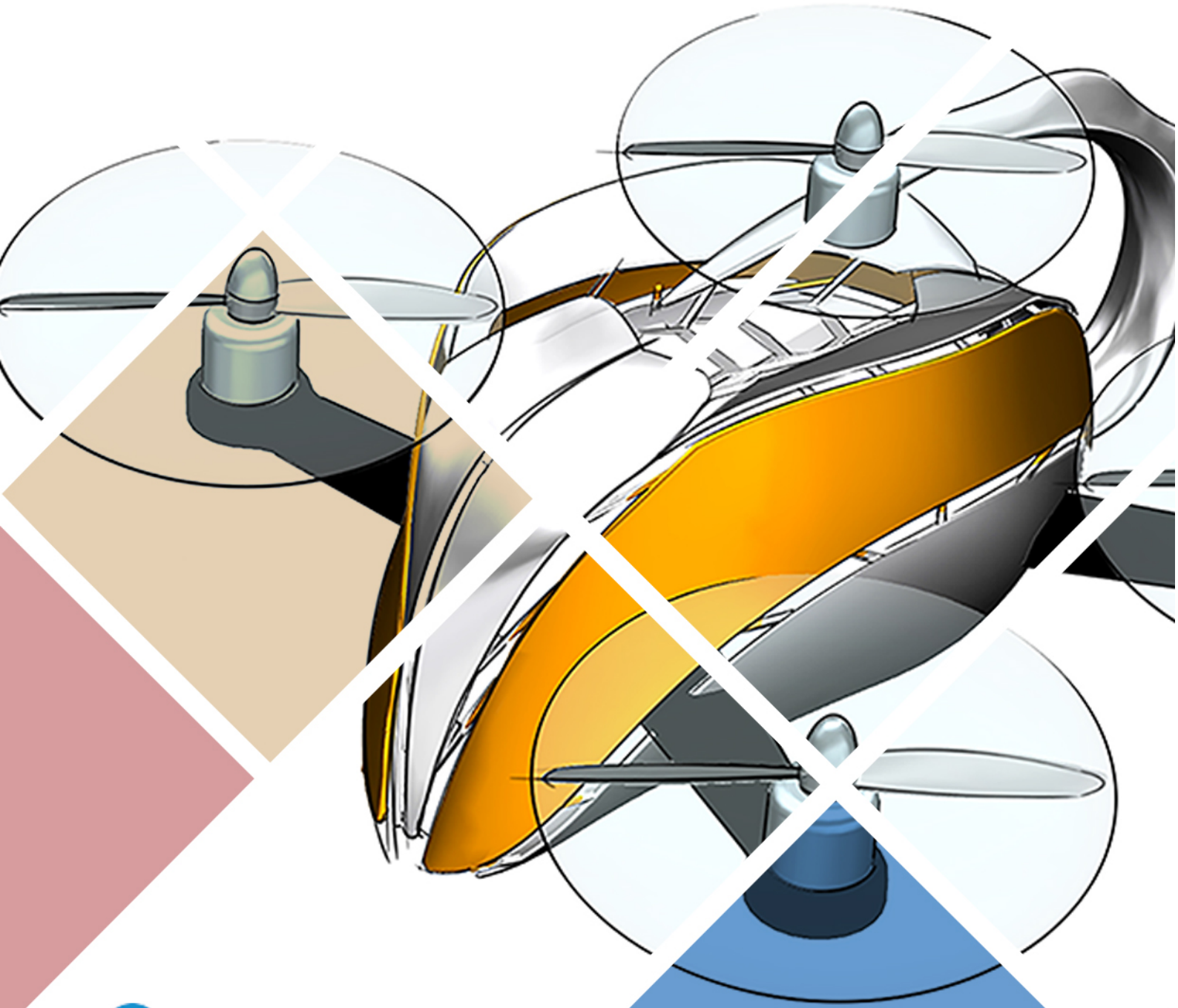


DRONE TEAM

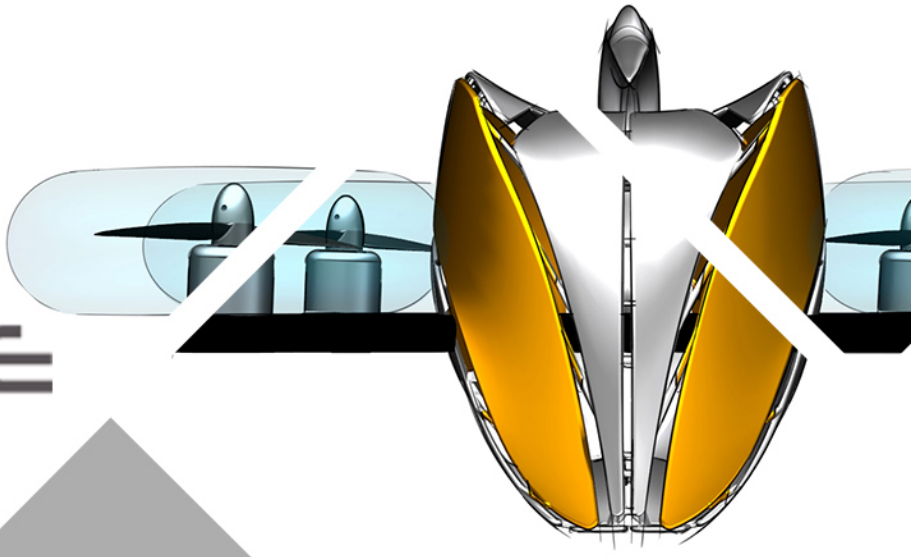
Drone It Yourself!

MAKING AND DESIGNING A TOY DRONE THROUGH MULTIDISCIPLINARY COLLABORATIVE WORK

Project no. 2015-1-ES01-KA202-015925

Co-funded by the Erasmus+ Programme of the European Union

Drone It Yourself! consists of the following modules:



DRONE TEAM

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

MODULE OF GPS/COMPASS CONTROL

2015-1-ES01-KA202-015925

Co-funded by the Erasmus+ Programme of the European Union

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1. INERTIAL MEASUREMENT UNIT (IMU)

The UMI is composed of a series of sensors that provide great stability in flight movements: accelerometers, gyroscopes, magnetometers and barometers allow to measure the essential parameters.

Accelerometers are sensors that permit to know the orientation with respect to the reference axes. This is the reason we have to calibrate the drone with the control software. Accelerometer sensor give the drone control and stability.

Gyroscopes can measure the rotation speed of one, two or all three directions of space.

Magnetometers are sensors that measure magnetic fields from the magnetic flux density that passes through them. Since the Earth generates a magnetic field, magnetometers are able to act as compasses to know at all times where the terrestrial Magnetic North is located. Magnetometers are used in drones to know at any time their orientation and the direction of their movement. It is advisable to control the location of the magnetometer. When it is close to other electronic devices or cables can cause variations in the magnetometer measurements. Therefore, is recommended positioning it in an elevated or away from any other metallic object. For this it is possible to use some application that allows to measure the magnetic field. You can find in Google Play or Apple Store several free apps to use as metal detector. It is really interesting you use one of them to assembly your drone.

A **barometer** is used to measure the altitude, that is, the height at which the drone is located comparing with sea level. Barometer sensor is based on the pressure difference that is produced by a difference in height.

The problem that must be corrected is that the pressure variation does not only depend on the height, but also that changes in the climate and latitude influence. Therefore, an adequate calibration is necessary to avoid major problems. The problem that must be corrected is that the pressure variation does not only depend on the height, but also that changes in the climate and latitude influence. Therefore, an adequate calibration is necessary to avoid major problems.

All these sensors are grouped in the IMU unit in the same component. That is why, although we speak of several sensors, in reality they are integrated into GPS component prepared for drones.

2. SOFTWARE RELATED TO DRONES. MISSION PLANNER

Each flight controller has dedicated software. For APM 2.6 we use Mission Planner

Mission Planner is free software. You can download it from official site: http://ardupilot.org

This program let you:

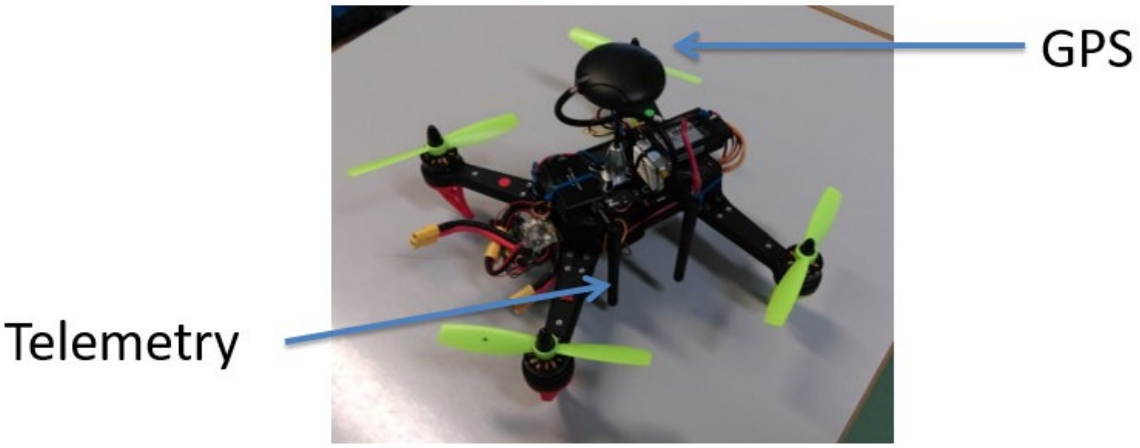
- Configure APM settings

- See the output from APM

- Point-and-click waypoint entry, using Google

  Select mission commands from drop-down menus

To use all option and features of program you should mount GPS Module and telemetry

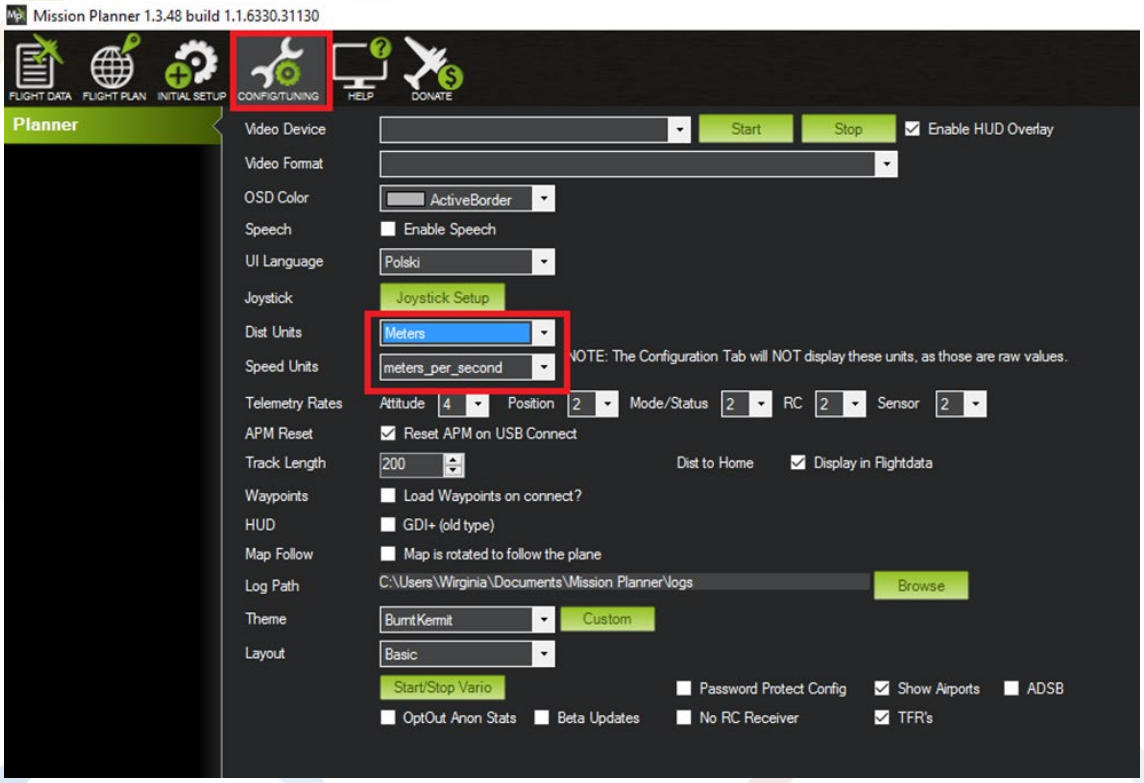


2.1. HOW TO PLAN A MISSION?

Use Mission Planner to plan flight. It is not necessary to connect drone to computer. It works off-line

2.1.1. STEP 1: CHECK UNIT LENGTH [M] AND SPEED [M/S]

Menu config/tunning



2.1.2. STEP 2: SETTING THE HOME POSITION

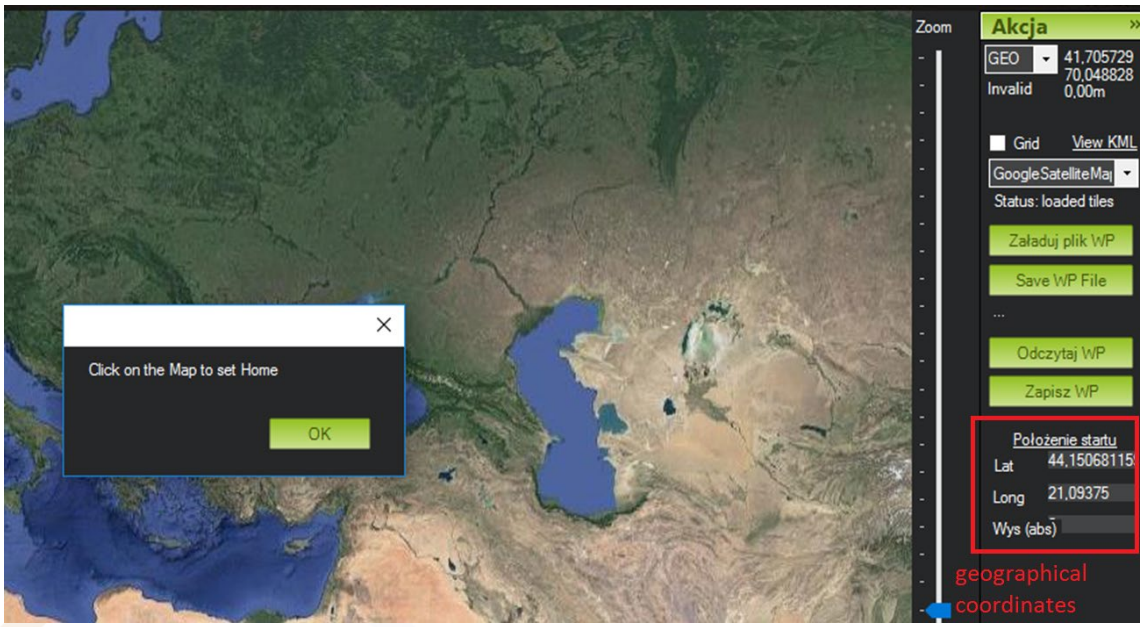
On FlightPlan panel find the place where you want to flight.

First you can check the coordinates using internet or other application with GPS

School in Krsko is: 15,486497

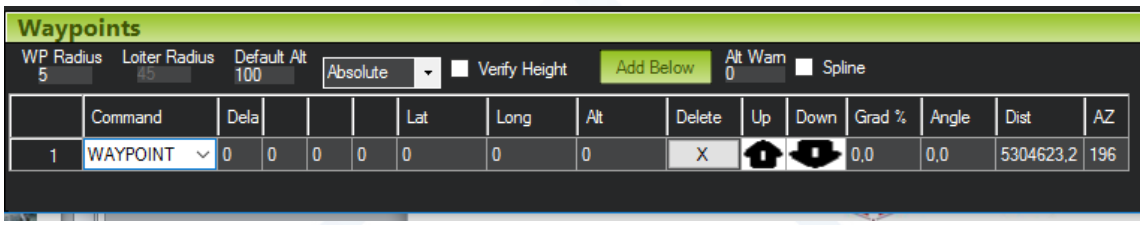
45,945337

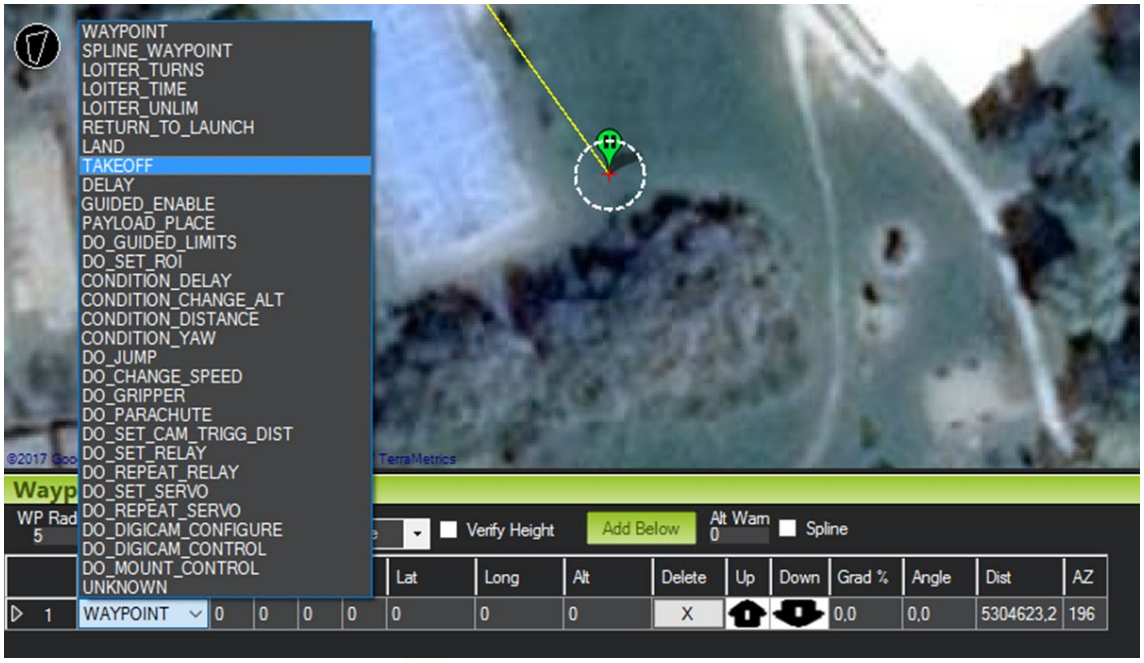
When you launch drone its position will be on the map



2.1.3. STEP 3: TAKING OFF

Planning the mission is adding waypoints to the list of tasks. Click the bottom **Add Below**. Each waypoint can be changed. The first one should be **TAKE OFF**



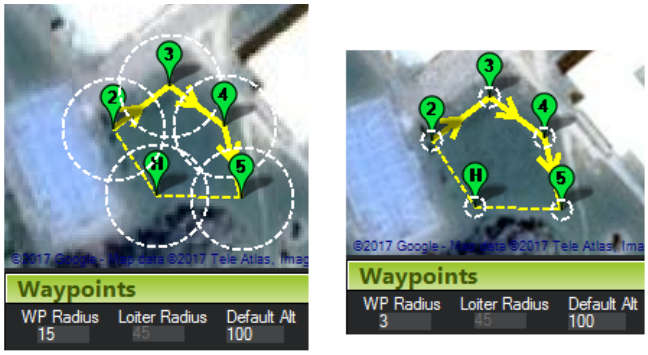


2.1.4. STEP 4: PLANNING THE FLIGHT

Click on the map to add next waypoints

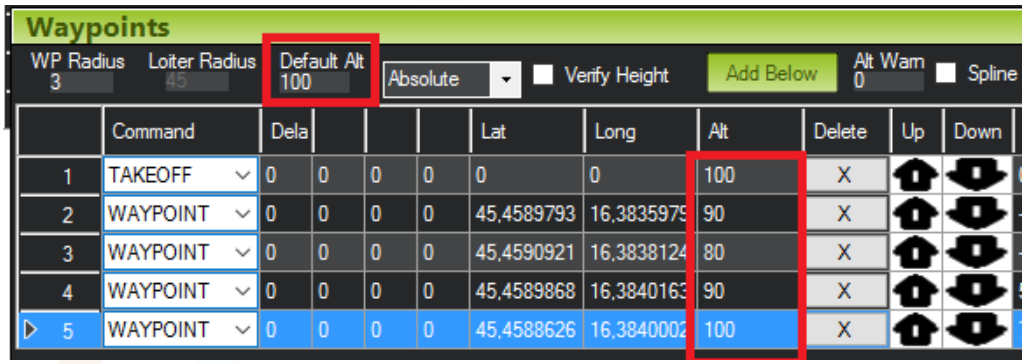
2.1.4.1. PLANNING THE FLIGHT – WP RADIUS

WP Radius is the radius of circle, when drone is inside this area flight controller confirm that point and go to the next place.



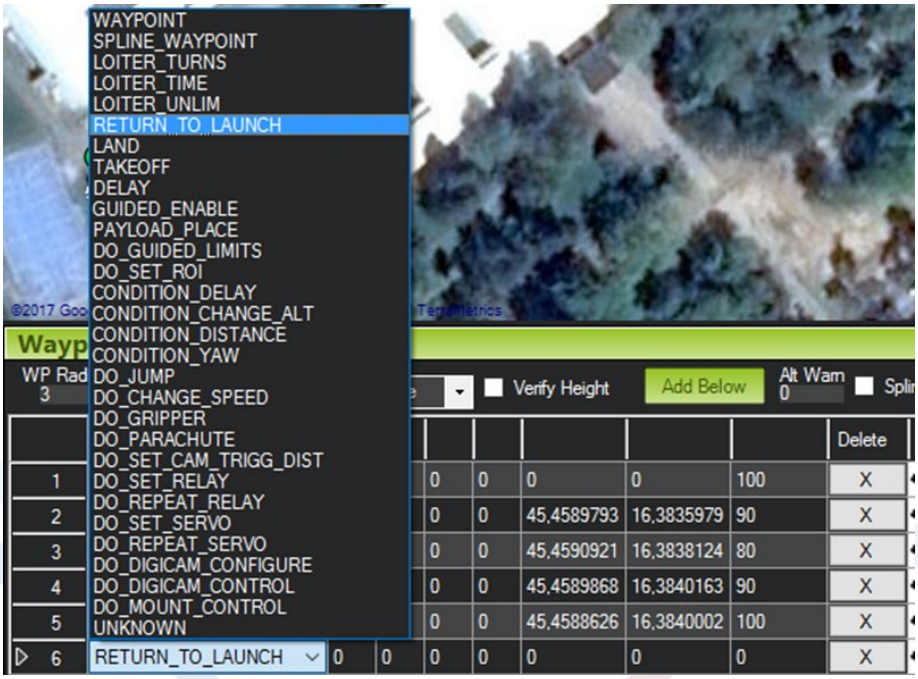
2.1.4.2. PLANNING THE FLIGHT – DEFAULT ALT

Default Alt is the default altitude when entering new waypoints. 100 m is very high so be careful about this number. Each waypoint has alt, which can be changed



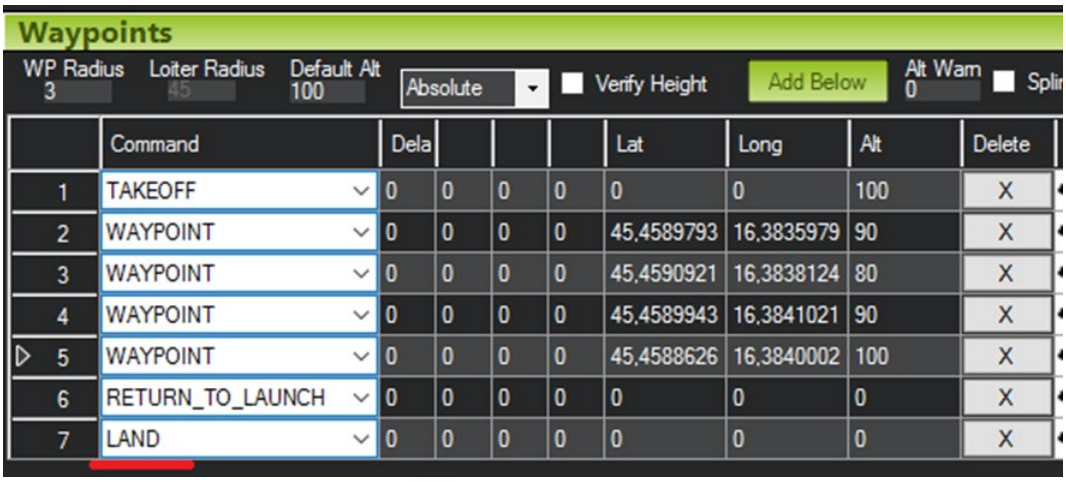
2.1.5. STEP 5: RETURNING TO HOME

The next waypoint is RETURN_TO_LAUNCH. The drone after the mission come back to home position, but is still above the ground



2.1.6. STEP 6: LANDING

To put gently the drone to the ground add Waypoint LAND



2.1.6.1. SAVING THE MISIÓN

Now you can save the file.

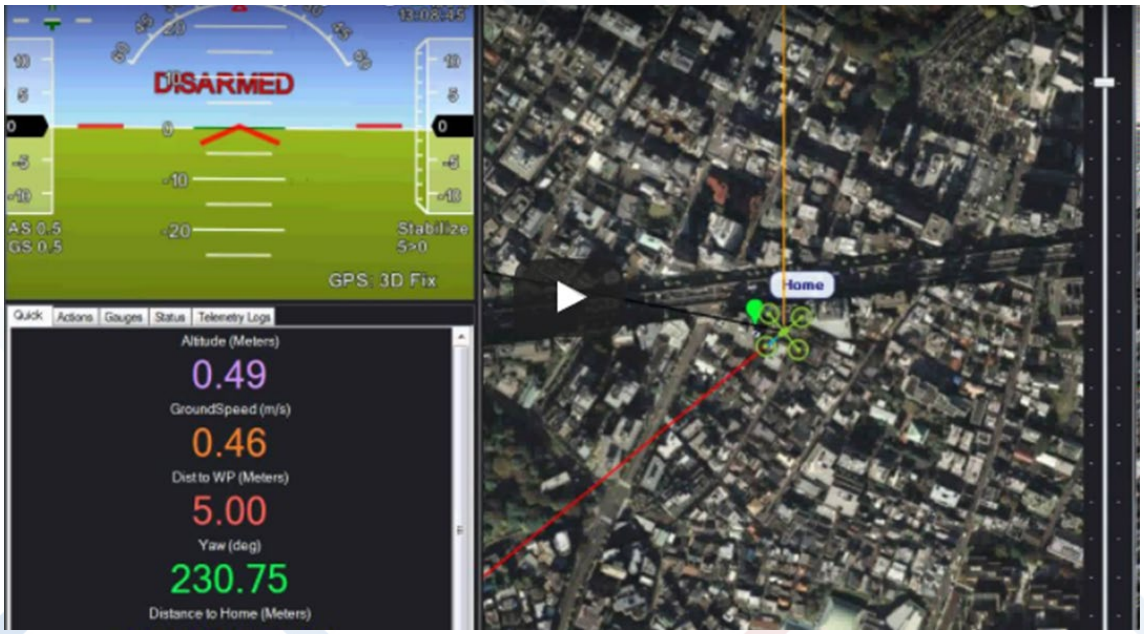
The most important is to load mission to drone.

Connect the drone to PC and click **Write WPs**

2.1.7. STEP 7: BEFORE THE FLIGHT – THE COMPASS LINE

Prepare drone to the flight – check with your list:

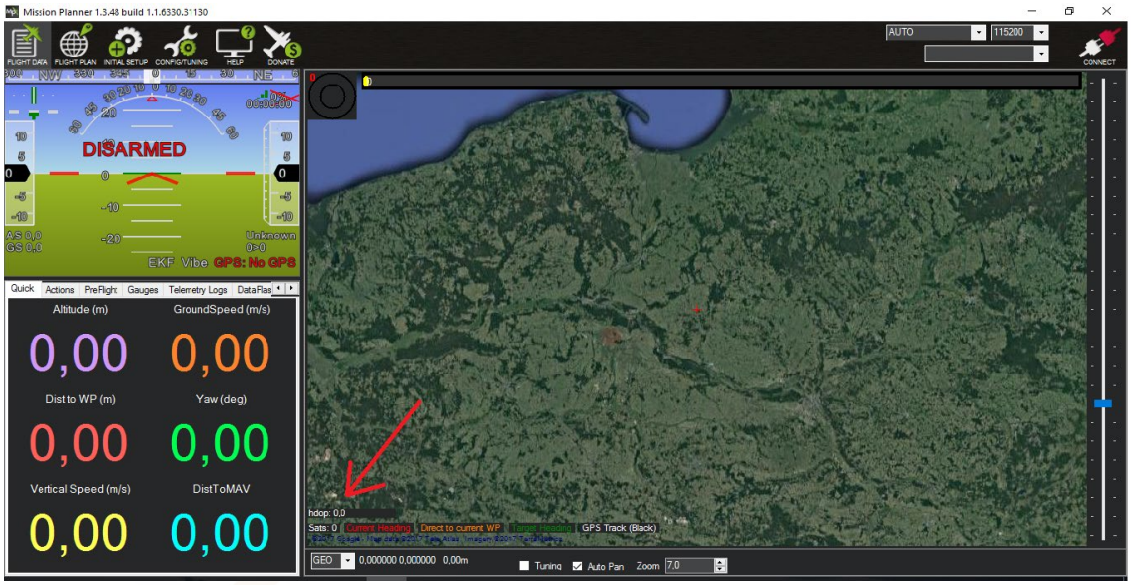
1. Place the drone near home point (check on the map)
2. The line from compass should be in good direction.
3. There can be 15 degrees' difference.



2.1.7.1. BEFORE THE FLIGHT – NUMBER OF SATELITES AND HDOP

The minimum number of satellites the drone should see is 6. In practise fly, when you have 8 or more.

Hdop is another important number. It should be really low: max is 2.5



2.1.8. STEP 8: FLIGHT

Armed the drone.

Switch to Auto mode

Put the throttle up.

Drone should start making mission

2.1.8.1. MISSION PLANNING – FIRST AUTOMATIC MISSION

To check the auto mode, try to do very simple mission in shape of square.

First automatic mission: only waypoints without start and landing. Operator starts the drone and changes flight mode in the air. After the mission operator lands.

2.1.8.2. MISSION PLANNING – REGULAR AUTOMATIC MISSION

Drone will fly without participation of pilot.

Mission should contain: taking off, flight, coming back and landing.

Operator only puts throttle up and drone starts.

Drone should be placed in home position (check on the map)

3. HOW TO PREPARE TO THE FIRST FLIGHT WITH A DRONE

3.1. FIRST STEP WE HAVE TO TRY FLYING WITH DRONE SIMULATOR

How to prepare the flight simulator?

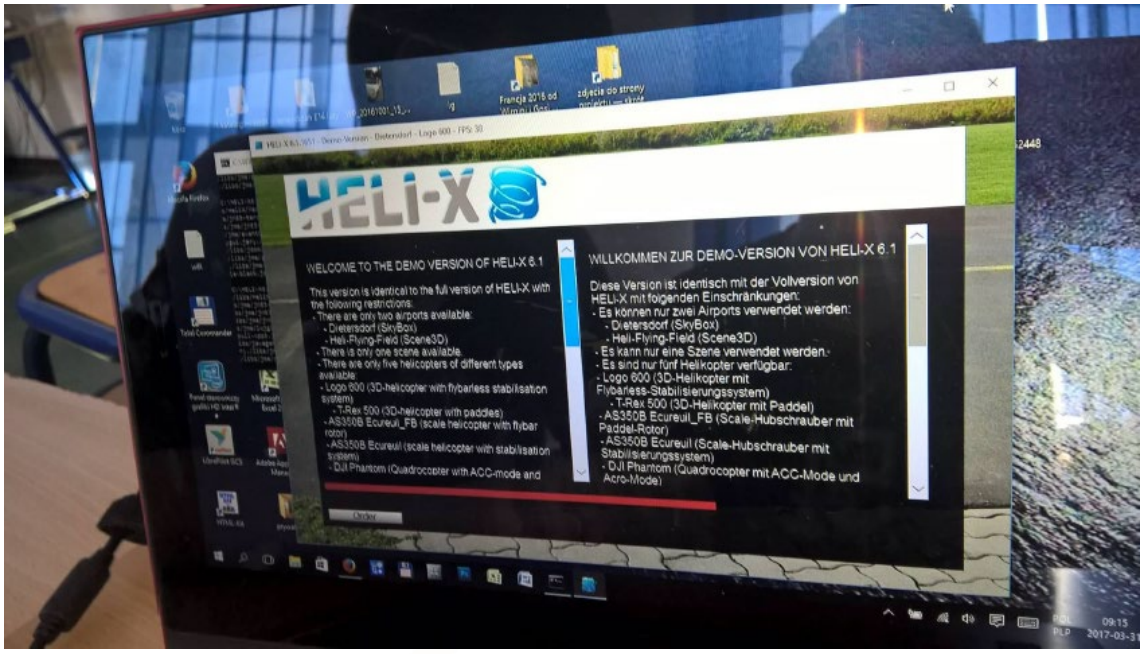
Before installation we can choose one of below options:

1. First install program after that connect transmitter to pc, but we should keep in mind to restart program after
2. First prepare and connect transmitter to pc, after that install program.

We choose the first option

First, start to install simulation program. We can use free software program for example HELI-X adware.

After software installation unfortunately, advertising appears in this version of this program from time to time.



Next, prepare our transmitter to connect with PC

We work in Mode 2. On the left side we have **Throttle/Yaw**, on the right site we have **Pitch/Roll**.

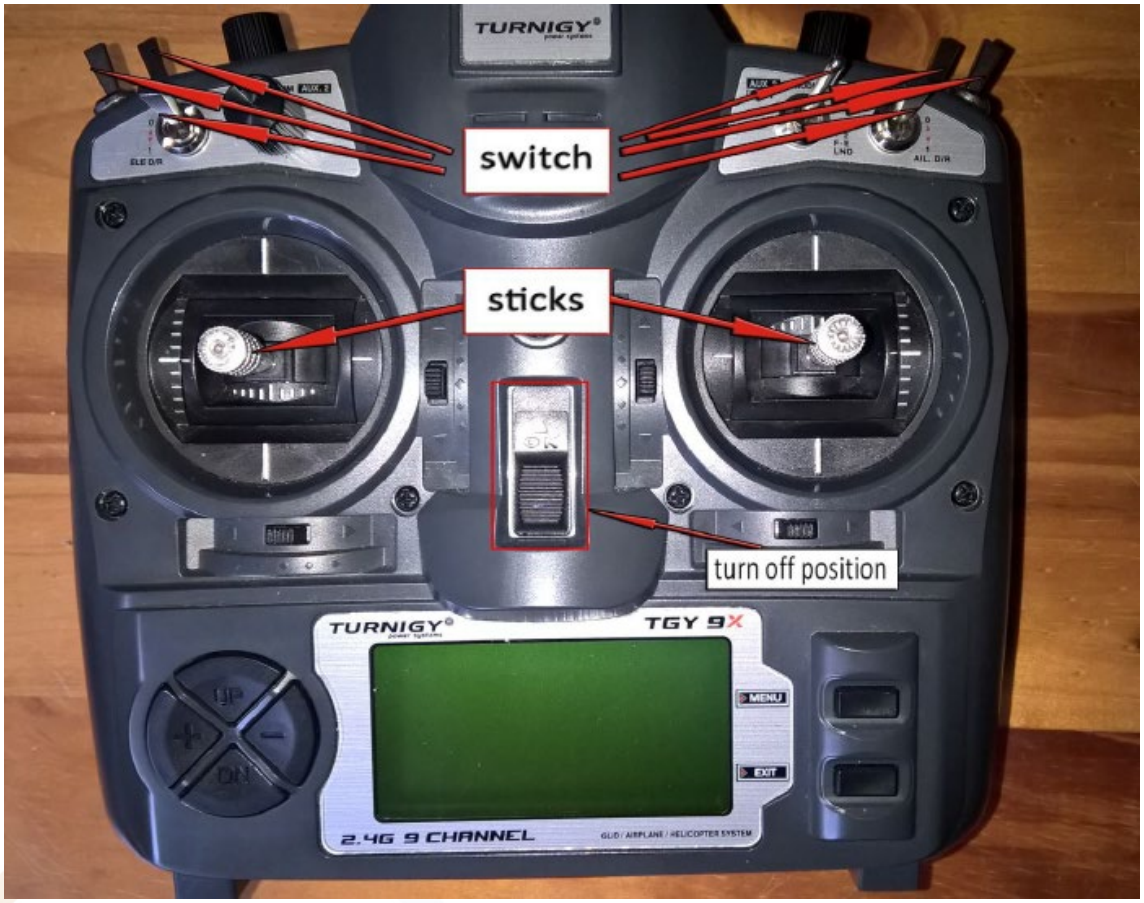
First, disconnect receiver from transmitter. This receiver is responsible for communication between transmitter and drone.

We must be careful, because **we can't break down** cable (white cable in this picture).

Connect mini jack to transmitter.

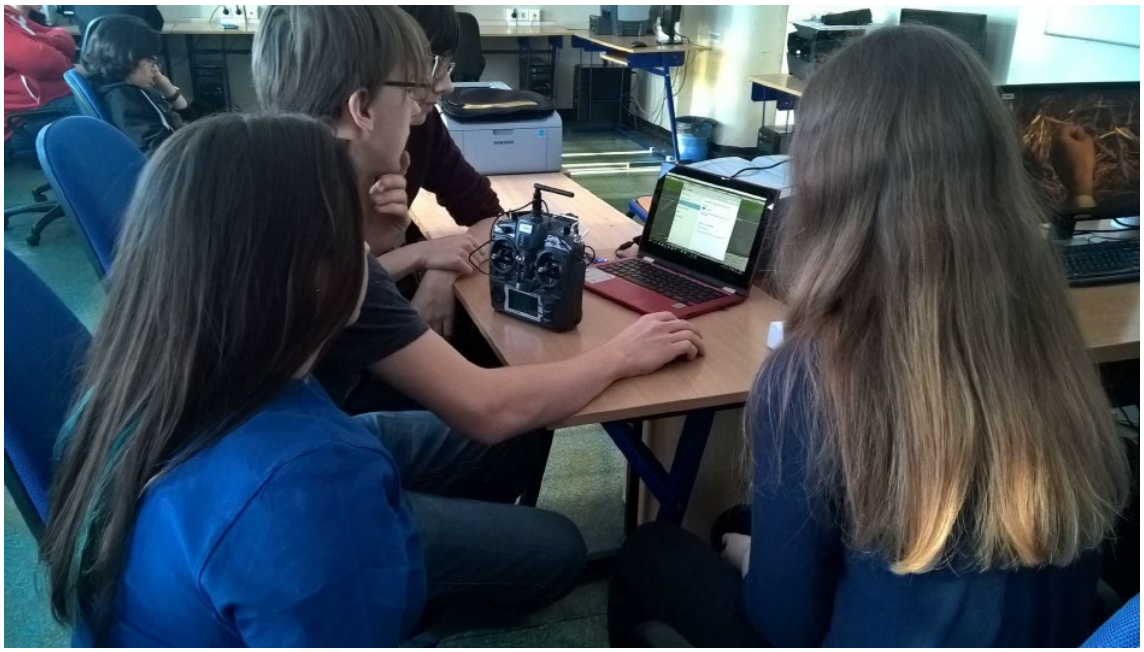
The transmitter must be in **turn off position**. And all the **switch** which you see on top of the transmitter should be **turned down.**

Next, connect transmitter to computer.

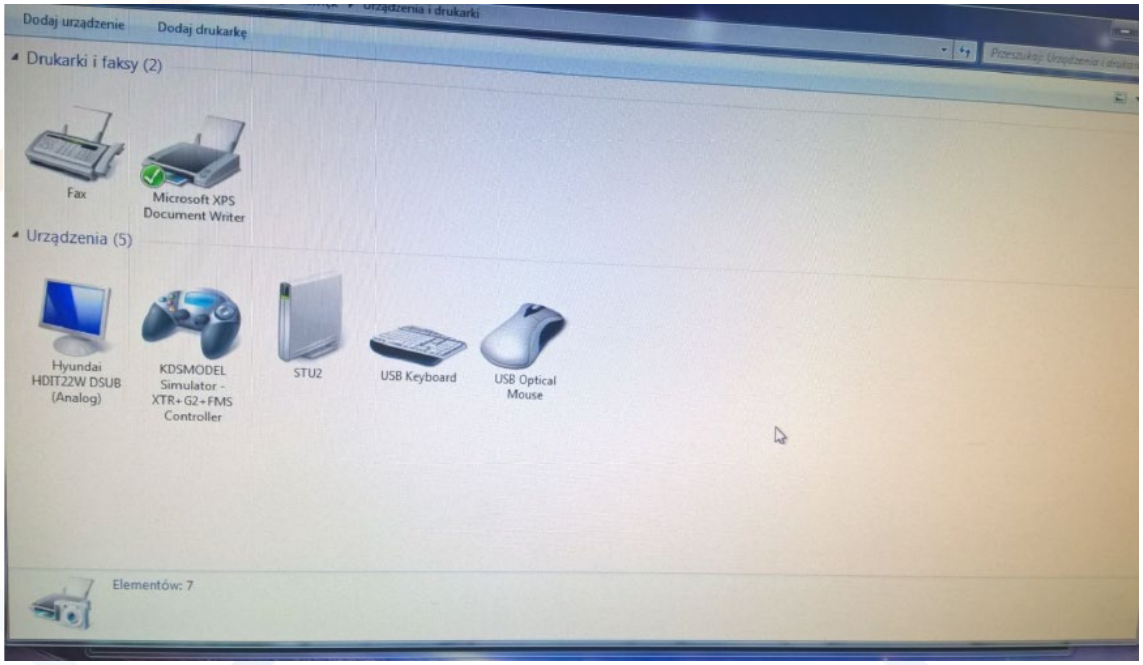


Connect USB cable to PC

If you have any problem with connecting transmitter with PC, you can check settings in Control Panel.



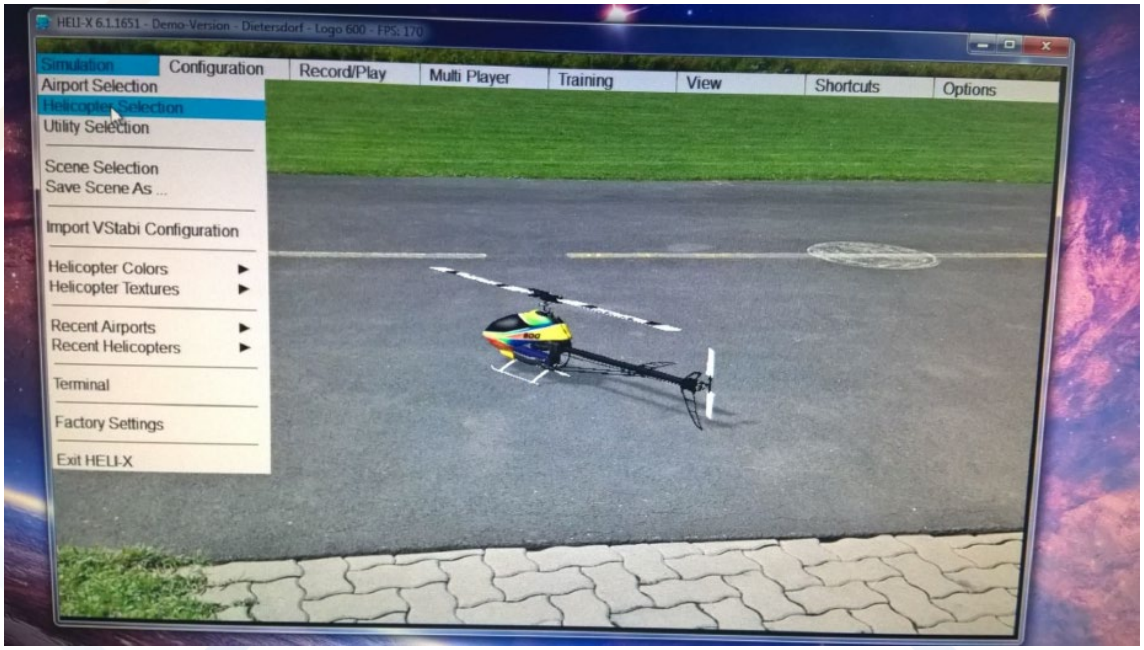
The transmitter should get installed automatically, bellow print screen from option on the control panel – devices and printers.



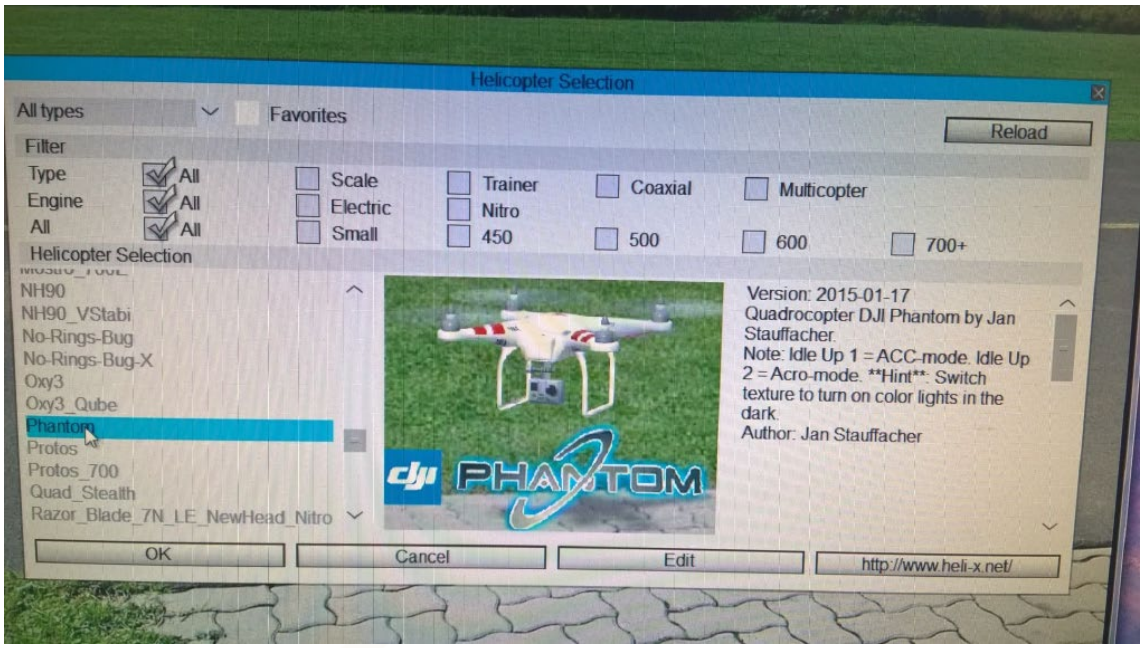
When all is ok, at this moment we must restart program.

After successful installation and restart program, next, we do configuration. **First we select model to fly.**

Run option from top menu – **„Simulation/Helicopter selection”**.

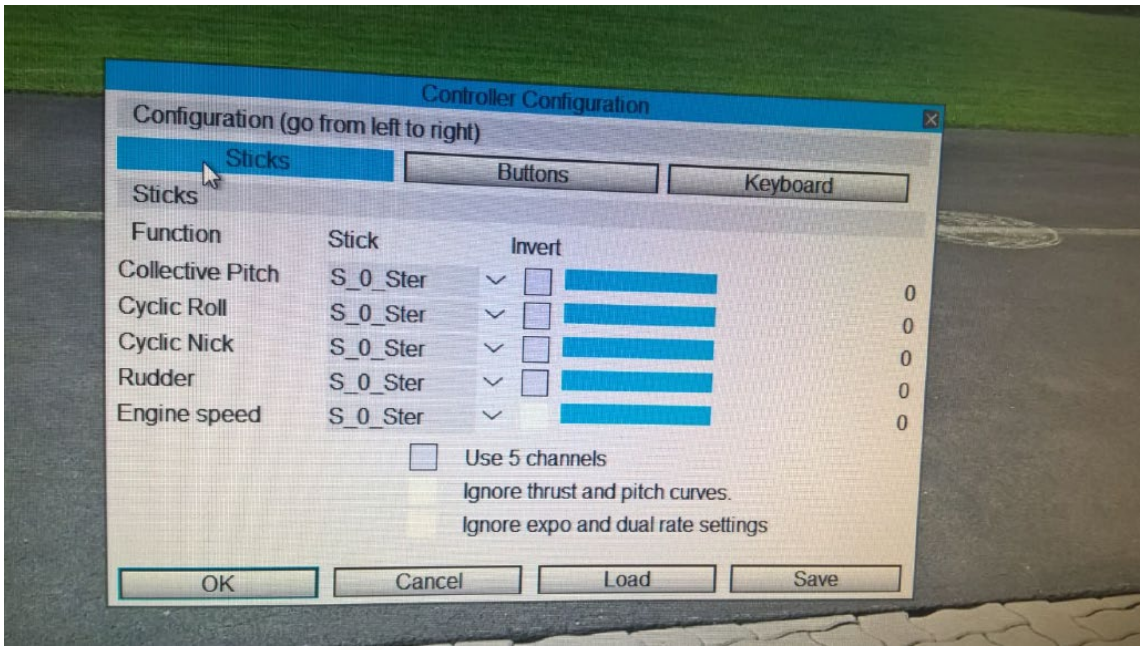


And choose **Phantom model**, which is displayed below.



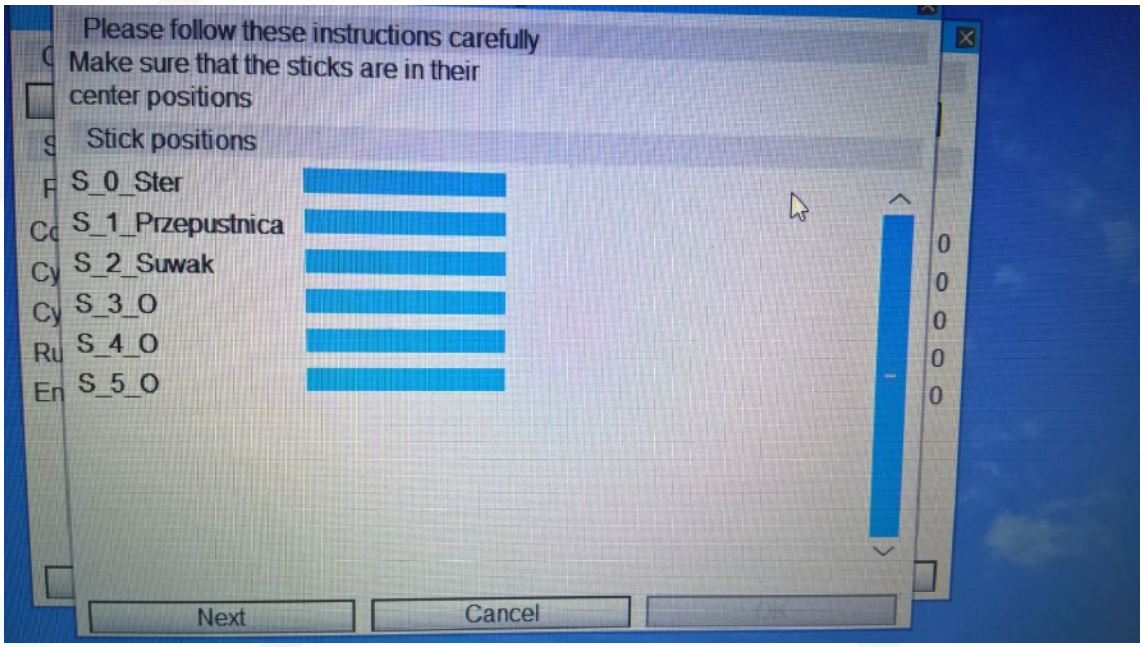
Next step, calibrate transmitter in HELI-X. Choose option from top menu – **„Configuration / Controller".**

……and **press button „Sticks”**

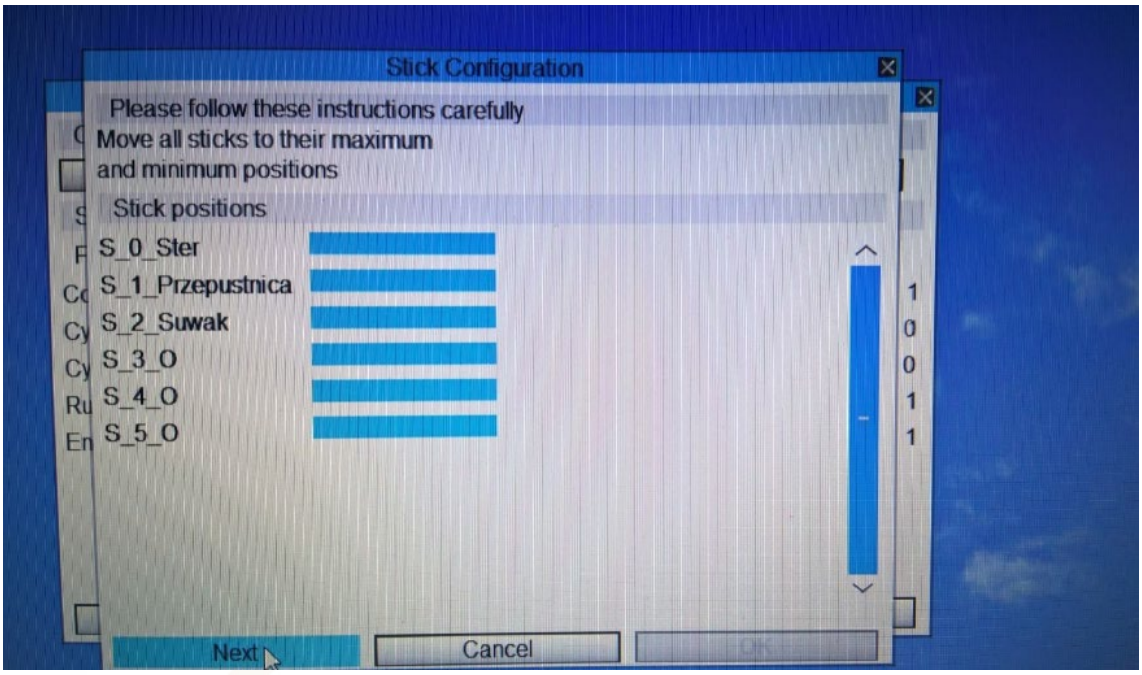


3.2. CALLIBRATION OF TRANSMITTER IN HELI-X

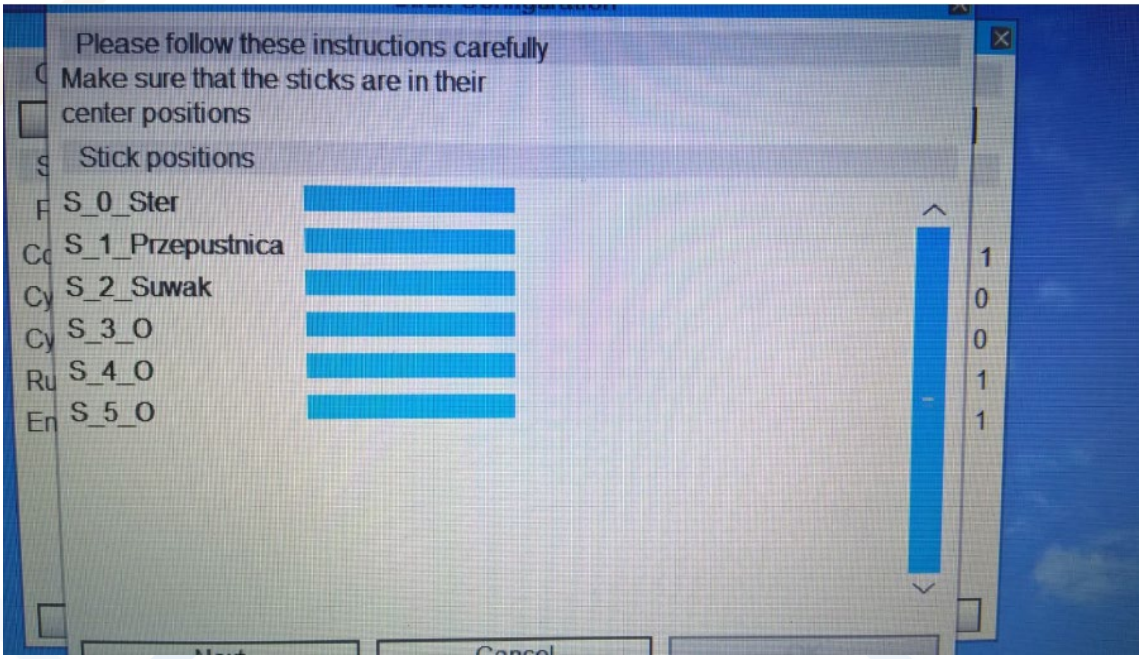
1. First the **sticks** should be in the **centre** position.



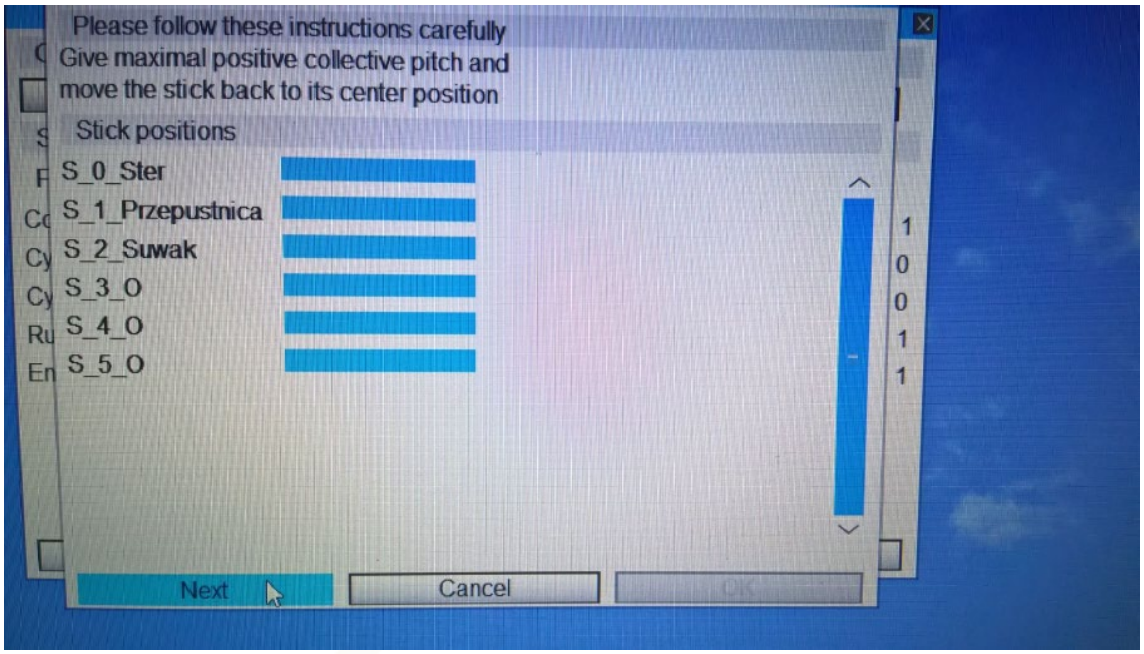
2. Move one of the **sticks** in all directions **several times** and then do the same with the second stick.



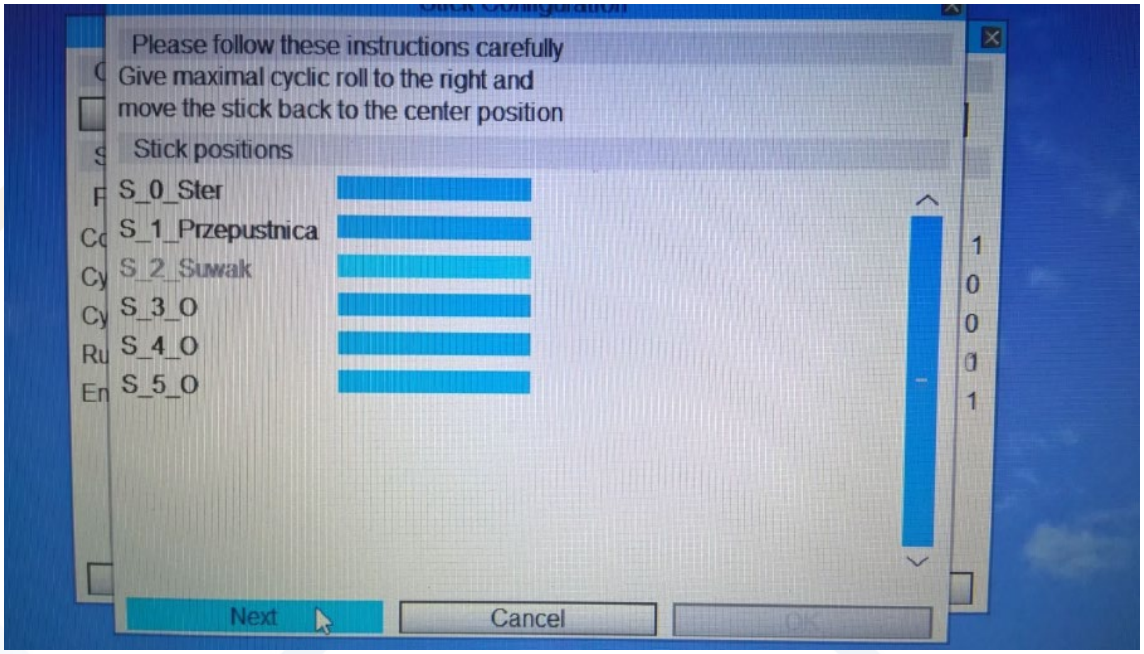
3. **Again** put the sticks **in the centre** position.



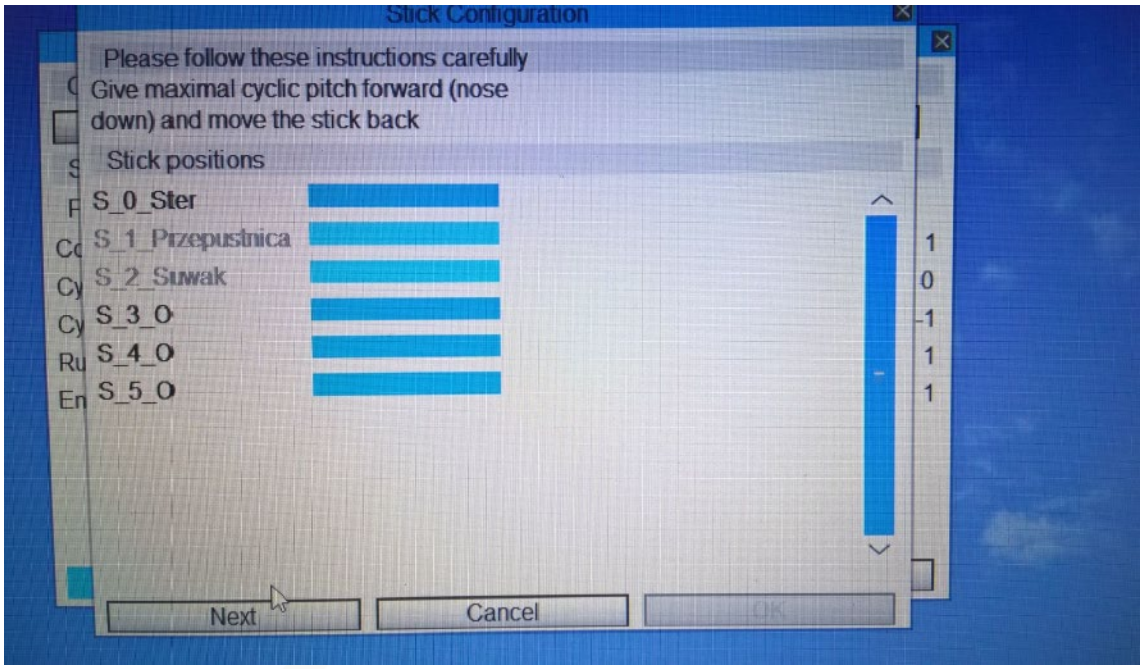
4. Give the **throttle** – in our case the left stick – **up to maximum** and return to the centre.



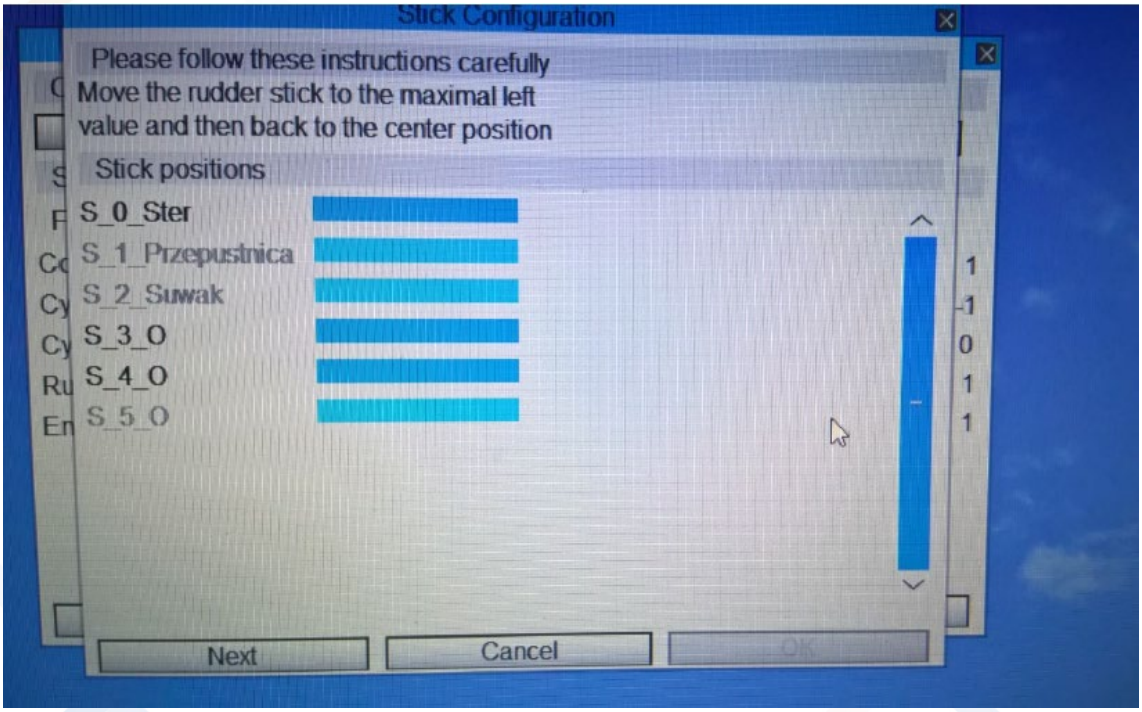
5. Give the **roll** – in our case the right stick – **right to maximum** and move stick back to the centre position.



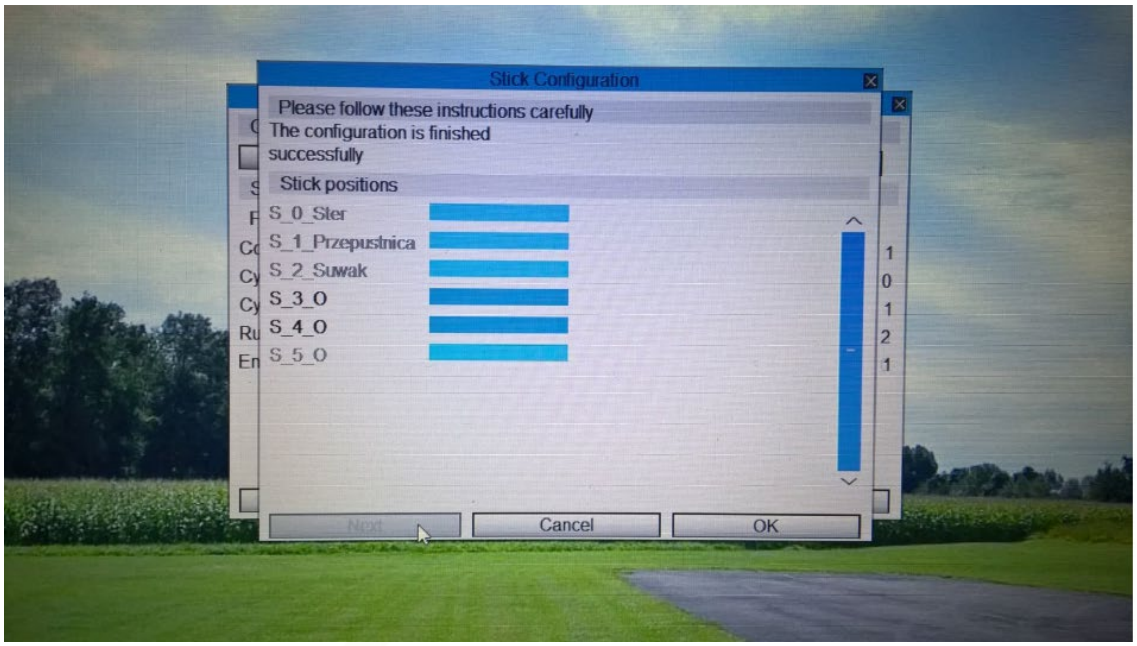
6. Move the **pitch** – in our case the right stick – **forward to maximum** and move stick back to the centre position.



7. Move the **yaw** – in our case the left stick – **left to maximum** and then back to the centre position.



8. If calibration good run, then **received communication** about all is ok.



Calibration went ok and we can **start simulation.**

4. HOW TO FLY A DRONE

4.1. PLANNING A SIMPLE MISSION

4.1.1. INTRODUCTION

The drone is equipped with GPS, so we can plan an autonomous mission for it. This means that we design a route in the Mission Planer program. The file will be loaded to drone, then in the field after switching to AUTO mode, the platform will perform specific tasks.

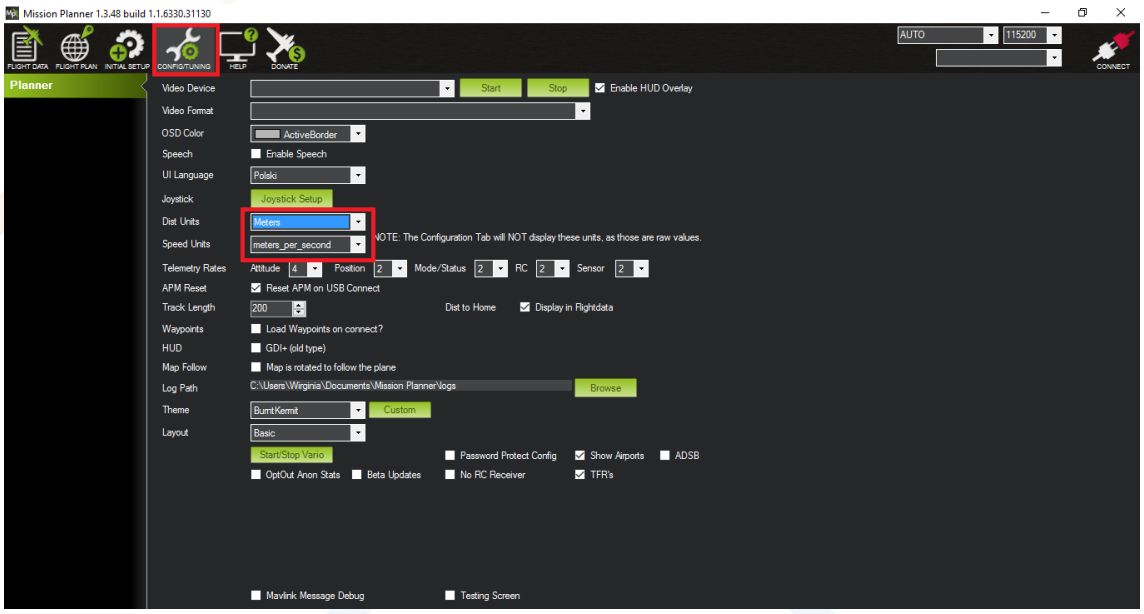
In general, the plan of such a mission should include:

- start
- flight
- landing

4.1.2. DISTANCE UNIT SETTINGS

Mission planning can be done without connecting to the flight controller.

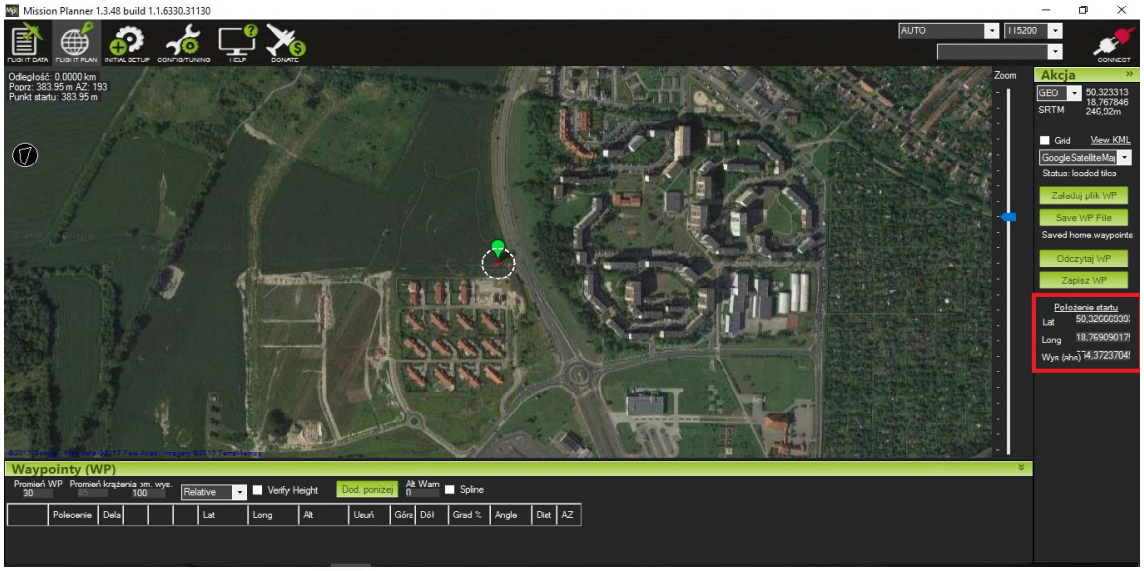
In the first step after starting the program, it is worth checking in which units the speeds and distance will be given. This can be done in the CONFIG / TUNING tab. You can choose meters or feet. Of course, we choose meters.



Did you know that NASA lost the Mars Climate Orbiter probe in 1999 due to the use of heterogeneous units? They used pound and newton in the project and this mistake cost millions of dollars.

4.1.3. DETERMINING THE HOME POINT

Let's now set the HOME point. This is the place where you will start your mission and the place where the drone will be armed. To do this, find your position on the map.

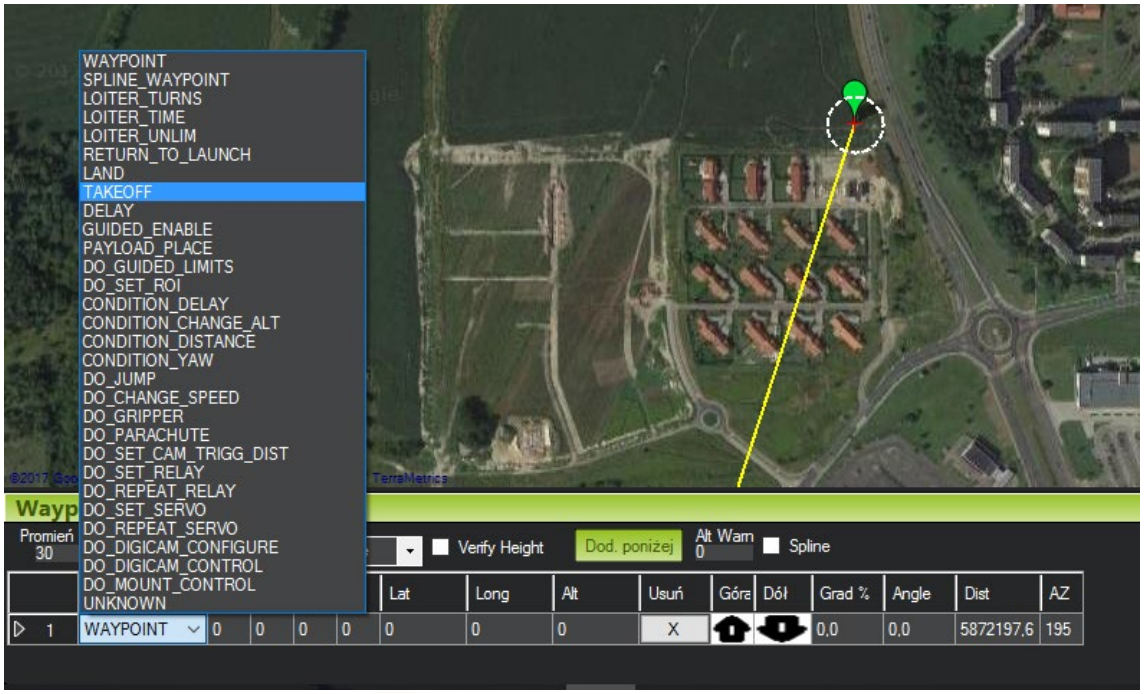


When you click on an empty map, the program will inform you that you must add this point. Then just move it around the map until you find the right area. The coordinates shown on the right are also helpful. If you have exact coordinate values, you can paste them into the appropriate fields.

When the drone is connected to the program a GPS signal is downloaded, and the map is opened immediately in the place where the drone is located.

4.2. MISSION PLANNING – START

The first command for a drone should be the start. So choose "add below" - WAYPOINT will be added, which has a secondary (0,0). We do not care about it, we only change to TAKEOFF. There, we also set the altitude to which the drone is supposed to rise - the Alt field

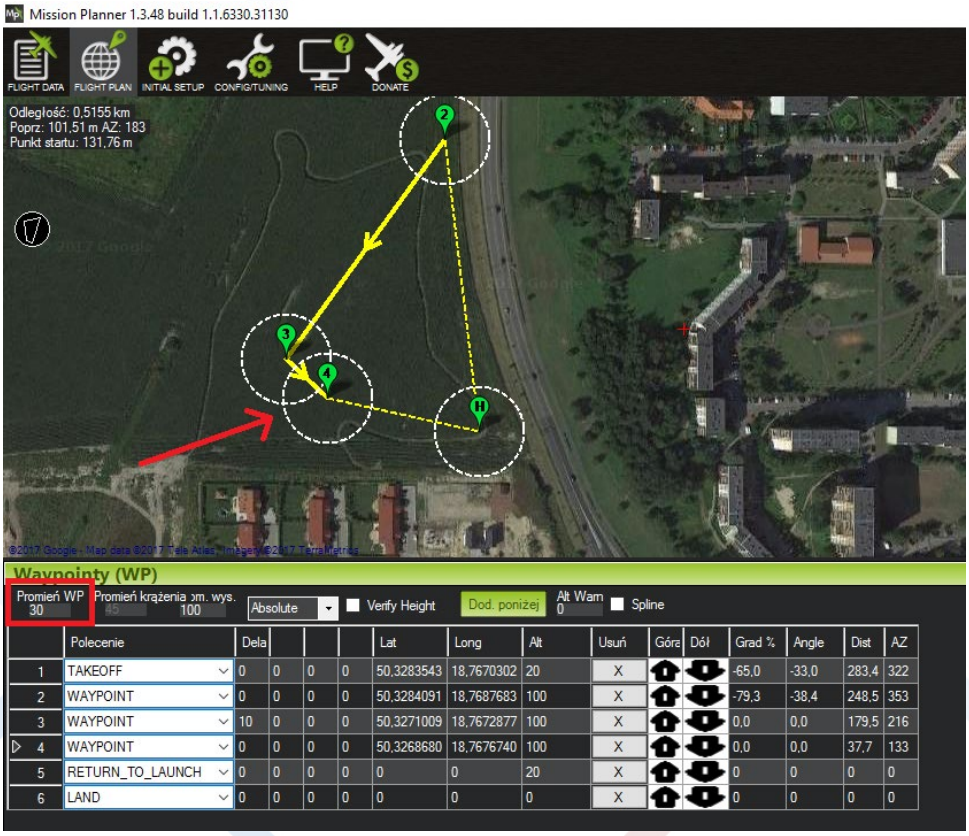


4.3. MISSION PLANNING - ADDING WAYPOINTS AND THEIR SETTINGS

After setting the automatic start, we can add additional points over which the drone is to be passed Just point your mouse to the next places and click. Additional items marked as WAYPOINT are added to the list. Points are counted if the drone is inside a circle around a specific point. To change the radius, use the field labelled WP Radius

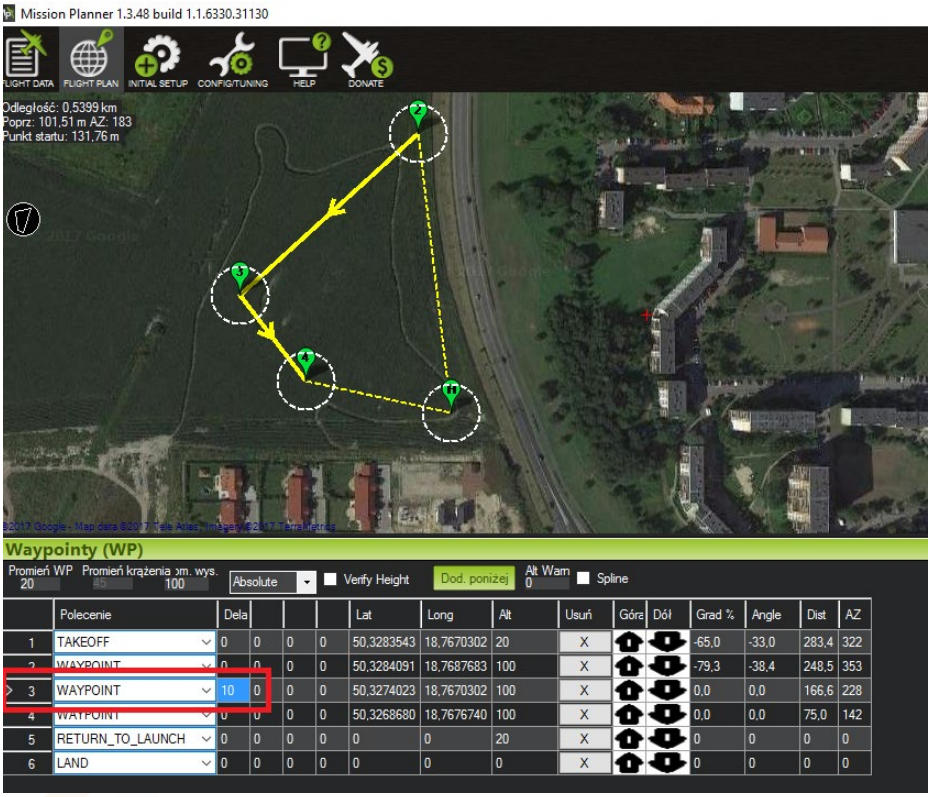
	Polecenie					Lat	Long	Alt	Usuń	Góra	Dół	Grad %	Angle	Dist	AZ
1	TAKEOFF	0	0	0	0	50,3283543	18,7670302	100	X			-65,0	-33,0	283,4	322
2	WAYPOINT	0	0	0	0	50,3284091	18,7687683	100	X			-79,3	-38,4	248,5	353
3	WAYPOINT	0	0	0	0	50,3274023	18,7670302	100	X			0,0	0,0	166,6	228
4	WAYPOINT	0	0	0	0	50,3268680	18,7676740	100	X			0,0	0,0	75,0	142
5	RETURN_TO_LAUNCH	0	0	0	0	0	0	20	X			0	0	0	0
6	LAND	0	0	0	0	0	0	0	X			0	0	0	0

Make sure that the circles do not overlap. When the drone fills over such a common area, the flight controller will consider that he has already scored another point and will go to the next one.

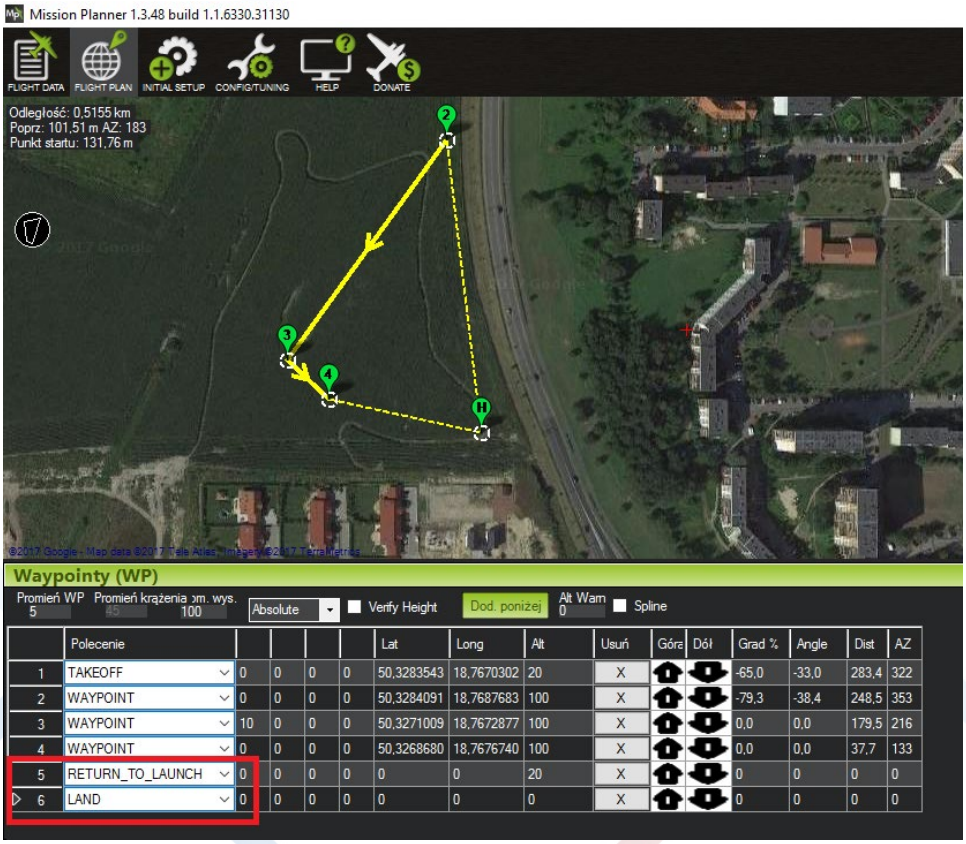


	Polecenie	Dela				Lat	Long	Alt	Usuń	Góra	Dół	Grad %	Angle	Dist	AZ
1	TAKEOFF	0	0	0	0	50,3283543	18,7670302	20	X			-65,0	-33,0	283,4	322
2	WAYPOINT	0	0	0	0	50,3284091	18,7687683	100	X			-79,3	-38,4	248,5	353
3	WAYPOINT	10	0	0	0	50,3271009	18,7672877	100	X			0,0	0,0	179,5	216
4	WAYPOINT	0	0	0	0	50,3268680	18,7676740	100	X			0,0	0,0	37,7	133
5	RETURN_TO_LAUNCH	0	0	0	0	0	0	20	X			0	0	0	0
6	LAND	0	0	0	0	0	0	0	X			0	0	0	0

If we want the drone to wait sometime after hitting a certain point, enter the number of seconds in the column marked Dela

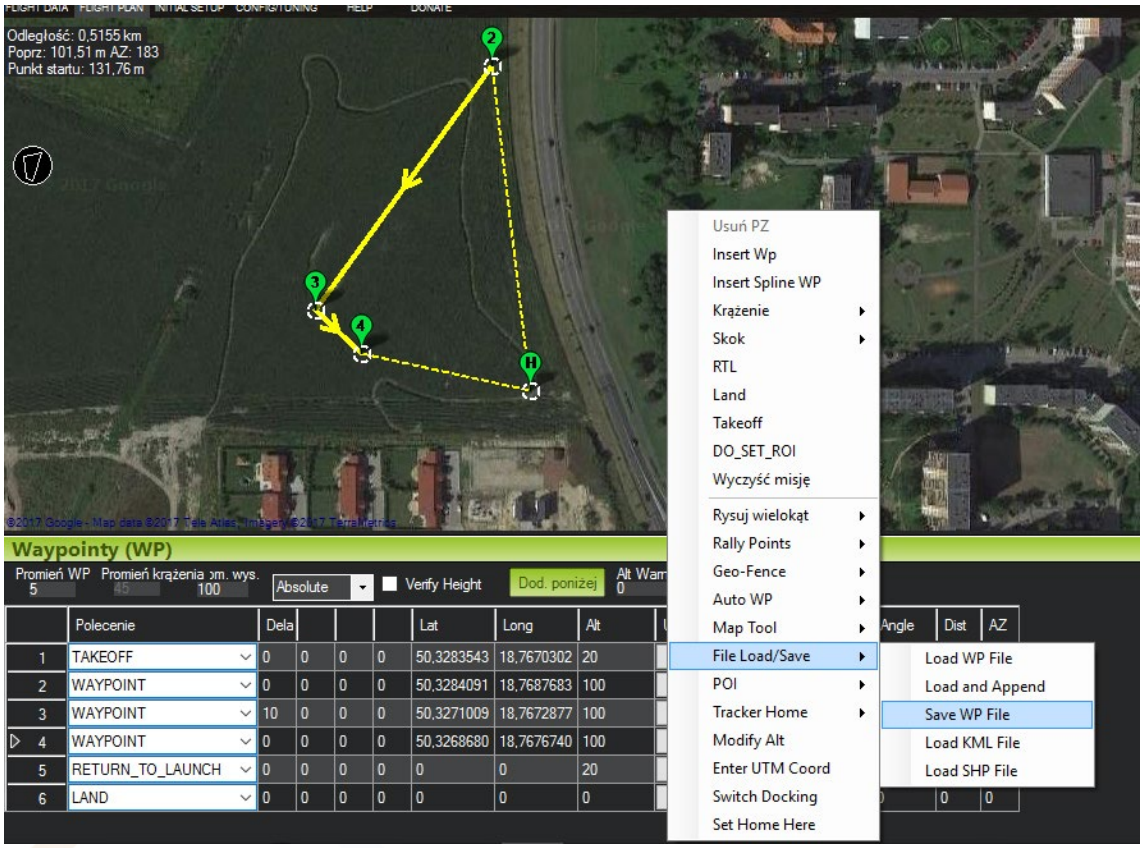


4.4. MISSION PLANNING - MISSION END



4.5. LOADING A MISSION TO THE FLIGHT CONTROLLER

After planning the mission, you must save it. Right-click on the map and select File Load / Save -> Save WP file Select the location for the file and enter its name.

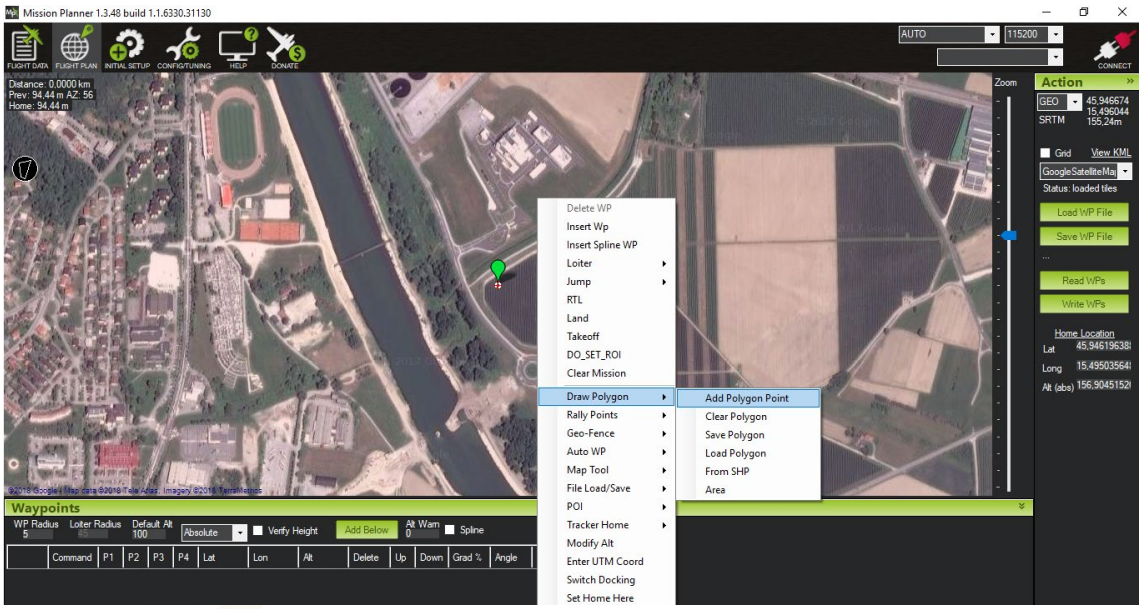


Here you can also select a previously saved file and load the mission into the Mission Planner Program. Now connect the drone (via USB cable or via telemetry). Then you can load the mission into the APM memory when you choose the WRITE option The mission will be performed after selecting the AUTO mode.

5. MISSION PLANNING

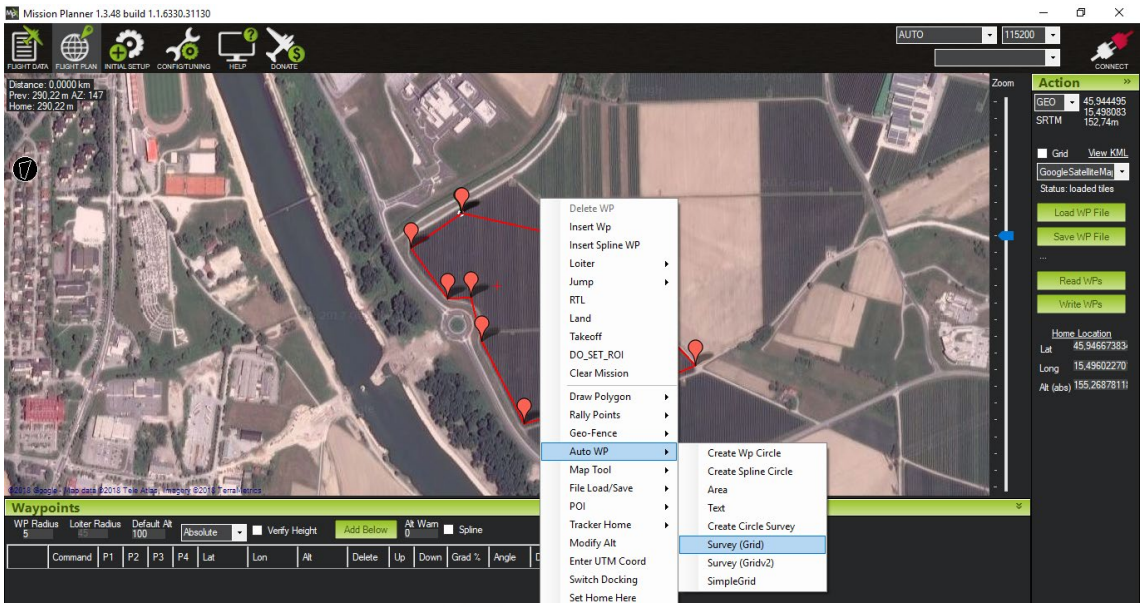
On the empty map with the Home point labelled, right-click and select from the menu

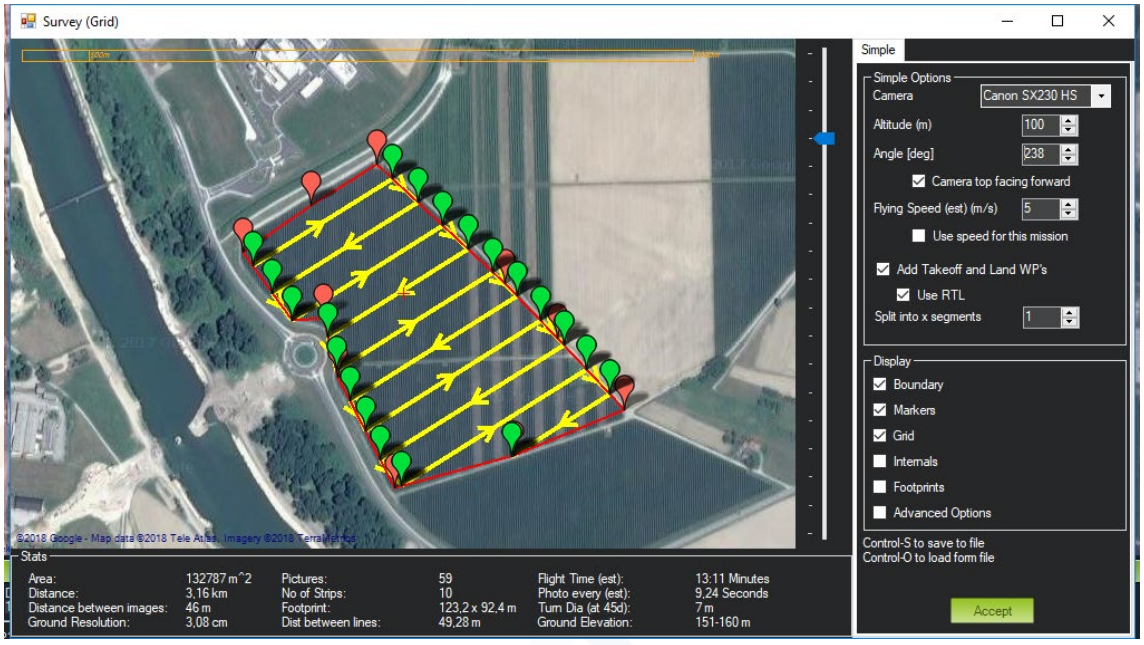
Draw Polygon ->Add polygon point



On the map, mark the points that are the boundaries of the area you want to study.

Click PPM again and choose AUTO WP -> Survey (grid). The windows will open, where you can add individual mission options such as altitude, flight speed and add take-off and landing





After approval, Mission Planner adds a whole range of Waypoints and other commands to the mission list.