

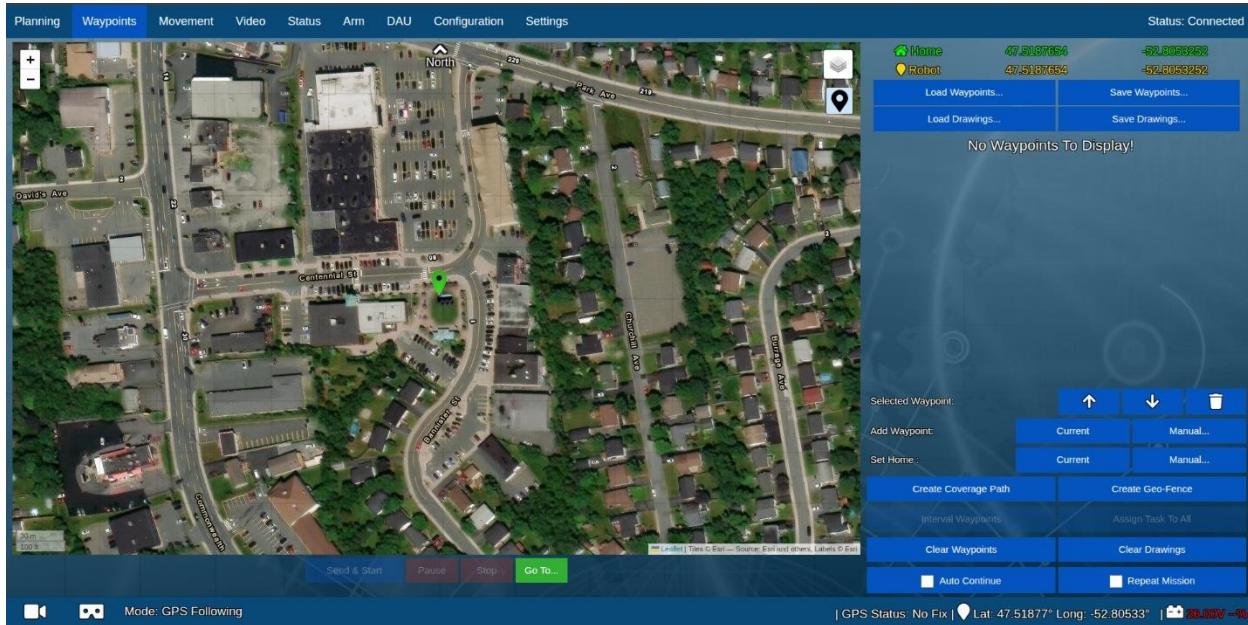
1.0 User Guide

1.1 Nanuk Control Software

The Nanuk Model 200 is a ROS2 based system running on a Linux platform, but all of its functions are intended to be controlled from the Nanuk Control Software deployed on a Mesa Pro tablet. The GUI has eight tabs, each meant for a specific purpose.

1.2 Nanuk Interface

1.2.1 Menu Bars



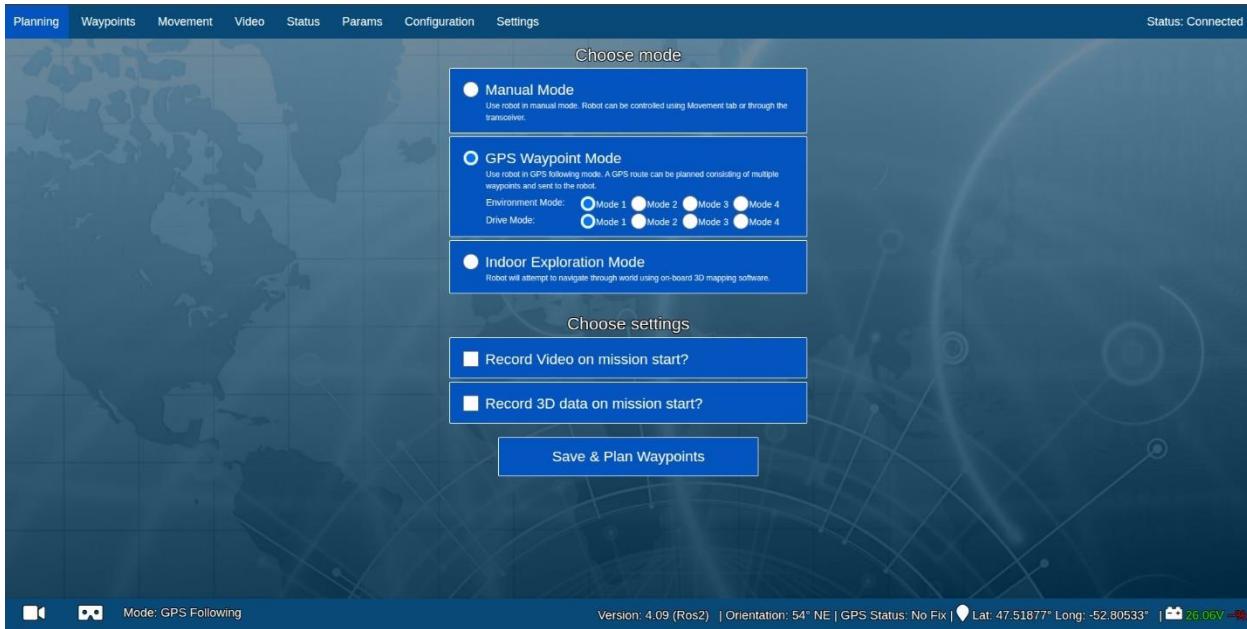
When controlling Nanuk, either manually or in an autonomous mode, there are some key pieces of information that the user always needs to be aware of. In the top right section of the GUI, there is a connection Status. Once connected to the UGV, this menu should stay blue and the label should say Status: Connected. If the tablet loses connection to the UGV, the menu will turn red and report the connectivity problem.

The bottom menubar reports several key pieces of information:

- Video Status - the video icon will turn green when 1080p 30fps video is being saved locally on the UGV. You can also click on the icon to toggle video recording on or off.
- PointCloud Status - the icon next to the video icon will turn green when PointCloud data is being saved locally on the UGV. You can also click on the icon to toggle PointCloud data saving on or off.

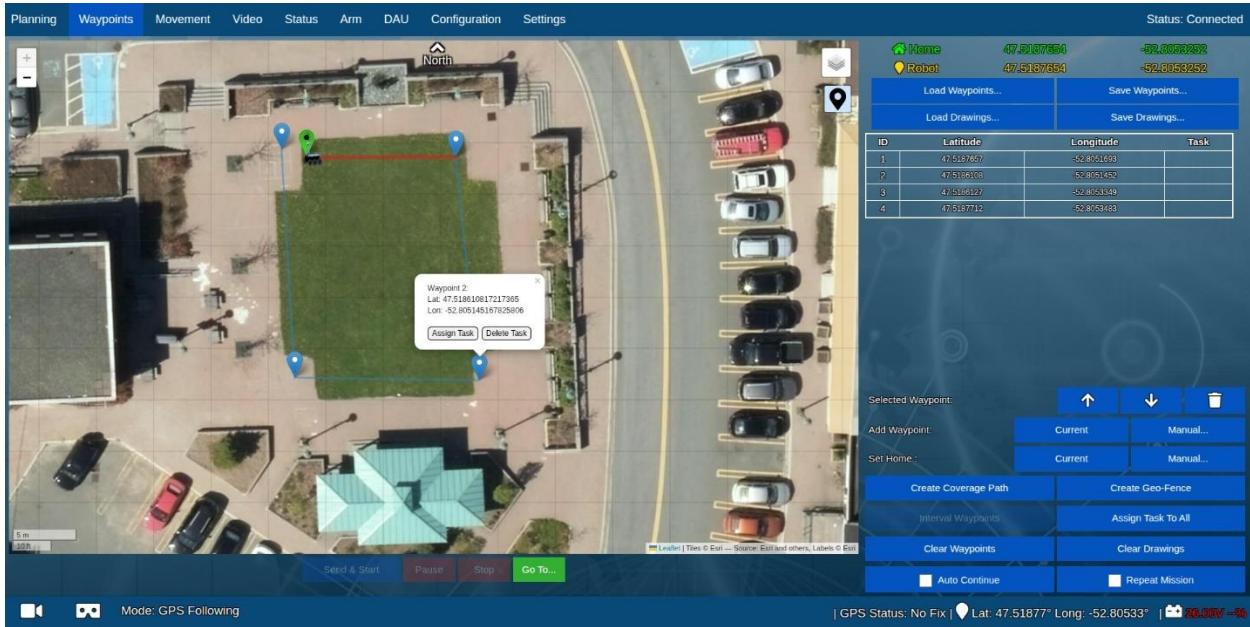
- Mode - There are three modes that the UGV can be operated in, Manual, GPS Following and Full Autonomous. The mode that the UGV is currently operating in will be displayed to the right of the PointCloud status icon.
- GPS Status - The GPS fix type currently being used to determine the coordinates of the UGV.
- GPS Coordinates - The current GPS coordinates being reported by the UGV are displayed.
- Battery Status - The present state of the UGV's LiPo battery is displayed in the lower left corner. This is shown as a voltage and percentage of total capacity.

1.2.2 Planning Tab



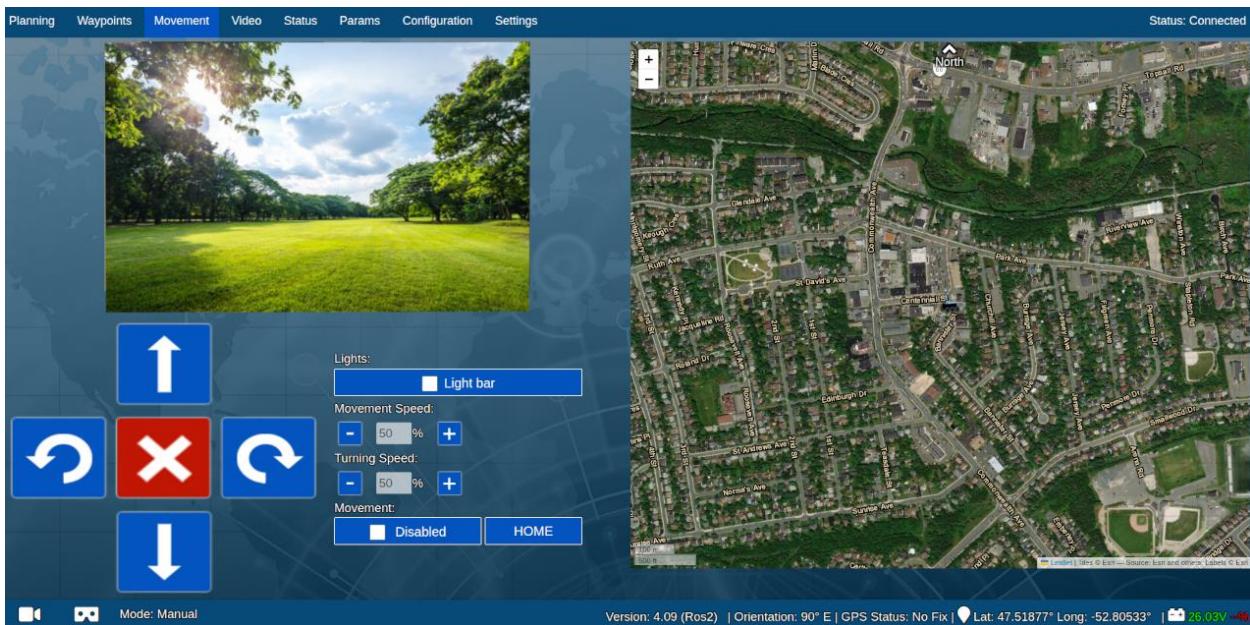
The Planning tab allows the user to choose which operational mode they want to use and whether or not they would like to record Video and/or 3D PointCloud Data.

1.2.3 Waypoints Tab



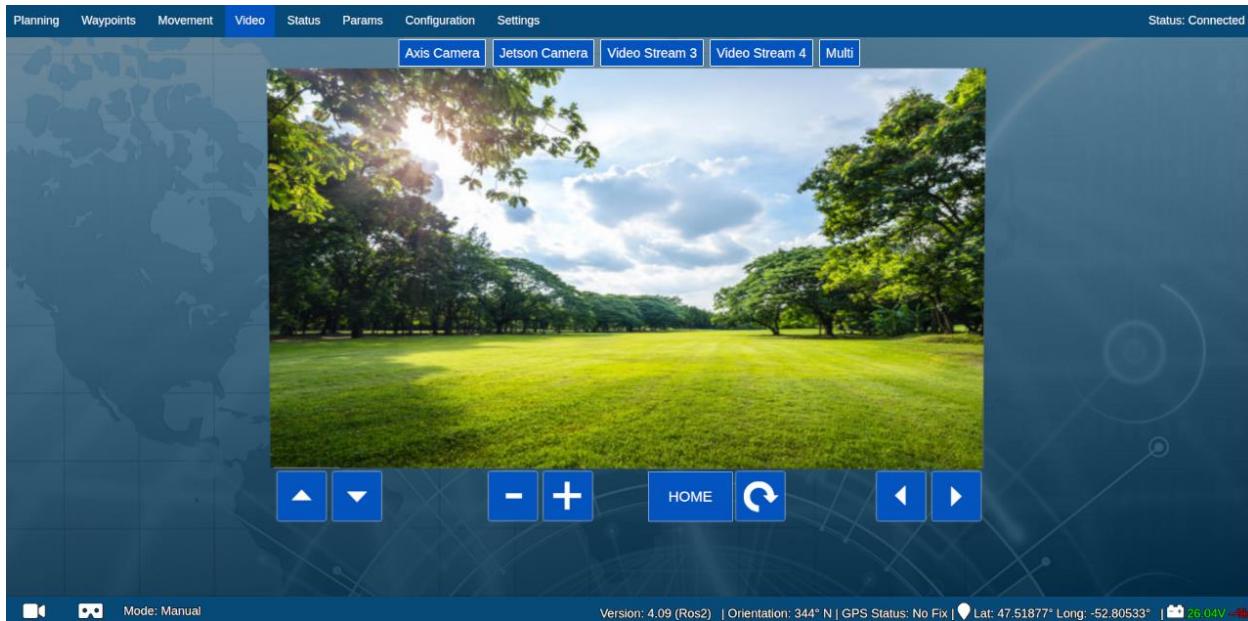
The Waypoints tab allows the user to configure the GPS Waypoints that they would like Nanuk to autonomously navigate to in GPS Following Mode. The waypoints can be typed in manually, chosen from the map, or generated by drawing polygon shapes. When the waypoints have been chosen, they can be saved or previously saved waypoint lists can be loaded. This screen also allows the user to start, stop and pause missions all while tracking Nanuks position on the map.

1.2.4 Movement Tab

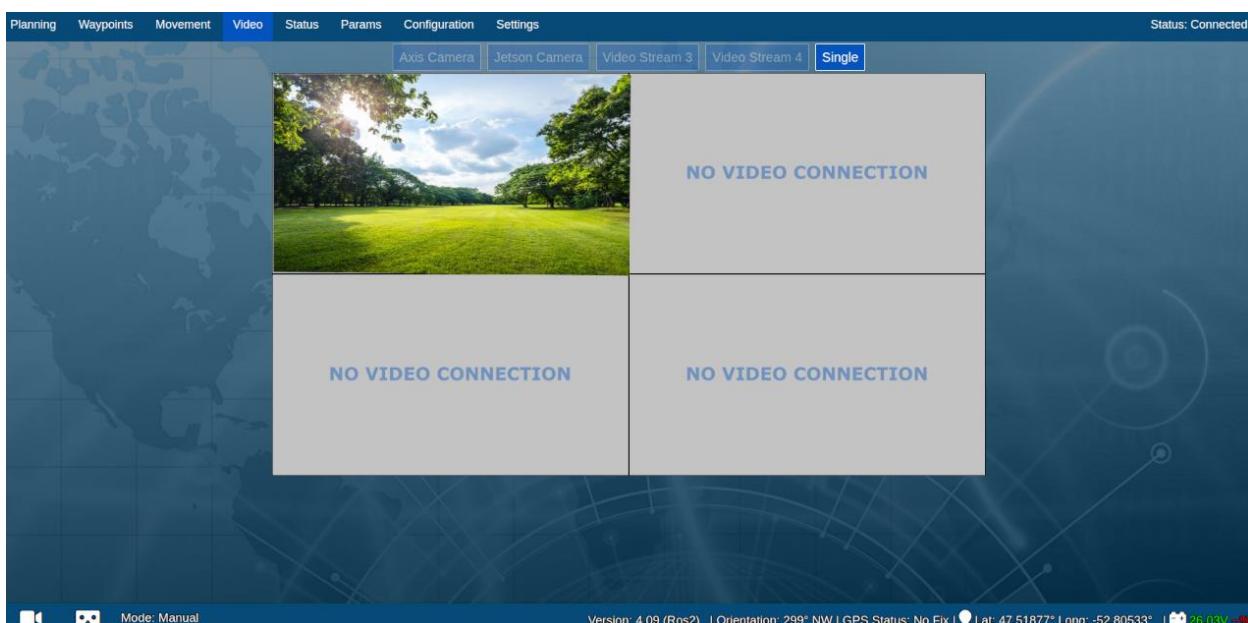


The Movement tab allows the user to control Nanuk using the on-screen arrows to drive the robot forward, backwards or turn, all while seeing the UGVs position on the map and the video stream from the Axis camera on the UGV. The user can also activate the light bar and adjust the UGVs speed settings.

1.2.5 Video Tab



The Video tab allows the user to view the live video feed from all cameras on the robot, including the Axis, Jetson, and RealSense cameras. The user can also use the controls below the video to pan, tilt and zoom the camera. Pressing the Home button will reset the camera to a position pointing straight forward with no zoom applied.



All video feeds can be toggled or viewed at the same time by pressing the Multi button.

1.2.6 Status Tab

The Status tab displays various system metrics. At the top right, it shows "Status: Connected". On the left, there's a world map. The right side contains several sections of text:

- Robot Coordinates:**
 - Latitude: 47.51877°
 - Longitude: -52.80533°
 - Altitude: 4 feet
- Battery:**
 - Voltage: 26.06V
 - Capacity: -%
- Orientation:** 352° N
- Disk Space:**

OS	Total	Free	Remaining
OS	53.86 GB	9.06 GB	17%
VIDEO	190.06 GB	180.34 GB	95%
LIDAR	668.75 GB	495.60 GB	74%
- Version:** 4.09 (Ros2)

At the bottom, it says "Mode: Manual" and "Version: 4.09 (Ros2) | Orientation: 352° N | GPS Status: No Fix | Lat: 47.51877° Long: -52.80533° | 26.06V -%".

The Status tab allows the user to view additional telemetry from Nanuk. The information listed includes the Battery status, GPS coordinates and altitude, Orientation and the storage used and available on the various drives/partitions on the UGV.

1.2.7 Arm Tab

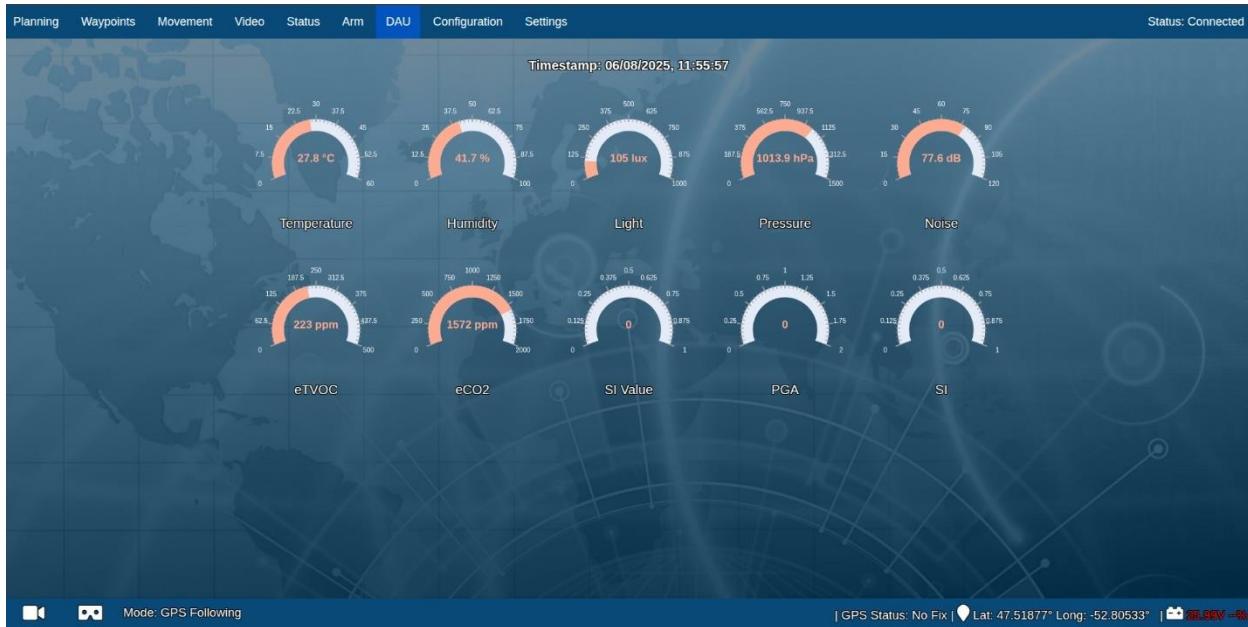
The Arm tab displays arm-related information. At the top right, it shows "Status: Connected". On the left, there's a world map. The right side contains several sections of text:

- Status & Health:**
 - Connected: True
 - Arm Ready: False
 - State: Stopped
 - Mode: Position
- Errors & Warnings:**
 - Error Status: Normal
 - Warning Code: Normal
- Motion:**
 - Speed Percent: 1%
 - Acceleration Percent: 0.1%
 - Position Step: 1mm
- Position:**
 - Joint Pose: J1: 0
 - J2: -0.4
 - J3: 0.3
 - J4: 0
 - J5: -0.1
 - J6: 0
 - TCP Pose: X: 142.8
 - Y: -2.3
 - Z: 63.5
 - Rx: -180
 - Ry: 0.8
 - Rz: 0

At the bottom, it says "Mode: GPS Following" and "GPS Status: No Fix | Lat: 47.51877° Long: -52.80533° | 26.06V -%".

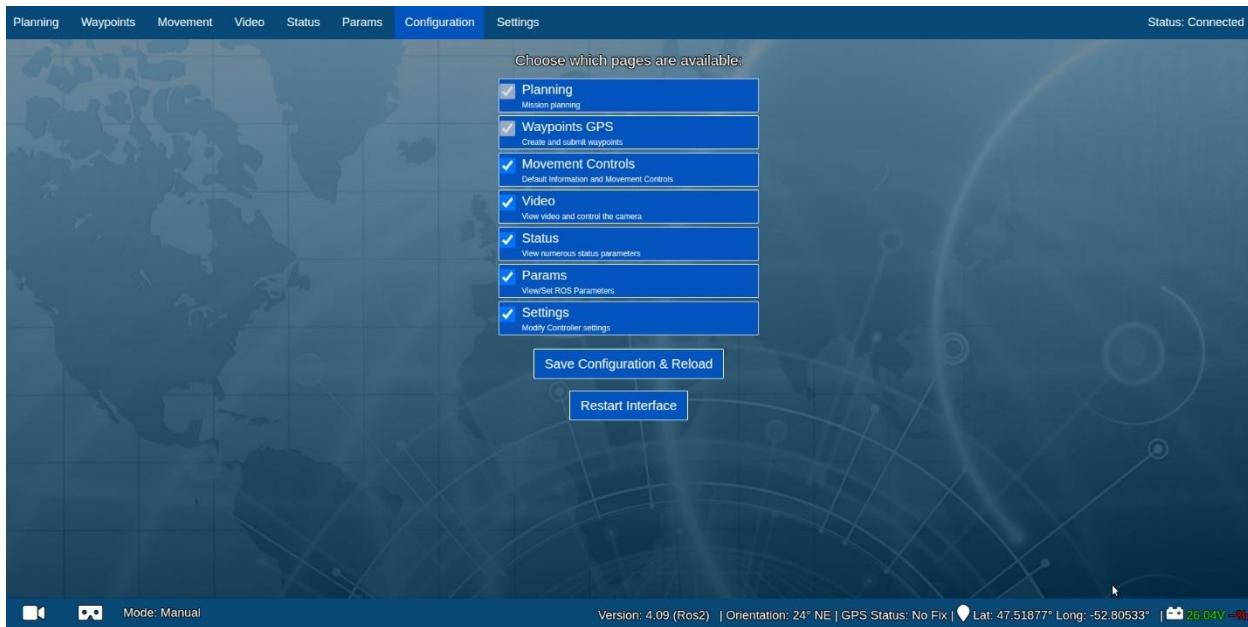
The Arm tab allows the user to view the status and metrics of the uFactory xArm when the arm is connected to the robot. The user can also enable and disable movement of the arm.

1.2.8 DAU Tab



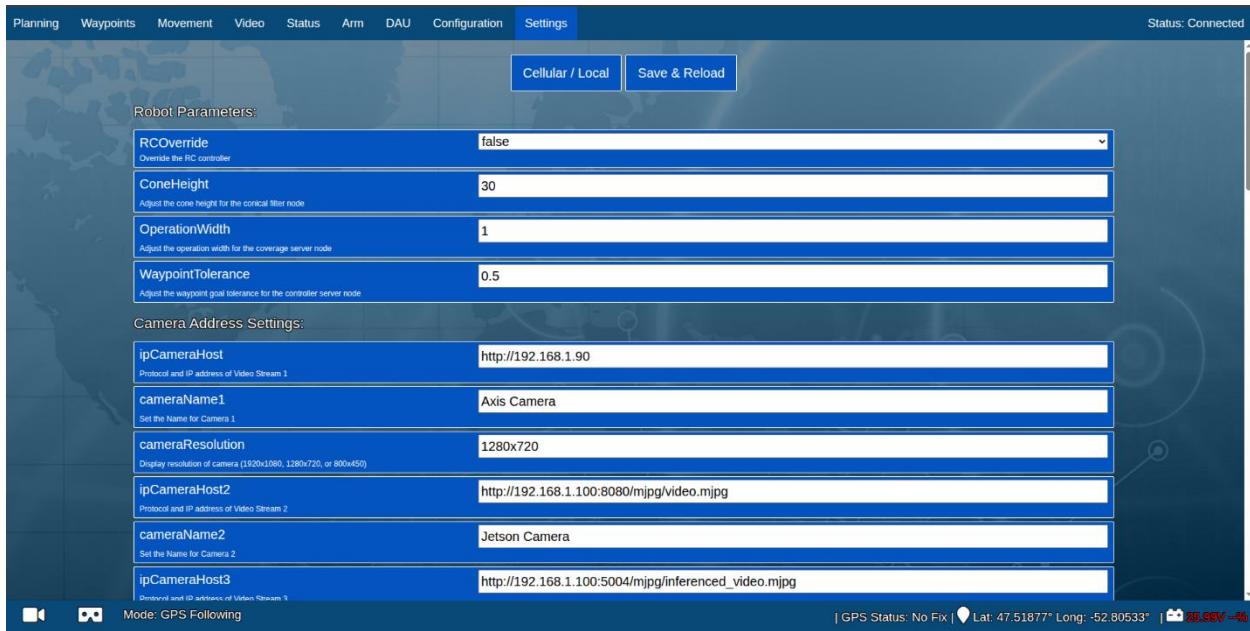
The DAU tab allows the user to view all metrics received from the DAU while the DAU is turned on and connected.

1.2.9 Configuration Tab



The configuration tab allows the user to choose which tabs are visible in the GUI.

1.2.10 Settings Tab



The Settings tab allows the user to change settings relating to every aspect of the GUI, from the camera IP address, video resolution, the maximum speed settings of the motors, and so on. It is recommended that users DO NOT make changes to this tab. Changing values could cause the Nanuk Control software to stop communicating with the UGV. We recommend turning this tab off from the Configuration tab to ensure settings are not changed inadvertently. Robot parameters can also be adjusted here, affecting how the robot will perform. These parameters include:

- RC Override - Overrides the RC controller, allowing the GUI to set the motor controller to Manual or Autonomous mode.
- Cone Height - Adjusts the Cone Height in the conical_filter_node. This setting influences what Nanuk considers an obstacle. A higher value causes Nanuk to ignore more potential obstacles.
- Operation Wide – Adjusts the distance, in meters, between each path in the coverage pattern.
- Waypoint Tolerance - Adjusts the radius around a waypoint that determines when it is considered reached. A larger value allows the waypoint to be marked as reached from a greater distance.

1.3 Nanuk Startup

The Nanuk system is comprised of the Nanuk UGV and Handheld controller. For optimal performance it is recommended to follow this procedure when initializing the system.

- If not already installed, plug a charged 92 AHr battery pack into the Nanuk.
- Using the switch on the back, power on the UGV. Verify that the green LED illuminates.
- Power ON the RC controller, ensure that the mode switch is in the manual position.
- Power on the Mesa pro tablet and login using the pin number 7457914.
- Connect to the Nanuk_CellBaseStation WiFi, this should occur automatically. It may take a couple of minutes. Verify that it connects.
- If the Nanuk GUI is not already launched, launch it from the shortcut pinned to the task-bar on the bottom of the screen (Nanuk Icon).
- The status of the connection is indicated in the top right corner. The GUI will automatically connect once connection has been established.

1.3.1 Operation – Manual Mode

An operator can manually drive Nanuk using a long-range RC Transmitter connected to its matching RC Receiver on-board the Nanuk. Alternatively, an operator can control Nanuk using the Nanuk Control Software running on a tablet connected to the Nanuk via a long-range wireless modem or cellular connection.

1.3.1.1 RC Transmitter Control

The Nanuk Model 200 can be operated manually with the use of an RC Transmitter. There are numerous controls on the transmitter, but the UGV only uses three of them.



- Mode Switch - This switch has three positions, AUTO (Autonomous Mode), CAM (Camera Control Mode) and MAN (Manual Mode). This switch is important because if the user wants to override the UGV's movement while in an autonomous mode, the switch will need to be placed in the MAN position first. When the switch is moved to this position, the UGV will immediately stop and await commands from the transmitter. While in the AUTO position, the joystick has no control of the UGV. The CAM position allows the user to pan, tilt and zoom the camera on the UGV.
- UGV/Camera Movement (Right Joystick) - When the mode switch is in MAN, deflecting this joystick moves the UGV. Deflecting up moves the UGV forward, deflecting it down move the UGV backwards, deflecting it left or right, turns the UGV in that direction. This is an analog control, meaning that the further the joystick is deflected, the faster the UGV will move. If the mode switch is in the CAM position, deflecting the joystick up and down will tilt the camera and deflecting it left and right will pan the camera.

- Camera Zoom - This dial zooms the camera in and out as you rotate the dial if the mode switch is in the CAM position.

The user will have a 1km range, Line Of Sight (LOS), between the transmitter and the UGV. The RC Transmitters antenna is directional and therefore needs to be pointed in the general direction of the UGV.

1.3.1.2 Nanuk GUI Control

The Nanuk can be operated manually with the use of the Nanuk GUI when used in conjunction with the WiFi network or cellular connection.

- Verify the Nanuk is in Manual mode by checking the bottom left corner.
- If it is not in Manual Mode:
 - Select the Planning page.
 - Select Manual Mode.
 - Select Save and Connect.
- Select the Movement Tab.
- Unlock the movement controls by unchecking the Disabled check-box.
- Using the movement arrows, slowly move the robot forward, then backwards and then rotate in place.
- The front facing lights can be activated by clicking the Light bar check-box. Verify that it illuminates.

1.3.2 Operation – GPS Following Mode

The Nanuk can be operated in a GPS Following Mode. This means that before going out into the field, you can use the GUI to plan GPS waypoints that can be sent to the Nanuk. Alternatively, the user can use the UGV to manually plot out the waypoints once in the field. Assuming the UGV, Base Station, RC Transmitter and Windows tablet are powered on and connected, follow these steps to plan and start a GPS Following mission.

1.3.2.1 Waypoint Missions

- Verify the Nanuk is in GPS Following mode by checking the bottom left corner.
- If it is not in GPS Mode:
 - Select the Planning page.
 - Select GPS Waypoint Mode.
 - Select Save and Connect.
- Verify that the mode switch on the RC Transmitter is in the Manual position.
- Open the Waypoints tab on the tablet.
- Set the home coordinates of the robot in one of two ways:

- By using the right joystick of the RC Transmitter to move the UGV to the desired home position and then clicking the Set Home Current button.
 - By clicking the Manual button by Set Home and typing in the coordinates.
- Add a GPS waypoint in one of three ways:
 - By clicking the Manual button by Add Waypoint and typing in the coordinates.
 - By clicking on the location on the map.
 - By using the right joystick of the RC Transmitter to move the UGV to a desired GPS goal and then clicking the Current Button by Add Waypoint.
- The GPS coordinates will be added to the waypoint list.
- Repeat to add as many waypoints as desired to the list.
- Individual waypoints can be moved up and down in order or deleted, by clicking a waypoint on the list and using the Arrows and Trash can buttons. Click Clear Waypoints to remove all current waypoints.
- Use the right joystick of the controller to move the UGV to the desired start position.
- Click the Send and Start button and wait for acknowledgment from the robot.
- Click Yes.
- On the controller, move the mode switch to the Auto position.
- Confirm that the UGV navigates to the GPS coordinate. When it reaches the goal, a message will appear. Click Go to Next Goal. In the bottom right there is an “Auto Continue” checkbox. This can be toggled at any point of the mission. If this is checked the Nanuk will continue to the next waypoint without user confirmation.
- Repeat the process for subsequent goals or choose Go Home to return the UGV to its Home coordinates.
- The user can click Pause or Stop Mission at any time to plan another mission or to use the Nanuk in manual mode.
- There is a “Repeat Mission” check box in the low right corner. If this is checked, once the robot reaches its home position and completes the mission it will begin the same mission again. It will continue the mission until the box is unchecked or the mission is aborted.
- To save a mission for reuse in the future:
 - Click the Save Waypoints button.
 - Give your mission a name.
 - Click Save.
- To load a previously saved mission:
 - Click Load Waypoints.
 - Select Desired mission.

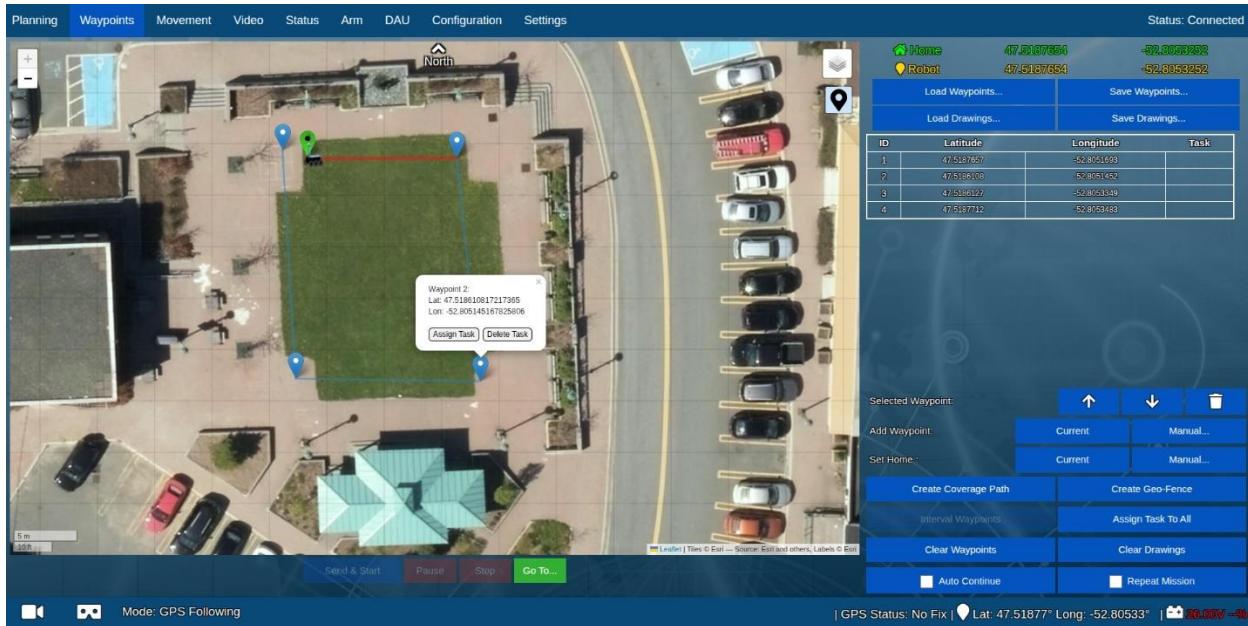
- Click Load.

1.3.2.2 Task Assignment

Different tasks can be completed by the Nanuk using the uFactory robot arm. The robot arm is mounted to the Nanuk's chassis and is connected to the robot via the Nanuk_CellBaseStation network. Tasks can be assigned to waypoints and will be carried out during the mission. To assign a task using the following procedure:

Assuming the Nanuk, RC transmitter and tablet are turned on and connected and the robot arm is mounted onto the Nanuk.

- Open the waypoints tab on the tablet.
- Create waypoints using the previous procedure (1.3.2.1 Waypoint Missions).
- Assign a task to a waypoint in one of three ways:
 - Map - Click on a created waypoint on the map and click assign task.
 - List – Click on a created waypoint from the waypoint list on the right-hand side and click assign task.
 - Assign Task To All – Click the Assign Task to All button on the right hand side. This will assign the task to all created waypoints.



- Choose a task from the dropdown menu and click submit.
- Once a task is assigned to a waypoint it will be labeled in the waypoint list on the right-hand side.

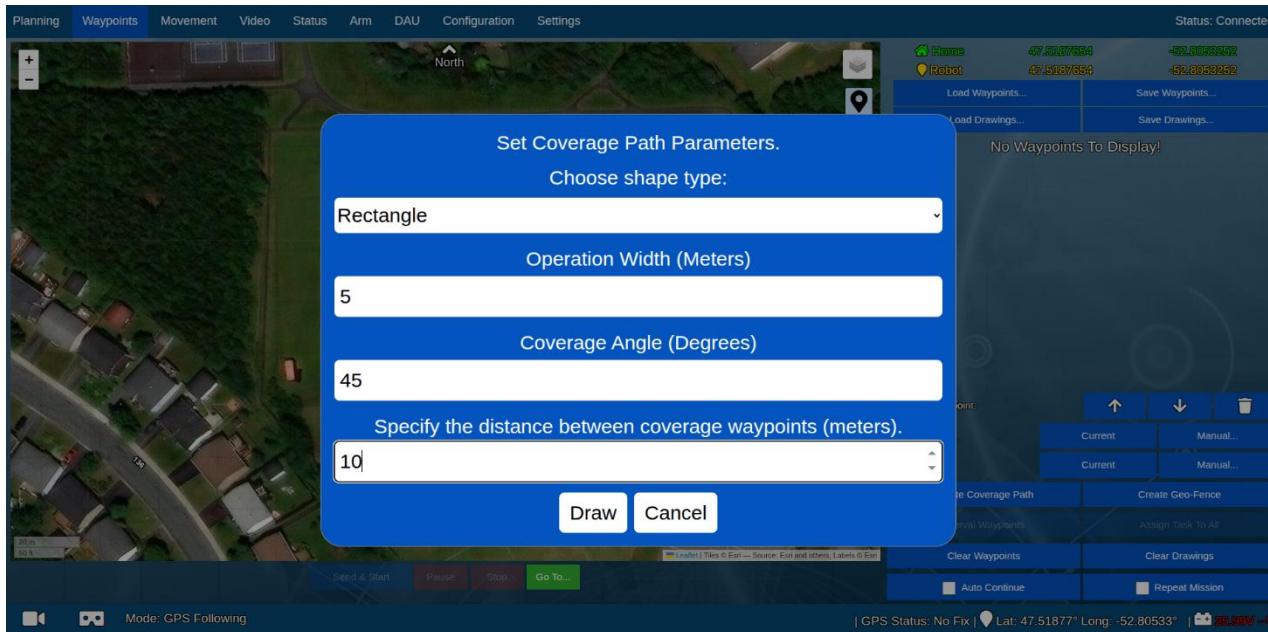
- Once all desired tasks have been assigned, click the Send & Start button and continue out a normal Waypoint mission from section (1.3.2.1 Waypoint Missions).

1.3.2.3 Coverage Path

The Nanuk can perform sweeping coverage of large areas by allowing users to draw polygon shapes directly on the map. The angle and spacing between each sweep row can be fully customized.

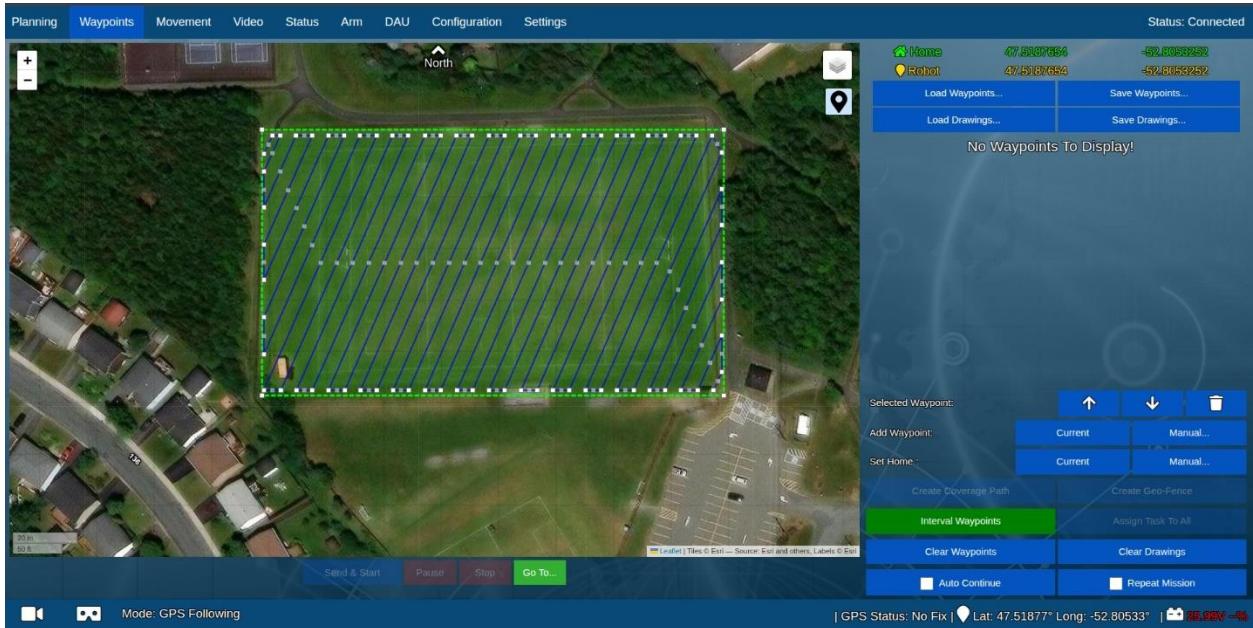
Assuming the Nanuk, RC transmitter and tablet are all turned on and connected, follow this procedure.

- Open the waypoints tab on the tablet.
- Verify the Nanuk is in GPS Following mode by checking the bottom left corner.
- If it is not in GPS Mode:
 - Select the Planning page.
 - Select GPS Waypoint Mode.
 - Select Save and Connect.
- Click the Create Coverage Path button.
- In the popup menu, select your desired drawing pattern shape, the Operation width (distance between each path), the coverage angle (angle of each path), and the distance between waypoints.

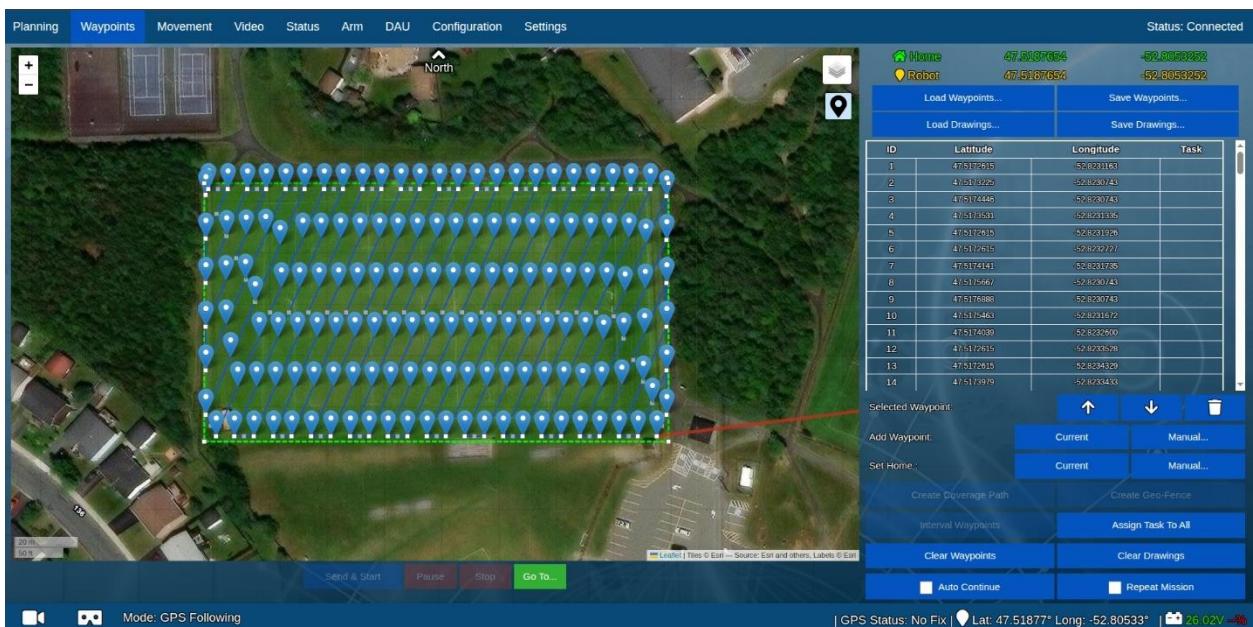


- Click Draw.

- On the map, draw your desired polygon. This will be the area used for the coverage sweeping pattern. The shape can be dragged, edited and rotated directly on the map
- When satisfied with your drawing, Click the green Submit Coverage Path button.
- Wait for the coverage paths to be generated. This may take some time depending on the size of your shape and operation width.



- Once the paths are generated, they can me adjusted manually on the map if desired.
- Click the Interval Waypoints button to generate waypoints along the paths are your set distance.



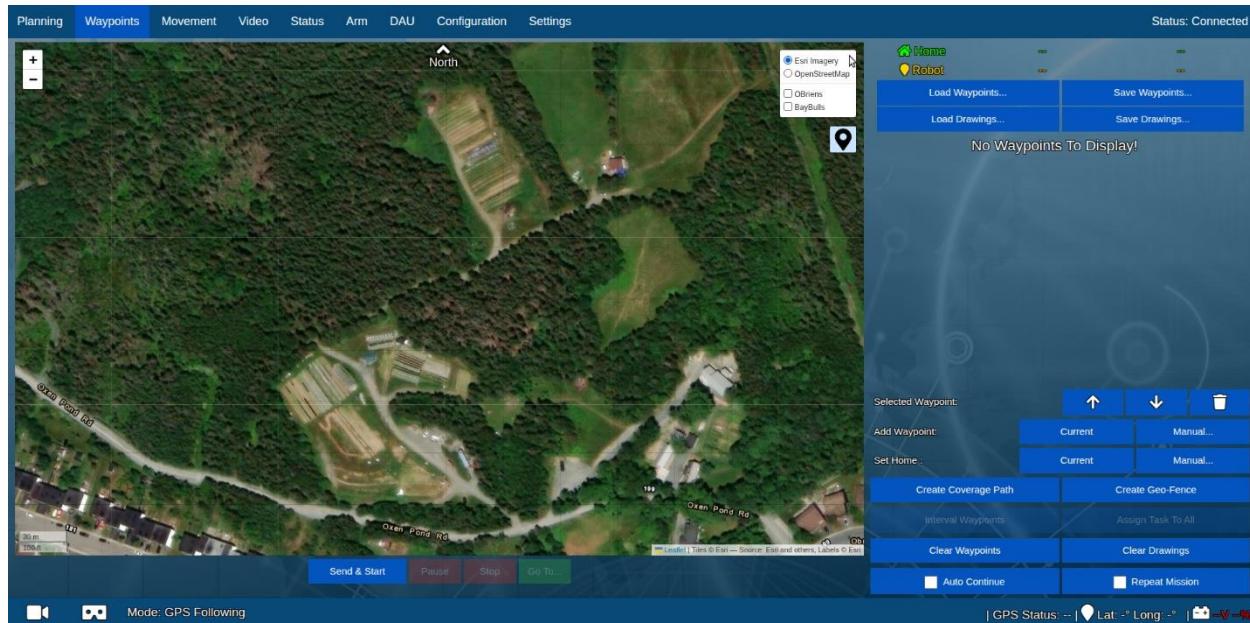
- The Nanuk GUI will generate equally spread-out waypoints along the path. Tasks can then be assigned using procedure (1.3.2.2 Assigning Tasks).
- Click Send & Start and continue with normal mission procedure (1.3.2.1 Waypoint Missions).

1.3.3 Operation – Image Overlay

The Nanuk GUI allows users to overlay geo-referenced images on the map, providing improved accuracy and access to more up-to-date imagery. The image must be .tif format for the GUI to extract the coordinates.

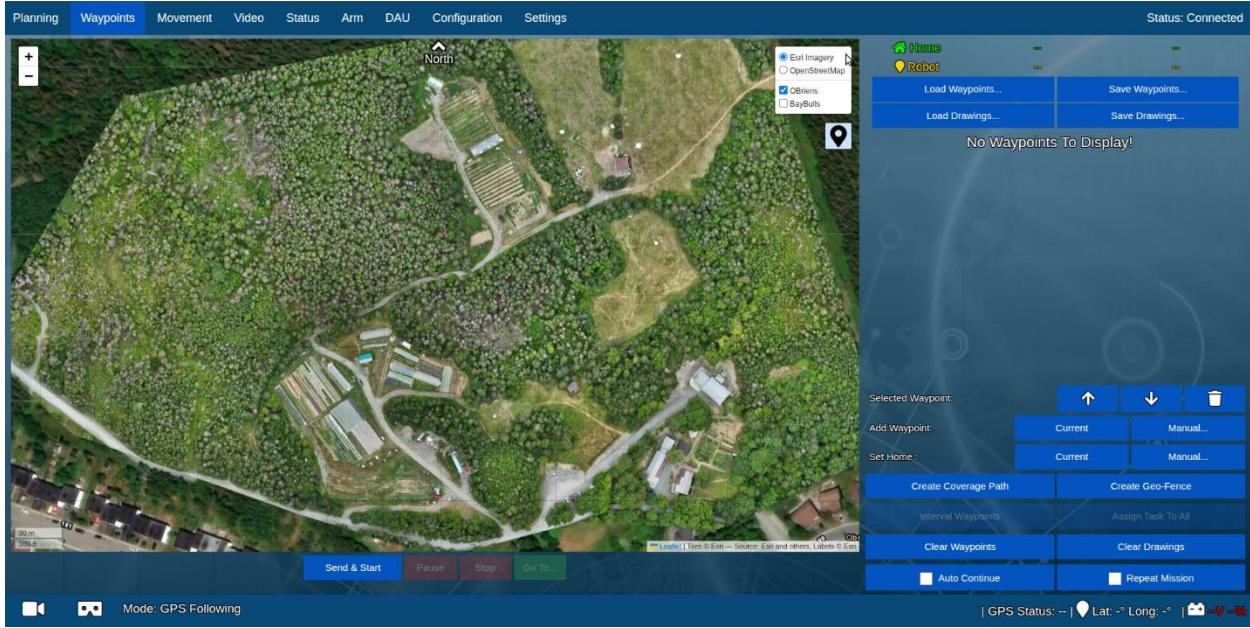
Assuming the Nanuk, RC transmitter and tablet are turned on and connected:

- Using a thumb drive or other method, upload a .tif image onto the Mesa Pro tablet.
- Using the tablets file system, place the .tif image into the C:\\Robot\\OverlayImages\\ directory. This will automatically extract the coordinates and convert the .tif into a png file. This may take some time.
- Navigate to the Nanuk GUI using the Task Bar at the bottom of the tablet.
- Open the waypoints tab on the GUI.
- Click the layer icon in the top right corner of the map. This can be used to toggle between satellite and open street maps. Below these two options will be checkboxes for each .tif files placed in the above directory.



- Select the checkbox for the desired overlay image.

- On the map, zoom out and pan to the overlay coordinates. The image will be placed on the map. This can be toggled on and off by the checkbox.



- Zoom in on the overlay image. Normal Waypoint or Coverage path missions can be used on top of the more accurate and detailed image.

1.4 Retrieving Data from the UGV

The Nanuk GUI gives the user the option to start and stop recording at any time, and in any mode. This data is all saved locally on the UGV. There are shortcuts on the tablets desktop to allow the user to see the files when the tablet is connected to the UGV. The 2D map and optionally the video files can be copied to the tablet using these shortcuts, but some of these files are very large, especially the PointCloud .bag files. There is however, an external Ethernet port on Nanuk. This port can be used to connect a laptop to the UGV using a standard Ethernet cable. Once connected, open an Explorer window and to the \\192.168.1.89 IP address. There will be three Samba shares viewable to the user.

The user can copy, move or delete the files from these shares. The user does NOT have access to any ROS files from these shares.