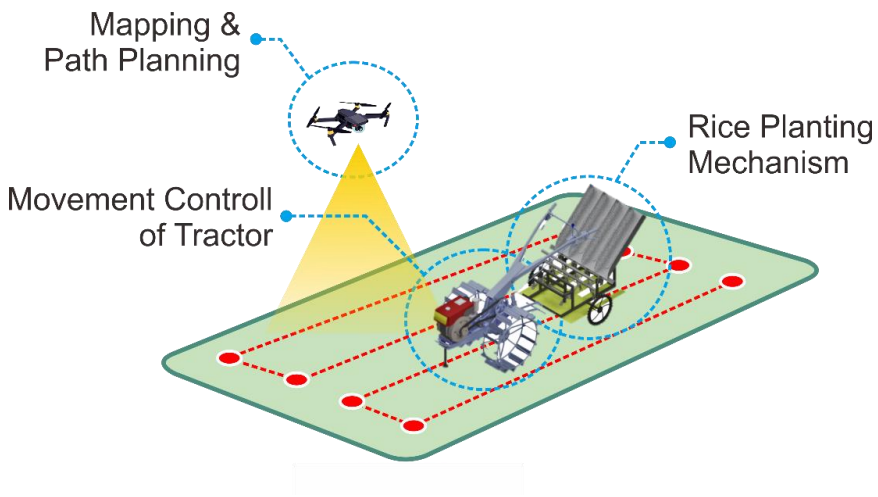
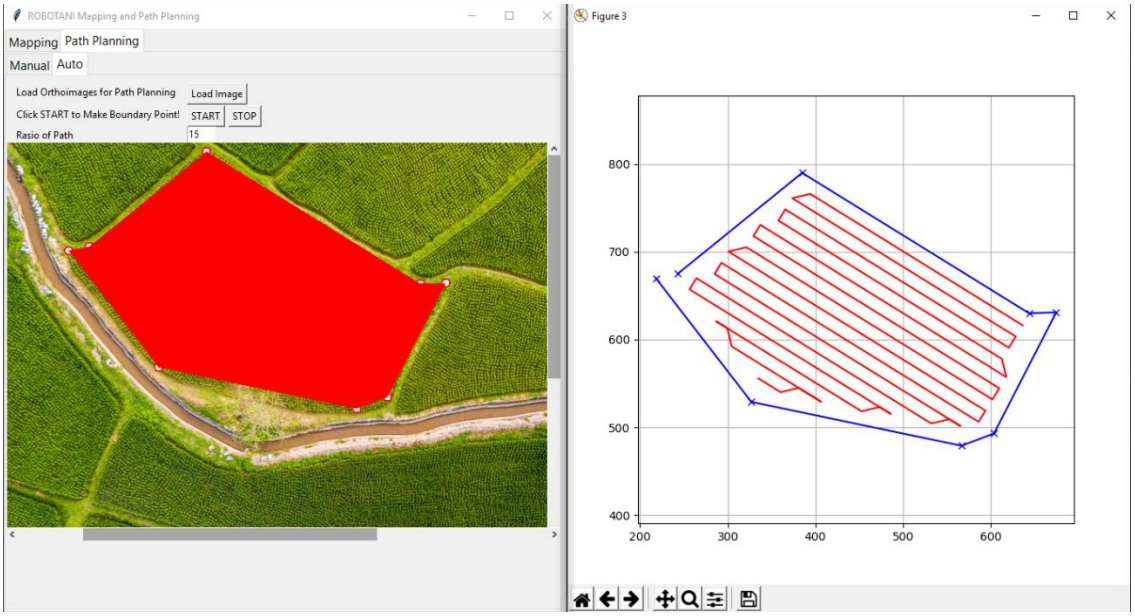
ROBOTANI : MAPPING AND PATH PLANNING SOFTWARE OPERATION MANUAL



---------- CONTENT ----------

1. INTRODUCTION

ROBOTANI : Planting Path Planning and Mapping System Software is a software system used to manage image and location data that have been obtained from aerial data collection on agricultural land. The output of this software is a high-resolution map image along with GPS-based location and planting path in the form of coordinates based on GPS location.



2. SPECIFICATION

2.1. Hardware Specification :

Flight Controller	Ardupilot Mega (APM) 2.8
- Dimension	70 x 45 x 13 (mm)
- Weight	28 gram
- Microcontroller	ATMEGA 2560 and ATMEGA 32U-2
- Additional Sensor	3-axis gyroscope, Accelerometer, Barometer
Receiver	Flysky FS-iA6
Remote Control	Flysky FS-i6
GPS & Compass	UBLOX 7M
Communication	Radio Telemetry 3DR 433 MHz
Camera	Xiaomi Yi Action Cam
- Dimension	6.08 x 4.56 x 10.9 (mm)
- Focal Length	2.73 mm +-5%; 155o wide angle
- Sensor Resolution	4608 x 3456 pixel

2.2. Server Minimum Specification :

OS	Windows 7 or Ubuntu 14.0
Processor	Intel Core i3
Memory	2 GB
Cache	512 KB
VGA	1 GB
HDD	500 GB
Monitor	14”
Min. Resolution	1366 x 768

2.3. Support Software :

Windows	Docker-Toolbox
	Oracle VM VirtualBox
	Kinematic Alpha
	Git Bash
	Visual Studio Code
Linux	Docker
	Terminal
	Visual Studio Code

2.4. System Specification :

Data Collecting	Height Flight	15 m
	Range	2 ha
Communication	Range	1,5 km

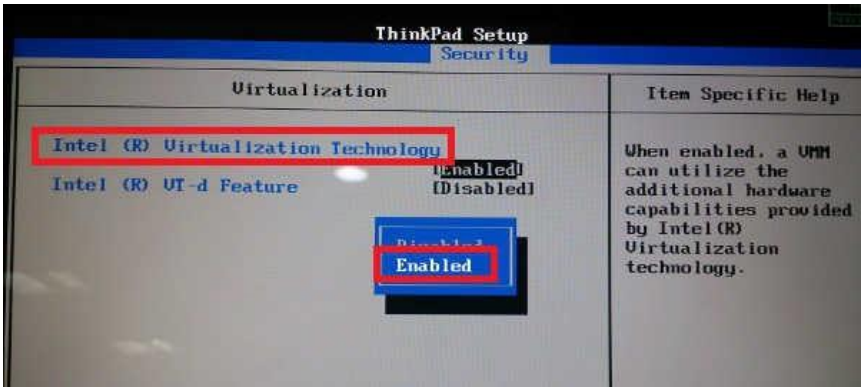
3. MANUAL OPERATION

3.1. Instalation

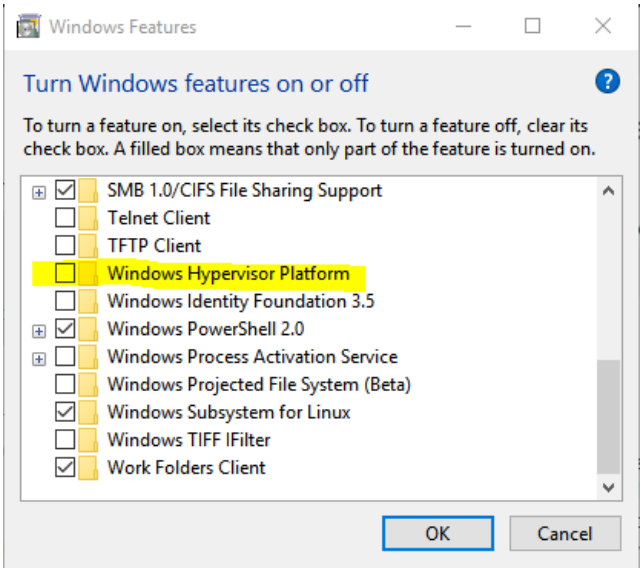
3.1.1. Windows

A. Configure Windows 10 Home

- Check that your system has Virtualization enabled. Enter your machine's BIOS and enable virtualization.



- Once your computer boots up, make sure that Hypervisor is turned OFF. In Windows Search Box type: Turn Windows features on or off. Make sure "Windows Hypervisor Platform" is Unchecked.



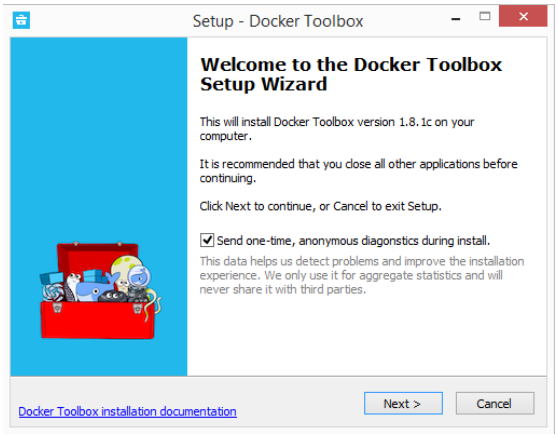
B. Install Docker Toolbox

The installation adds the following software to your machine:

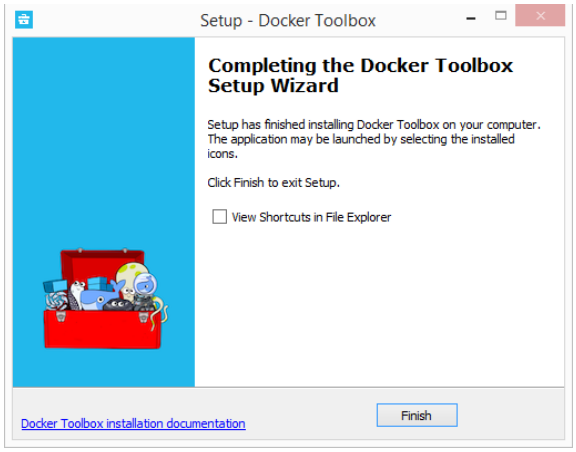
- Docker Client for Windows
- Docker Toolbox management tool and ISO
- Oracle VM VirtualBox
- Git MSYS-git UNIX tools

Step for the installation :

- Go to https://github.com/docker/toolbox/releases and download the latest `.exe` file.
- Install Docker Toolbox by double-clicking the installer. The installer launches the "Setup - Docker Toolbox" dialog. If Windows security dialog prompts you to allow the program to make a change, choose **Yes**. The system displays **the Setup - Docker Toolbox for Windows** wizard.



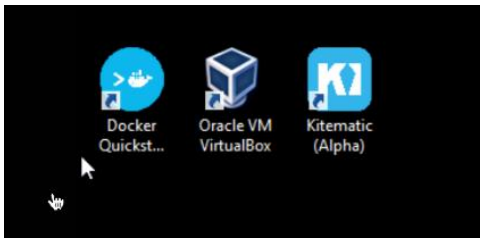
- Press **Next** to accept all the defaults and then **Install**. Accept all the installer defaults. The installer takes a few minutes to install all the components.
- When notified by Windows Security the installer will make changes, make sure you allow the installer to make the necessary changes. When it completes, the installer reports it was successful:



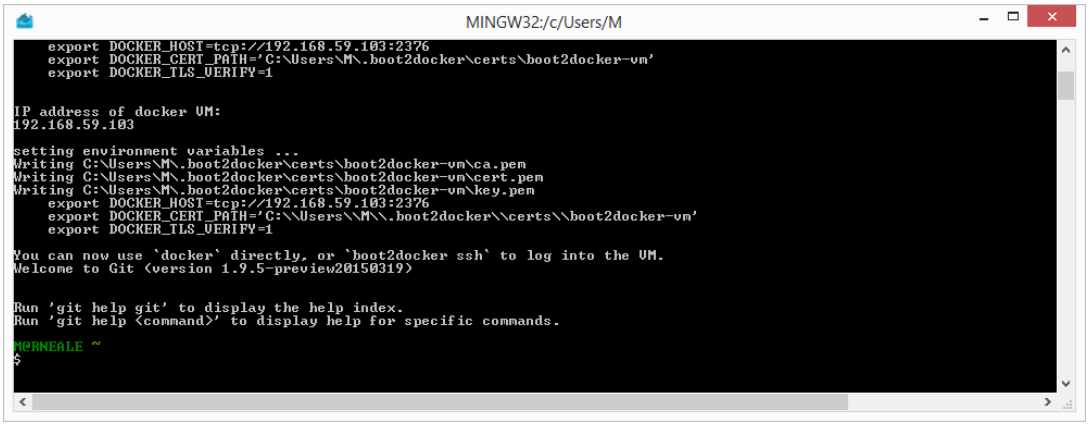
- Uncheck “View Shortcuts in File Explorer” and press **Finish**.

Verify your installation

- On your Desktop, find the Docker QuickStart Terminal icon.



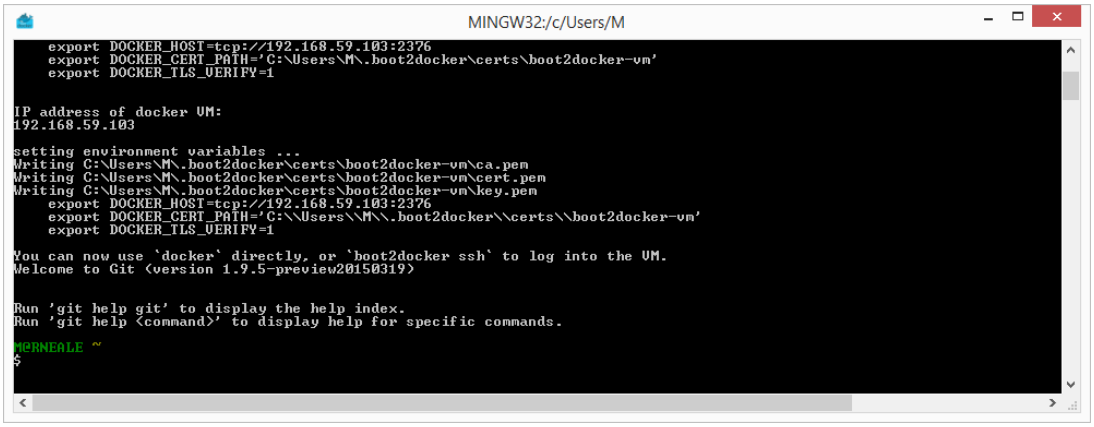
- Click the Docker QuickStart icon to launch a pre-configured Docker Toolbox terminal.
  If the system displays a **User Account Control** prompt to allow VirtualBox to make changes to your computer. Choose **Yes**.
  The terminal does several things to set up Docker Toolbox for you. When it is done, the terminal displays the `$` prompt.



  The terminal runs a special `bash` environment instead of the standard Windows command prompt. The `bash` environment is required by Docker.

- Make the terminal active by clicking your mouse next to the `$` prompt.

If you aren't familiar with a terminal window, here are some quick tips.



The prompt is traditionally a $ dollar sign. You type commands into the command line which is the area after the prompt. Your cursor is indicated by a highlighted area or a | that appears in the command line. After typing a command, always press RETURN.

- Type the `docker run hello-world` command and press RETURN.
  The command does some work for you, if everything runs well, the command's output looks like this:

```
$ docker run hello-world
Unable to find image 'hello-world:latest' locally
Pulling repository hello-world
91c95931e552: Download complete
a8219747be10: Download complete
Status: Downloaded newer image for hello-world:latest
Hello from Docker.
This message shows that your installation appears to be working

To generate this message, Docker took the following steps:
 1. The Docker Engine CLI client contacted the Docker Engine dae
 2. The Docker Engine daemon pulled the "hello-world" image from
    (Assuming it was not already locally available.)
 3. The Docker Engine daemon created a new container from that i
    executable that produces the output you are currently readin
 4. The Docker Engine daemon streamed that output to the Docker
    to your terminal.

To try something more ambitious, you can run an Ubuntu container
 $ docker run -it ubuntu bash

For more examples and ideas, visit:
 https://docs.docker.com/userguide/
```

Configure the Oracle VM Virtual Box :

- Open Oracle VM Virtual Box

- You should see the default machine
- Right click on the machine and go to Settings > Shared Folders
- This is where you can mount your guest containers on your local host
- **C/Users** should be setup, but you can amend or add another drive as needed
- Once 5 is complete, go back to the Oracle Box settings.
  Settings > Network > Advanced > Port Forwarding
- Configure protocols – don't fill out the cells that are not shown below
  |Name | Protocol | Host port | Guest port | |---|---|---|---| |http|TCP|80|80|
  |whateva|TCP|8080|8080|
- Save and close Oracle VM virtual box.

Mounting an ngix container :

```
docker container run -d -p 8080:80 -v //c/Users/M.\
Cameron/dockertest:/usr/share/nginx/html --name ngwebstart
nginx
```

Check if image has been created :

```
docker ps
```

Log into Docker Hub account. To run the docker login command non-interactively.

- You can set the --password-stdin flag to provide a password through STDIN.
- Using STDIN prevents the password from ending up in the shell's history, or log-files.

```
$ cat ~/my_password.txt | docker login --username foo --password-
stdin
```

Build and push to you docker hub repo :

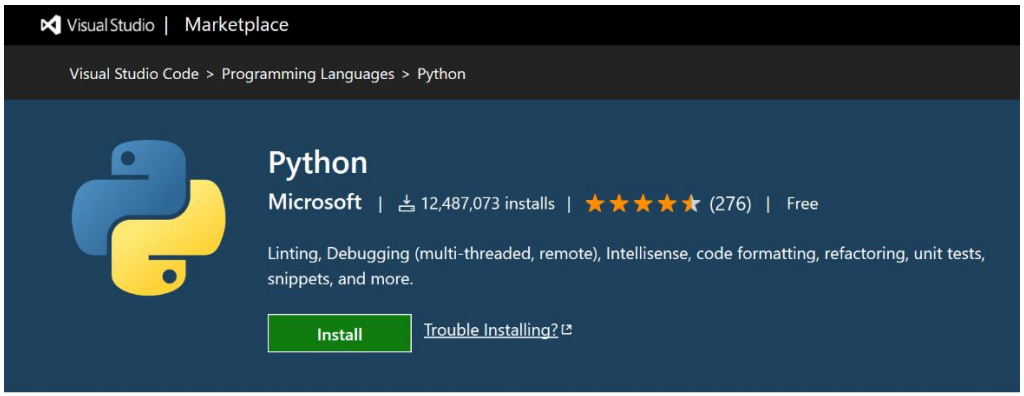
```
docker image build -t markcam1/nginxtest
```

Check build :

```
docker images
```

C. Install Visual Studio Code

- Go to https://code.visualstudio.com/ download and install VS Code.
- Next, install the **Python extension for VS Code** from the Visual Studio Marketplace. For additional details on installing extensions, see **Extension Marketplace**. The Python extension is named Python and published by Microsoft.



- Go to https://www.python.org/downloads/ download and install python interpreter.

3.1.2. Linux

A. Install Docker

Before you install Docker Engine - Community for the first time on a new host machine, you need to set up the Docker repository. Afterward, you can install and update Docker from the repository.

SET UP THE REPOSITORY

1. Update the apt package index:

```
$ sudo apt-get update
```

2. Install packages to allow apt to use a repository over HTTPS:

```
$ sudo apt-get install \
    apt-transport-https \
    ca-certificates \
    curl \
    gnupg-agent \
    software-properties-common
```

3. Add Docker's official GPG key:

```
$ curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-
  key add –
```

Verify that you now have the key with the fingerprint 9DC8 5822 9FC7 DD38 854A E2D8 8D81 803C 0EBF CD88, by searching for the last 8 characters of the fingerprint.

```
$ sudo apt-key fingerprint 0EBFCD88

  pub   rsa4096 2017-02-22 [SCEA]
        9DC8 5822 9FC7 DD38 854A  E2D8 8D81 803C 0EBF  CD88
  uid   [ unknown] Docker Release (CE deb) <docker@docker.com>
  sub    rsa4096 2017-02-22 [S]
```

4. Use the following command to set up the **stable** repository. To add the **nightly** or **test** repository, add the word `nightly` or `test` (or both) after the word `stable` in the commands below. Learn about nightly and test channels.

B. Install Python

Option 1: Install Python 3.7 Using apt (Easier)

This process uses the apt package manager to install Python. There are fewer steps, but it's dependent on a third party hosting software updates. You may not see new releases as quickly on a third-party repository.

Most factory versions of Ubuntu 18.04 come with Python pre-installed. Check your version of Python by entering the following:

```
python --version
```

If the revision level is lower than 3.7.x, or if Python is not installed, continue to the next step.

1. Update and Refresh Repository Lists

   Open a terminal window, and enter the following:

   ```
   sudo apt update
   ```

2. Install Supporting Software

   The software-properties-common package gives you better control over your package manager by letting you add PPA (Personal Package Archive) repositories. Install the supporting software with the command:

   ```
   sudo apt install software-properties-common
   ```

3. Add Deadsnakes PPA

   Deadsnakes is a PPA with newer releases than the default Ubuntu repositories. Add the PPA by entering the following:

   ```
   sudo add-apt-repository ppa:deadsnakes/ppa
   ```

   The system will prompt you to press enter to continue. Do so, and allow it to finish. Refresh the package lists again:

   ```
   sudo apt update
   ```

4. Install Python 3.7

   Now you can start the installation of Python 3.7 with the command:

   ```
   sudo apt install python3.7
   ```

   Allow the process to complete and verify the Python version was installed sucessfully::

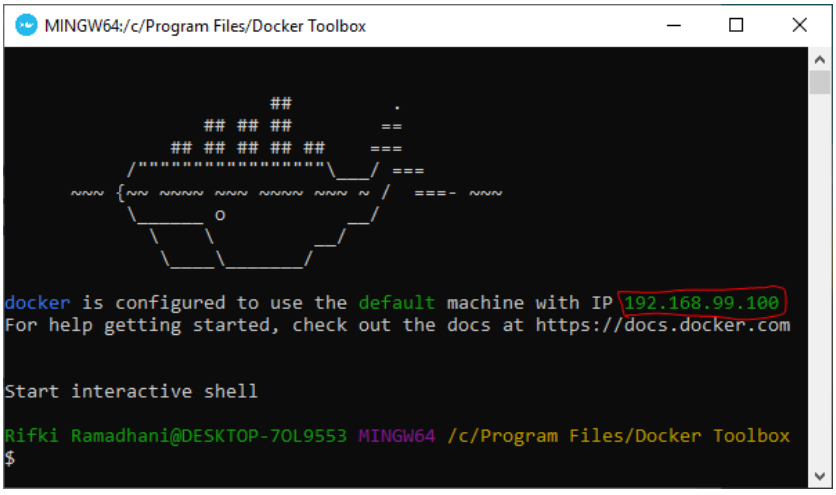
   ```
   python --version
   ```

3.2. Running Program

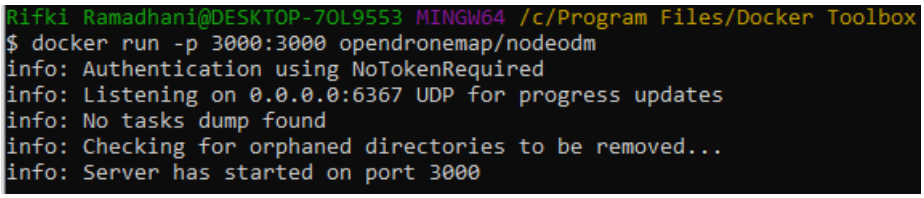
3.2.1. Windows

1. Run NodeODM

- Open “Docker Quickstart Terminal”, wait until IP of your PC displayed.

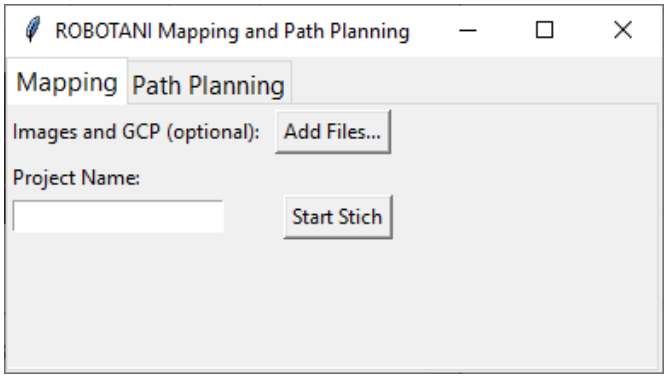


- Note the machine IP
- Run `docker run -p 3000:3000 opendronemap/nodeodm`
- Wait until nodeODM started



2. Run Graphical User Interface

- Open “Administrator : Command Prompt” or “Terminal of Visual Studio Code”
- Enter directory of code, e.g : “C:\Users\Rifki Ramadhani” by run `cd C:\Users\Rifki Ramadhani`
- Open the software by run `python ROBOTANI_GUI.py`
- Wait until GUI displayed.



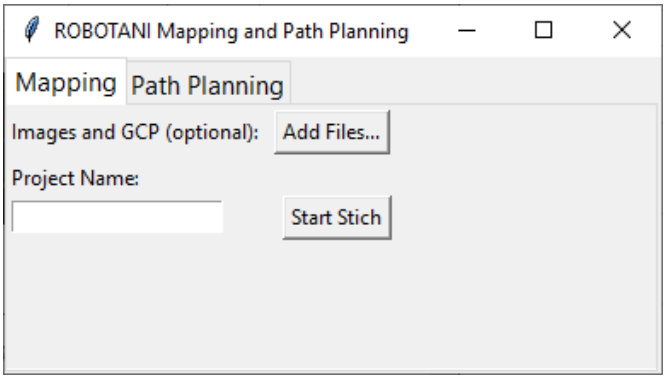
3.2.2. Linux

1. Run NodeODM

- Open terminal
- Run `docker run -p 3000:3000 opendronemap/nodeodm`
- Note the machine IP
- Wait until NodeODM started

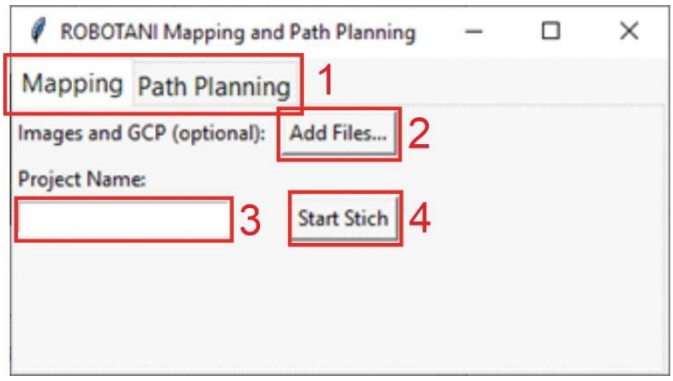
2. Run Graphical User Interface

- Open Terminal
- Enter directory of code, e.g : "/home/Robotani/" by run `cd Robotani`
- Open the software by run `python ROBOTANI_GUI.py`
- Wait until GUI displayed.



3.3. Software Layout

3.3.1. Mapping



1. **Tab Indicator**
   Give indicator about which tab is activated on that time
2. **Open File Button**
   Function to looking for the files (images) that will be mapped by system
3. **Title Box**
   Place to enter the title of each mapping project
4. **Start Mapping Button**
   Function to start the operation of mapping system

3.3.2. Path Planning Manual

1. **Tab1 Indicator**
   Give indicator about which tab is activated on that time, specially between Mapping and Path planning.
2. **Tab2 Indicator**
   Give indicator about which tab is activated on that time, specially under the path planning of the system which is Manually or Autonomous.

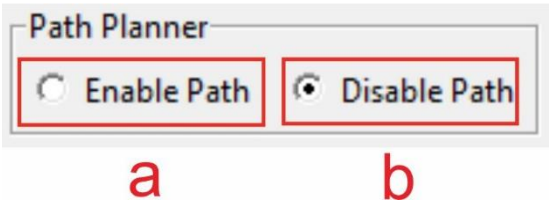
3. **File Map Group**

Manage the function of the input data

a. **Scale Box :** Place to enter the scale of Orthoimage
b. **Open File Button :** Function to looking for the map (orthoimages) that will be planned

4. **Path Planner Group**

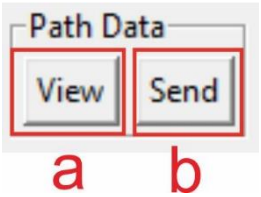
Manage the function of the path maker



a. Enable Path : activate the path maker function, when activate the pointer will be changed into cross icon and every clicked will record by the path.
b. Disable Path : deactivate the path maker function, when deactivate the pointer will be back into the arrow icon and will not record the path.

5. **Path Data Group**

Manage the data result of the path maker



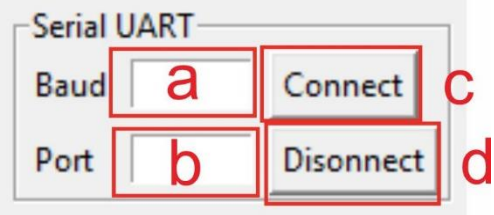
a. **View Data Button :** Display the coordinate data of the path to make sure the path was correct.
b. **Send Data Button :** Send the corrdinate data of the path after realize that the data was correct

6. **Help**

Give some instruction about how to use the software.

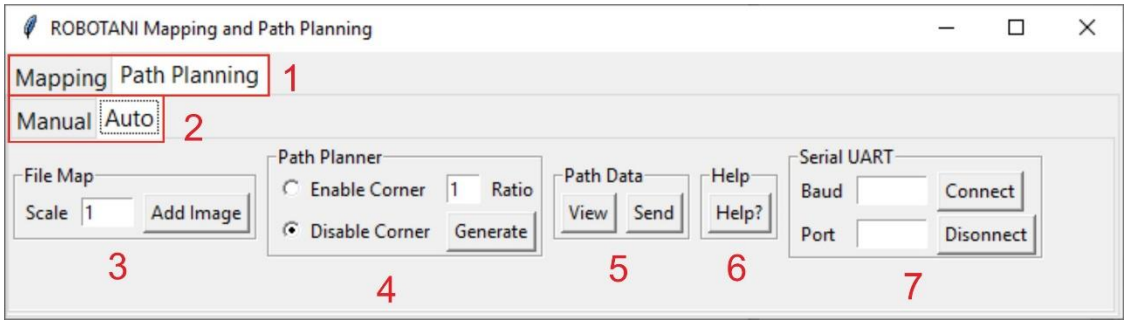
7. **Serial UART Group**

   Manage the function about the communication of the system



   a. **Baud Rate Box :** Place to enter the Baud Rate of Communication
   b. **Port Box :** Place to enter the Port of Serial
   c. **Connect Button :** Function of connection from the PC to the Controller box
   d. **Disconnect Button :** Function to disconnect PC with other devices

3.3.3. Path Planning Auto



1. **Tab1 Indicator**

   Give indicator about which tab is activated on that time, specially between Mapping and Path planning.

2. **Tab2 Indicator**

   Give indicator about which tab is activated on that time, specially under the path planning of the system which is Manually or Autonomous.

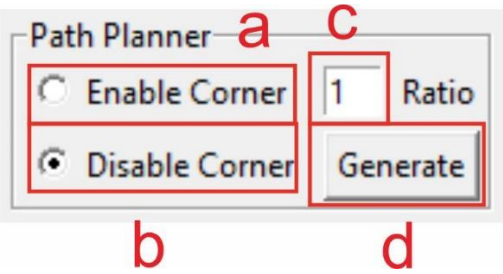
3. **File Map Group**

   Manage the function of the input data

   a. **Scale Box :** Place to enter the scale of Orthoimage
   b. **Open File Button :** Function to looking for the map (orthoimages) that will be planned

4. **Path Planner Group**

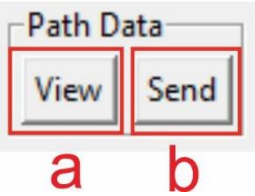
Manage the function of the path maker



   a. **Enable Corner :** activate the corner maker function, when activate the pointer will be changed into cross icon and every clicked will record as the point of corner.
   b. **Disable Path :** deactivate the corner maker function, when deactivate the pointer will be back into the arrow icon and will not record the corner point.
   c. **Ratio Box :** Place to enter the ratio of path, ratio will influenced by the diameter of the robot
   d. **Generate Button :** Function to generate the path based on the corner point that recorded before.

5. **Path Data Group**

Manage the data result of the path maker



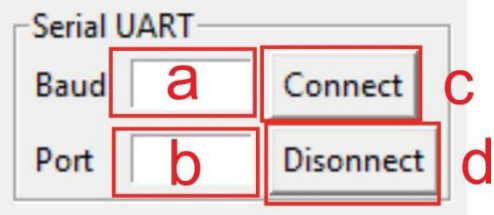
   c. **View Data Button :** Display the coordinate data of the path to make sure the path was correct.
   d. **Send Data Button :** Send the corrdinate data of the path after realize that the data was correct

6. **Help**

Give some instruction about how to use the software.

7. **Serial UART Group**

Manage the function about the communication of the system

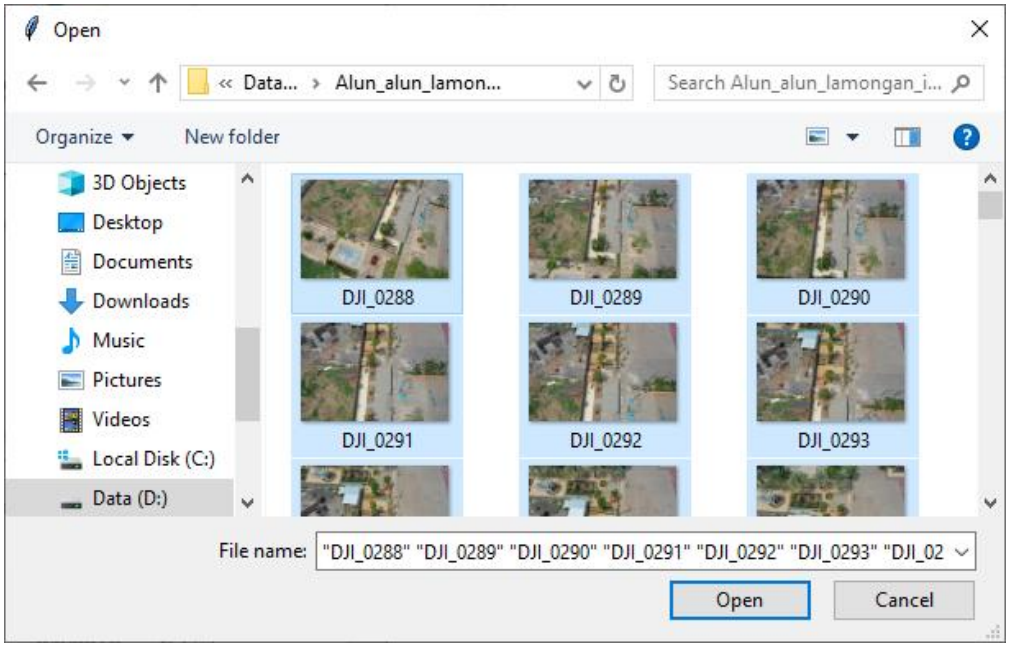


e. **Baud Rate Box :** Place to enter the Baud Rate of Communication
f. **Port Box :** Place to enter the Port of Serial
g. **Connect Button :** Function of connection from the PC to the Controller box
h. **Disconnect Button :** Function to disconnect PC with other devices

3.4. Software Operation

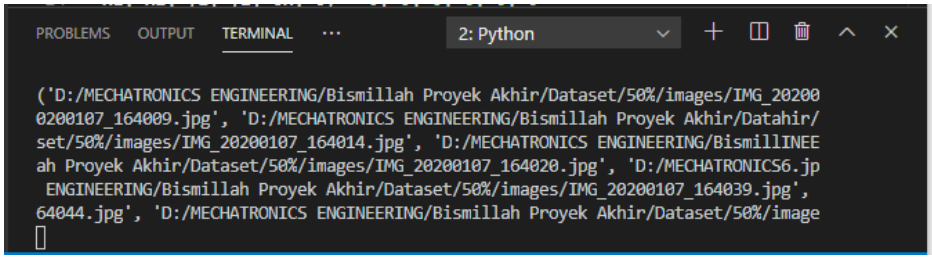
3.4.1. Mapping

- Run the ROBOTANI_GUI.py
- Open the dataset of images by click “Add Files…”. Wait untuk open file dialog displayed



- Select all the dataset then click open.

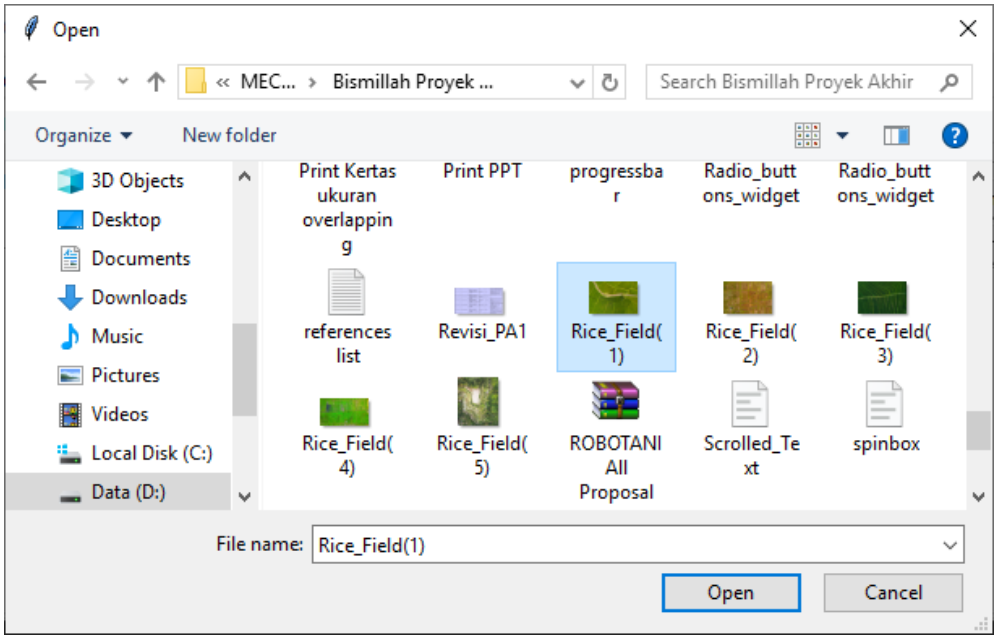
- After selected, the information of file will be printed on the terminal.



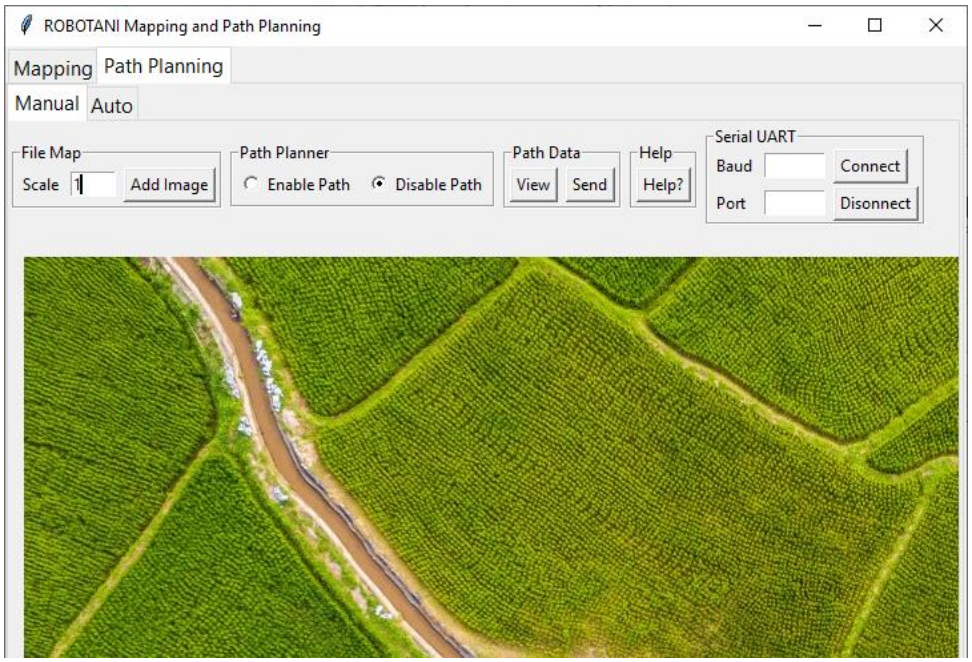
- Enter the name of the project, then click “Start Stitch”.
- The information of task will be displayed on the terminal.

3.4.2. Path Planning Manual

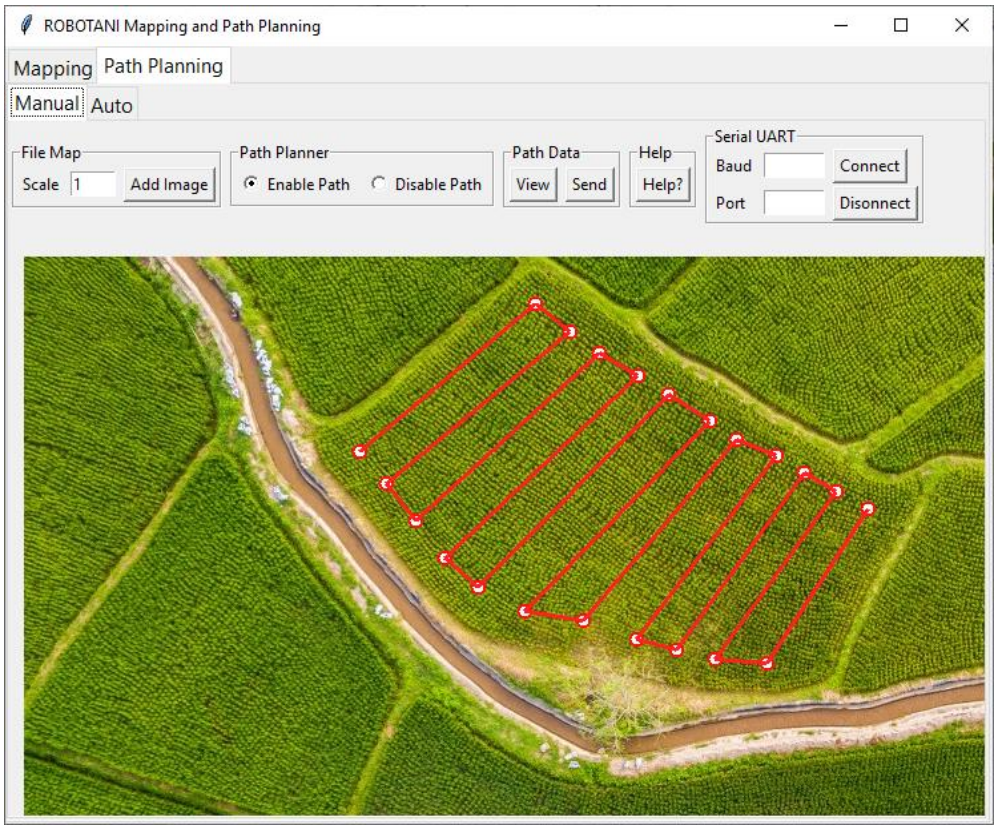
- Run the ROBOTANI_GUI.py
- Set the scale of map
- Open the map result of image by click “Add Image”. Wait for open file dialog displayed



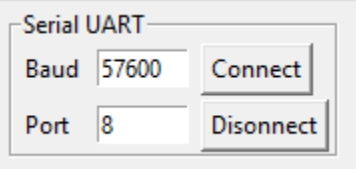
- Choose the orthoimage (map) of the map result. Click Open. Wait until software displayed like this



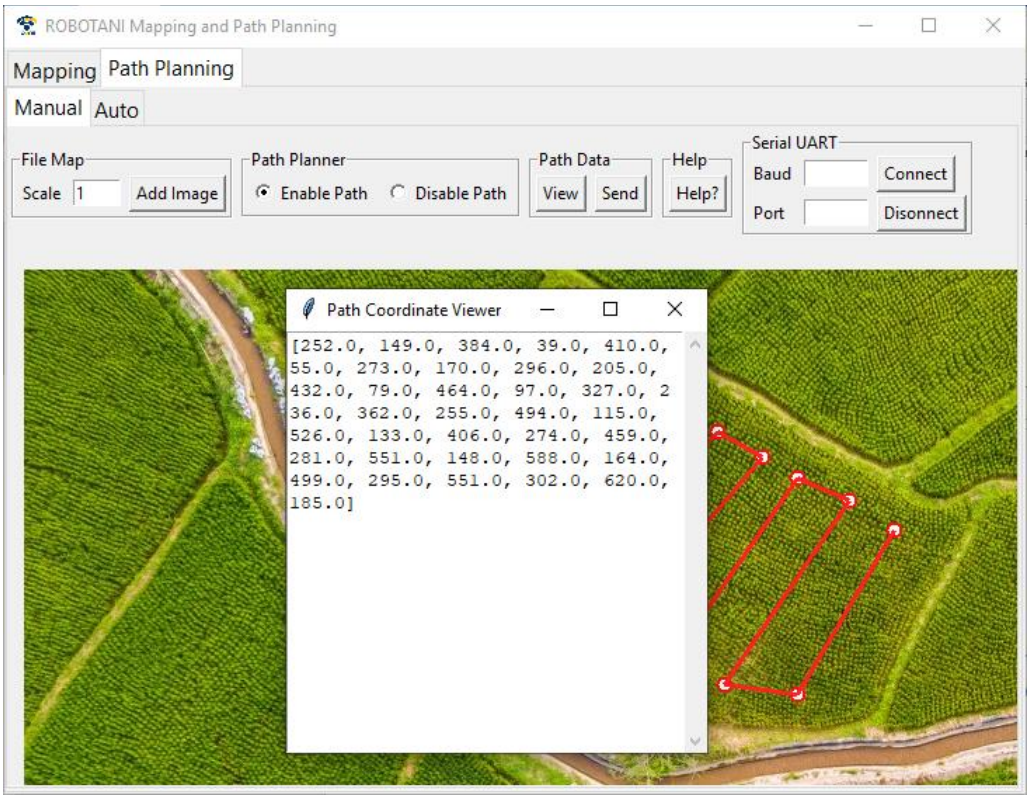
- Click Enable Path on Path Planner Group. Make sure the pointer will be changed with “+” icon. Click every path coordinate that you desire.



- After path was generated, then you can send the path data. Set the Baud rate and the port. For example the Baud rate is 57600 and the port is COM8. See the picture below



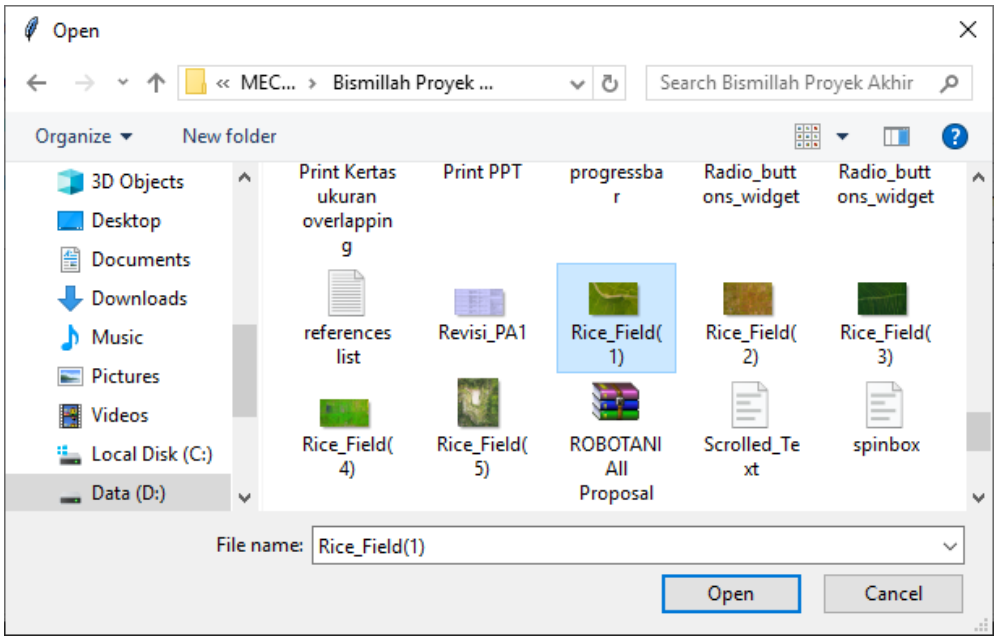
- Click Connect set the baud and port.
- After the serial communication was connected, then make sure that the path data was recorded correctly. Click View. The path data will displayed like this.



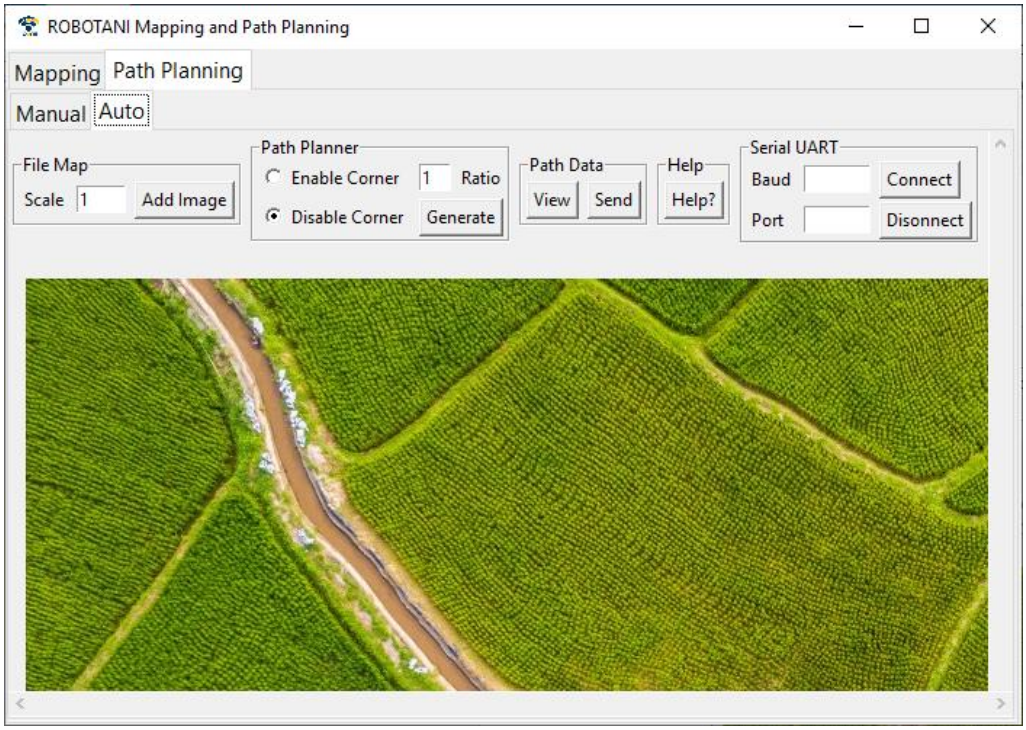
- If the path data was recorded yet, then click Send to send the data to the other device by using serial communication.

3.4.3. Path Planning Auto

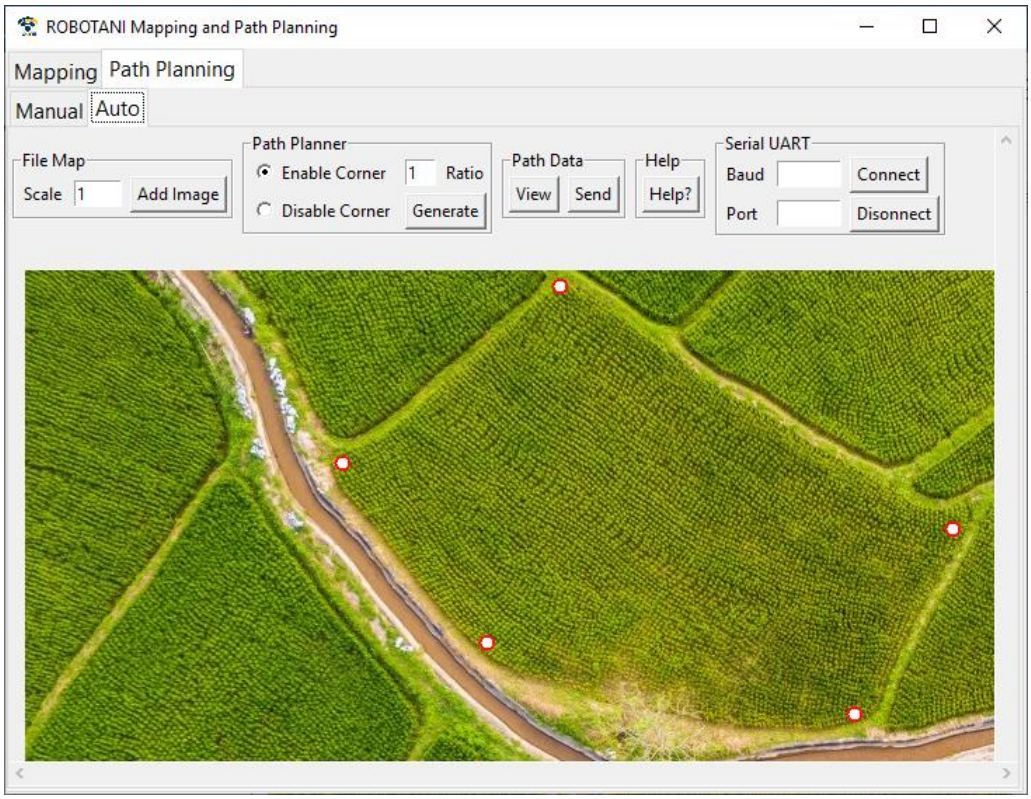
- Run the ROBOTANI_GUI.py
- Set the scale of map
- Open the map result of image by click “Add Image”. Wait for open file dialog displayed



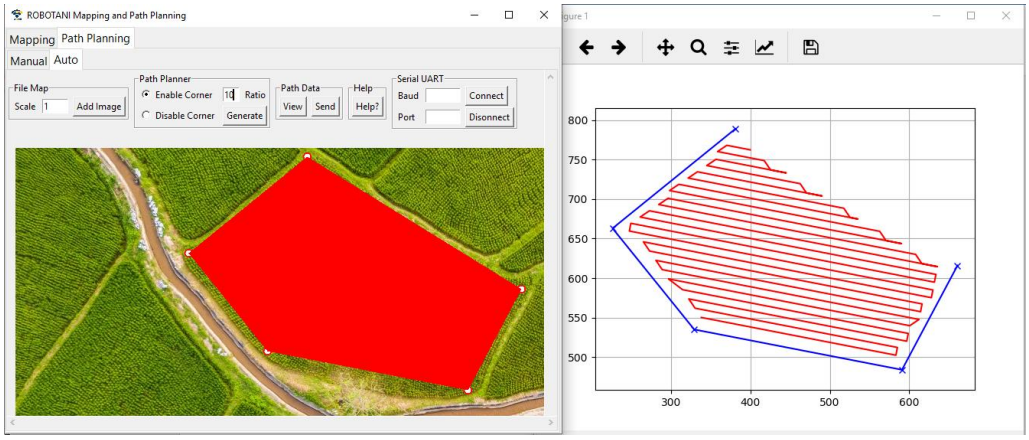
- Choose the orthoimage (map) of the map result. Click Open. Wait until software displayed like this



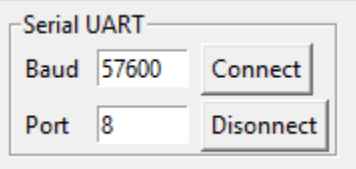
- Click Enable Corner on Path Planner Group. Make sure the pointer will be changed with “+” icon. Click every corner of the area that you desire. The corner will displayed as white circle shape. See the picture below.



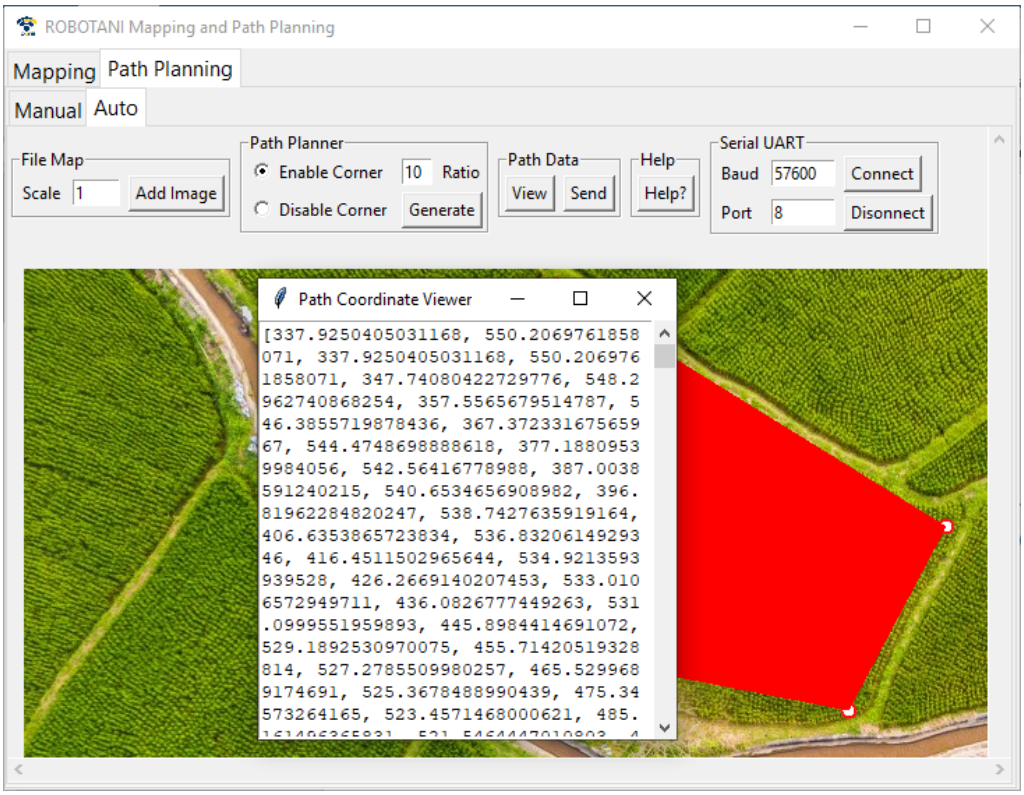
- Set the ratio of path. Ratio is the distance between path. The greater value will make the greater distance. For example we set by 10.
- Click Generate to generate the path. The area that we desired will be blocked as polygon and the path will displayed by pop up plot. See the picture below.



- After path was generated, then you can send the path data. Set the Baud rate and the port. For example the Baud rate is 57600 and the port is COM8. See the picture below



- Click Connect set the baud and port.
- After the serial communication was connected, then make sure that the path data was recorded correctly. Click View. The path data will displayed like this.

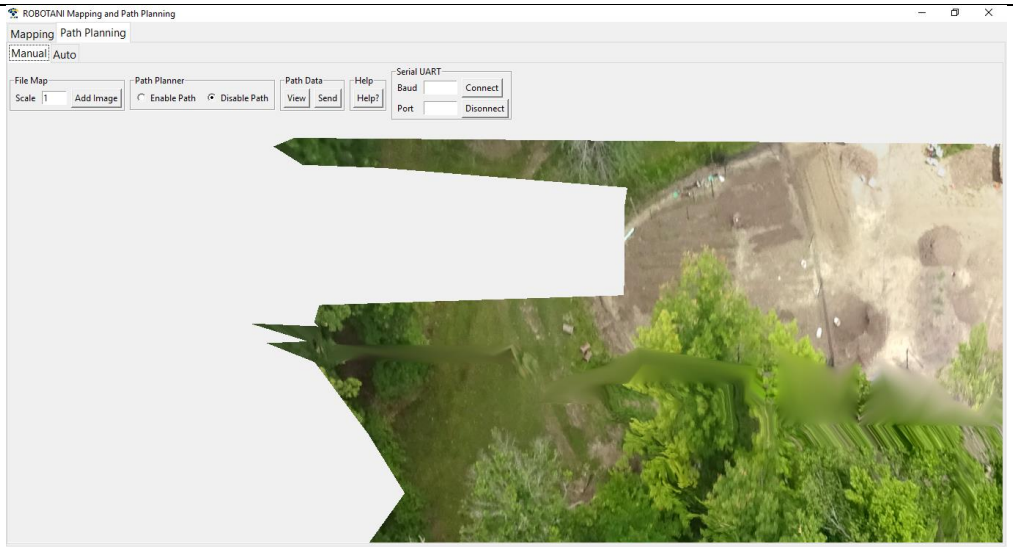
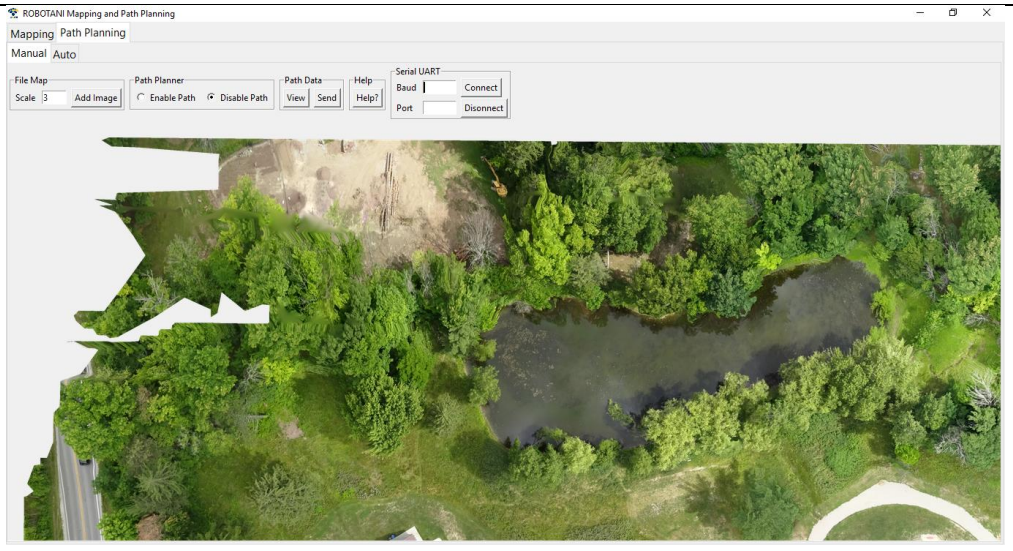


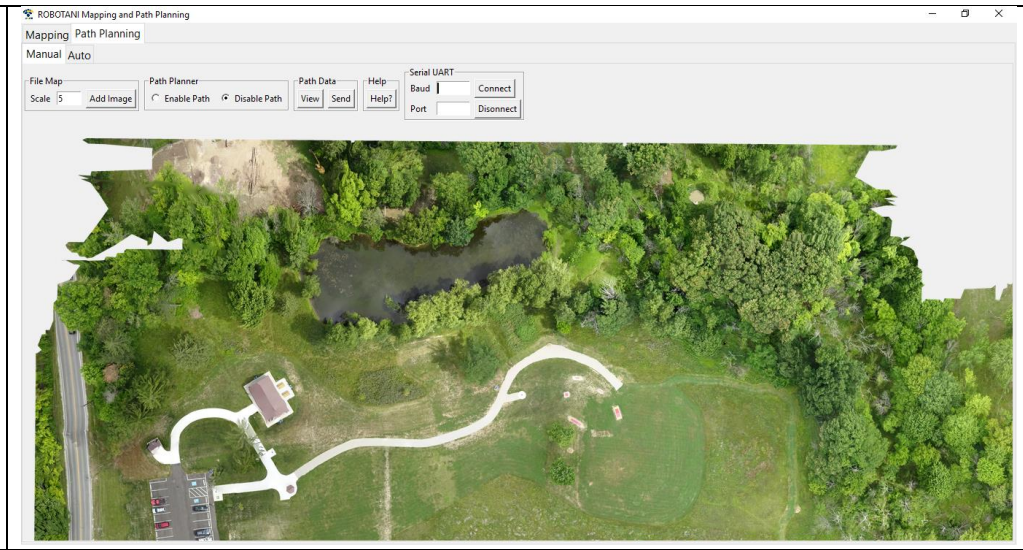
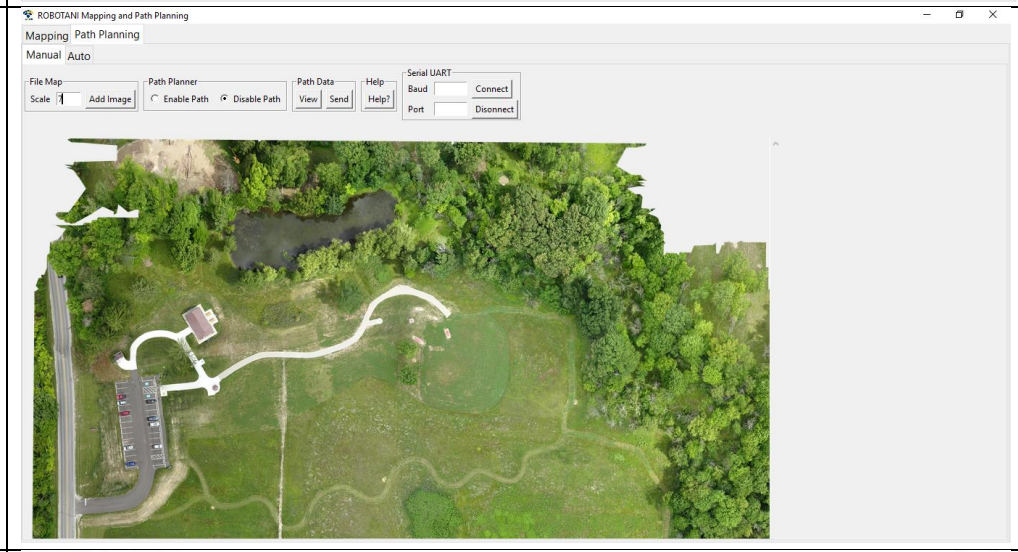
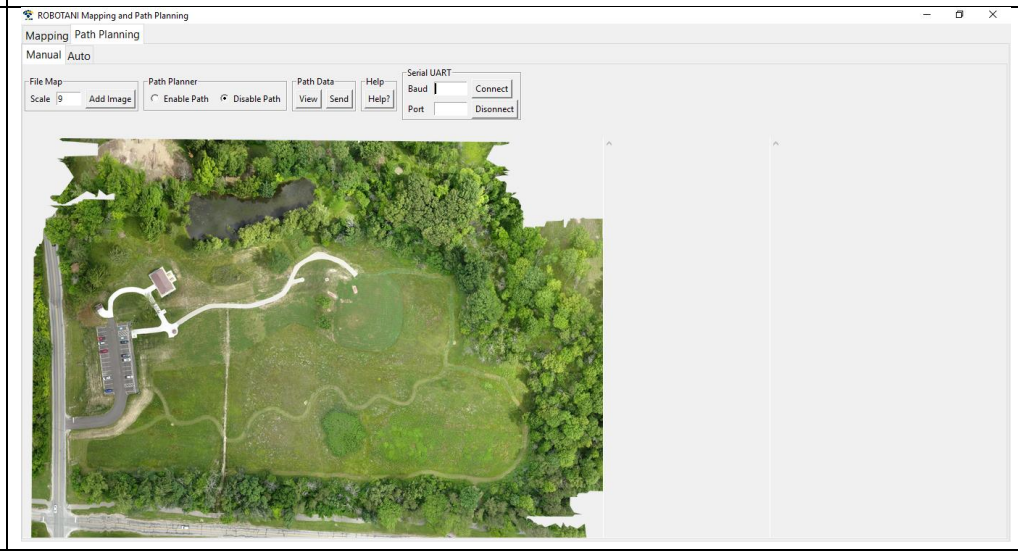
- If the path data was recorded yet, then click Send to send the data to the other device by using serial communication.

4. ADJUSMENT PROCEDURE

4.1. Orthoimage Scale Adjustment

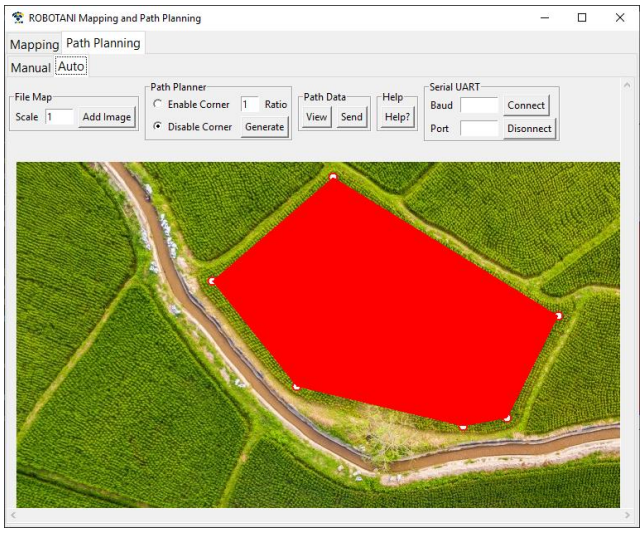
This section is used to make adjustments of the map size values generated by the mapping system. There is a scale adjustment in the path planning tab that must be entered in a value before selecting an orthoimage image to use. Scale value work by divide the actual size of mapped image into the smallest size to get the display covered by the system without losing any information. Examples of applying the adjustment scale to the software are shown in the table below by using the original size of mapped image is 7239 x 5272 pixels.

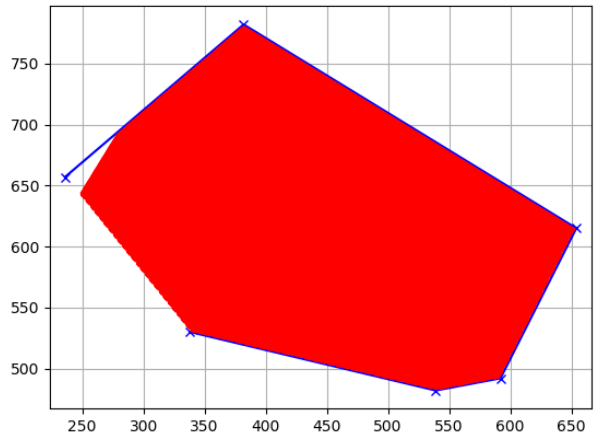
Scale	Output
1	
3	

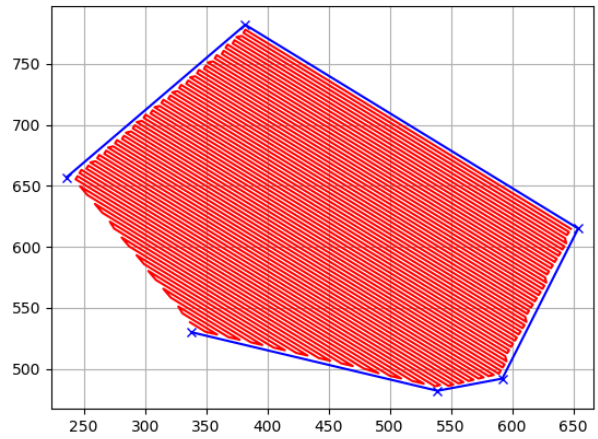
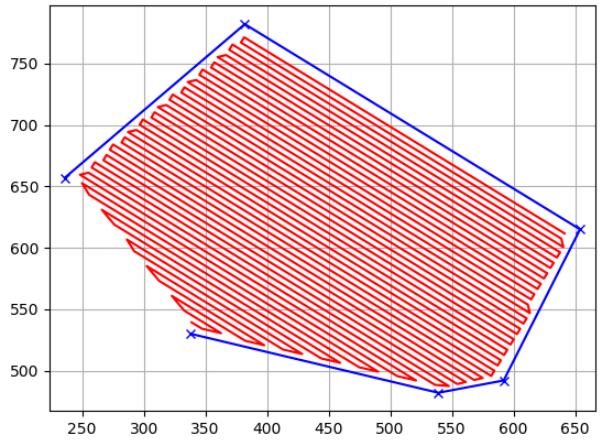
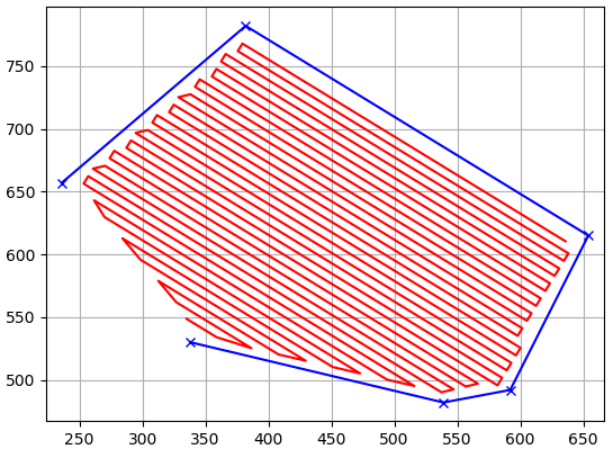
5	 ROBOTANI Mapping and Path Planning Mapping Path Planning Manual Auto File Map Scale 5 Add Image Path Planner Enable Path Disable Path Path Data View Send Help Help? Serial UART Baud Connect Port Disonnect
7	 ROBOTANI Mapping and Path Planning Mapping Path Planning Manual Auto File Map Scale 7 Add Image Path Planner Enable Path Disable Path Path Data View Send Help Help? Serial UART Baud Connect Port Disonnect
9	 ROBOTANI Mapping and Path Planning Mapping Path Planning Manual Auto File Map Scale 9 Add Image Path Planner Enable Path Disable Path Path Data View Send Help Help? Serial UART Baud Connect Port Disonnect

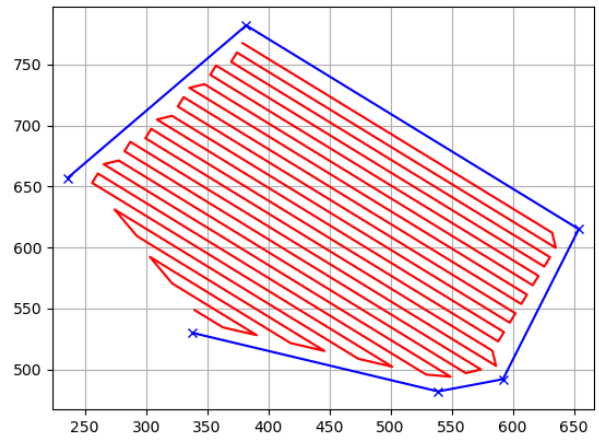
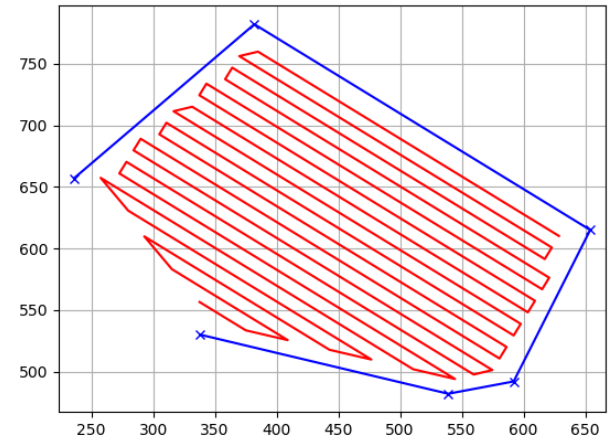
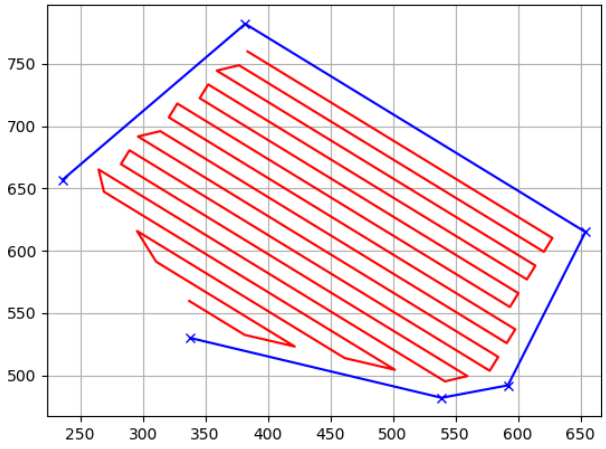
4.2. Path Ratio Adjustment

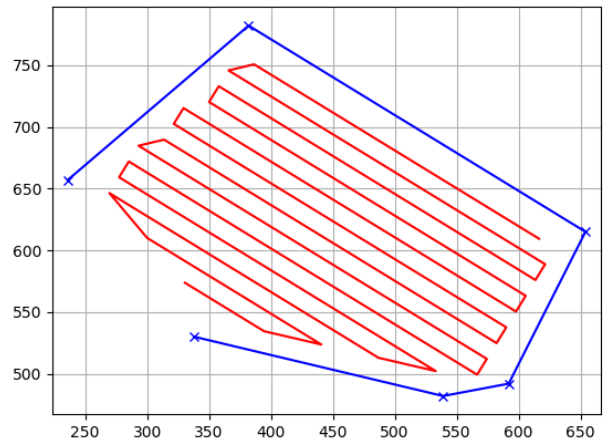
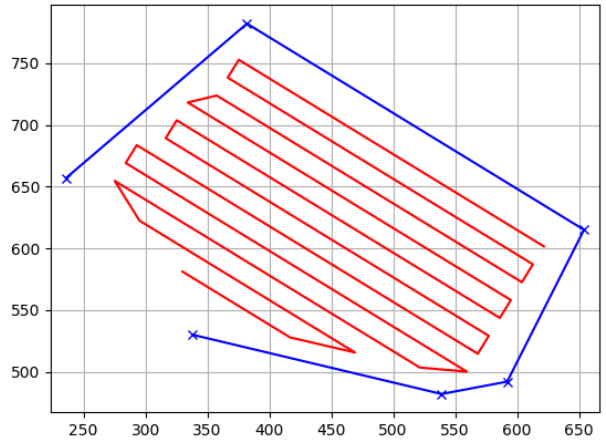
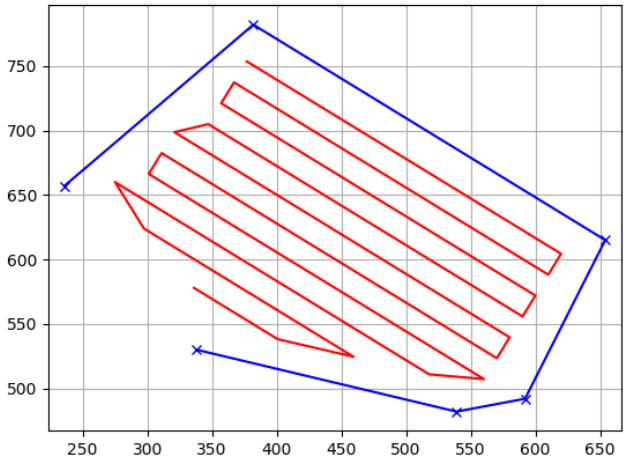
Path Ratio features is used for adjust the distance between path. This system using Grid-Based Coverage Path Planning. The greater value will make the greater distance. It's important to know the diameter of the mobile UGV robot. The path ratio work by calculate the value then consider for the next iteration path until cover the whole area. Examples of applying the adjustment path ratio to the software are shown in the table below by using the are below.



Ratio	Path Length	Output
1	71142	

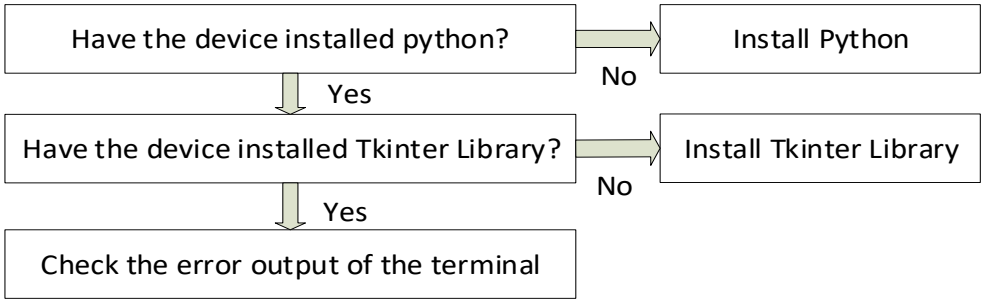
3	7750	
5	2669	
7	1313	

9	776	
11	503	
13	355	

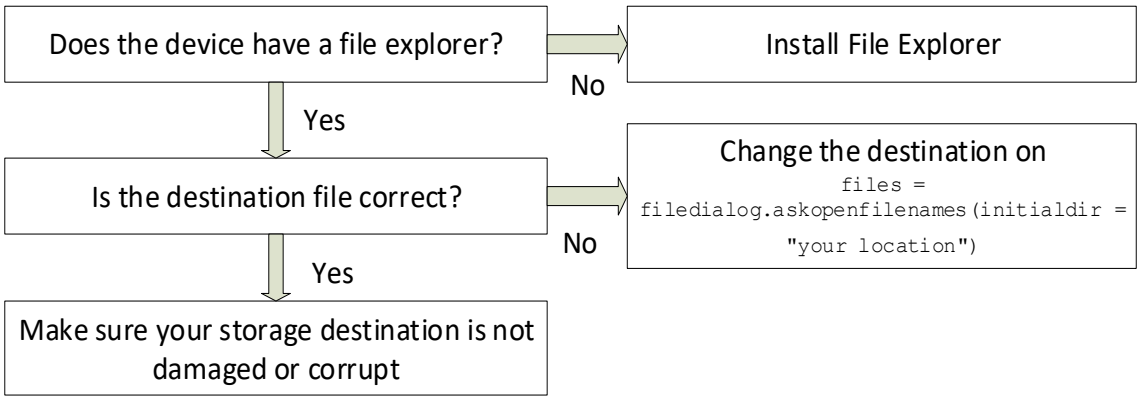
15	251	
17	189	
19	147	

5. TROUBLESHOOT

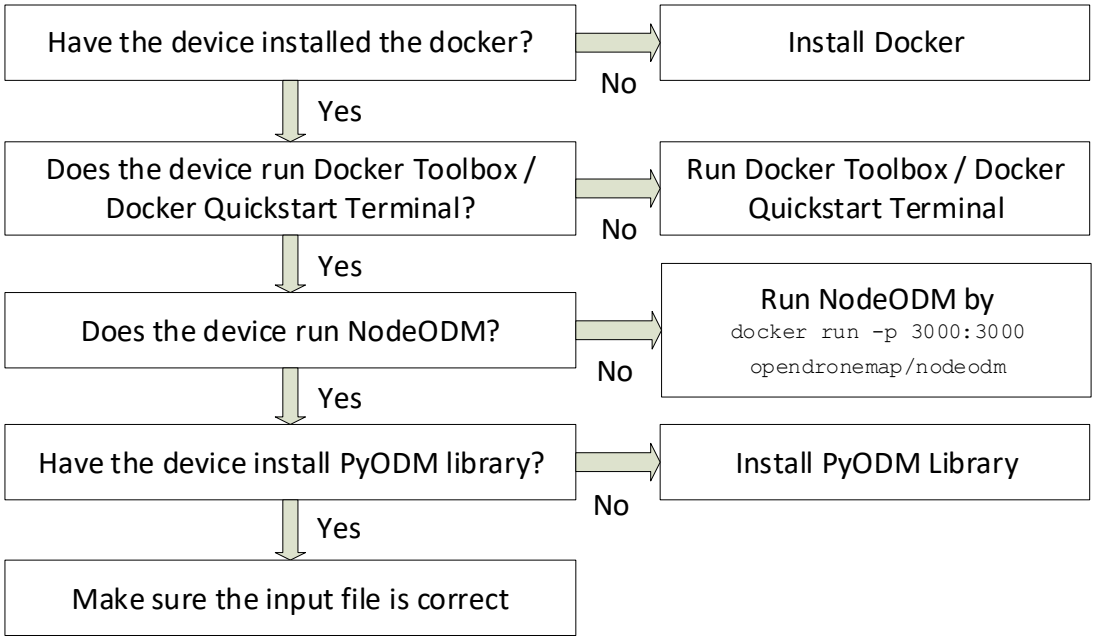
- **No display on startup GUI**



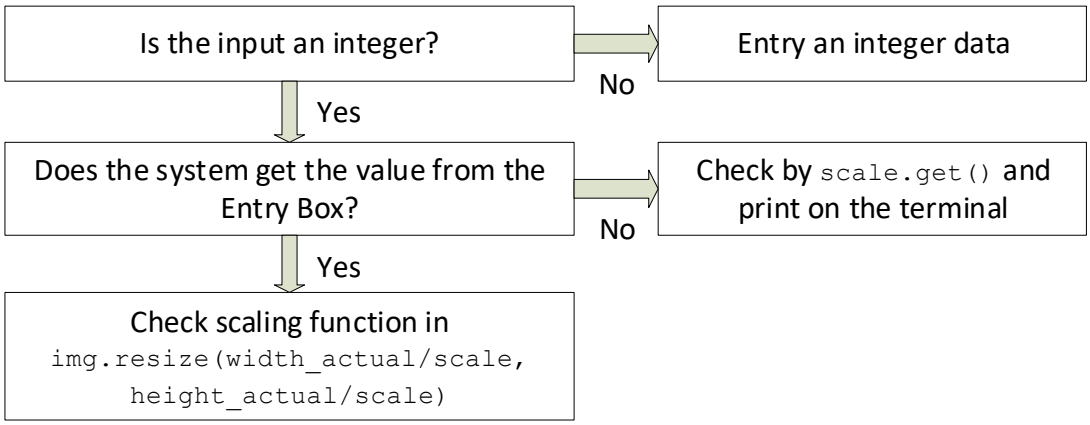
- **Can't open file dialog**



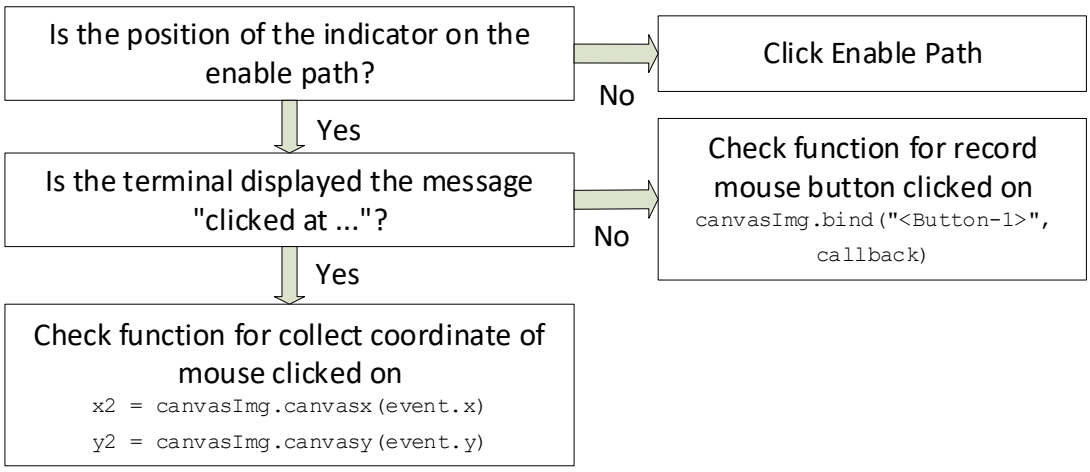
- **Can't Start Mapping**



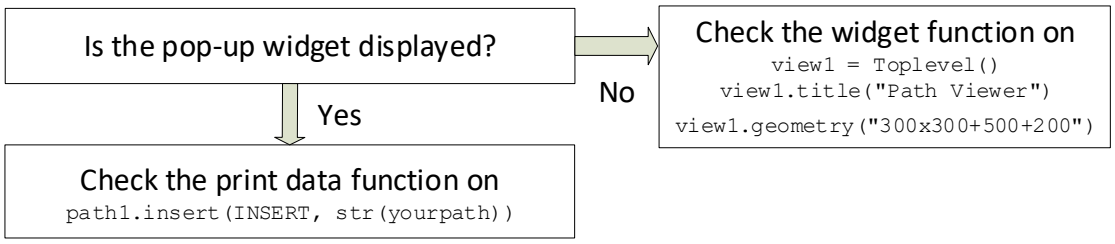
- **The image is not scaled**



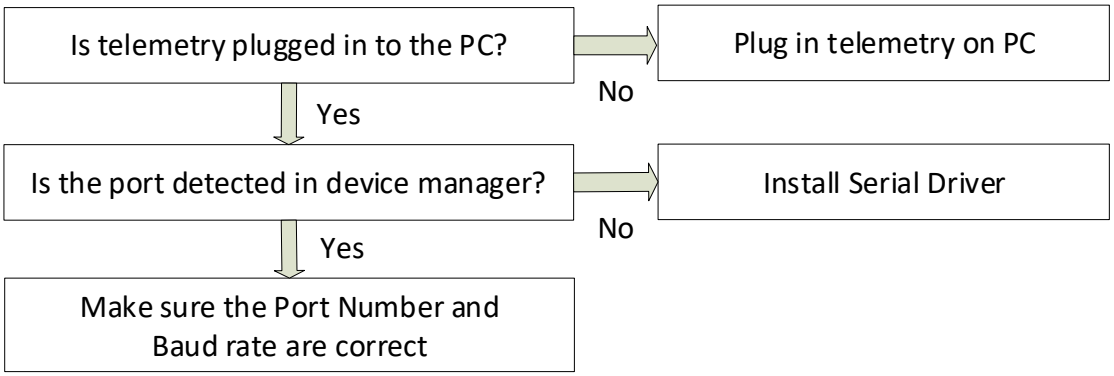
- **Path not recorded (Manual tab)**



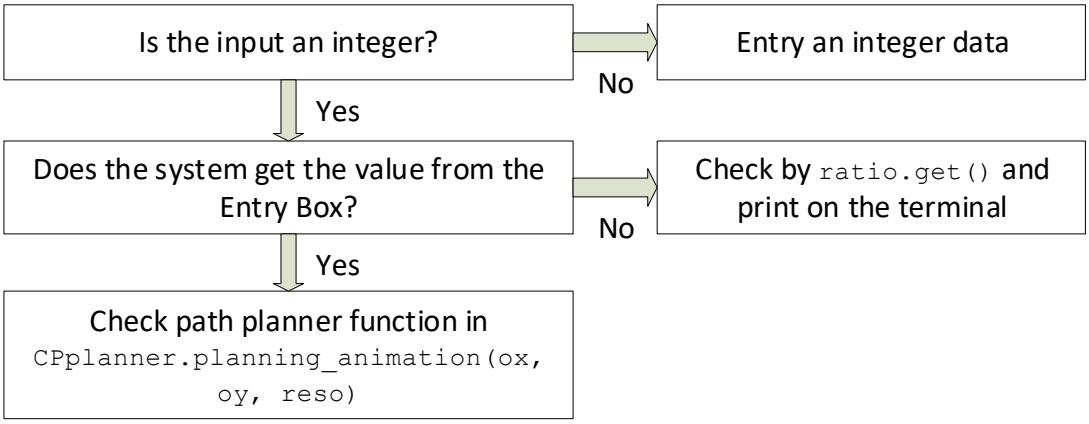
- **Path not displayed on View Note**



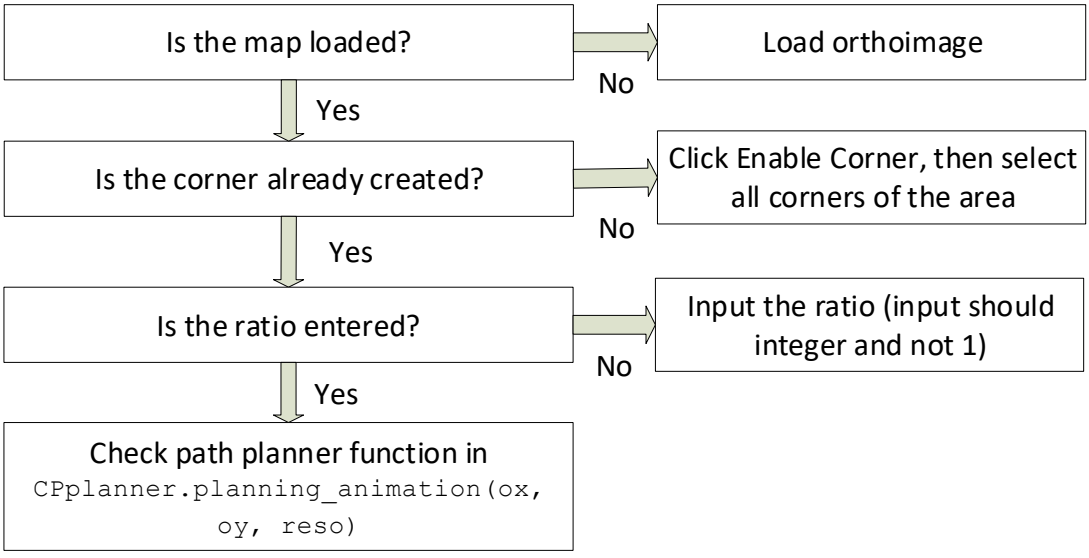
- **Can’t connect serial device and send data**



- **The ratio of the path doesn't work**



- **Can’t generate the path**



6. STATE MACHINE DIAGRAM