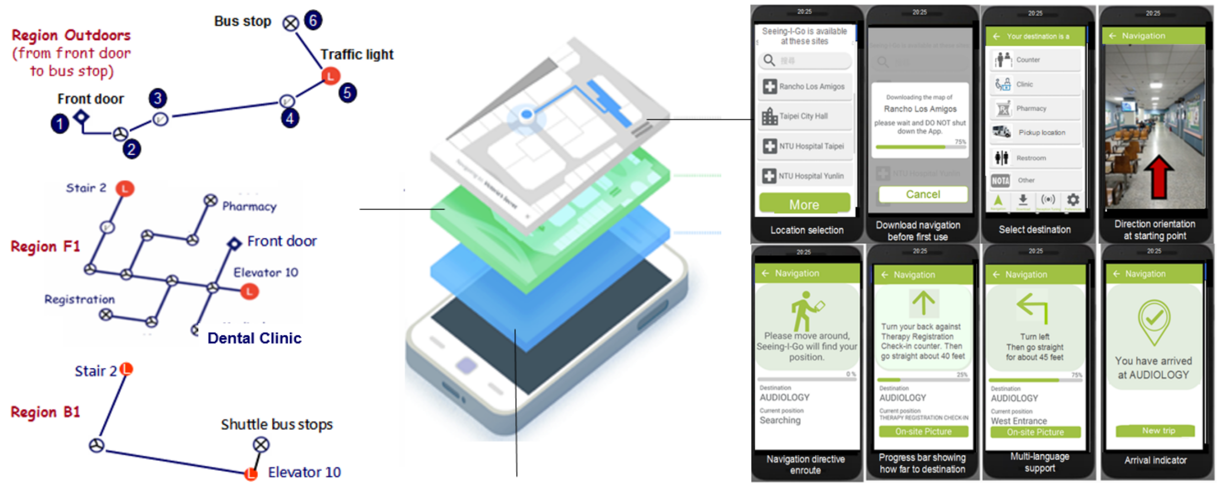
Positioning Support Another property of each region node is an interface to the positioning system (PS) used in the region. It is depicted in Figure 1 as PSInterface. The navigator relies on the system to determine at any time whether it has reached the next waypoint enroute.

In areas where Lbeacons are deployed, there is a Lbeacon at each waypoint. It broadcasts the UID of the waypoint to navigators passing by. Such waypoints are said to be *active*. Active waypoints make the implementation of navigators simpler as there is no need for the application to monitor their own positions. This is a distinct advantage of Lbeacons. Alternatively, a region may deploy a triangulation/trilateration system or a fingerprint-based system for positioning. An outdoor region may rely on GPS. When such positioning systems are used, the PS module must periodically compute, or query for, its position during travel in order to determine whether and when it has reached a specified waypoint. So, waypoints supported by such systems are said to be *passive*.

Layered Structure Figure 2 illustrates the structure of Seeing-I-Go. The user interface layer at the top interacts with the user via a heads-up display style GUI and provides the user with visual and audio instructions. At the start of each navigation session, the user interface requests the navigation layer to select a route connecting the starting point and destination provided as input by the user. During travel, it monitors user's progress as the user travels from waypoint to waypoint. At each waypoint along the way, it provides the user with navigation directives and/or assurances until the session ends upon the user's arrival at the selected destination. Whenever it detects that the user is on a wrong route, it requests the navigation layer to compute a correction route and uses it instead of the original route

In the bottom layer, the PS module contains a component module for each type of indoor positioning system used in the coverage area indoors and GPS or outdoor Lbeacons for outdoor spaces between buildings. All PS module components implement the common PSInterface.

The interface enables the user interface to invoke their services without regards to their types.



Incremental downloadable navigation graph

Interface to underlying positioning support systems

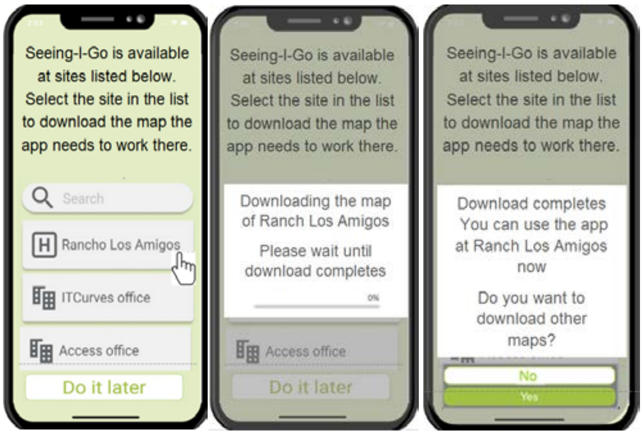
UI with heads-up style display and audio instructions

Figure 2 Layered navigator structure

The navigation layer does not interact with the user and has no interaction with the PS modules. In fact, it may be more correct to say that the navigation layer is a data repository and utility: It provides all the data and information and methods to support the user interface. Navigation layer is also the natural place where other types of data and information on the coverage area are kept. Examples include pictures used to orient the user when the navigator needs to be sure that the user is facing a known direction and text segments needed to customize navigation instructions at some waypoints, and so on.

Symbols, buttons* and *sample screen shots We now present examples of symbols, buttons and screen shots for illustrative purposes. The screenshots list as a covered location Los Rancho Amigos, a national rehab center in Los Angeles, USA. Seeing-I-Go serves a part of the outpatient building and passage to inpatient area, together with two shuttle pickup/drop-off locations outside the building .

- Seeing-I-Go presents the screenshots shown below and at top of the next page when you open it for the first time after it is installed: The term *map* refers to navigation graph.



Seeing-I-Go is available at sites listed below. Select the site in the list to download the map the app needs to work there.

Search

Rancho Los Amigos

ITCurves office

Access office

Do it later

Seeing-I-Go is available at sites listed below. Select the site in the list to download the map the app needs to work there.

Downloading the map of Ranch Los Amigos

Please wait until download completes

0%

Access office

Do it later

Seeing-I-Go is available at sites listed below. Select the site in the list to download the map the app needs to work there.

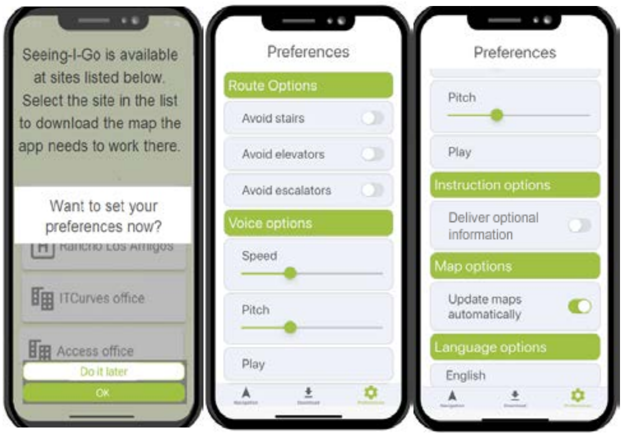
Download completes You can use the app at Ranch Los Amigos now

Do you want to download other maps?

No

Yes

- Left: When you open Seeing-I-Go, it shows you a list of sites where you can use the app. You can download the map of a site by selecting its name from the list.
- Middle: In response, Seeing-I-Go downloads the map of the site selected by you or closes if you tap the Do it later button.
- Right: When download completes, the app will download maps of other sites if you tell it to do so.



Seeing-I-Go is available at sites listed below. Select the site in the list to download the map the app needs to work there.

Want to set your preferences now?

Rancho Los Amigos

ITCurves office

Access office

Do it later

OK

Preferences

Route Options

Avoid stairs

Avoid elevators

Avoid escalators

Voice options

Speed

Pitch

Play

Preferences

Pitch

Play

Instruction options

Deliver optional information

Map options

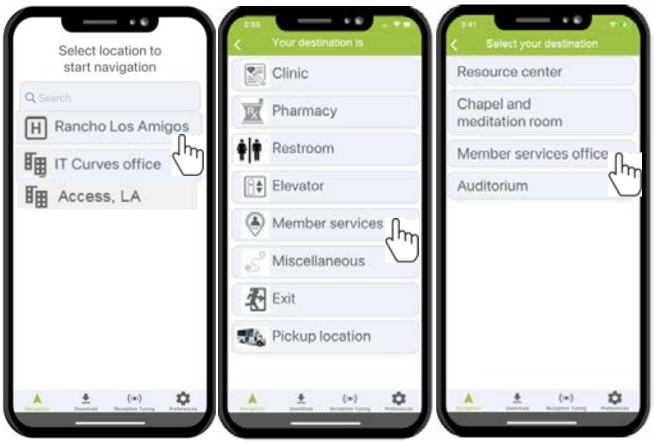
Update maps automatically

Language options

English

- Left: When map download completes, you may want to set Seeing-I-Go preferences.
- Middle: You can tell Seeing-I-Go restrictions in routes selected for you and the way you want spoken navigation instructions to sound.
- Right: Optional information include descriptions of obstacles ahead.You will receive this information if you turn on this option. Map options lets you choose to have the app automatically update maps that have been revised.

- Below are screenshots Seeing-I-Go uses to interact with you at the start of each navigation session before guiding you to your destination:



Select location to start navigation

Search

Rancho Los Amigos

IT Curves office

Access, LA

Your destination is

Clinic

Pharmacy

Restroom

Elevator

Member services

Miscellaneous

Exit

Pickup location

Select your destination

Resource center

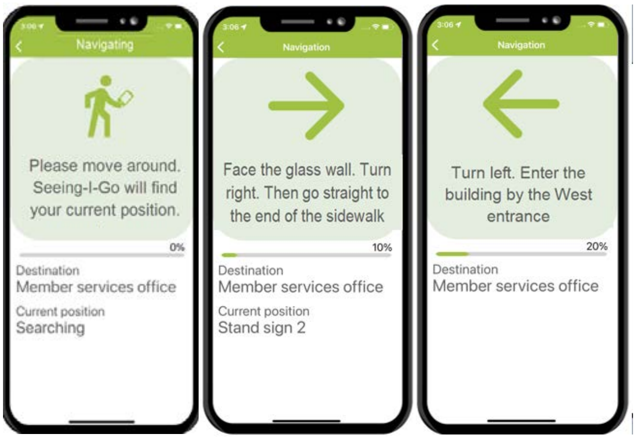
Chapel and meditation room

Member services office

Auditorium

Before Seeing-I-Go can guide you, it must know your destination.

- Left: It first lets you select the site where you will use it.
- Middle and right: You are to tell it where you wish to go by selecting the category of your destination first, and then the destination.



Navigating

Please move around. Seeing-I-Go will find your current position.

0%

Destination
Member services office

Current position
Searching

Navigation

Face the glass wall. Turn right. Then go straight to the end of the sidewalk

10%

Destination
Member services office

Current position
Stand sign 2

Navigation

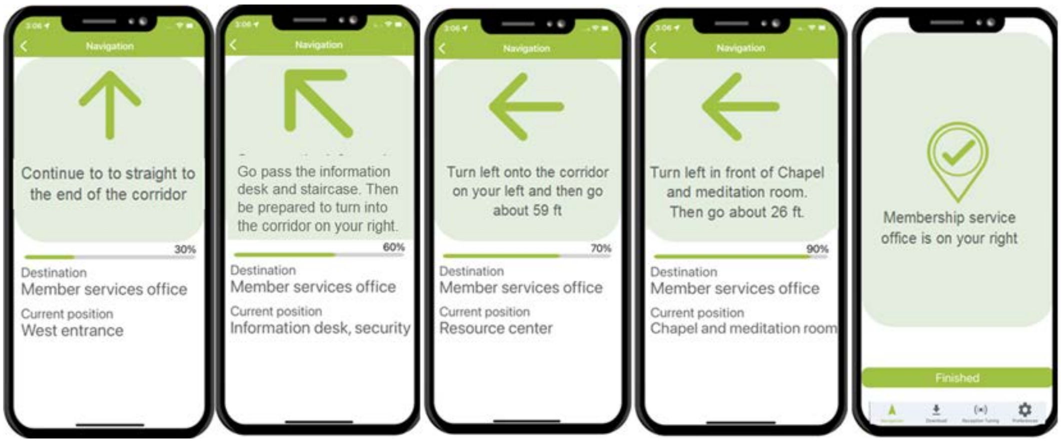
Turn left. Enter the building by the West entrance

20%

Destination
Member services office

- Left: The next step Seeing-I-Go takes is to find your current position. You can help by moving several feet around you in different directions until it finds you.
- Middle: In order to instruct you correctly from the start, Seeing-I-Go needs to make sure that you are facing a known direction. It does so by asking you to face an easily recognized object near by.
- Right: This is an example of instructions delivered to you enroute

- The screenshots on the top of the next page show examples of instructions delivered to you at decision points via display and speech as you move towards your destination. The navigation session ends when you arrive at the destination. You can close Seeing-I-Go by taping the Finished button or start a new navigation session by taping the Navigation tab at the bottom of the screen.



Continue to to straight to the end of the corridor

30%

Destination
Member services office

Current position
West entrance

Go pass the information desk and staircase. Then be prepared to turn into the corridor on your right.

60%

Destination
Member services office

Current position
Information desk, security

Turn left onto the corridor on your left and then go about 59 ft

70%

Destination
Member services office

Current position
Resource center

Turn left in front of Chapel and meditation room. Then go about 26 ft.

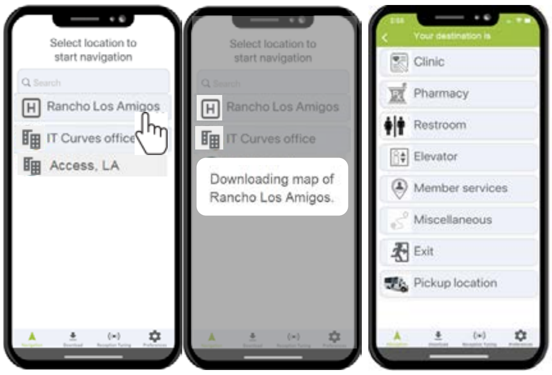
90%

Destination
Member services office

Current position
Chapel and meditation room

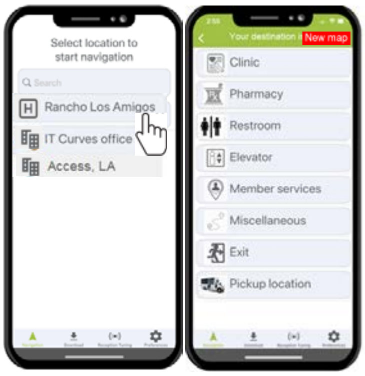
Membership service office is on your right

- An assumption thus far is that the map of the selected site has not been revised since it was downloaded. When this assumption is not valid, how Seeing-I-Go behaves depends on your map option setting as illustrated below:

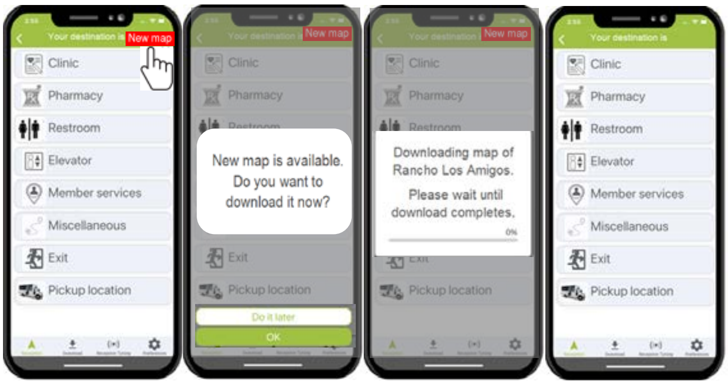

Select location to start navigation

Downloading map of Rancho Los Amigos.

If you have turned on the Update map automatically option, Seeing-I-Go will download the map of your selected site when it finds the map revised. It then lets you specify your destination.


Select location to start navigation

If your Update map automatically option is turned off, Seeing-I-Go will use the red icon New map to alert you of the need to download the revise map. You can choose to ignore the alert and proceed to specify your destination. The icon will stay on the screen as long as the revised map has not been downloaded.



New map is available. Do you want to download it now?

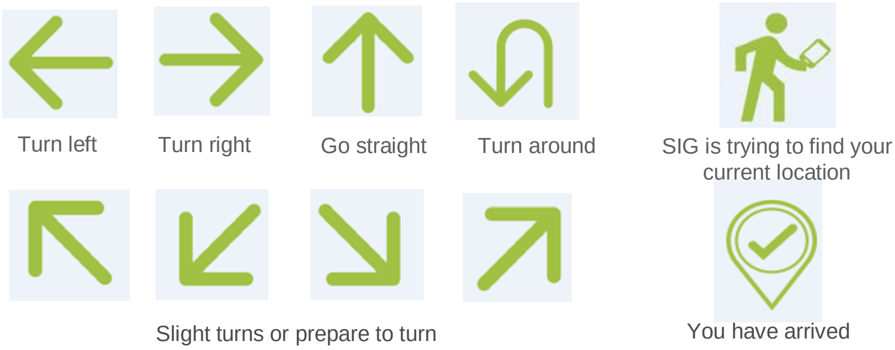
Downloading map of Rancho Los Amigos.

Please wait until download completes.

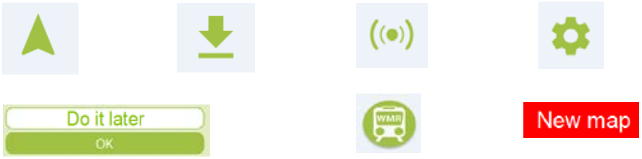
0%

When you tap the new map Icon, the app will download the revised map if you tell it to do so. It presents the destination selection screen without the New map icon when download completes

- Seeing-I-Go uses symbols to clarify its visual instructions. Below are examples.


Turn left
Turn right
Go straight
Turn around
SIG is trying to find your current location
Slight turns or prepare to turn
You have arrived

- Seeing-I-Go provides you with buttons and icons shown below to control its operation and call for your attention:



  - Tabs in the top row, from left to right: you can use them to start or resume navigation, request download, request signal tuning, and go to settings.
  - Buttons and icon in the bottom row from left to right: Examples are Do it later/OK buttons for you to tell the app what to do next, a button for you to launch WMR (Whereis My Ride) app from Seeing-I-Go, and an icon to notify you of the need to download the new map of the selected site.

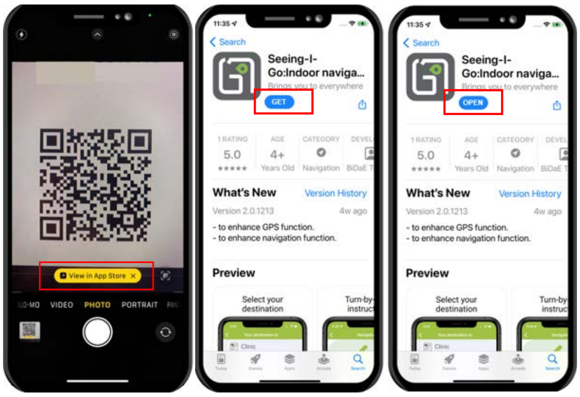
Install Seeing-I-Go Want to use Seeing-I-Go? You can download and install the app from Apple App Store or Google Play Store.

- If your phone is an iPhone: Go to Apple App Store.

  - The link to Apple App Store is https://apps.apple.com/tw/app/%E5%B8%B6%E8%B7%AF%E6%A9%9F/id1492849115

  - Seeing-I-Go's QR code for Apple App Store is shown below. You can reach the store by scanning the QR code.

- After reaching the store, follow the instructions shown in the middle and right screenshots below and wait for installation to complete.

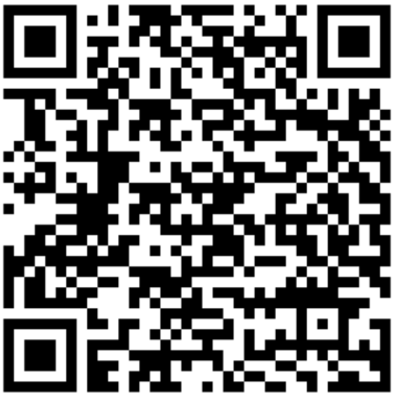


- Left: Scan the QR-code to reach Apple App Store.
- Middle: In Apple App Store, tap GET to download Seeing-I-Go app. Wait for download to complete.
- Right: When download completes, tap OPEN to start Seeing-I-Go.

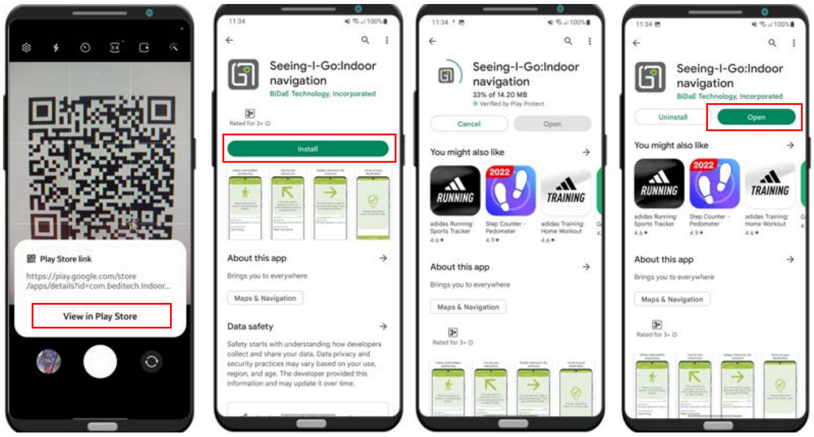
- If you use an Android phone: Go to Google Play Store

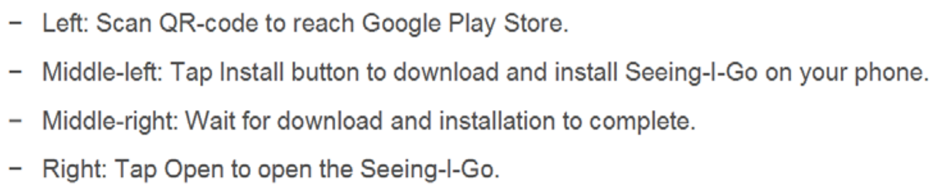
  - The link to Google Play Store is https://play.google.com/store/apps/details?id=com.beditech.IndoorNavigation.OPFM&hl=zh_TW

  - Seeing-I-Go's QR code for Google Play Store is shown below. You can reach Google Play Store by scanning the QR code.



  - After reaching the store, follow the instructions shown in the middle-left screenshot. Wait for installation to complete and then open Seeing-I-Go.





- Left: Scan QR-code to reach Google Play Store.
- Middle-left: Tap Install button to download and install Seeing-I-Go on your phone.
- Middle-right: Wait for download and installation to complete.
- Right: Tap Open to open the Seeing-I-Go.