Control App User Guide

14 November 2023

QUANTUM ROBOTIC SYSTEMS

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1 Safety Information

Before using the Control App to operate your robot, please familiarize yourself with the following safety information:

1. **Your robot is not a toy.** It should not be operated by a child unless under the direct supervision of a responsible adult who is familiar with the safe operation of the robot.

2. The robot is an electrical appliance. Basic precautions for electrically powered devices should always be followed.

3. Small children and pets should be supervised when the robot is operating nearby. Never deliberately drive the robot towards a person or an animal.

4. Your robot does not automatically detect edges or cliffs. Do not drive the robot or program a path near a stair edge or other discontinuity in the floor.

5. Although the robot is equipped with range-finding sensors that can detect obstacles, they are not foolproof and are not a substitute for responsible operation.

6. Never deliberately drive the robot towards walls, furniture, or anything else that might cause the robot to suffer damage.

7. Your robot is designed to operate indoors on clean, bare floors that are free of obstructions.

8. The robot may drive on low-pile carpet but not on deep-pile carpet.

9. Do not drive over electrical cords, ropes, string, loose cloth, or anything else that might become entangled in the robot's wheels. If this happens, stop the robot immediately, turn it off, and remove the battery if it is safe to do so. If the obstruction is an electrical cord, unplug it from its source before touching the robot.

10. Do not expose the robot to water.

2 Before You Begin

To use the Control App, you must first ensure the following:

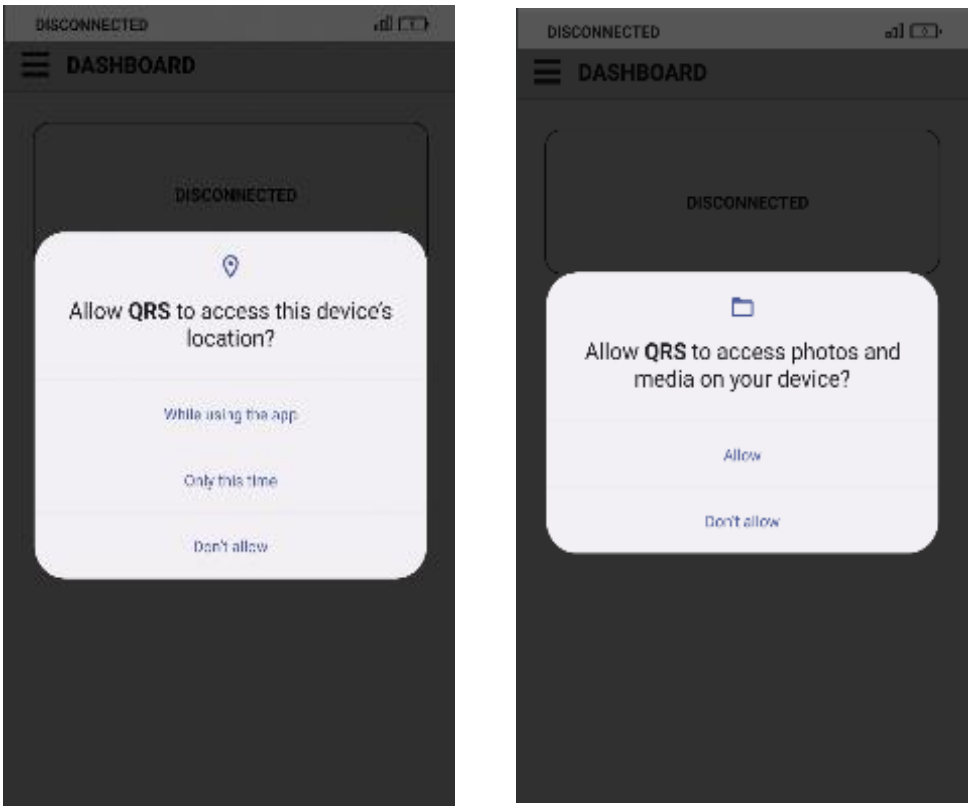
1. Install the Control App on your mobile device.

   Instructions on how to do this may be found in a separate document called "App Installation Instructions".

2. During installation, allow the Control App access to your mobile device's:

   - Location Services
     - Click "While using the app"
   - Storage (photos and media)
     - Click "Allow"

Figure 2-1 App Permissions



3. Turn on Bluetooth on your mobile device. This can be done on your device's settings.

   The Control App communicates with your robot via Bluetooth Low Energy (Bluetooth LE or BLE). You must ensure that Bluetooth is enabled on your device.

4. Update the robot's firmware, if necessary.

Ensure that your robot is running the latest version of its firmware.

Instructions on how to do this may be found in a separate document called “Arduino QBii Environment Instructions”.

3 Key Concepts

The Control App makes use of many important concepts in robotics. These concepts involve specific terminology which may not be familiar in day-to-day life. We recommend that you familiarize yourself with these terms and concepts to enhance your experience with your robot.

3.1 Workspace

For a mobile robot, its *workspace* is defined as the area in which it can navigate from place to place. An example of a workspace may be your home, as represented by a floor plan:

Figure 3-1 Workspace

3.2 Teleoperation ('Joystick') Mode

In this mode of operation, your robot navigates through its workspace under the guidance of the operator. In other words, the operator 'drives' the robot from place to place using a *joystick*, making decisions about where to turn, where to drive straight, etc.

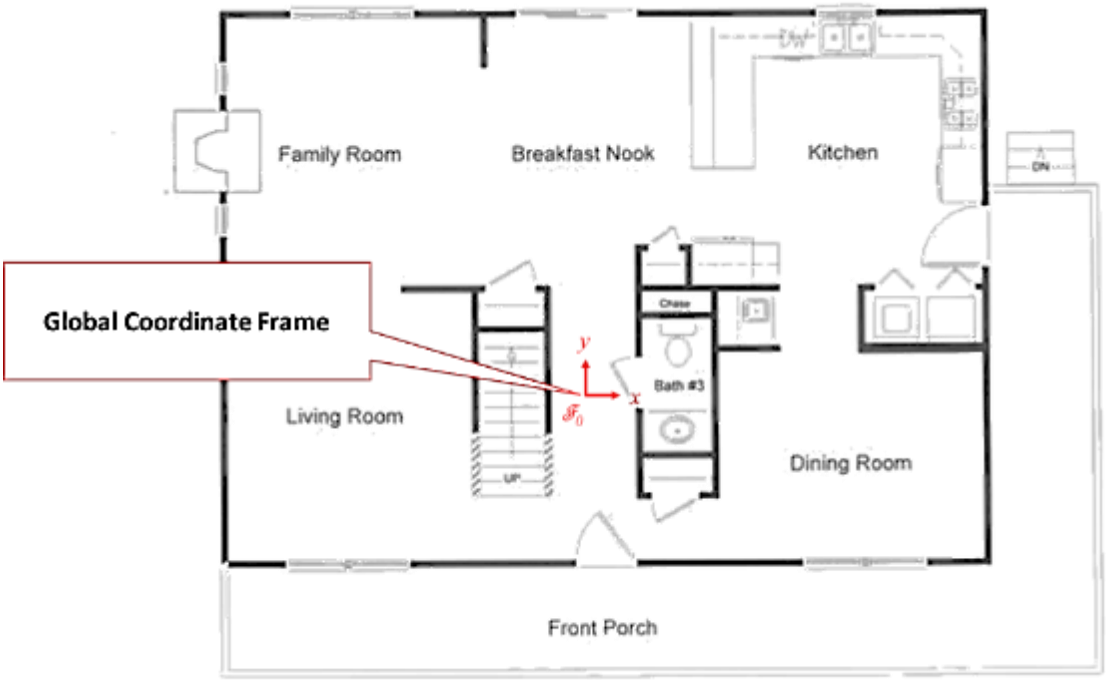
3.3 Autonomous ('Path') Mode

In this mode, your robot navigates though its workspace *autonomously*. The robot follows a *path* from place to place based on pre-programmed instructions instead of operator intervention.

3.4 Global Coordinate Frame

To describe where the robot is in its workspace, we need a reference frame that is affixed to the workspace. We call this the *global coordinate frame*, denoted by $\mathcal{F}_0$. The *x* and *y* axes of this coordinate frame are typically aligned with landmarks within the workspace (e.g., walls). The origin is selected to be some convenient reference location.

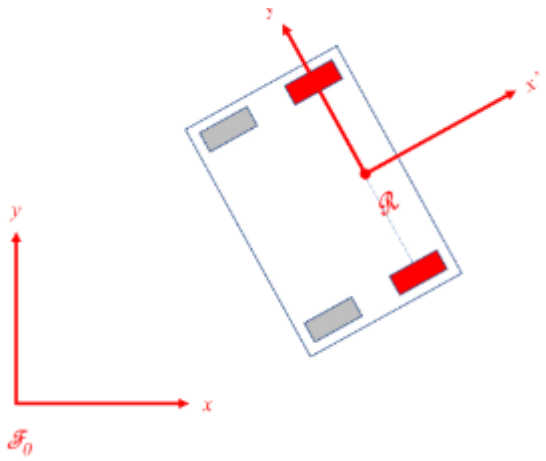
Figure 3-2 Global Coordinate Frame



3.5 Robot Coordinate Frame

A second special reference frame is the robot coordinate frame, ***R***. Rather than being affixed to the workspace, this frame is affixed to the robot itself. The *x* axis is aligned with the robot's forward direction of motion. The origin is fixed to the centre of rotation between the two drive wheels.

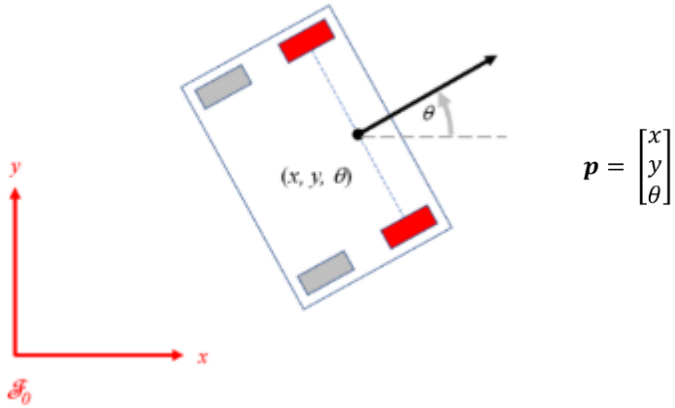
Figure 3-3 Robot Coordinate Frame



3.6 Pose

The robot's position and orientation in the global coordinate frame is called its *pose*.

Figure 3-4 Pose

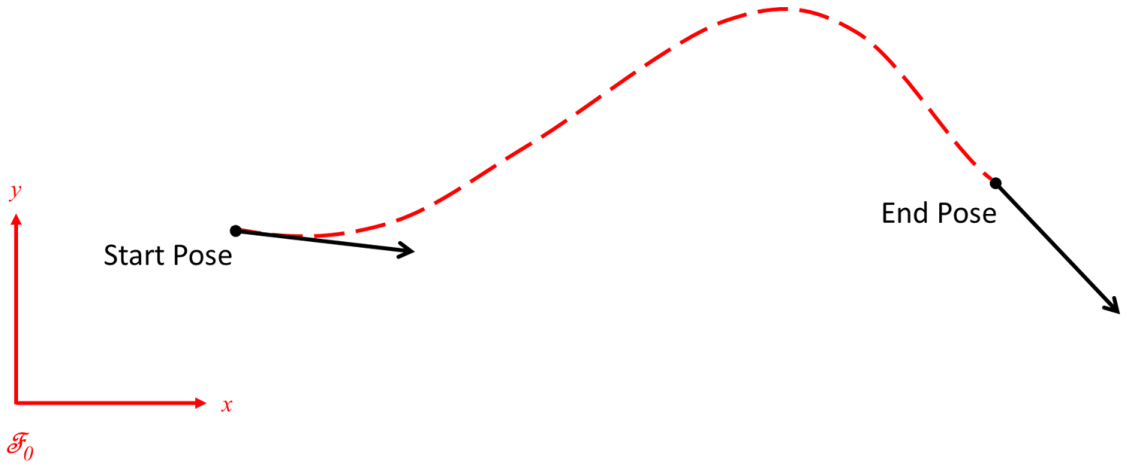


Mathematically, the robot's pose is described by three quantities: x, y and θ. Together, these form the vector $\boldsymbol{p}$. The θ coordinate is the angle that the robot's x-axis makes with the global x-axis, with the counter-clockwise (CCW) direction defined as the positive direction. For the purposes of this App, the range for this angle is $\theta \in [-180°, +180°]$.

3.7 Path

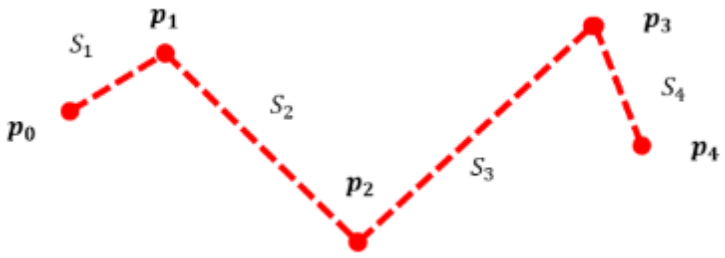
A *path* is a geometric curve in the global coordinate frame that takes the robot from a *start pose* to an *end pose*. The shape of the path is chosen to avoid obstacles in the workspace. Following collision-free paths allows the robot to navigate autonomously.

Figure 3-5 Path



3.8 Path Segments & Path Waypoints

Figure 3-6 Path Segments

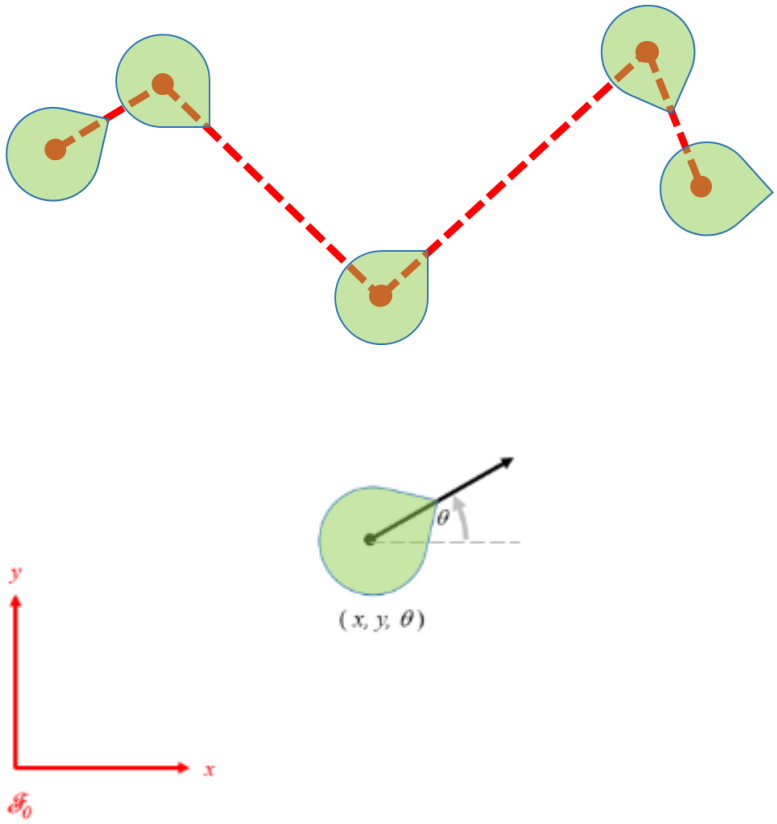


Typically, robot paths are broken up into discrete *path segments*, S_k. The start and end points for each segment are called *path waypoints* – a term borrowed from navigation.

So, when a robot follows a path, it moves from one waypoint to the next along a segment. In other words, paths are an ordered sequence of waypoints and segments.

Since we are interested in controlling not only the robot's position but also its orientation everywhere along the path, the waypoints are themselves poses – i.e., they are described by x, y and θ. We have represented the path waypoints with 'teardrop' symbols to denote that they have both a position and an orientation (i.e., they are poses).

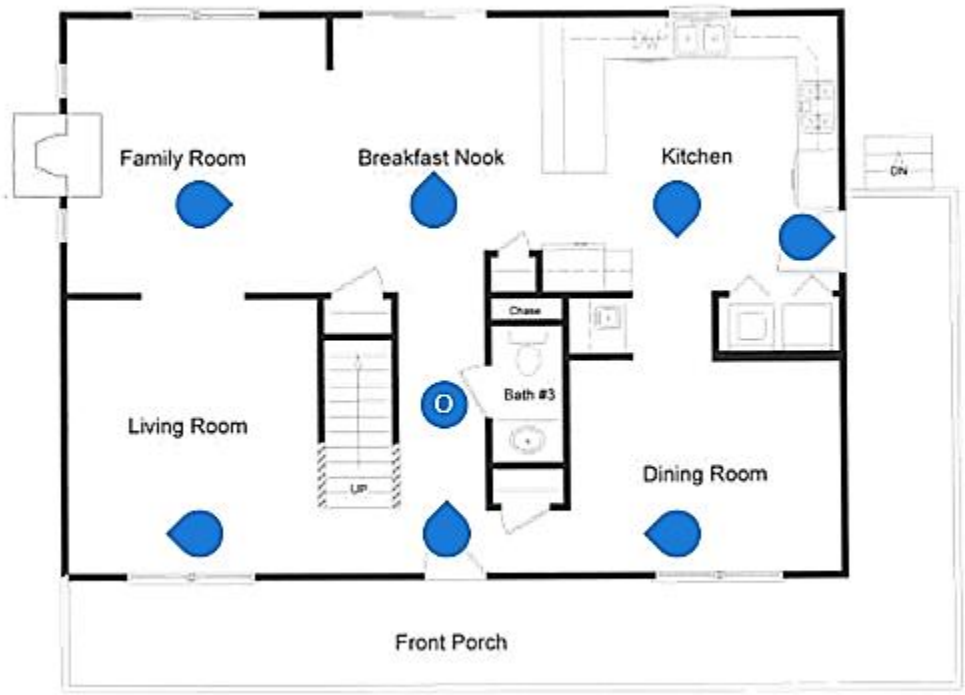
Figure 3-7 Path Waypoints



3.9 Reference Waypoints & Waypoint Lists

Reference waypoints are special or physically significant poses in the workspace. We may wish our robot to navigate to, from, or through these reference waypoints.

Figure 3-8 Reference Waypoints



For example, we can define a reference waypoint at the entrance to your home (“Entrance”), or at the doorway to your kitchen (“Kitchen”). We can repeat this process for all the rooms on the main floor of our house. We can also define reference points that provide “safe passage”, e.g., “Hallway”, “Doorway”, etc.

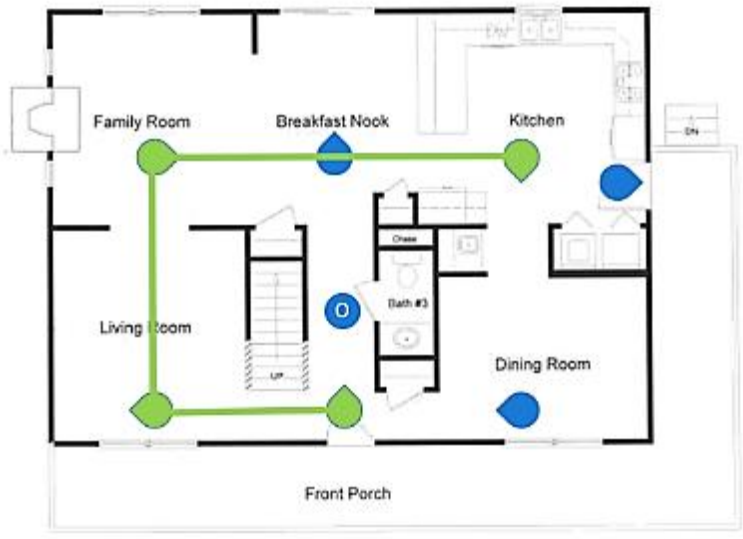
In this way, we can create a “pool” of useful reference waypoints to describe our workspace, which we can use later to create paths.

The App stores reference waypoints in their own Waypoints List. Different Waypoint Lists may be created for different workspaces, (e.g., “Home Waypoint List”, “School Waypoint List”, etc.).

3.10 Creating Paths using Reference Waypoints

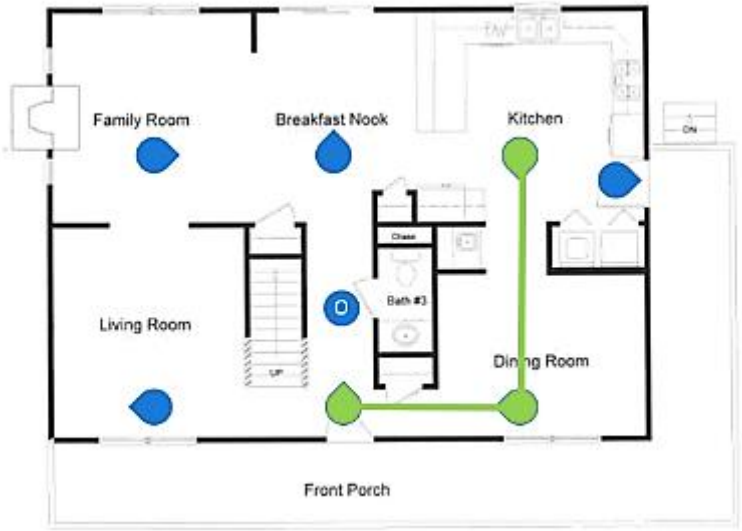
It is possible to use reference waypoints to define paths. From the pool of reference waypoints in the Waypoints List, we can choose a *subset* of those special waypoints in a specific order to define a path. For example, a path that requires the robot to start at “Front Entrance”, move through “Living Room” and “Family Room”, and end at “Kitchen” would look like this:

Figure 3-9 Sample Path 1: Front Entrance to Kitchen



An alternative path from “Front Entrance” to “Kitchen” via “Dining Room” would look like this:

Figure 3-10 Sample Path 2: Front Entrance to Kitchen through Dining Room



Important notes:

- Not all reference waypoints necessarily appear in path, but rather only a subset
- Reference waypoints may be used in multiple paths
- When used in a path, a *copy* of the reference waypoint is made
- Order matters – the same waypoints arranged in different orders create new paths

3.11 Creating Paths using Segments

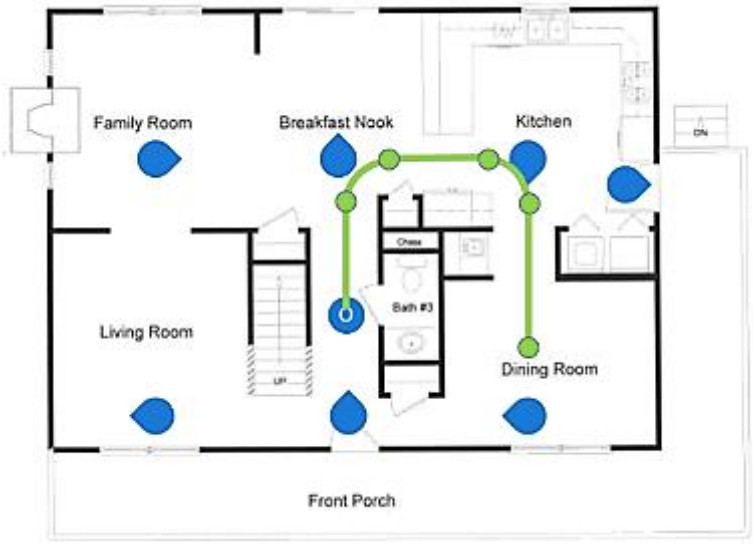
Paths are a sequence of waypoints and segments. In the previous section, we saw how a path may be defined from a sequence of reference waypoints. In that scenario, the path segments connecting the waypoints are merely straight lines.

Alternatively, we could begin by specifying a sequence of path segments. In such a case, the path waypoints would not come from the pool of reference waypoints in the Waypoint List; rather, the path waypoints would be *derived* from the geometry of the path segments.

Consider this example. Starting at the origin, the robot is commanded to do the following five (5) maneuvers, each of which constituting a distinct path segment:

Segment 1: Drive straight 5m
Segment 2: Arc right 90° with radius 1m
Segment 3: Drive straight 4m
Segment 4: Arc right 90° with radius 1m
Segment 5: Drive straight 6m

Figure 3-11 Sample Path Using Segments



Using this ‘segment-based’ method for building a path, the waypoints are still there (shown as circular green nodes). However, they do not correspond to any reference waypoints. Instead, they are derived from the *geometry* of each segment.

4 Control App Basics

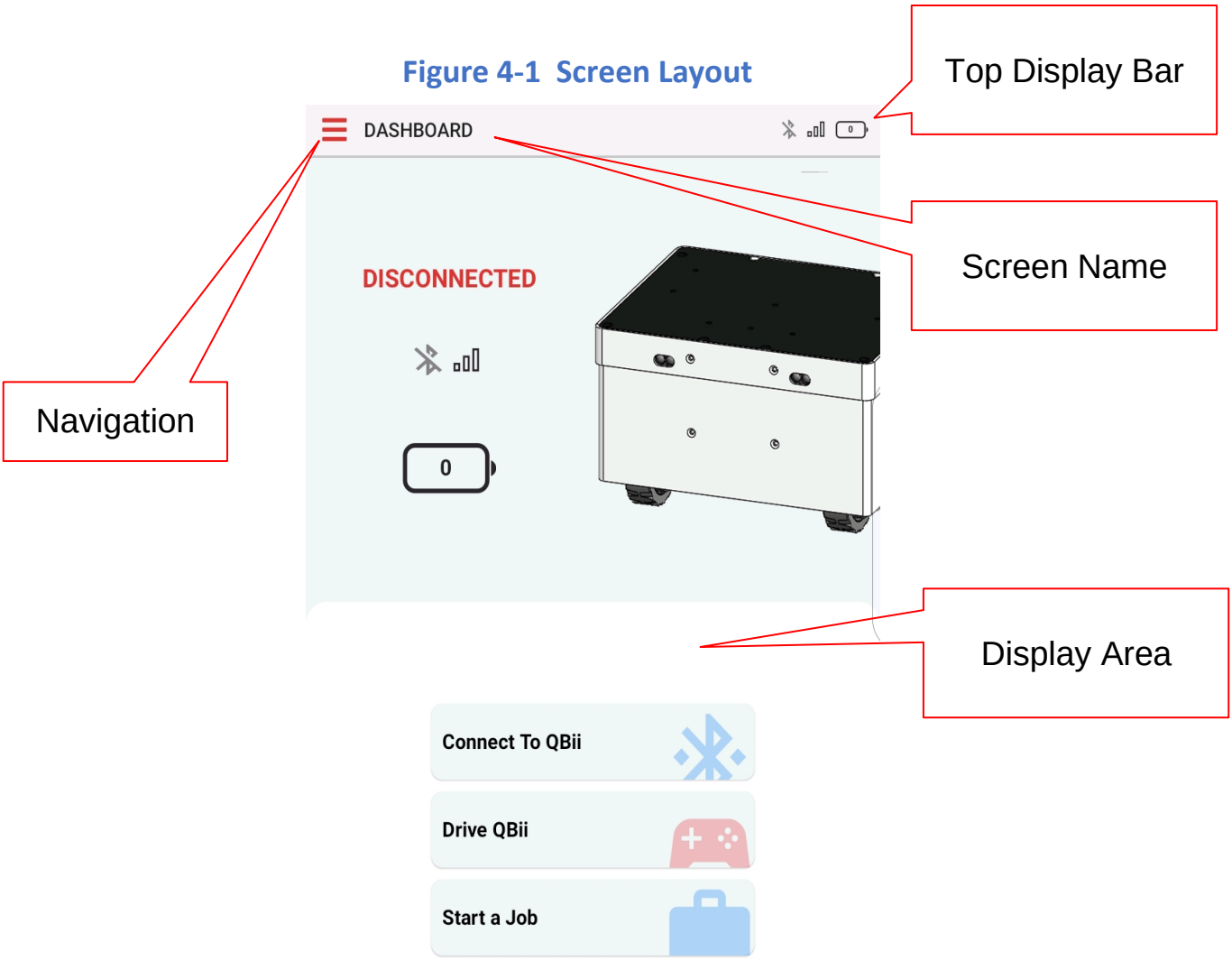
4.1 Starting the App

Locate and tap the “QRS” icon to start the Control App.

Figure 4 QRS Logo

4.2 Screen Elements

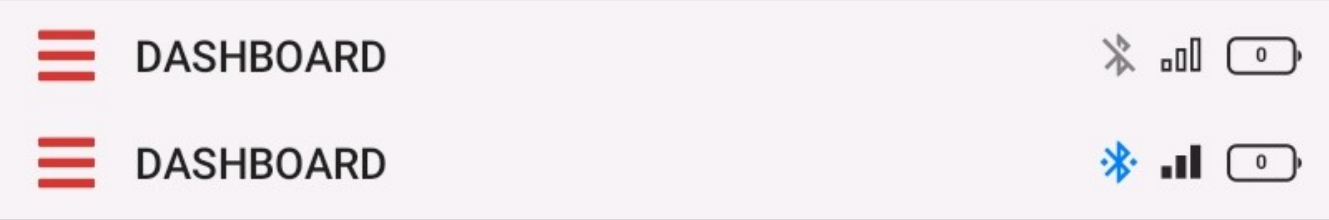
Figure 4-1 Screen Layout



Top Display Bar

The **Top Display Bar** appears above every screen in the App. From left to right, this bar displays the following information:

- Bluetooth connection status (Disconnected or Connected)
- Robot name (if connected) or blank (if disconnected)
- Bluetooth connection strength (if connected)
- Robot battery level (estimated, if connected)



Screen Name

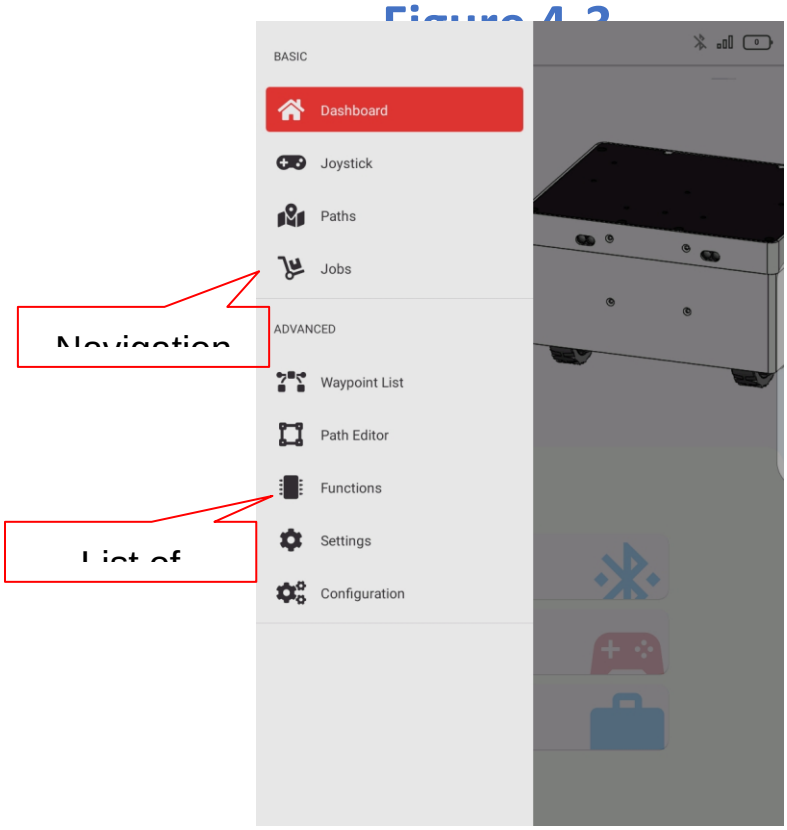
The name of the current screen is displayed beside the Navigation Menu icon.

Display Area

The functional parts of the current screen (buttons, texts, graphics, etc.) appear in the Display Area.

4.3 Navigation Menu

The Navigation Menu icon appears at the top/left of each screen, immediately to the left of the screen name. This icon has the familiar three-line ‘hamburger’ design.

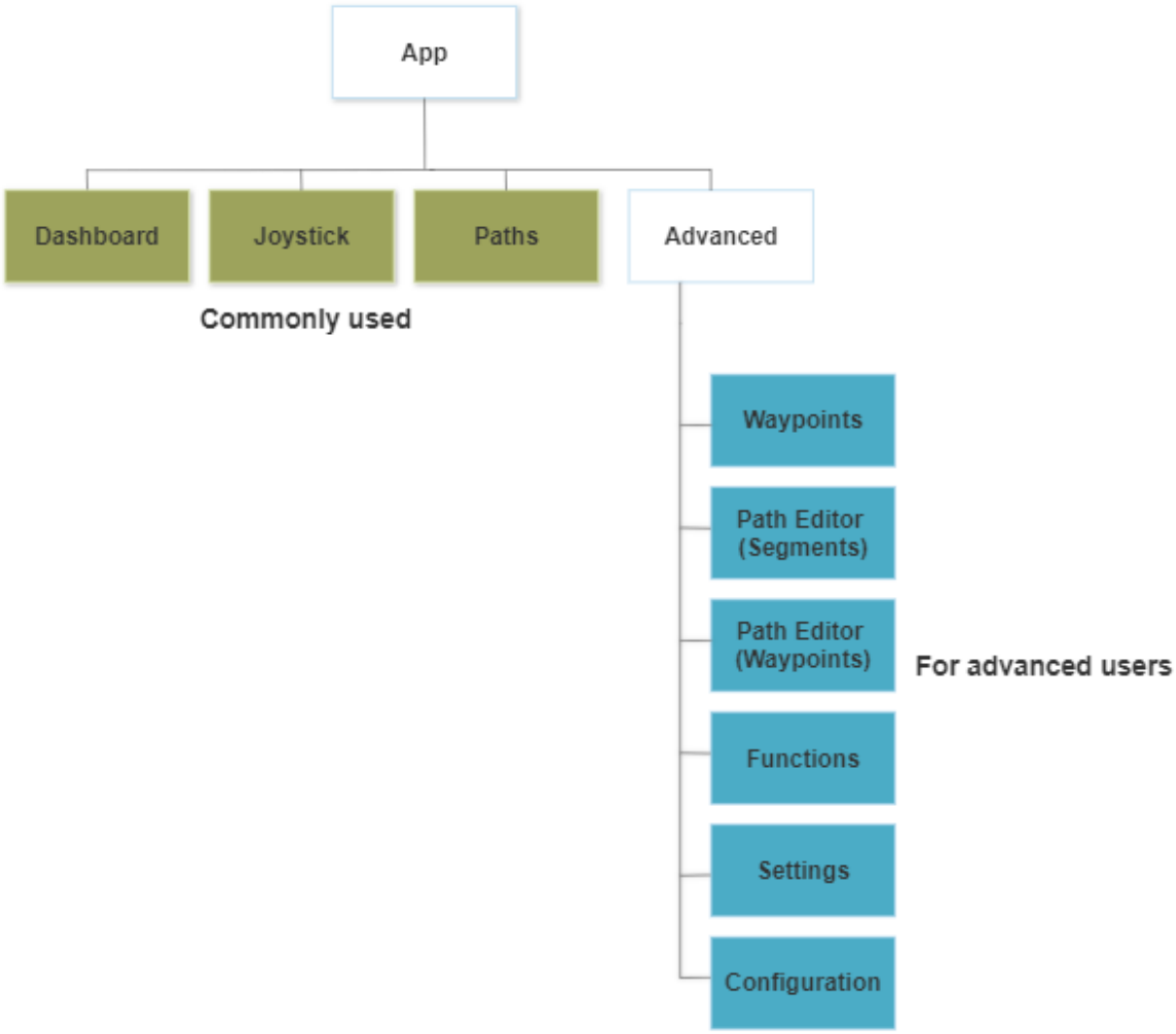


Tapping this icon reveals the Navigation Menu, which is a vertical drop-down list of available screens. Tapping a screen name will open that screen.

The Navigation Menu can be exited via clicking the highlighted name of the current screen or swiping left on the screen.

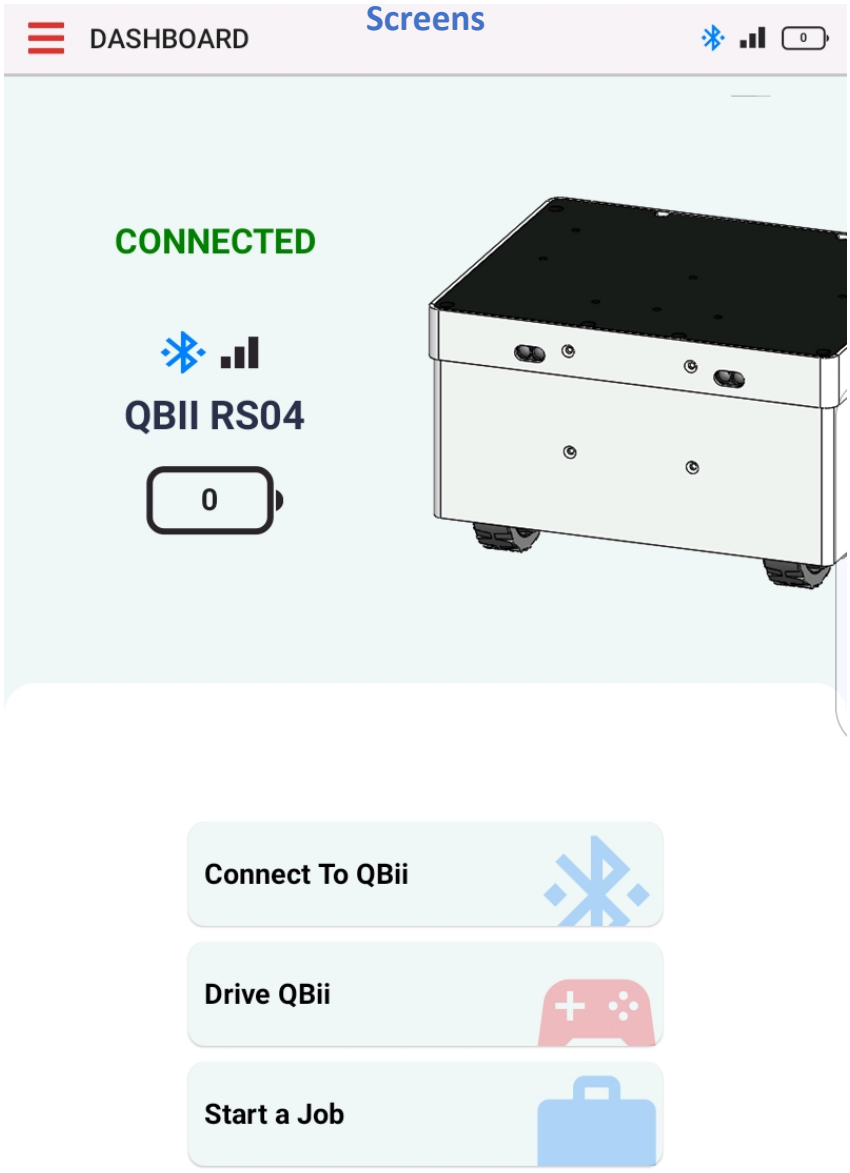
4.4 List of App Screens

Figure 4-4 Overview of App Screens



5 Dashboard Screen

Figure 5-1 Overview of App Screens



The Dashboard Screen is the first screen you will see when you open the App.

There are four main components to the Dashboard:

- Robot Status Display Window

- Connect to Robot Button
- Drive the Robot Button
- Run a Path Button

5.1 Robot Status Display Window

Until you connect to a robot, this window will display “Disconnected.”

After you connect, this window will display four pieces of information about the robot’s status:

- Whether there is a Bluetooth connection (Disconnected or Connected)
- The name of the robot to which the App is currently connected
- Estimated robot battery charge (represented as a percentage inside a battery icon)
- Alerts icon (if there are any current alerts)

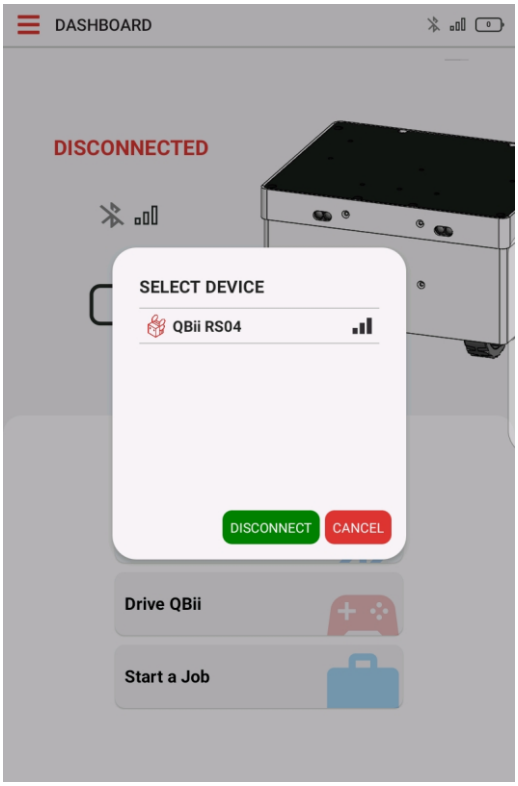
5.2 Alerts Icon

An Alerts icon (see yellow triangle in screenshot) will be displayed if any warnings or errors have occurred on start-up. Clicking the icon will open a further dialogue box listing all current warning messages. Typically, these warnings relate to sensors that may or may not be connected at start-up.

5.3 Connect to Robot

The App communicates with the robot via a Bluetooth Low Energy (BLE) connection. A BLE connection must be made before you can operate your robot.

Figure 5-2 Device



Important Note: Bluetooth needs to be enabled on your mobile device first in order to establish a connection. Do this through your device's Settings.

The Connect to Robot button will open a dialog box called *Select Device*. All available *QBii* robots discovered by your mobile device will be displayed, as well as any unit that is already connected. If a robot is currently connected, that robot's name will be displayed at the top of the list and the option to disconnect or connect will be shown. BLE signal strength is also displayed next to the name.

To connect, tap the robot's name to select it, then tap Connect.

5.4 Drive the Robot

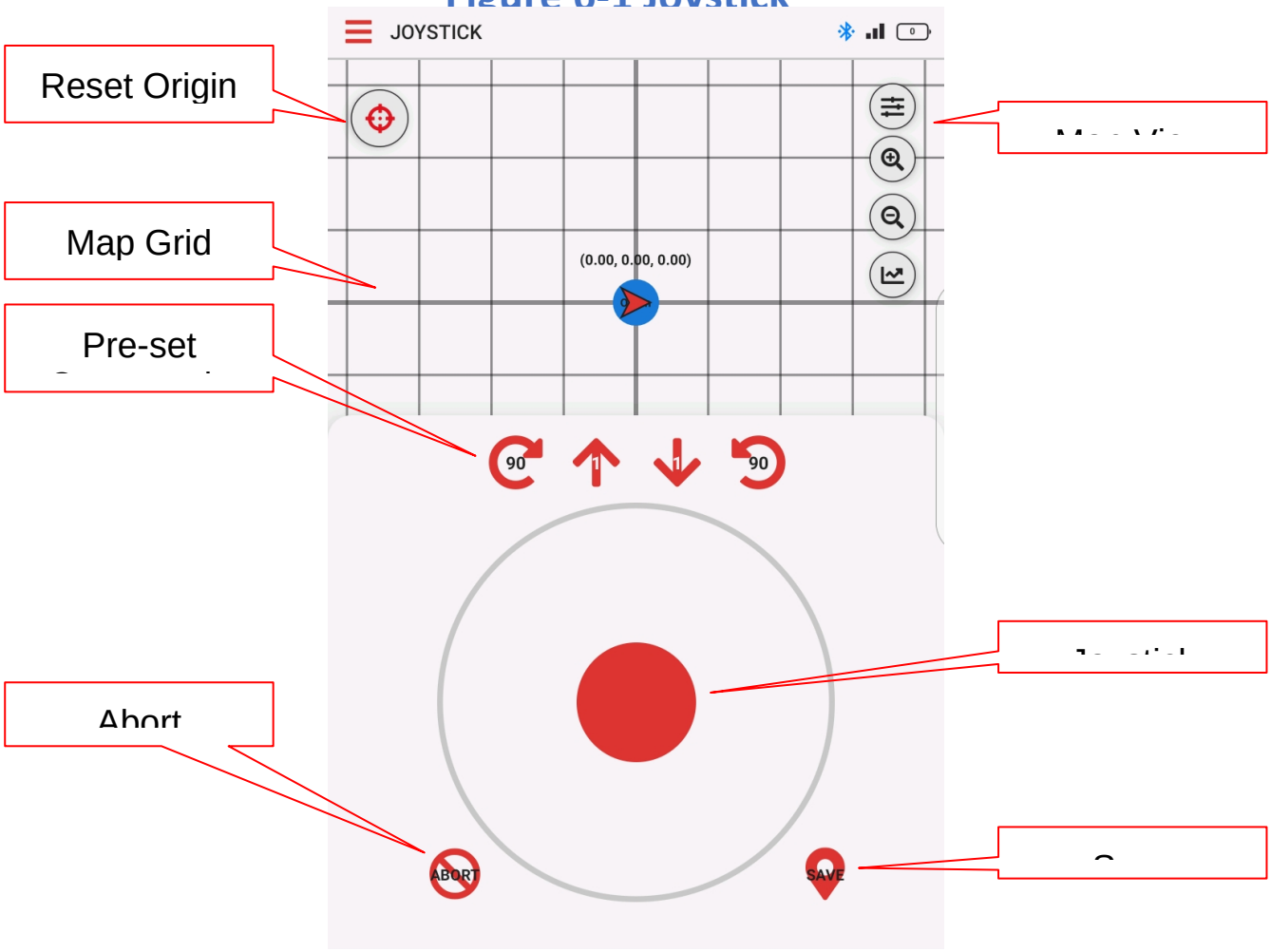
This shortcut button will redirect to the *Joystick Screen* (see below). This is used to access manual robot controls, i.e., 'remote control' or 'teleoperation' mode.

5.5 Run a Path

This shortcut button will redirect to the *Path Screen* (see section 7). This is used to have the robot drive a path autonomously.

6 Joystick Screen – Teleoperation Mode

Figure 6-1 Joystick



The Joystick Screen is used for manual control of the robot, i.e., 'teleoperation' mode (see Section 3.2). The screen is divided into two parts:

- Map Grid
- Joystick Pad

6.1 Map Grid

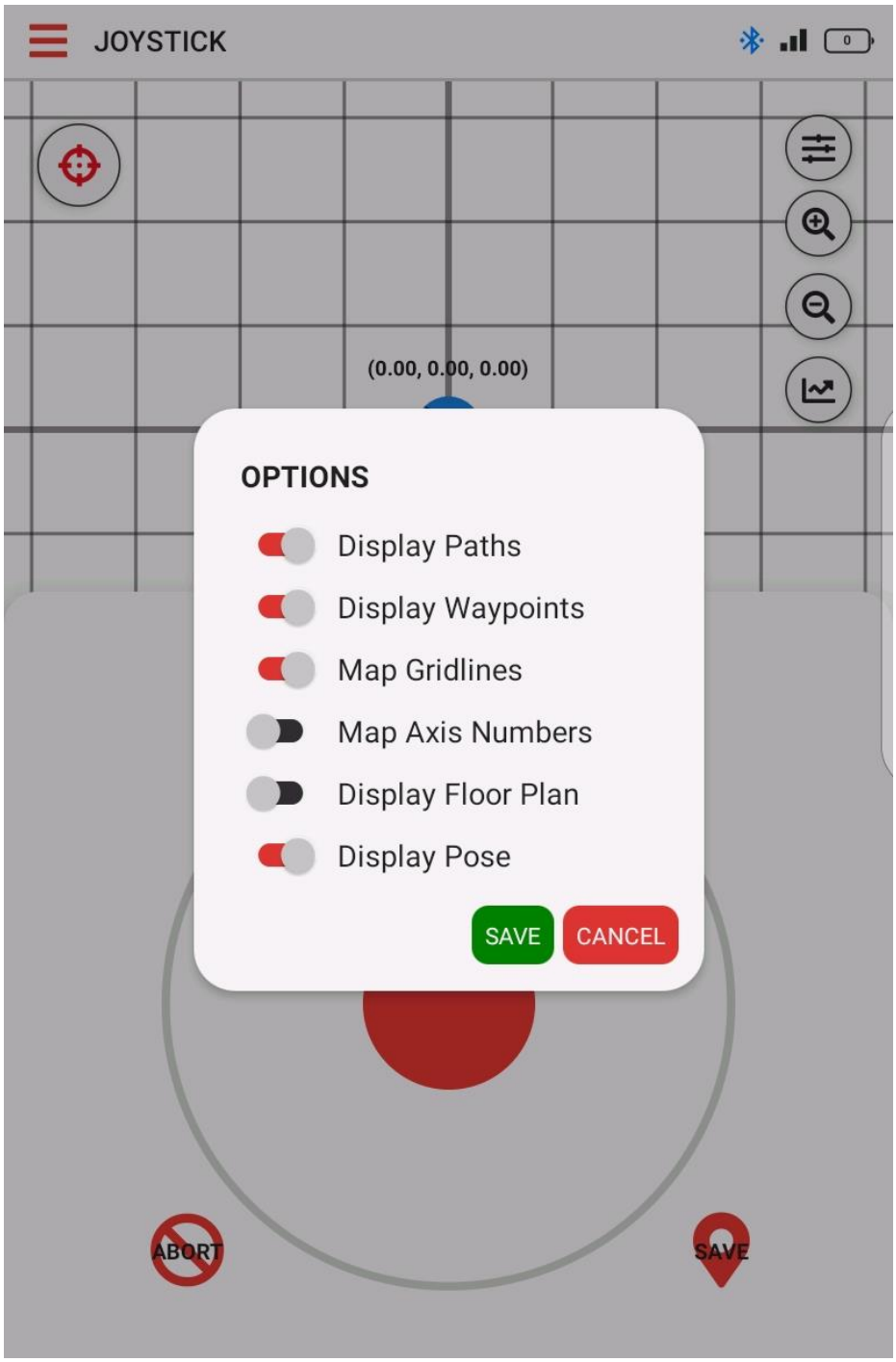
This grid displays the current *pose* (position and orientation) of the robot in the global coordinate frame. The robot in motion will be represented by a red arrow icon.

The icons on the right side of the Map Grid allow you to access various map view options:

- Slider Options: The slider icon on grid will open a new dialog box showing the following:

- Display Paths (toggle on/ off) – show current Paths
- Display Waypoints (toggle on/ off) – show current Waypoints
- Map Gridlines (toggle on/off) – shows gridlines
- Map Axis Numbers (toggle on/off) – shows grid units (in meters), default off
- Floor Plan (toggle on/off) – shows the imported floor plan, default off

Figure 6-2 Options Window



- Magnifying Glass + – zoom in on grid display
- Magnifying Glass - – zoom out on grid display
- Home Button – the home button will appear when navigating and will reset the map origin.

6.2 Joystick Pad

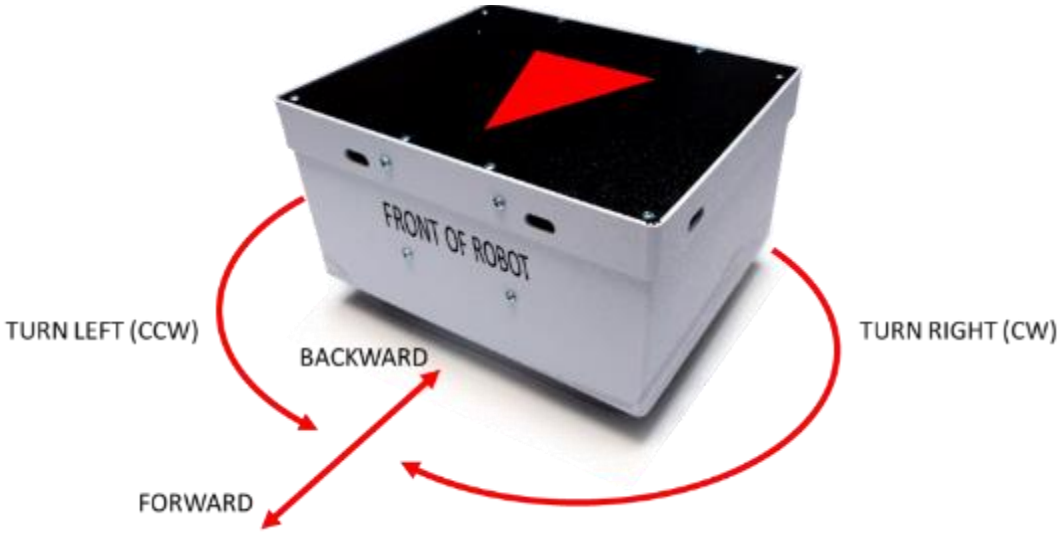
The Joystick Pad allows for manual control of the robot's motion. This portion of the Joystick Screen consists of the following elements:

- Joystick Controller: The red dot inside a larger circle represents a traditional gaming joystick and operates in a similar manner.
- Pre-Set Turns: Causes the robot to move through pre-programmed turns of specific increments.
- Abort Icon: Will stop a Pre-Set Turn.
- Save Waypoint: This function will allow the user to "memorize" the robot's current pose and save it as a reference Waypoint.

6.3 Directions of Motion for Joystick Mode

The robot can move in following directions (see diagram):

Figure 6-3 Directions of Robot Movement



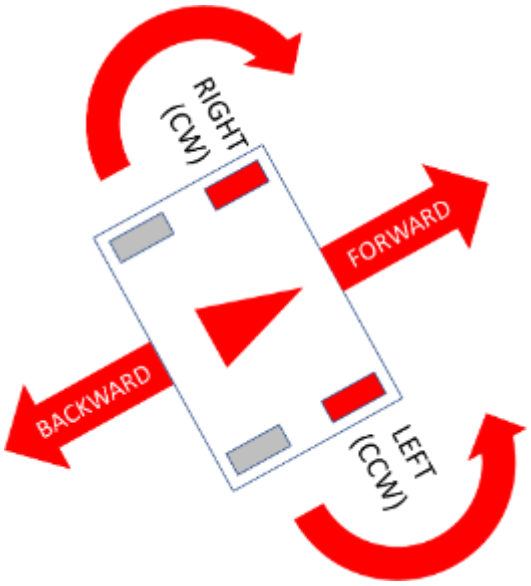
Note that these directions are defined in a coordinate frame that is attached to the robot. In other words, "forward" and "backward" are always defined relative to the robot's current orientation, in line with its current direction of motion and perpendicular to the robot's front face.

This is best illustrated in the diagram below. When looking down at the robot, a "right" turn is always in the clockwise (CW) direction and a "left" turn is always in the counter-clockwise (CCW) direction. However, "forward" and "backward" are aligned with the robot's *current* orientation, which means the "forward/backward" arrows can point in an arbitrary direction in the global coordinate frame.

This diagram illustrates how the directions of motion for the robot are defined for Joystick mode:

- Forward/Backward Motion is always aligned with the robot's current direction of travel, defined as if you were driving the robot like a car.
- Right (Clockwise)/Left (Counter-Clockwise) Turns are defined as if you were looking down on the robot from above.

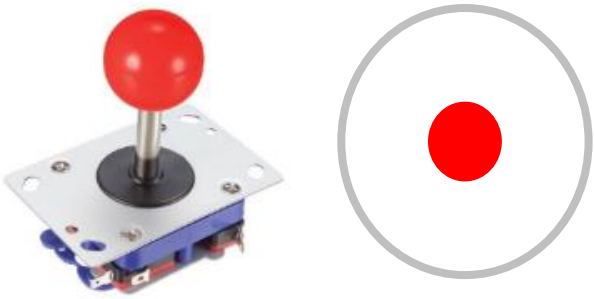
Figure 6-4 Top View of Robot Movement



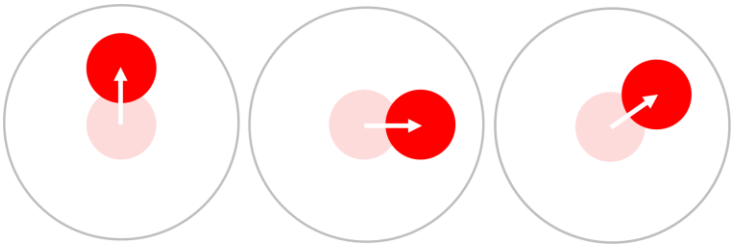
6.4 Joystick Controller

The Joystick Controller element of the Joystick Screen is a red dot inside a larger circle. It is meant to be reminiscent of a traditional gaming joystick.

Figure 6-5 Joystick



The red dot may be moved anywhere within the circle. You can move purely vertically in the up/down direction, or purely horizontally in the left/right direction, or in a combination of both.



Pressing and dragging the red dot within the circle causes the robot to move. Releasing the dot will return it to its central location, causing the robot to stop.

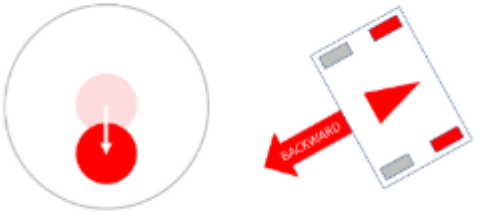
The position of the red dot relative to the vertical and horizontal axes of the Joystick Controller does the following:

- When the red dot is at the center of the Joystick, the robot stops moving.

Robot is stationary

- The vertical (up/down) axis controls the ***linear*** (forwards/backwards) speed of robot. The further from the center towards the top of the circle, the faster the robot will go in the forward direction. Moving towards the bottom of the circle causes the robot to travel backwards faster.

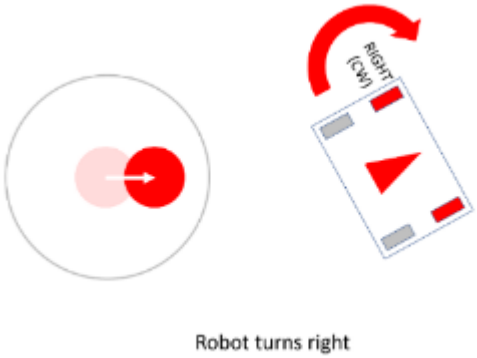
Robot moves forward



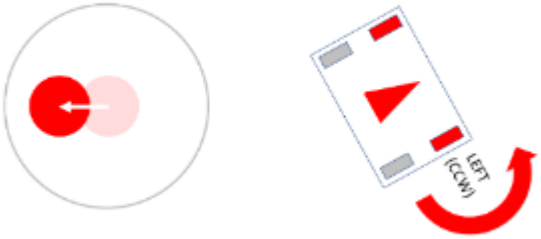
Robot moves backward

- The horizontal (left/right) axis controls the ***rotational*** (turning) speed of the robot unit. The further to the right causes the robot to turn faster in a clockwise direction. The further to the left causes faster counter-clockwise rotation.

- By moving the red dot to an arbitrary X/Y position, you will *combine* linear and rotational speeds. This will cause the robot to move in an arc.

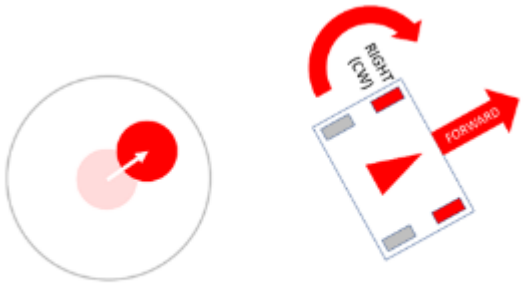


Robot turns right



Robot turns left

- A slight dead-band of ±10% exists along each axis of the Joystick Controller. This is to allow



Robot turns right while driving forward

for bet ter control even if the red dot is slightly off center.

6.5 Pre-Set Turns

- Clockwise 90 – Robot will turn clockwise 90 degrees and then halt movement
- Counter-clockwise 90 – Robot will turn counter clockwise 90 degrees and then halt movement
- Forward 1m – Robot will move forward 1 m then halt movement
- Backward 1m – Robot will move backward 1 m then halt movement

Figure 6-6 Preset Motions

6.6 Abort

This is the emergency stop button in bottom left. This will immediately halt the robot.

Abort

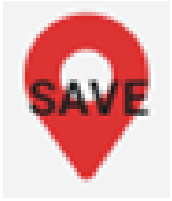
6.7 Save Waypoint

The button at the bottom right will allow the user to save the robot's current *pose* (position and orientation) on the grid as a reference Waypoint.

A dialog box will appear that is labelled SAVE WAYPOINT with a text field to name the Waypoint

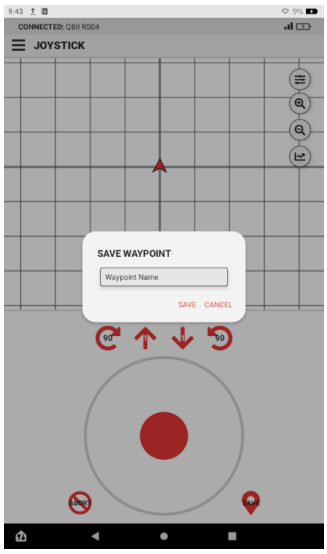
This Waypoint will then be added to the current list of active Waypoints and can be displayed on map grids within the App.

Save Waypoint Symbol



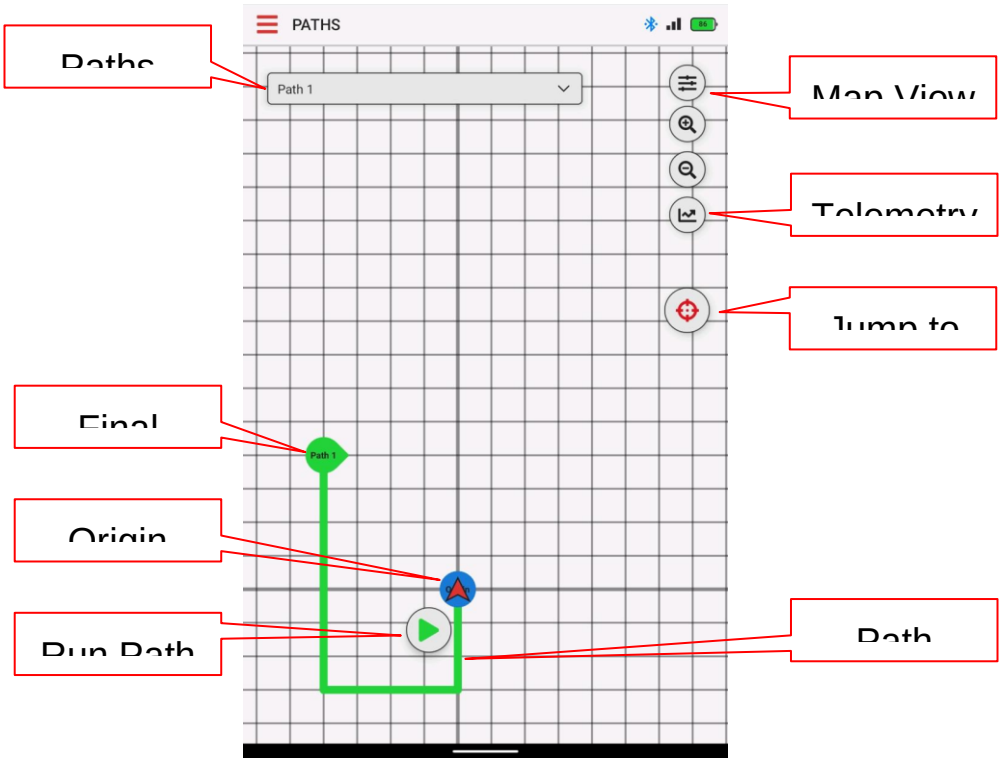
Saving Waypoints in this way will be handy when defining Paths.

Figure 6-7 Saving a



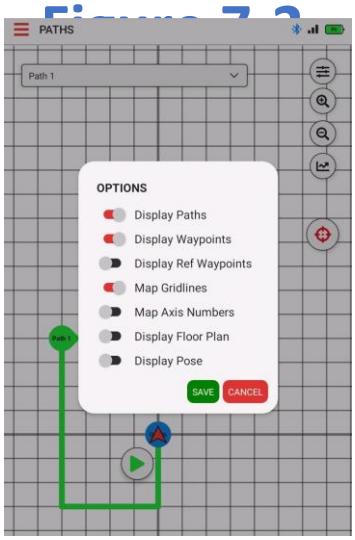
7 Paths Screen – Autonomous Mode

Figure 7-1 Paths Screen



The Paths Screen allows you to command the robot to run a Path by itself, i.e., 'autonomous' mode (see Section 3.3). The currently selected path will be displayed on map grid as a green line.

7.1 Map View Options



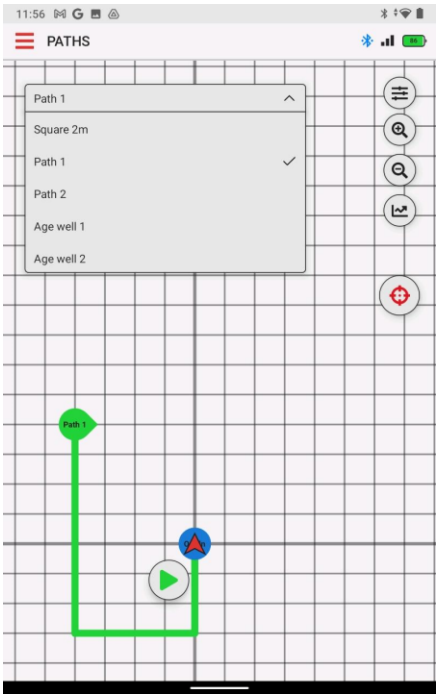
The icons on the right allow you to access various map view options:

- Slider Options: The slider icon on grid will open a new dialog box showing the following on/off toggles:
  - Display Paths – show current Paths
  - Display Waypoints – show the final Waypoint in the Path
  - Display Ref Waypoints – show the reference Waypoints from the current Waypoint List
  - Map Gridlines – shows gridlines
  - Map Axis Numbers – shows grid units (in meters), default off
  - Floor Plan (toggle on/off) – shows the imported floor plan, default off

- Magnifying Glass + – zoom in on grid display
- Magnifying Glass - – zoom out on grid display

7.2 Paths Drop Down Menu

Figure 7-3 Paths Screen Drop Down Menu



The Paths Drop Down Menu allows you to view of all pre-programed Paths by their saved name.

Tap a Path name to select it. The previously selected Path will be replaced by the new Path.

7.3 Origin Symbol

The origin of the global coordinate system will be represented by a blue circle labelled “origin”. The origin is located at x = 0 and y = 0.

7.4 Current Robot Pose

When connected to a robot, its current *pose* in the global coordinate system, defined as (x, y, θ), is displayed as red arrow.

This current pose is based on telemetry received from the robot. Many times per second, the robot regularly updates an estimate of its pose based on internal encoder and gyroscope readings.

Telemetry Icon

7.5 Telemetry

Reads various data from the robot. This includes distance readings from all 4 distance sensors and data from the wheel encoders.

Home Icon

7.6 Home Button

Clicking the home button resets the map grid to center the robot. This button only occurs when the map grid is moved from the origin.

Jump to Waypoint Icon

7.7 Jump to Waypoint

The current robot pose is calculated relative to the last time the robot’s origin was reset. By default, the robot’s pose is reset to (0, 0, 0°) at power-up.

After driving the robot for some time, or if you have disconnected and re-connected without cycling power to the robot, the robot's pose can be anywhere in the global coordinate system.

In the case of a power off-on cycle it may be necessary to start path from desirable location instead of starting from the origin. Using the Jump to Waypoint button robot pose can be moved to a previously saved waypoint.

7.8 Path Control Buttons

The following buttons also appear if you are connected to a robot:

- Play Button – Starts the robot on the selected Path.
- Pause Button – Temporarily pause the Path. You can resume.
- Stop Button – Halts the robot. Path will not resume.

Figure Play, Pause, Stop Buttons

7.9 Once You Press “Play”

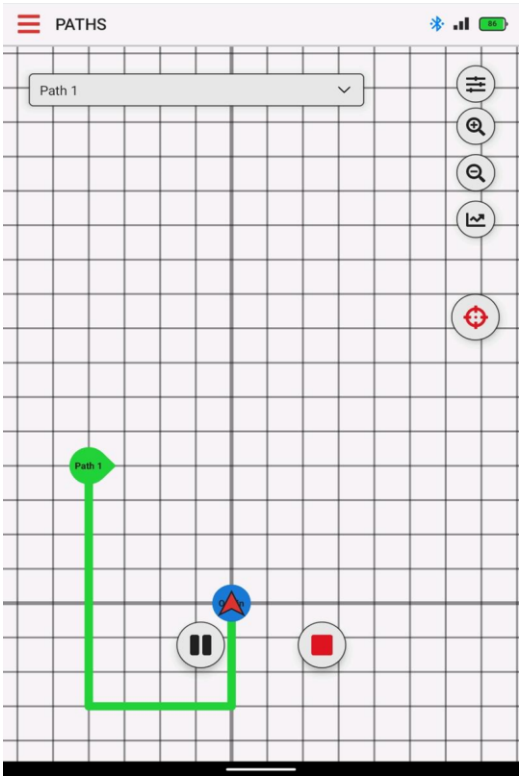
CAUTION: Keep in mind that once you press the “Play” button, the robot will immediately begin to execute the selected path *by itself.* The robot will continue until any of the following occur:

- The path is complete
- The path is paused because an obstacle is detected
- The path is paused by the user
- The path is stopped by the user

A few changes to the Paths screen will occur while a Path is active:

- The “Play” icon is replaced with “Pause” and “Stop”
- If the robot is not at the start of the path, the robot icon (red arrow) will begin moving towards the start in a straight line. Once there, the robot will begin to follow each segment of the path (green line) in sequence.
- If the robot is already at the start of the path, it will begin following the path’s green line.

Figure 7-4 Screen During Active Path



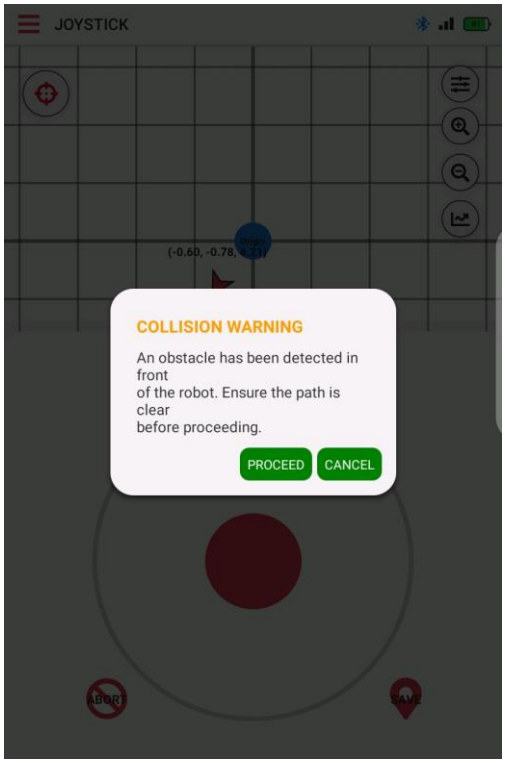
7.10 Collision Warning

If the robot’s sensors detect an obstacle, the robot should bring itself to a stop before a collision happens.

With the robot in “pause” mode, a “Collision Warning” dialog will be displayed, prompting the user to clear the obstacle. Clicking “Proceed” will resume the current path.

CAUTION: Collision detection is not foolproof. Care must always be taken to ensure that the robot’s path is free from obstacles, especially young children and pets.

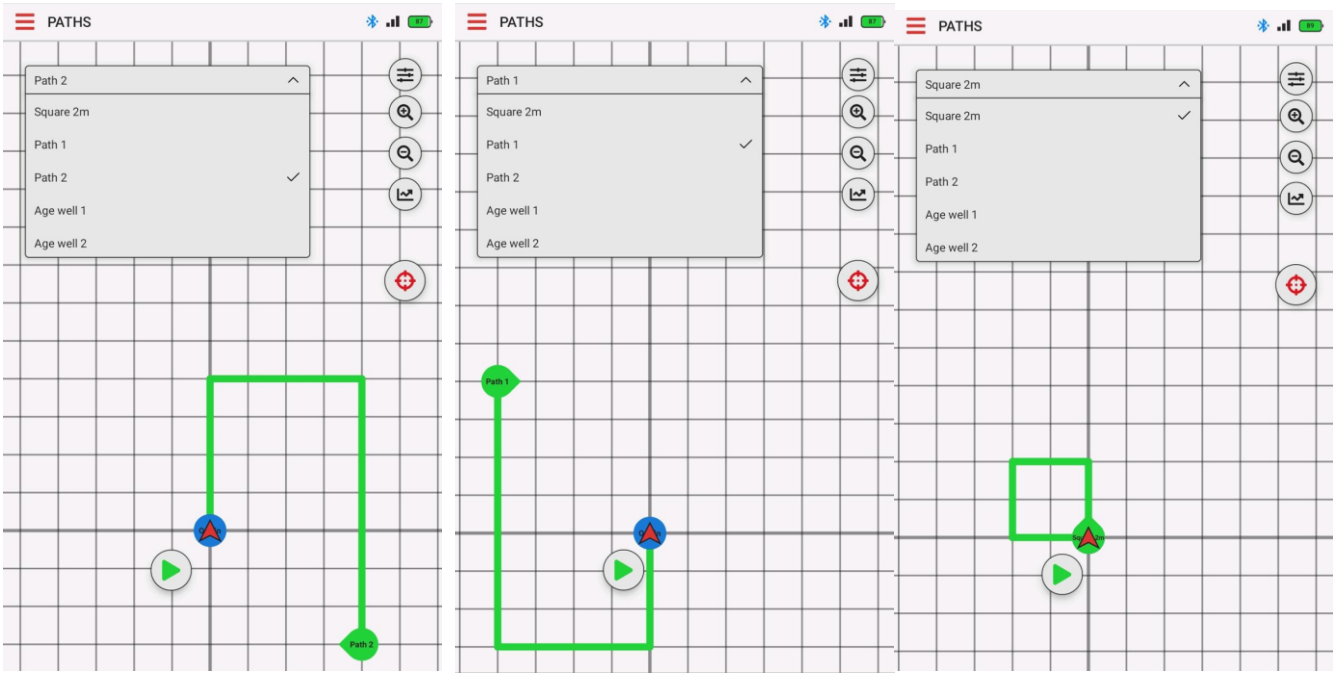
Figure 7-5 Collision



7.11 Choosing Different Paths

Only one path can be loaded into the Path Screen at a time. However, it is possible to change paths by using the Paths Drop Down Menu. This menu lists all the Paths that have been previously created and saved within the Control App memory (see *Path Editors*).

Figure 7-6 Choosing Different

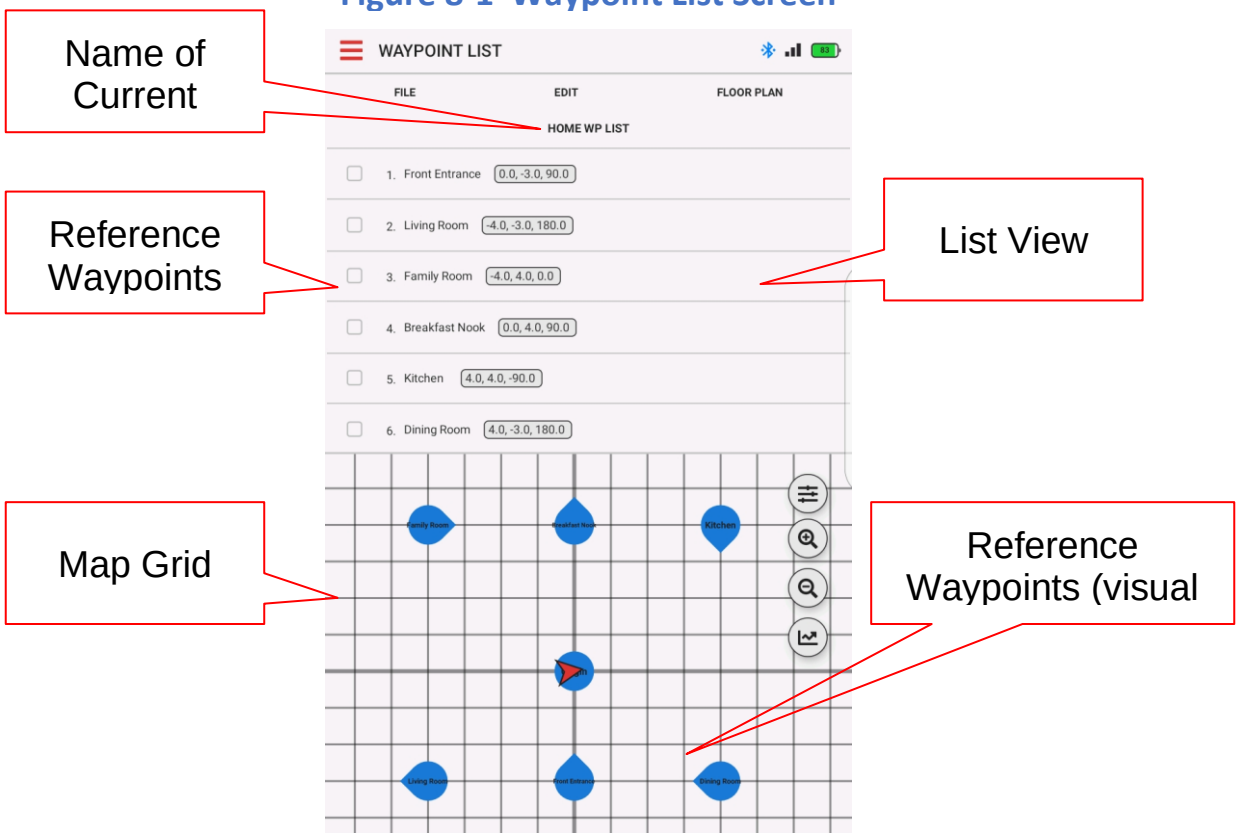


8 Waypoint List Screen

8.1 Overview

The Waypoints List Screen is used to create and manage lists of Reference Waypoints (see Section 3.9). This screen is divided into two parts:

Figure 8-1 Waypoint List Screen



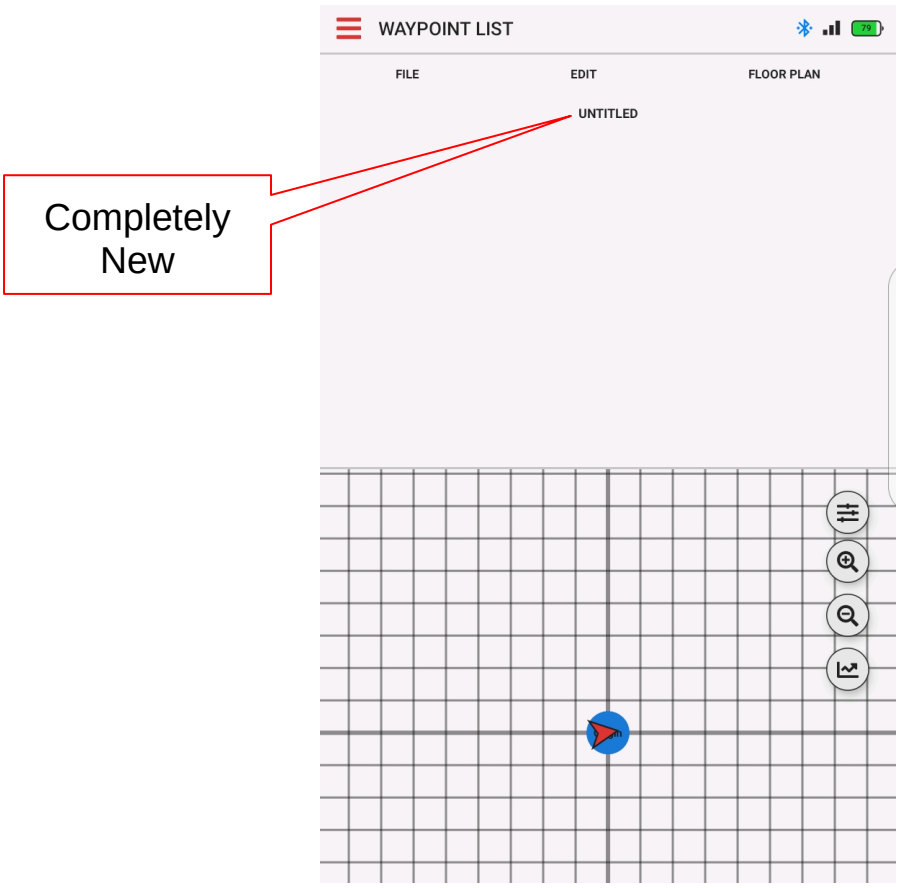
- List View
  - The name of the current Waypoint List is displayed at the top of the List View
  - Each line of the List View contains information about individual Reference Waypoints belonging to the current Waypoint List, including
    - ID number
    - Name
    - Default Pose (x, y, θ)

- Map Grid
  - Contains a visual representation of the Reference Waypoints in the Waypoints List within the global coordinate frame
  - The origin of the global coordinate frame is represented by a blue circle
  - Each Reference Waypoint is shown as a blue teardrop, with the point indicating the waypoint's default orientation

8.2 Creating the First Waypoint List

For a newly installed Control App, no Waypoint List yet exists. Navigating to the Waypoint List screen will show an empty list. You must create new Reference Waypoints, add them, then save the list.

Figure 8-2 Creating Waypoint



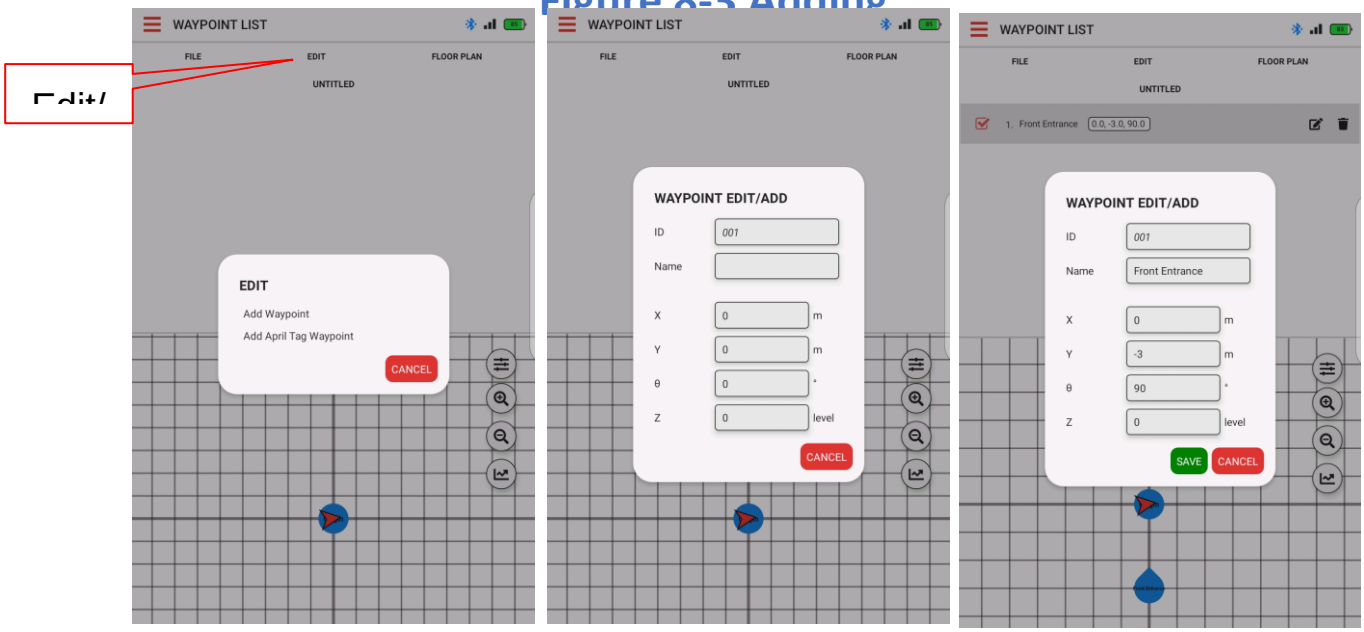
8.3 Adding the First Reference Waypoint

To add the first Reference Waypoint, click on Edit to open the Edit dialog box, then tap Add. This will open the Waypoint Edit/Add dialog. Enter data for this Reference Waypoint:

- ID: This number is generated automatically
- Name: Enter a descriptive name like “Front Entrance”
- Pose: Enter the (x, y, θ) coordinates for this Waypoint (leave level Z at 0).

Finally, tap Add to include this Reference Waypoint in the Waypoint List.

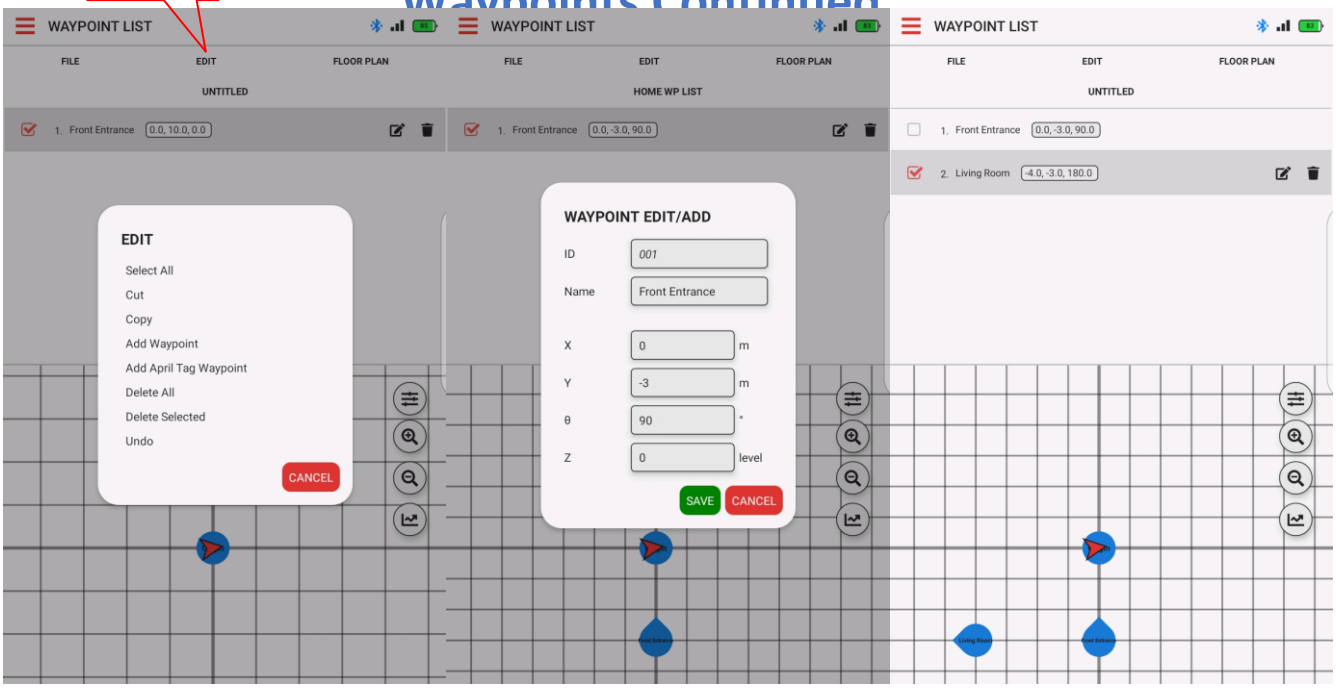
Figure 8-3 Adding



8.4 Adding More Reference Waypoints

To add more Reference Waypoints, repeat the process from Section 8.3.

Figure 8-4 Adding Waypoints Continued



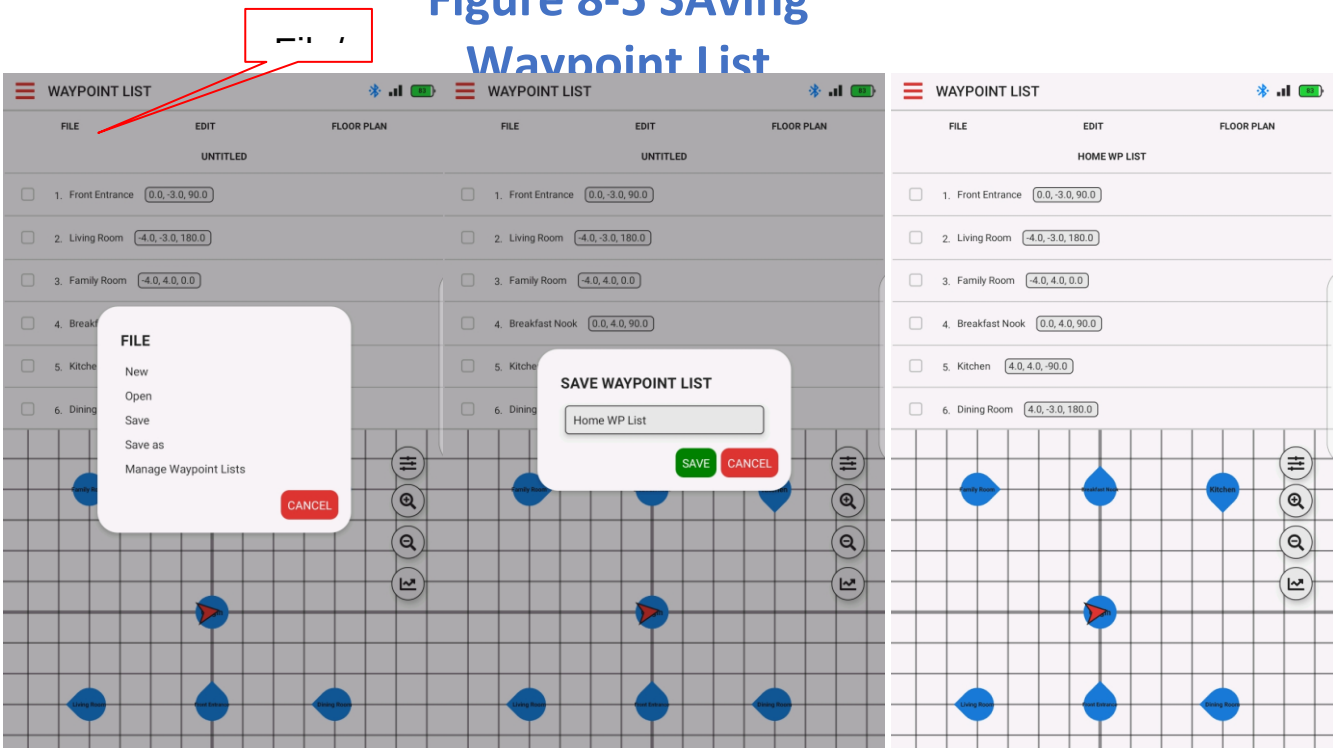
8.5 Saving the Waypoint List

To assign a name your list of Reference Waypoints, click on File to open the File dialog box, then tap Save As. This will open the Save Waypoint List dialog. Enter the name for this Waypoint List.

In the example below, we have assigned the name “Home WP List” to this Waypoint List.

Use File/Save to save the Waypoint List to the same name. If you have made any changes since the previous save, the current version will overwrite the previous version.
Use File/Save As to save the Waypoint List under a different name (e.g., “Home WP List 2”).

Figure 8-5 SAving Waypoint List

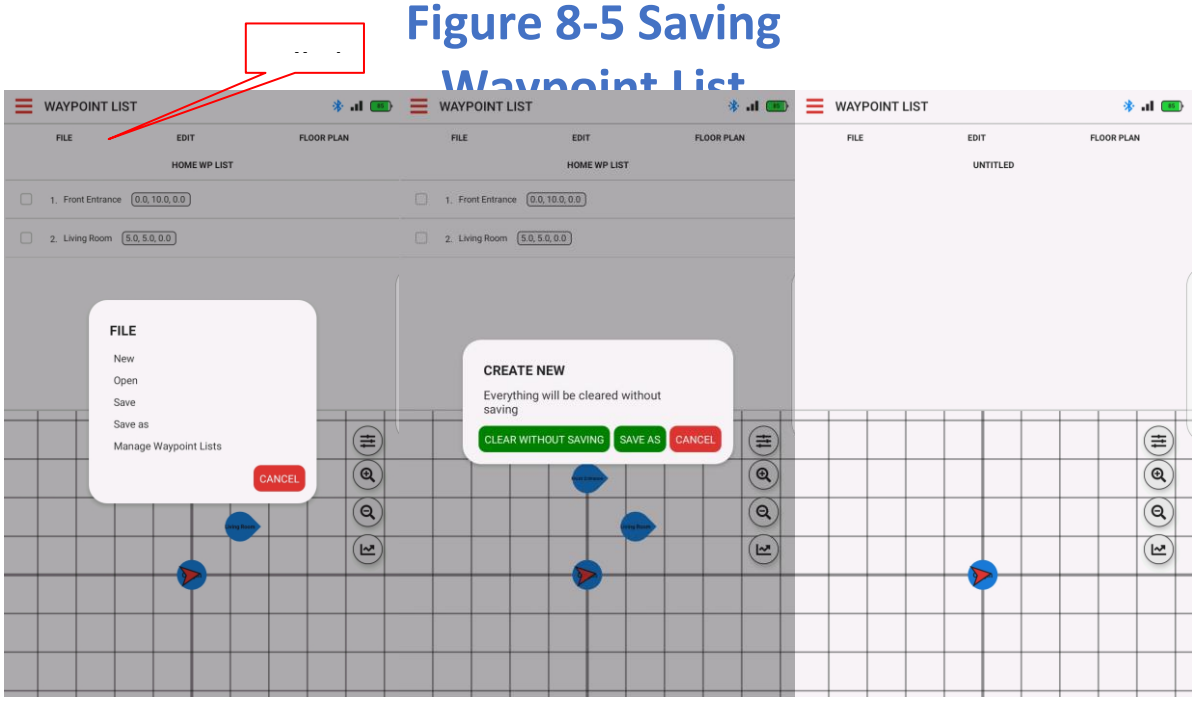


8.6 Creating a New Waypoint List

To create an entirely new Waypoint List, use File/New. This will open the Create/New dialog, which will warn you that you are about to “clear” the Waypoint List. If you have not yet saved changes, this is your opportunity to do so.

CAUTION: Selecting “Clear without saving” will replace the current Waypoint List with a blank list without a title.

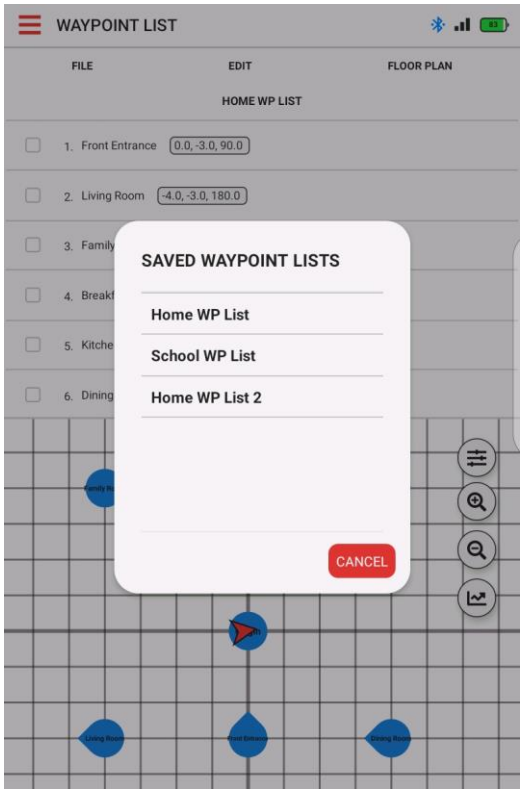
Figure 8-5 Saving Waypoint List



8.7 Opening a Different Waypoint List

Use File/Open to load a different Waypoint List. This will activate the Saved Waypoint Lists dialog, which presents the user with a list of all previously saved Waypoints Lists.

Figure 8-6 Opening a Different



8.8 Manage Waypoint Lists (Export/Import/Delete)

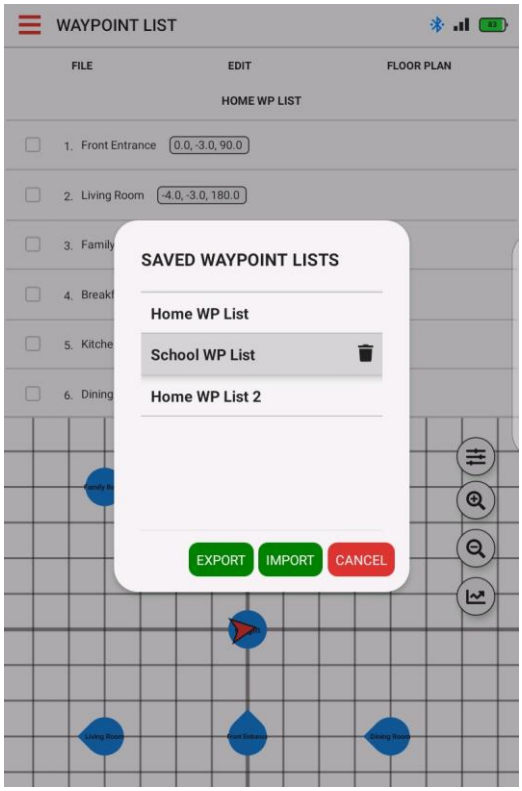
You can manage the available Waypoint Lists on your device by using File/Manage Waypoint Lists. This will open a slightly different version of the Saved Waypoint Lists dialog. As before, this will list all the Waypoint Lists that have been saved to the App's memory.

Within this dialog, you can do the following:

- Delete a Waypoint List
  - Select the name of the Waypoint List you wish to delete
  - Tap the 'trash' icon beside its name
- Export a Waypoint List
  - Select the name of the Waypoint List you wish to export
  - Tap 'Export'
  - This will open the Export Waypoint Dialog
  - Enter a file name in the 'Export As' field
  - Tap 'Export' – this will create a (file name).JSON file in your device's 'Downloads' folder
- Import a Waypoint List
  - Tap 'Import'
  - This will open your device's file explorer dialog
  - Navigate to the 'Downloads' folder on your device

- A list of available JSON files should appear
- Select the JSON file you wish to import
- Tap ‘Import’

Figure 8-7 Managing Waypoint Lists



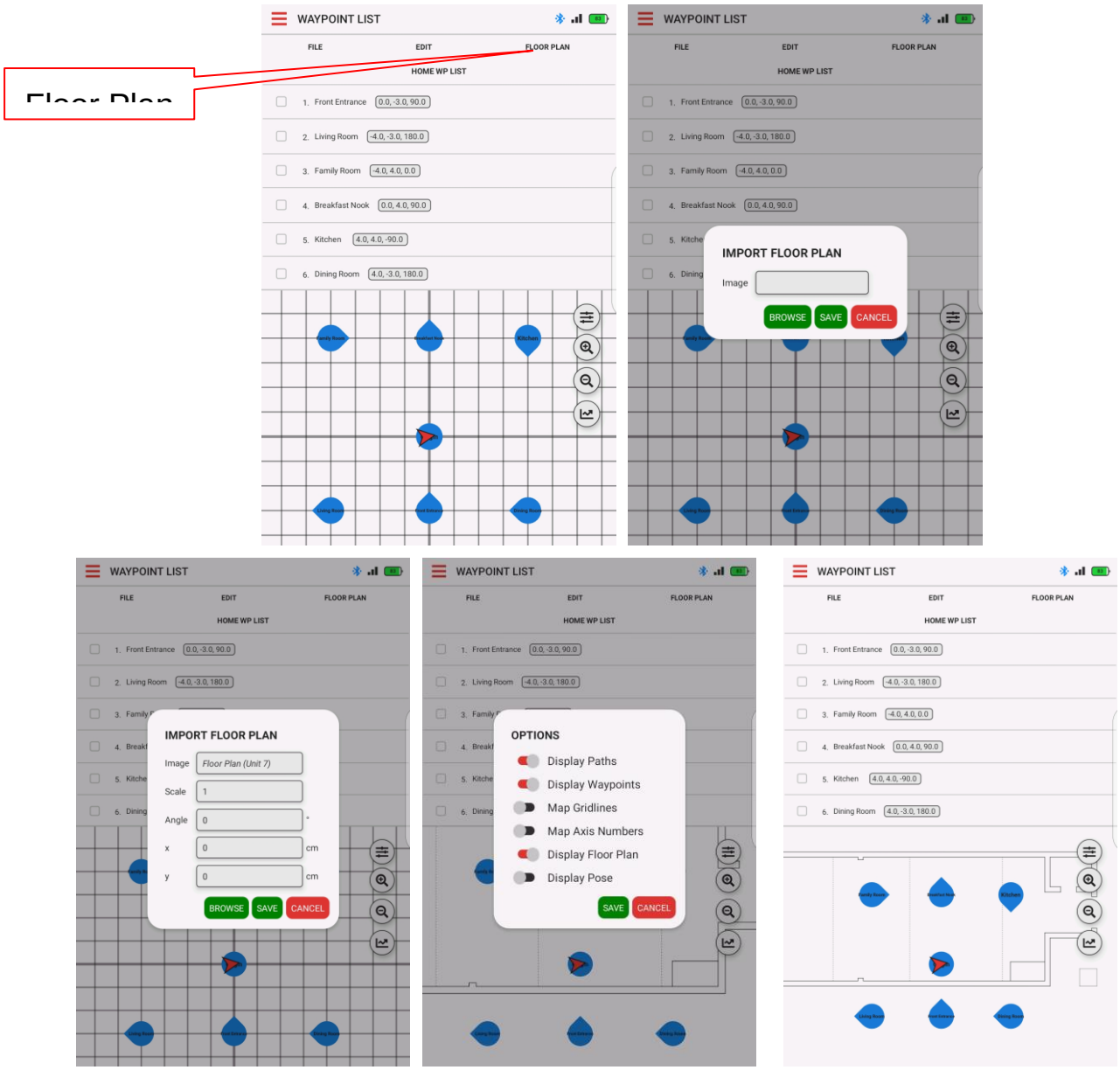
8.9 Managing Floor Plans (Import)

You can visualize how the robot moves around your environment by importing a .svg file of your floor plan.

Simply follow the following steps:

- Press ‘Floor Plan’ on the top-right corner of the Waypoint List screen
- Click on Browse
- Select the floor plan you want to import (must be a .svg file)
- Optional: Enter pose values if you want to orient the floor plan a certain way
- Optional: Go to the Map View Options and disable the Grid Lines and Gris Axis Numbers sliders to see the floor plan and waypoints clearly

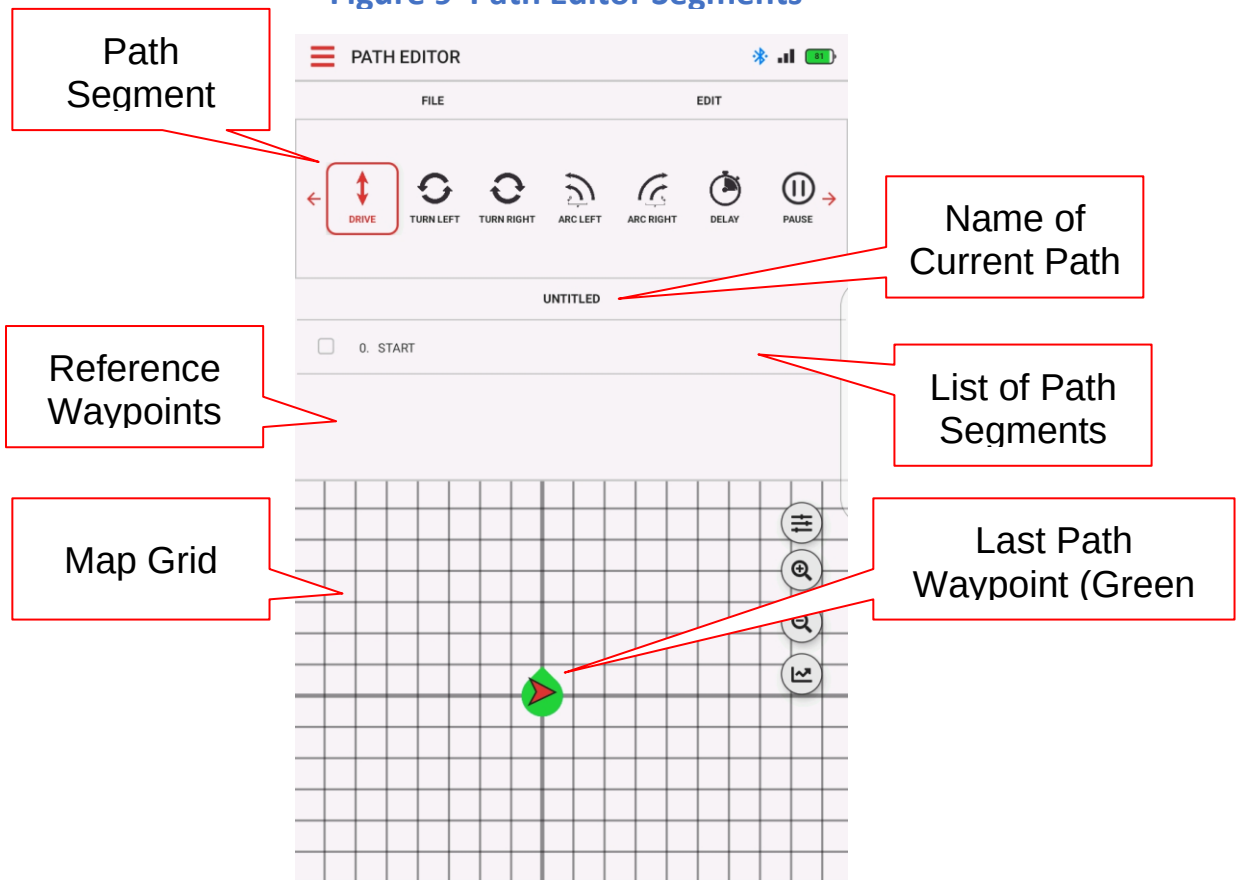
Figure 8-8 Managing Floor Plan



9 Path Editor (Segments) Screen

9.1 Overview

Figure 9 Path Editor Segments



The Path Editor (Segments) Screen is used to create and manage autonomous robot paths that are created using Segments (see Section 3.11). This screen is divided into three parts:

- Path Segment Types
  - This is a menu of the following basic path segment types: Drive, Turn, Arc, Delay

- List View
  - The name of the current Path is displayed at the top of the List View
  - Each line of the List View contains information about individual Segments belonging to the current Path, including
    - ID number
    - Maneuver Type
    - Maneuver Parameters

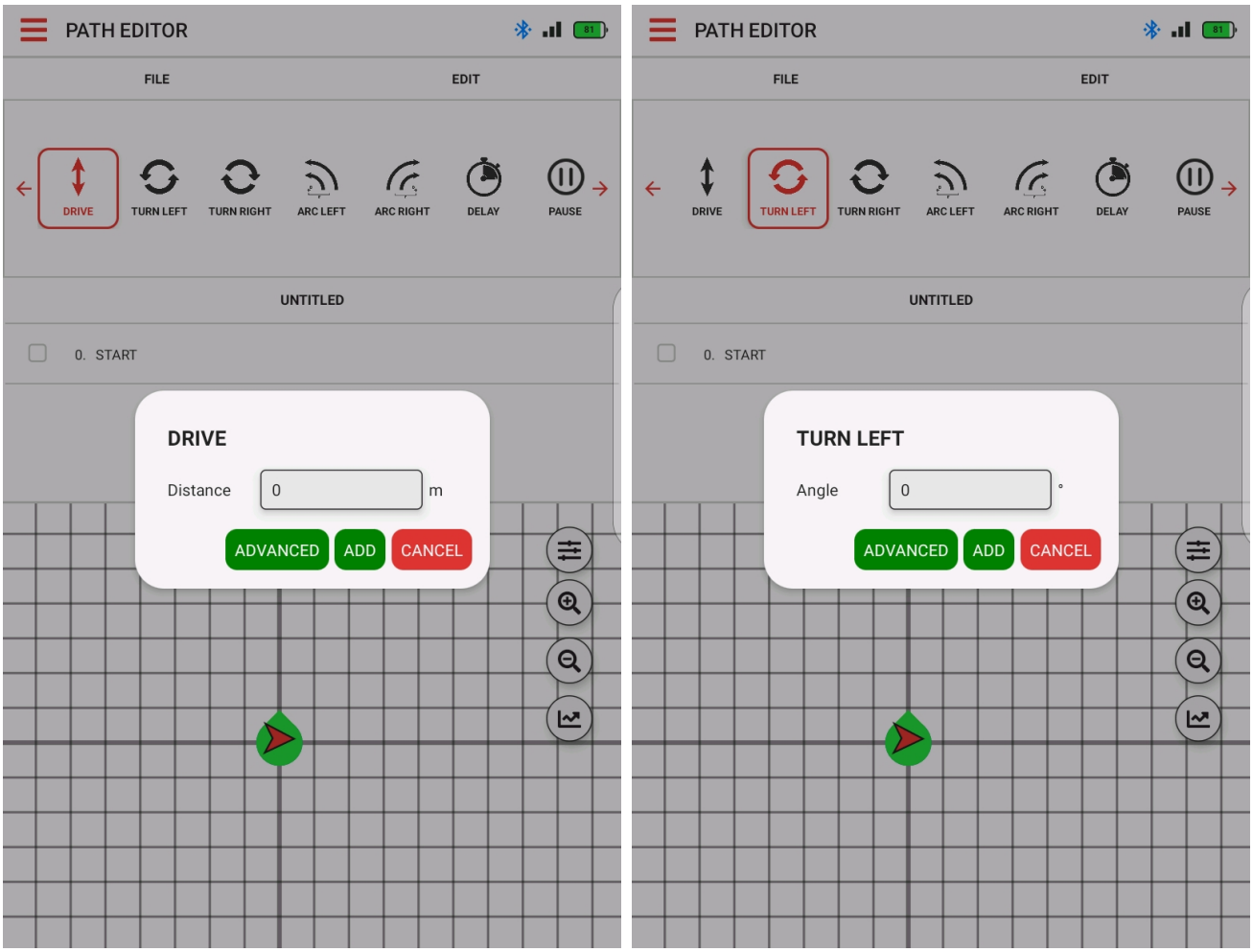
- Map Grid
  - Contains a visual representation of the current Path (in green) within the global coordinate frame
  - The waypoint at the end of the Path is shown as a green teardrop
  - The origin of the global coordinate frame is represented by a blue circle

9.2 Path Segment Types

Figure 9-1 Path Segment Types

The Path Segment Types are basic maneuvers that may be thought of as the ‘building blocks’ of Path.

Figure 9-2 Drive Segment and Turn Segment

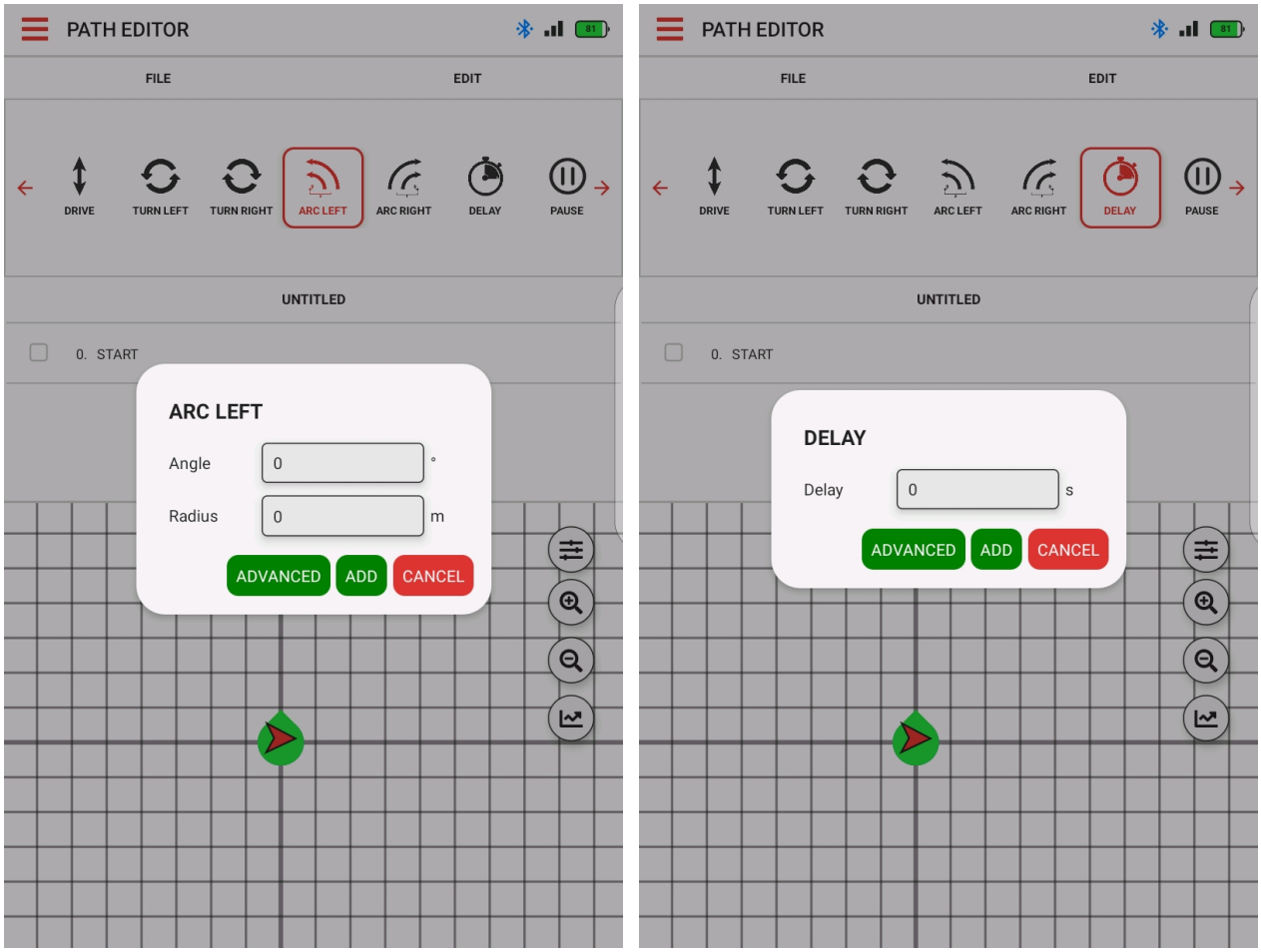


When you tap on a Path Segment Type, its dialog opens, allowing you to specify parameters for that specific type:

- Drive
  - Distance: the straight-line distance the robot will travel
- Turn

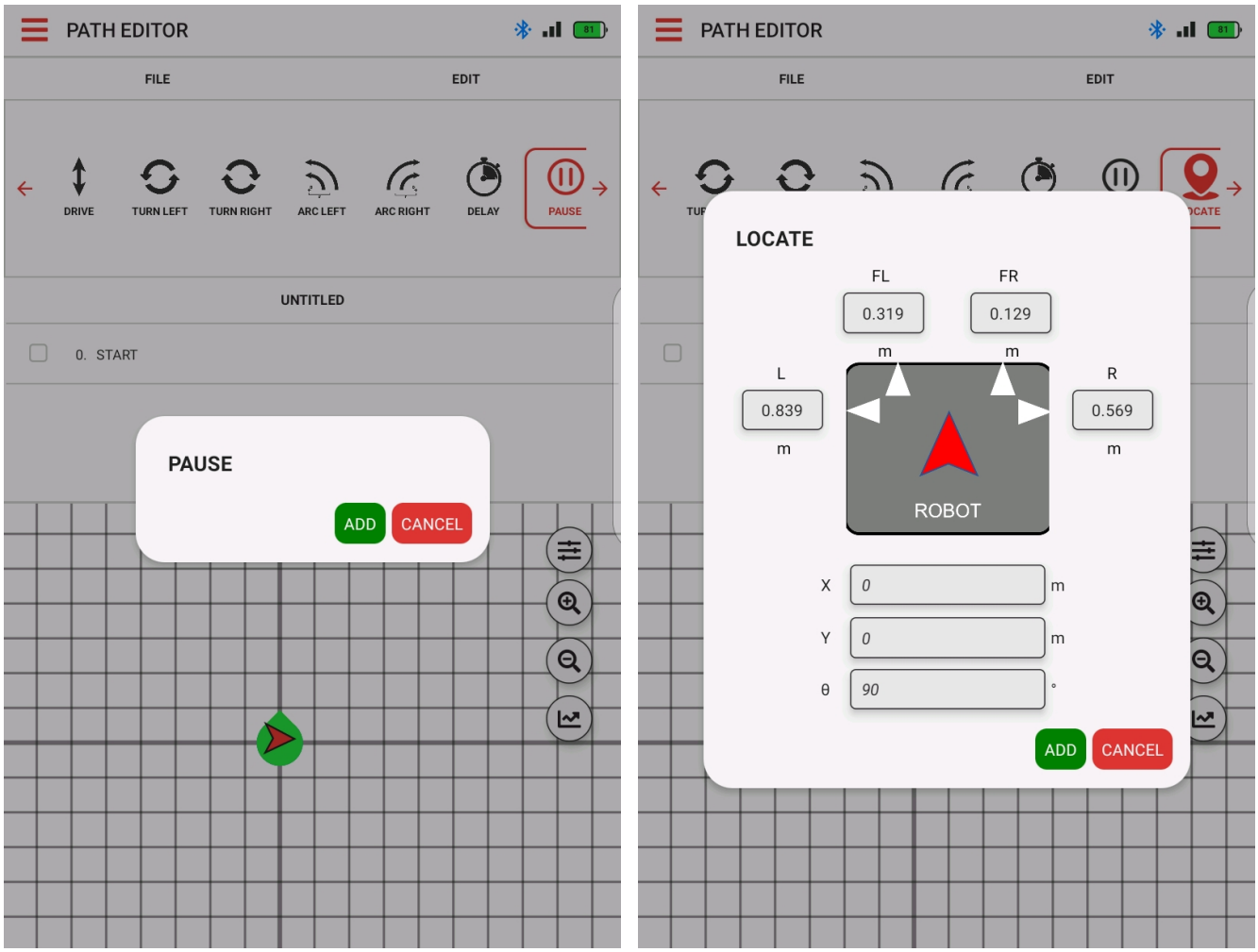
- Angle: the angle through which the robot will turn on the spot

Figure 9-3 Arc Segment to Delay Segment



- Arc
  - Angle: total rotation executed during the arc maneuver
  - Radius: the geometric radius of the arc
- Delay
  - Time: the duration of the delay at that waypoint

Figure 9-4 Pause Segment and Locate Segment



- Pause
  - The robot will stop and ask the user if it should continue its path or stop.
- Locate
  - The robot uses its range sensors to locate its position relative to known landmarks. The robot's current location in the global coordinate frame is updated accordingly.

9.3 Start Segment – Waypoint 'Zero'

The Path Editor (Segments) constructs paths using basic segment 'building blocks' (see Section 9.2). However, by definition, every path must have a starting waypoint. For this Editor, all Paths are assumed to start at the 'origin' with the robot pointing in the +y direction, i.e., (0, 0, 90°).

This is called the *Start Segment*. It is assigned ID = 0.

Following this convention allows consistency between the Path Editor (Segments) and the Path Editor (Waypoints) – see Section 10.

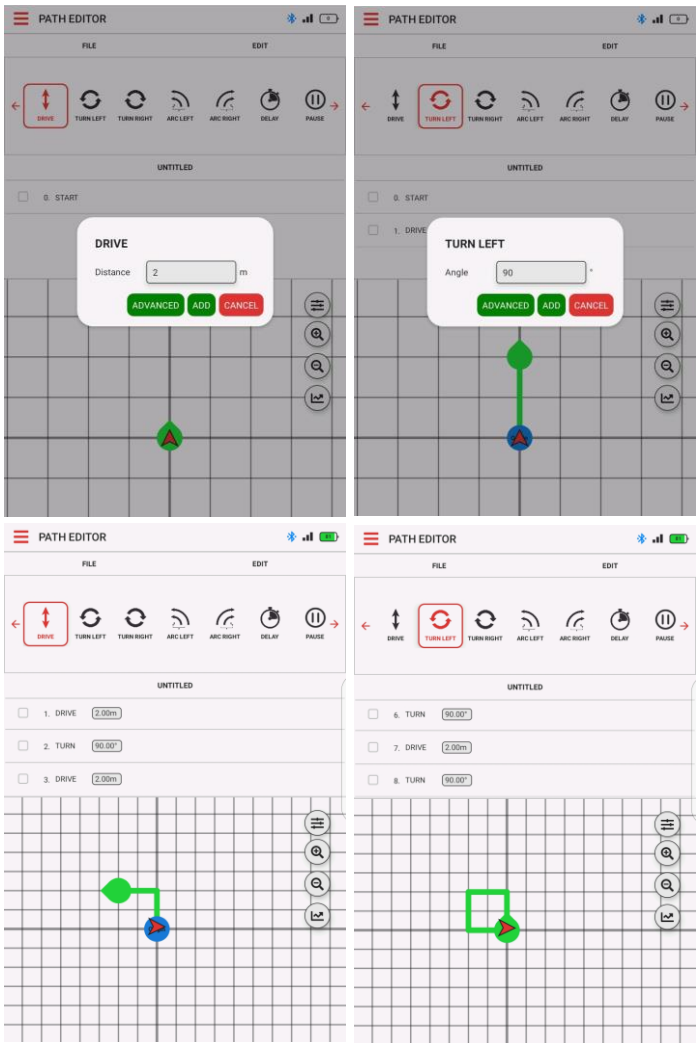
Since the Start Segment is essential, *it cannot be deleted*.

9.4 Adding Path Segments to the Path

In the following example, we construct a square path that consists of the following segment sequence:

- Drive 2m
- Turn 90°
- Drive 2m
- Turn 90°
- Drive 2m
- Turn 90°
- Drive 2m
- Turn 90°

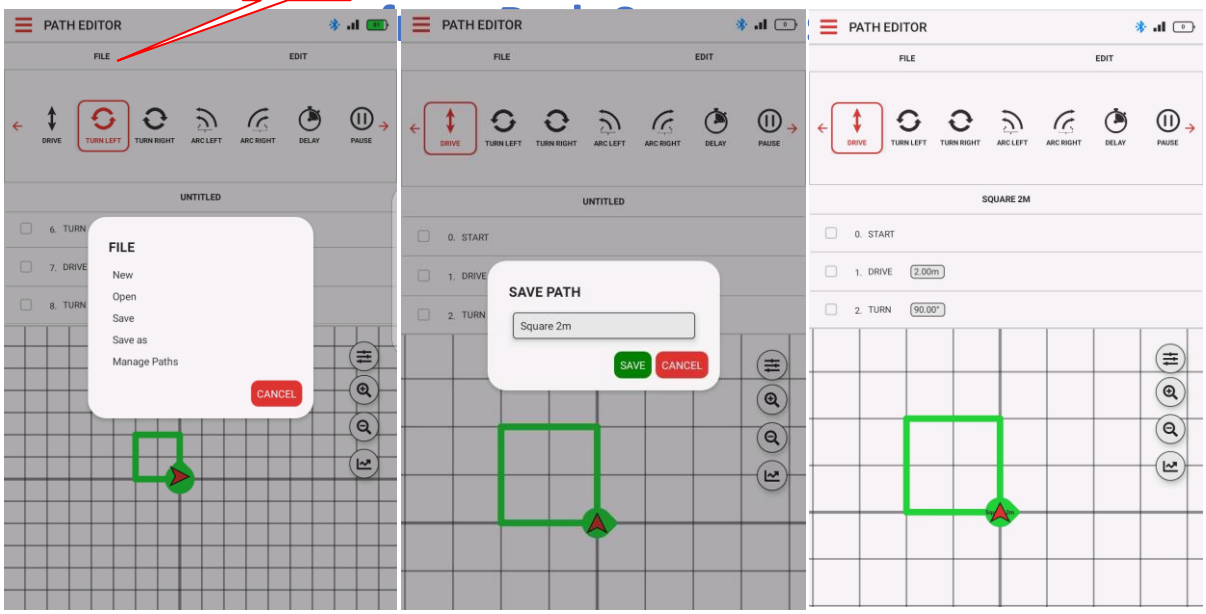
Figure 9-5 Square Path



9.5 Saving the Path

To assign a name your Path, click on File to open the File dialog box, then tap Save As. This will open the Save Path dialog. Enter a name. In the example below, we have assigned the name “Square 2m”.

Figure 9-6 Saving Path



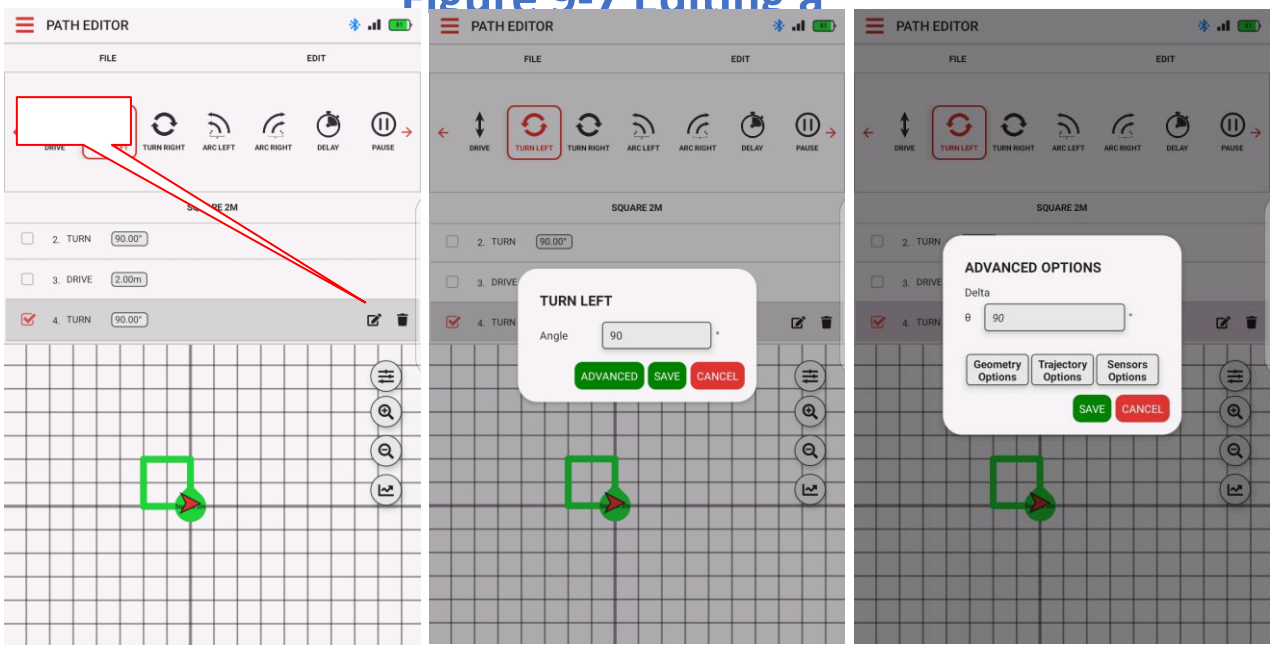
9.6 Editing a Path Segment

It is possible to edit individual path segments. First, tap a segment to select it. Two icons will appear beside the segment name:

- Edit Icon – will open further editing dialogs
- Delete Icon – will remove the segment from the path

Clicking on the Edit Icon will open the editing dialog for that segment. You can, for example, change the value of a Turn from 90° to 45°.

Figure 9-7 Editing a

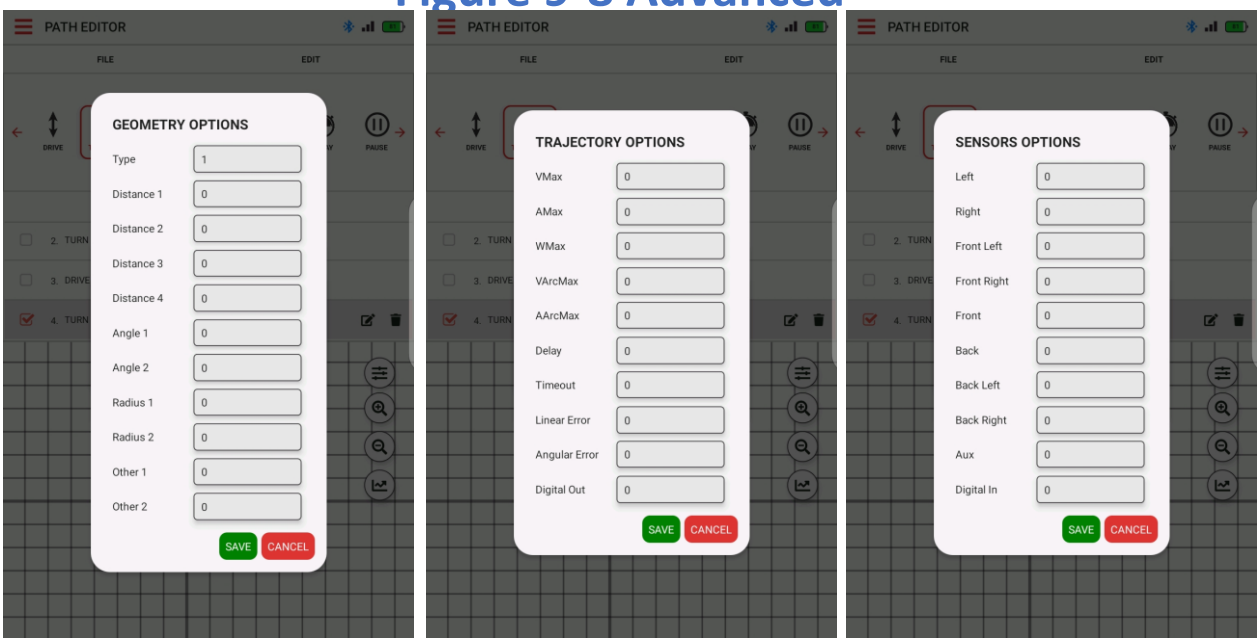


9.7 Advanced Editing Options

Clicking Advanced in the segment editing dialog will open the Advanced Options. In this box, you can change the “Delta” values associated with this segment. You then open the following options:

- Geometry
- Trajectory
- Sensors

Figure 9-8 Advanced



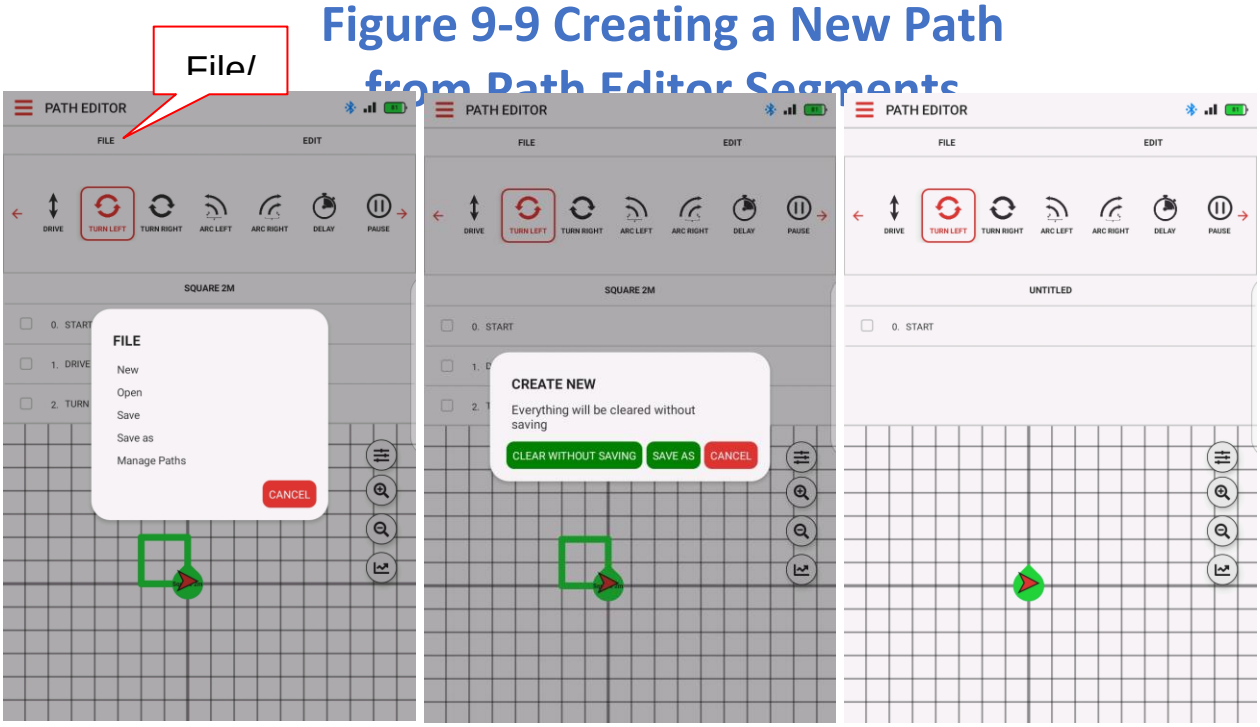
9.8 Creating a New Path

To create an entirely new Path, use File/New. This will open the Create/New dialog, which will warn you that you are about to “clear” the Path. If you have not yet saved changes, this is your opportunity to do so.

CAUTION: Selecting “Clear without saving” will replace the current Path with a blank one without a title.

Note that the new blank path will always have a default zero-length “Start” segment (ID = 0).

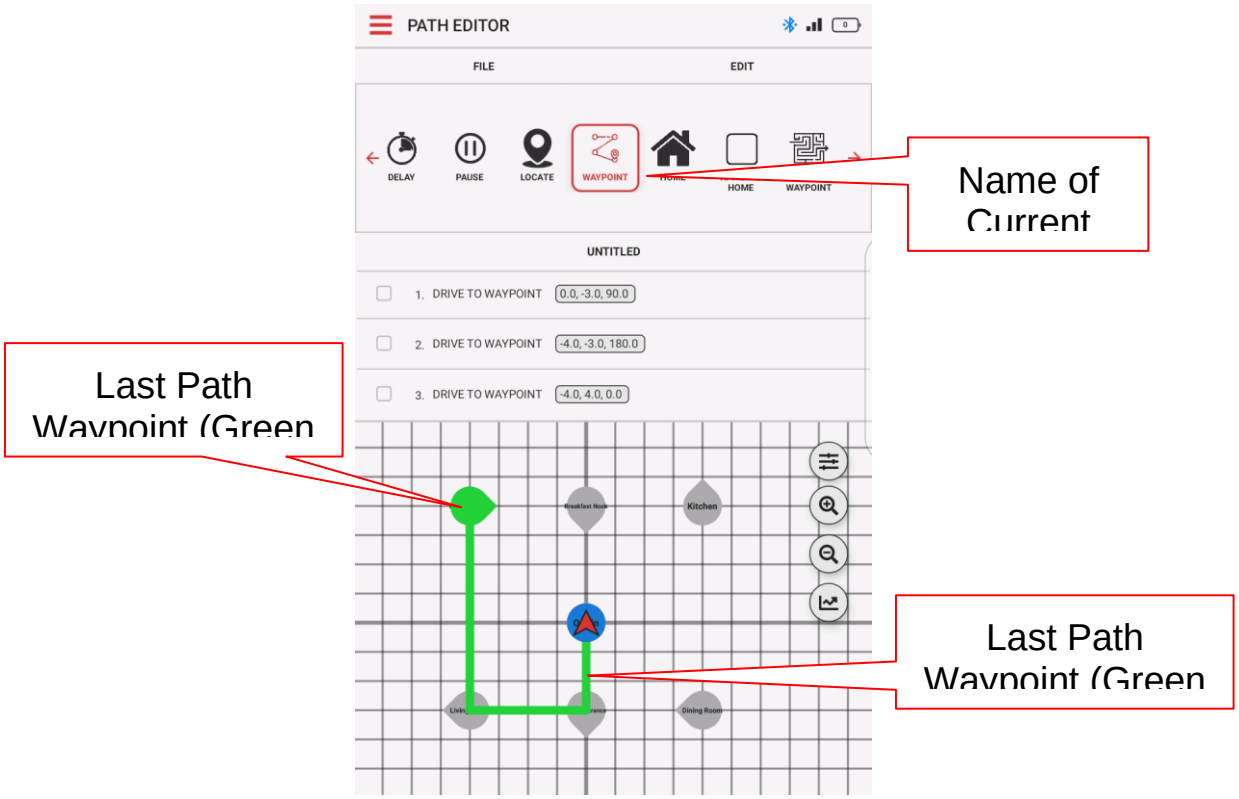
Figure 9-9 Creating a New Path from Path Editor Segments



10 Path Editor (Waypoints) Screen

10.1 Overview

Figure 10-1 Path Editor



The Path Editor (Waypoints) Screen is used to create and manage autonomous robot paths that are created using Waypoints (see Section 3.10). This screen is divided into two parts:

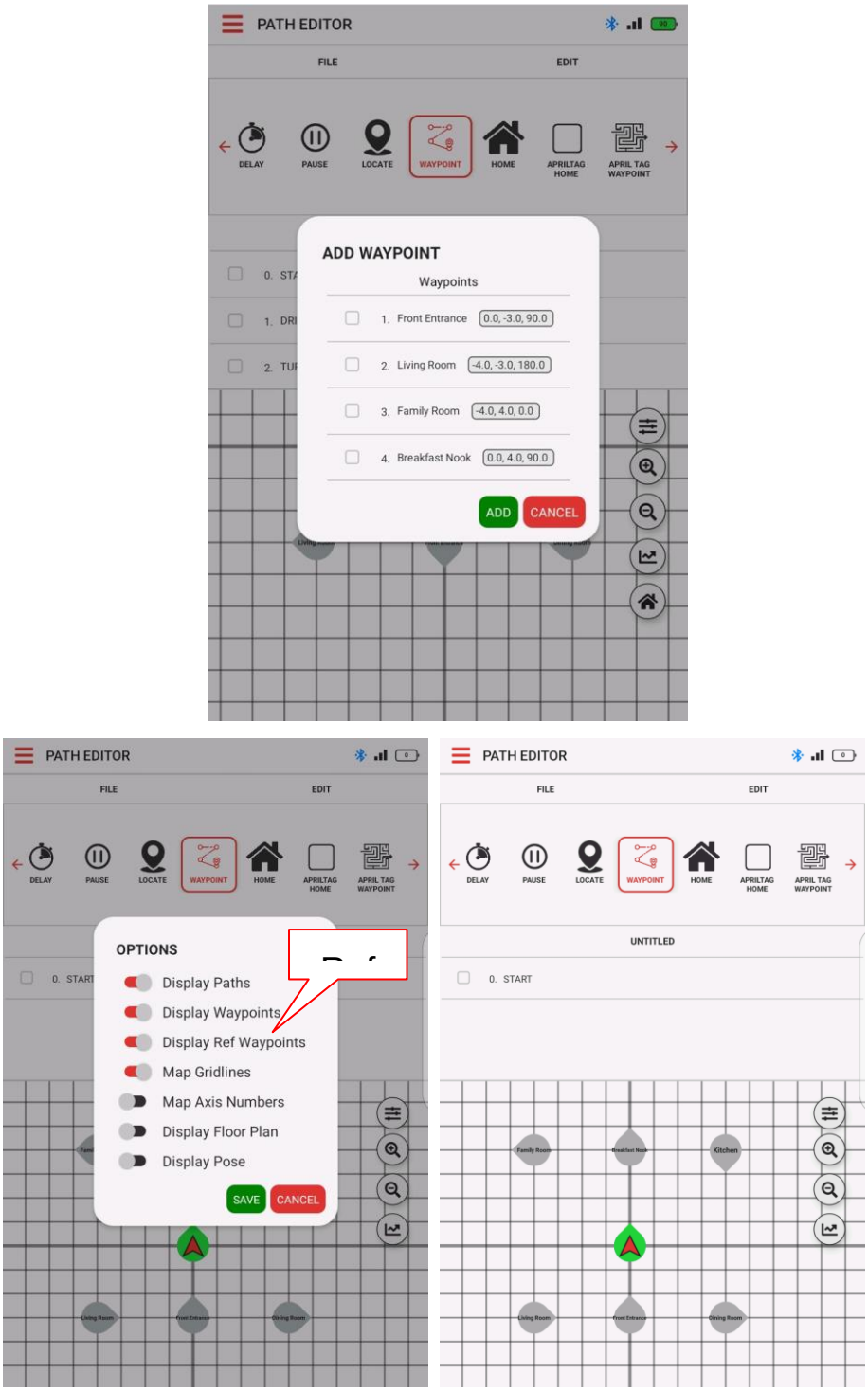
- List View
  - The name of the current Path is displayed at the top of the List View
  - Each line of the List View contains information about individual Waypoints belonging to the current Path, including
    - ID number
    - Name
    - Pose coordinates (x, y, θ)

- Map Grid
  - Contains a visual representation of the current Path (in green) within the global coordinate frame
  - The waypoint at the end of the Path is shown as a green teardrop
  - The origin of the global coordinate frame is represented by a blue circle
  - For the user's convenience, the original Reference Waypoints are displayed as gray teardrops

10.2 Displaying Reference Waypoints in Map Grid

Before any Waypoints have been added to a Path, both the List View and Map Grid in the Path Editor (Waypoints) Screen are blank:

Figure 10-2 Displaying Reference Waypoints in Path Editor Waypoints



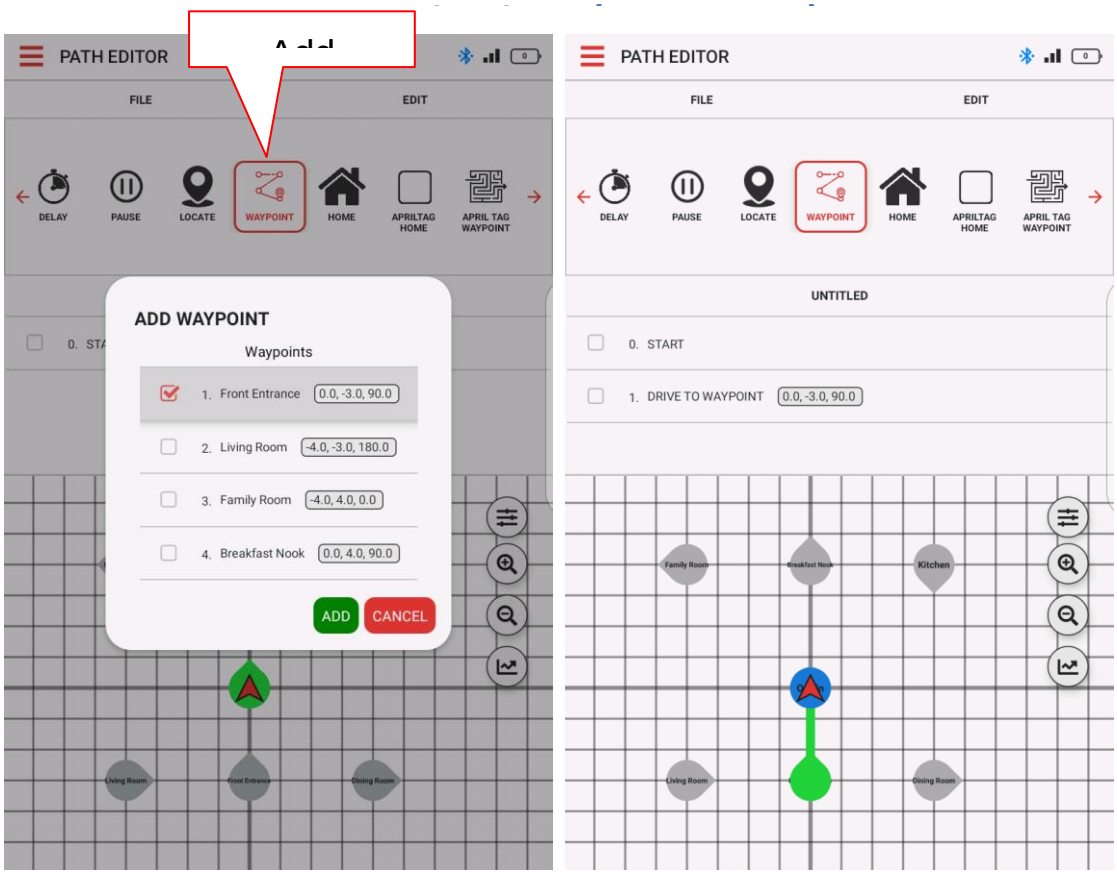
To help with creating the Path, we recommend turning on the “Display Reference Waypoint” option. This shows all the Reference Waypoints in the current Waypoints List.

10.3 Adding Reference Waypoints to the Path

To add the first Reference Waypoint to the Path, click on Edit to open the Edit dialog box, then tap Add. This will open the Add Waypoint dialog, which contains a list of the Reference Waypoints from the current Waypoint List. Tap to select one of the Reference Waypoints (in this case “Front Entrance”), then click Add to include it in the List View.

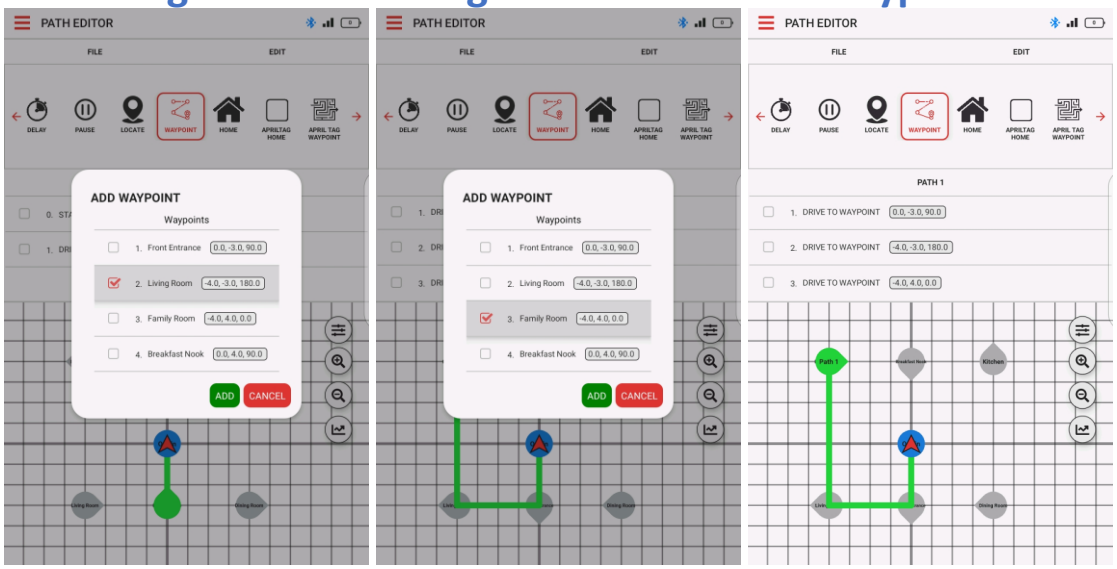
Once this is done, the current Waypoint (i.e., the last on the list) will be displayed in the Map Grid as a green teardrop.

Figure 10-3 Adding Reference Waypoints to Path in



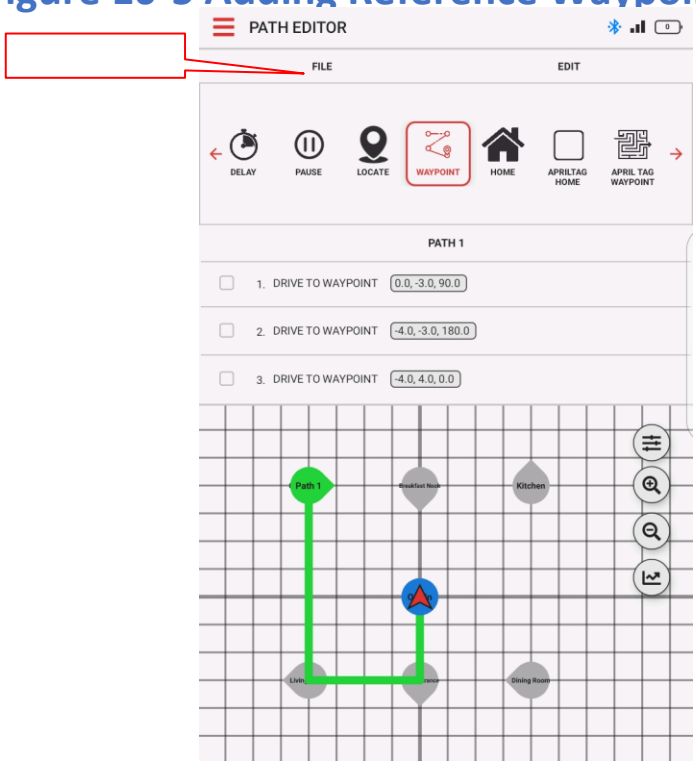
Repeat this process to add a series of Reference Waypoints build up the Path.

Figure 10-4 Adding More Reference Waypoints



10.4 Saving the Path

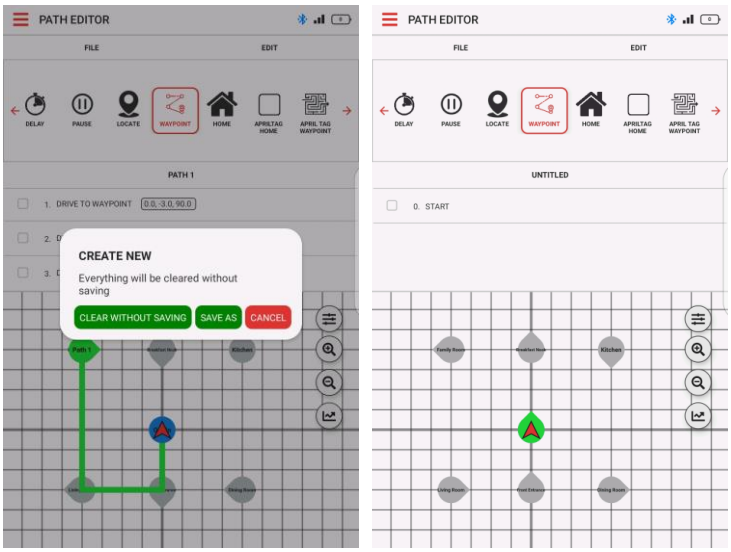
Figure 10-5 Adding Reference Waypoints



To assign a name your Path, click on File to open the File dialog box, then tap Save As. This will open the Save Path dialog. Enter a name. In the example below, we have assigned the name “Path 1”.

10.5 Creating a New Path

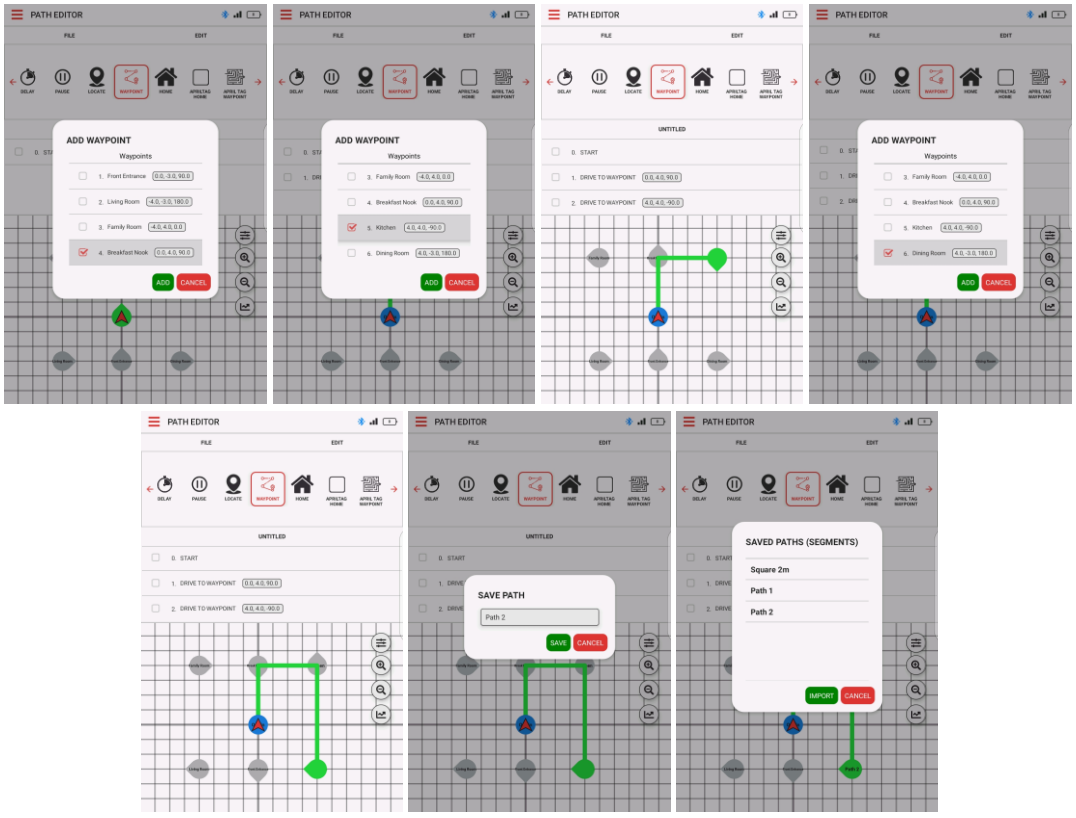
To create an entirely new Path, use File/New. This will open the Create/New dialog, which will warn you that you are about to “clear” the Path. If you have not yet saved changes, this is your opportunity to do so.



CAUTION: Selecting “Clear without saving” will replace the current Path with a blank one without a title.

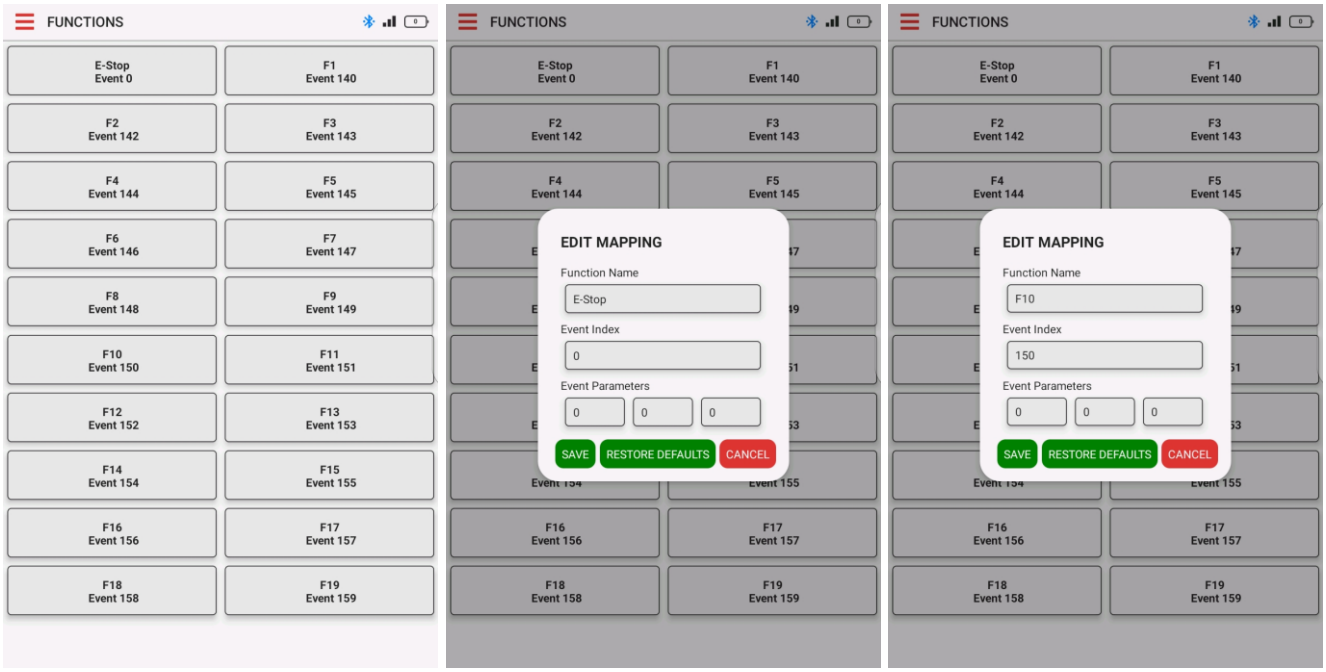
Using the same process, you can add a different set of Reference Waypoints – in a different order – to create a different Path, which we can then save under a new name (“Path 2”).

Figure 10-7 Adding Alternative Reference



11 Functions Screen

Figure 11-1 Functions Screen



The App allows you to activate customized functions within the QBii robot's software though the use of user-defined Event Indices. These are accessed through the Functions Screen.

The Functions Screen consists of an array of 20 buttons that allow you to trigger user-defined Events. The event numbering scheme sends events to the robot from a range of reserved event numbers.

There E-Stop event (Index 0) is a pre-programmed default event.

By clicking or doing a *long press* on any of the function buttons will open the Edit Mapping dialog box. This allows modification of the event, including

- Renaming the button
- Changing the Event Index (proceed with care)
- Setting up to three parameters associated with the Event.

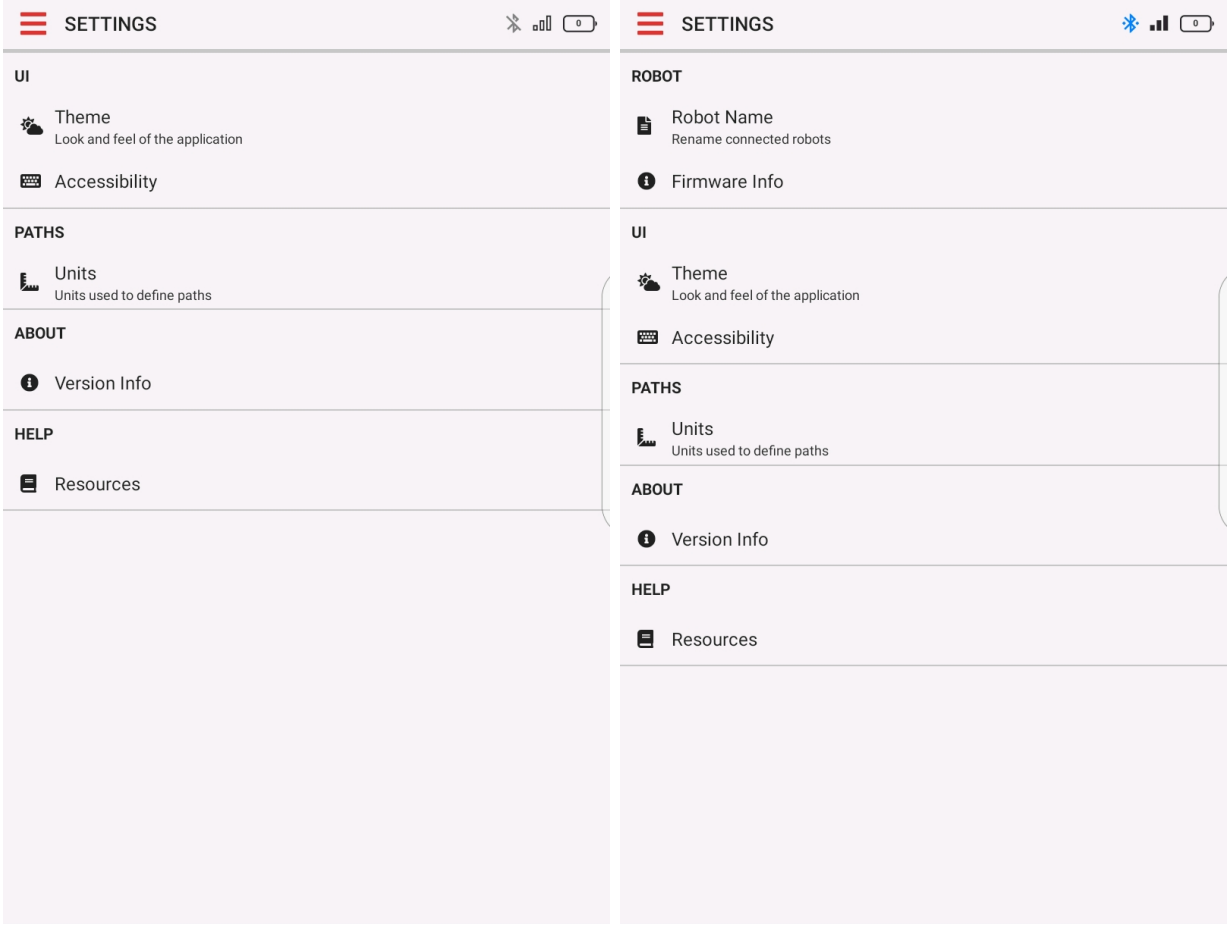
All modifications are saved automatically.

The Event Index numbers reserved for uses ranges between 0 and 255.
Some indexes are reserved for low level functions such as e stop or path data

Modifying beyond the range of 140- 160 is inadvisable as 140 to 160 is reserved for user defined functions. These will be called on the robot side when the button on the app is pressed. Parameters are integers that range between zero and 255, any can be set or left blank

12 Settings Screen

Figure 12-1 Settings Screen

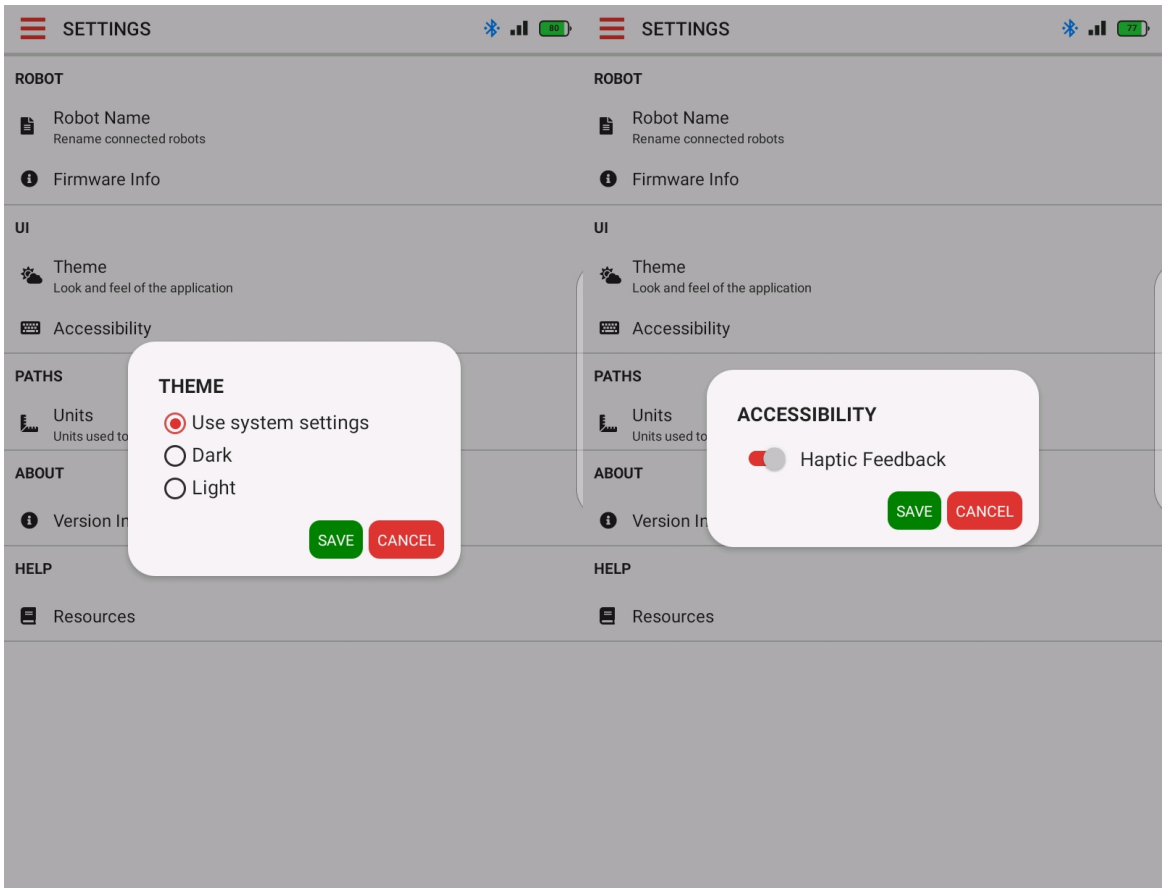


12.1 Disconnected Options

If the App is not connected to a robot, the following options are available:

- UI (User Interface Settings)
  - Theme: By default, the App will use the device theme settings unless otherwise selected. However, the following additional options are offered:
    - Use system settings
    - Dark mode
    - Light mode
  - Accessibility: Haptic feedback toggle (vibration on and off when actions are completed)

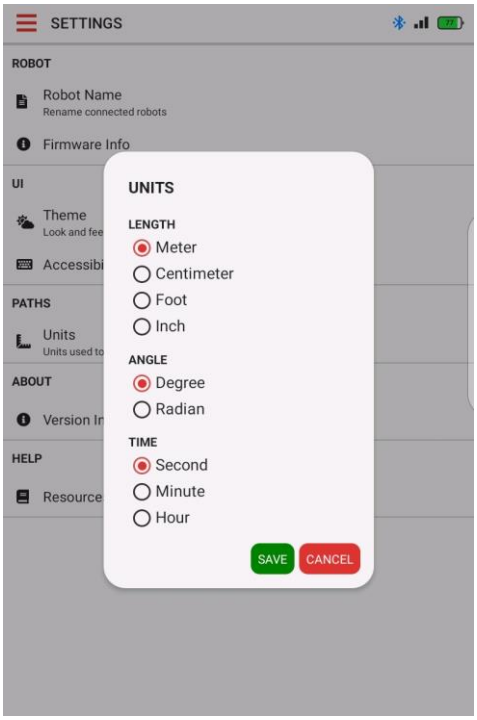
Figure 12-2 Settings Screen: User Interface Settings



- Paths Settings

  - Units: modify units used in the App
    - length: meter, centimetre, foot, inch
    - angle: degree, radian
    - time: second, minute, hour

Figure 12-3 Units



- About

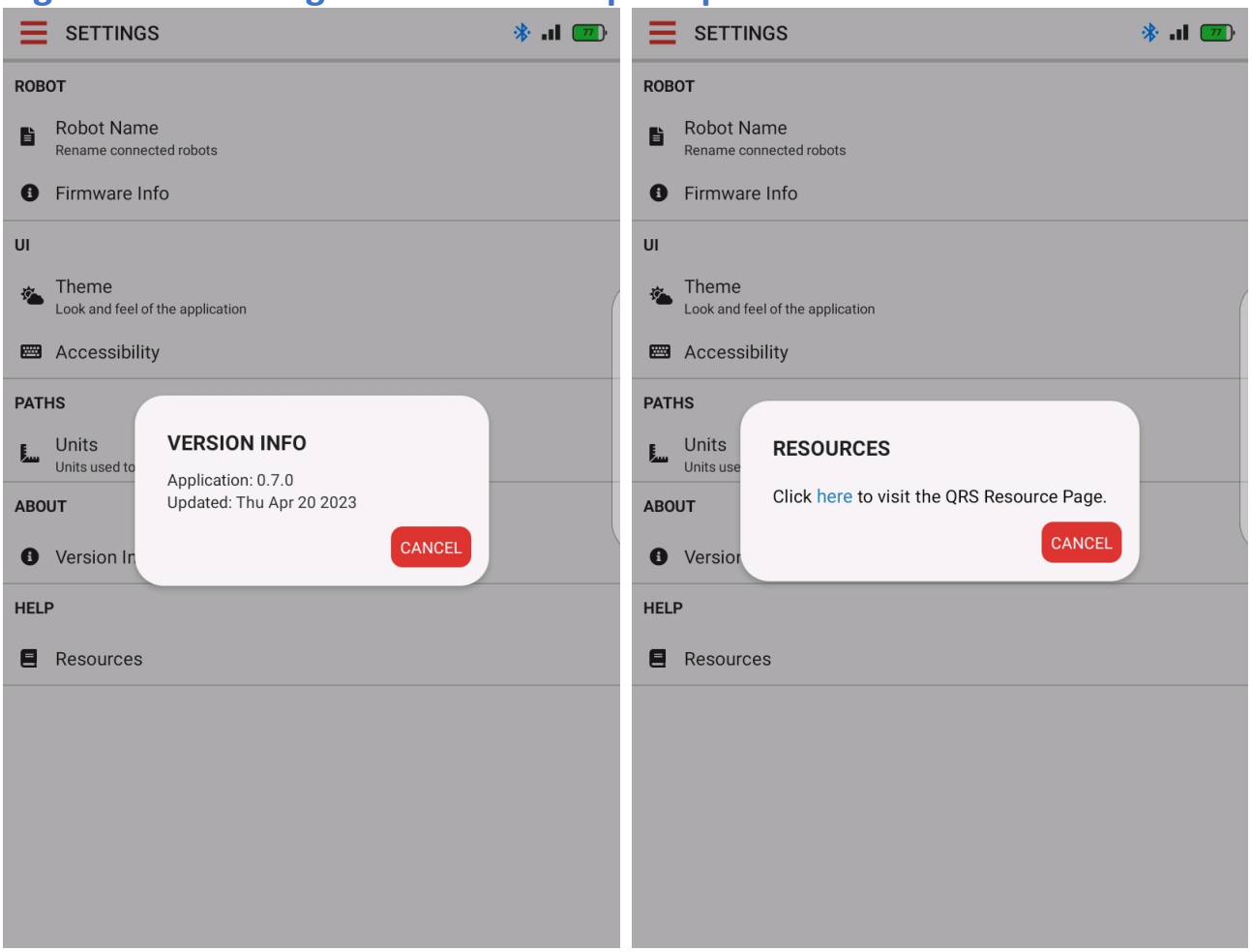
  - Developer Options & Version Information:
    - Application current version and date of last update
    - By clicking on *application version* fives times, it will open developer settings
    - ***Caution***: Developer options store settings used in development and ***should rarely be modified by users.***
    - Currently not functional or should not be modified by end user.
  - Details:
    - *Map Debug* will show the robots current coordinates in the map

    - *Sensor Alert* will disable sensor alert if a sensor is unplugged from the robot - by default toggled on and should be kept on. This is useful for warning if a sensor is not connected and will indicate the robot will not operate properly.
      Caution: Disabling this will risk operating Robot in unsafe condition

    - *Reset Global State* will wipe all your data from the App. ***This is irreversible. All paths and configurations will be removed and should only be used if app data is corrupted or if new version is installed that creates conflict. Can be used to rarely solve crashing issues.***

    - *Map Point Cloud, Map Vector Cloud and Save New Points* are not currently used.

Figure 12-4 Settings Screen: Developer Options and Version Information

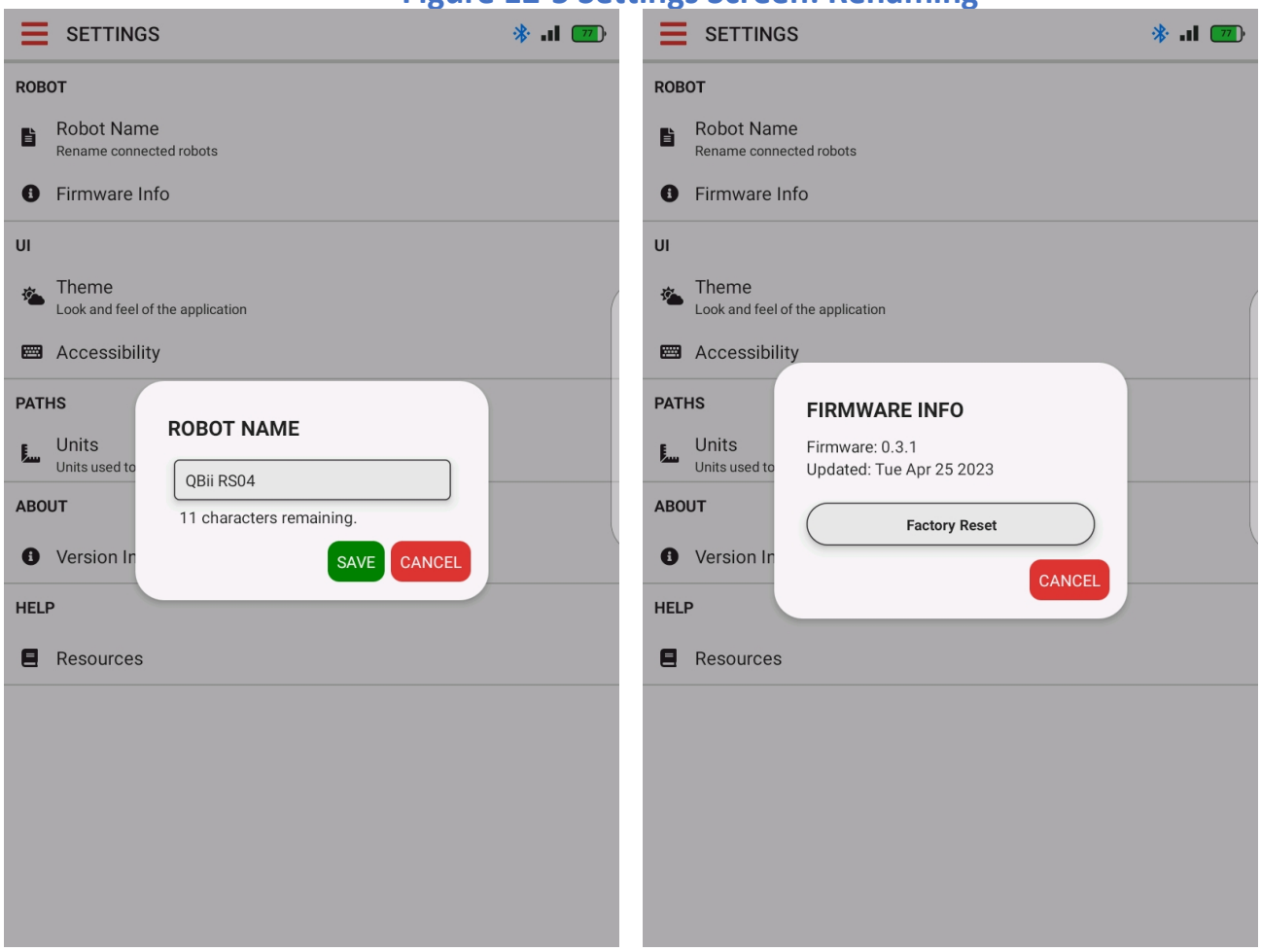


12.2 Connected Options

Once the App is connected to a robot, two new options appear under the “Robot” heading:

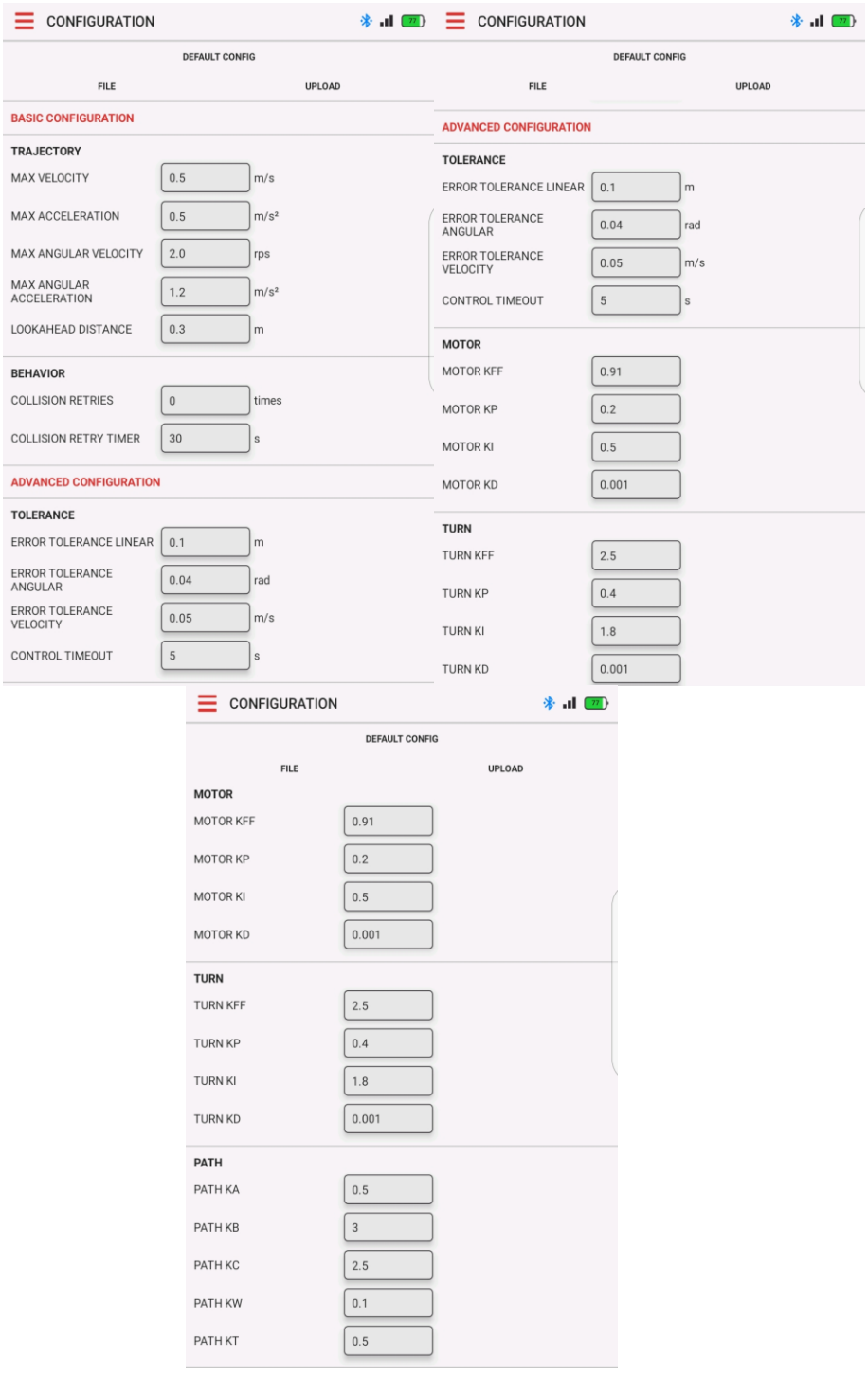
- Robot
    - Rename Robot: An option dialog box creates a text input to rename robot up to 20 characters long
    - Robot Firmware Version: This will display the version of the robot’s firmware currently installed, and the date of update.

Figure 12-5 Settings Screen: Renaming



13 Configuration Screen

Figure 13 Configuration Screen



This Screen allows you to change specific control parameters.

CAUTION: This is reserved for only very advanced users.