DRONES4VET

Co-funded by the European Union

MODULE 05

TRAINING PROGRAMME

FLIGHT PRACTICE

Comunidad de Madrid | Dirección General de Formación | CONSEJERÍA DE ECONOMÍA, HACIENDA Y EMPLEO

DEX Desarrollo de Estrategias Exteriores

CAMPUS DES MÉTIERS ET DES QUALIFICATIONS D'EXCELLENCE Habitat, énergies renouvelables et éco-construction Occitanie

MTU Ollscoil Teicneolaíochta na Mumhan Munster Technological University

BZB Bildungszentren des Baugewerbes e.V.

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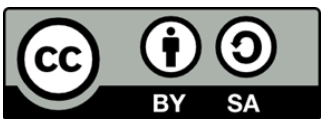

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1. Objectives of the module

This module allows you to take control of the drone from a beginner's level to a first step allowing you to fly in the open category sub-category A2 where a self-training flight course must be done.

A secured flight zone is proposed, and all the exercises take place in this zone.

The flights are purely utilitarian in nature, with a view to taking manual photographs:

- Photogrammetry
- Expertise of constructions
- Thermography
- Lidar

NB: The module is written for a teacher who explains to his students, but a student alone can practice by following the module.

2. Flight preparation

Refer to module 2: FLIGHT PLANNING AND REPORTING to prepare your flight. It is important to review the checklist and fill the “drone mission sheet” with students.

Fill their flight logs and show them how to report an eventual incident.

Refer to the “maintenance” part of module 3: DRONE DYNAMICS AND MAINTENANCE for more in-depth technical preparation.

It is considered essential for students to register on the national website and pass the "open category A1/A3" online exam. It's very easy to do and also allows students to check that they've learnt the basic rules, and to fly legally.

It would be an error to go directly to the field and begin the exercises described below without giving the students good aeronautical habits.

3. General precautions

3.1 Learning Zone

The area must be forbidden to any outside person, we place ourselves as much as possible in category A3, at 150m from external persons and houses. A private ground is essential, no learning flight over the public domain. The authorization of the owner is, of course, necessary.

If this is not possible, sufficiently clear and wide area of the school can be used , marked out against intrusion, we are in a training unit and therefore covered by insurance for activities related to teaching. The flight will then be in subcategory A1, the drones used will not be able to exceed 900g and be certified C1 (except for old uncertified drones of less than 500g until January 2024, likely to be extended).

It is preferable that in this area the GPS is well connected.

In particular, with small drones, it is also possible to make the very first flights in a gymnasium, closed to any outside person. This is the ideal solution for the first manual flight of "big" drones, as no rules apply, fly when needed. WARNING: the GPS does not work or does not work well, it must be deactivated to avoid any problem, if possible.

3.2 Flight Settings

The configuration of the drone for the flight has been made by the teacher in advance and will only be changed after the first exercises have been successfully completed.

Example of learning settings for a Parrot ANAFI

- Mode 2 for joysticks (right=up/down and rotation; left=forward/backward and right/left translation), classic by default.
- Overall reactivity 50%.
- Inclined turn: YES
- Maximum drone inclination 8°, so horizontal speed not too fast.
- Vertical speed 1 m/s
- Rotation speed 50°/s
- In hand take-off : NO
- Hovering altitude 2m (outdoors), 1m (indoors)
- Manual flight
- Film mode (the slowest mode)
- Geo-cage: set a maximum height (20m is correct to learn and avoid bad visibility) and a maximum distance from take-off position (depending on your exercises, but we recommend 30m for security at the beginning)

3.3 Example of secured drone evolution zone

We experimented this kind of positioning for a group of 9 students.

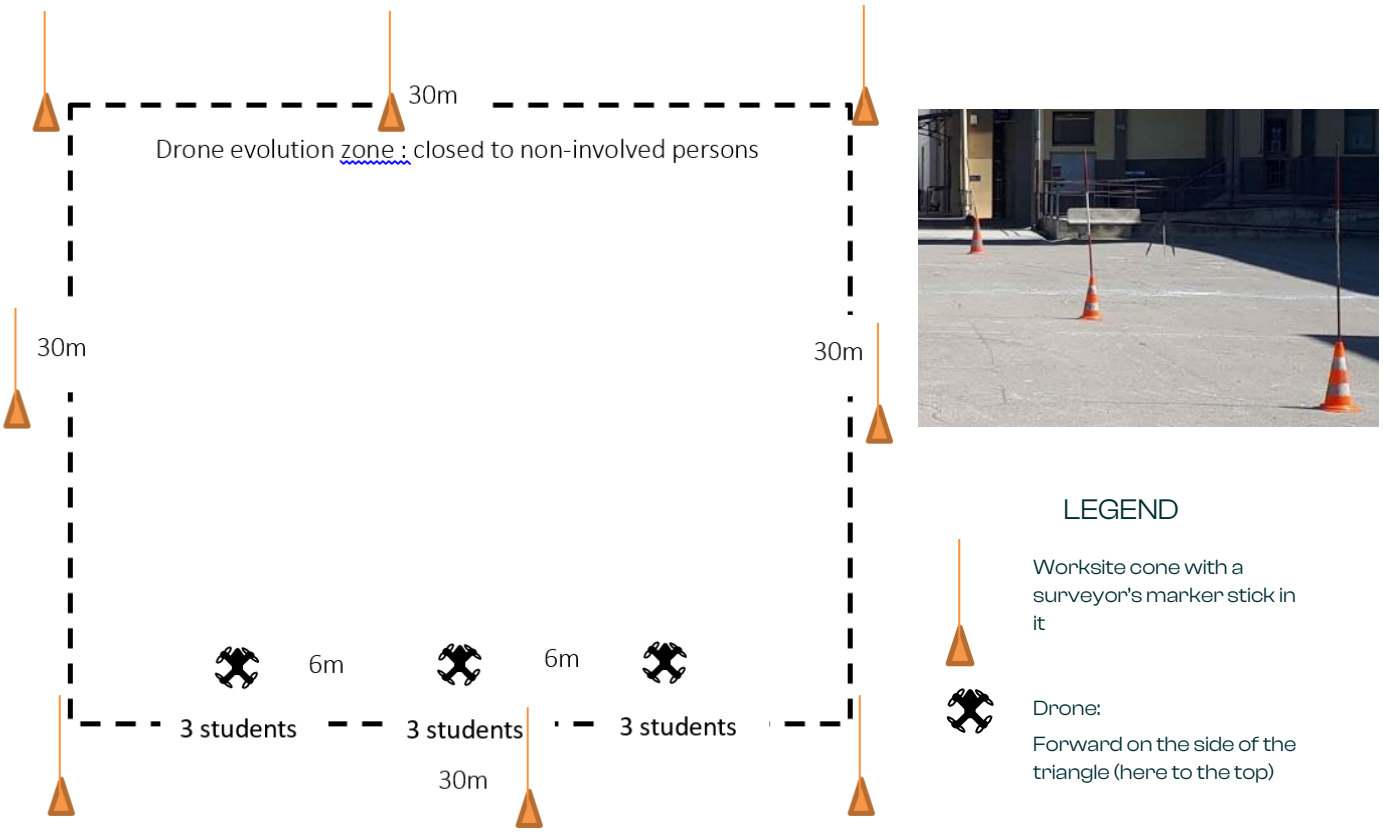


Figure 3-1Example of flight zone

The teacher is behind his pilots, the drones are in front of the pilots, THE BACK OF THE DRONE TO THE PILOT during take-off and landing.

A maximum of 3 small drones can be flown simultaneously in this context, a spacing of 5 to 7m is necessary between the drones, and each student-pilot is supervised by a fellow student, with the teacher in the middle. Each take-off area is clearly marked on the ground.

NB altitude : each pilot has an assigned altitude, such as 5, 10, 15 meters, or more if necessary when all drones are simultaneously in flight.

NB **TEACHER**: the teacher must be ready to shout "**STOP**"! in case of danger, and must first explain to his students that it means to **remove the fingers from the joysticks**: the drone stops immediately without moving.

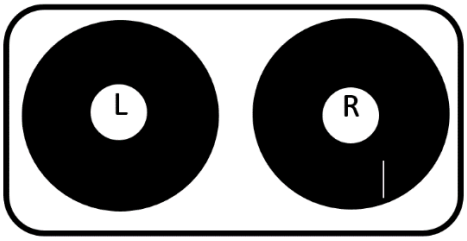


Figure 3-2 drone controller image

4. Basic exercices : understand the controller

4.1 Controller's display

Start the drones on the ground

Review the indications on the remote control display:

- Camera visualization
- Map visualization
- Altitude
- Distance from the take-off point
- Horizontal speed
- Battery charge of the drone / remote control
- GPS in good reception – RTH memorized
- WIFI in good reception
- Camera tilt
- Camera settings / shooting

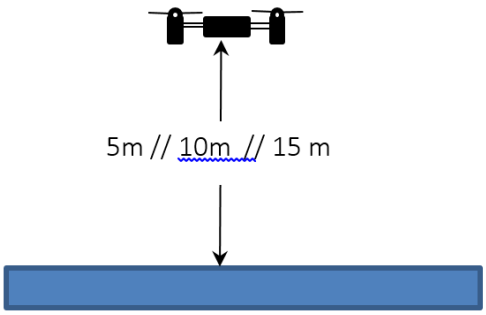
4.2 Unidirectional flight

These exercises allow for individual understanding of each piloting command.

On instruction, all students perform the manoeuvres at the same time:

> ***TEACHER'S REMINDER: If the teacher shouts "STOP"! it means to lift the fingers of the joysticks: the drone stops at the same moment without moving.***

Take-off by pressing the dedicated button, one pilot after the other, and hovering flight



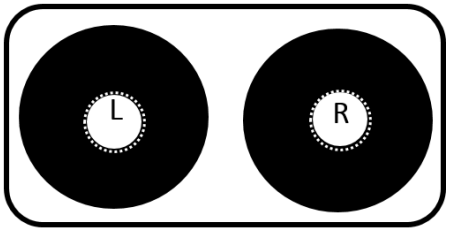


Figure 4-1 take off and hovering flight

Right joystick " horizontal translation stick " (it can be written on the school controls)

- To the left and to the right in translation, stop at 10m

Figure 4-2 horizontal translation: sideway

- Back to the centre, above the take-off area
- Forward and backwards stop at 15m

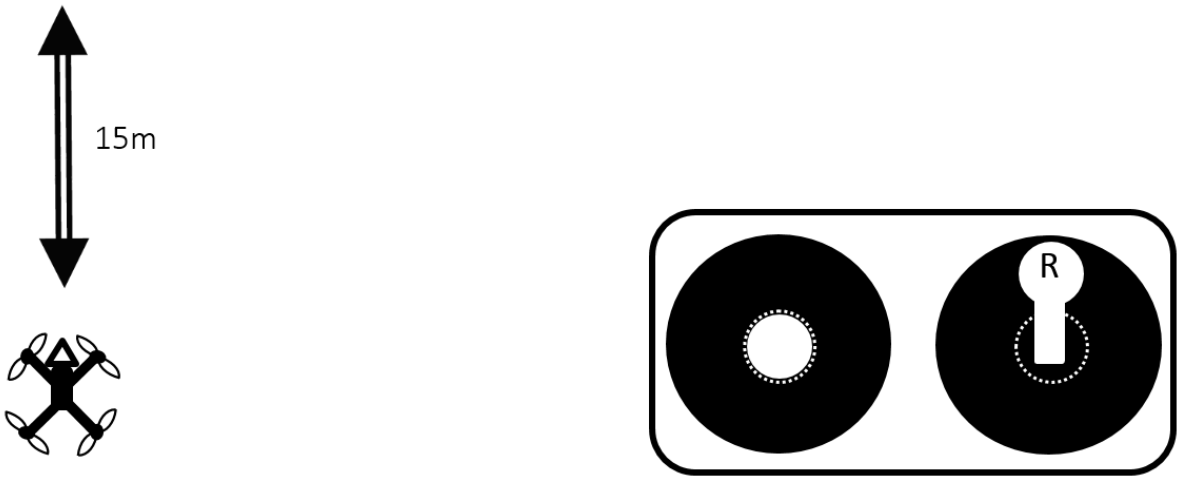


Figure 4-3 horizontal translation: forward/reverse

- Return to centre, above the take-off area

Left joystick " vertical axis joystick ".

- Up, stop at maximum programmed altitude and down, stop at 3m

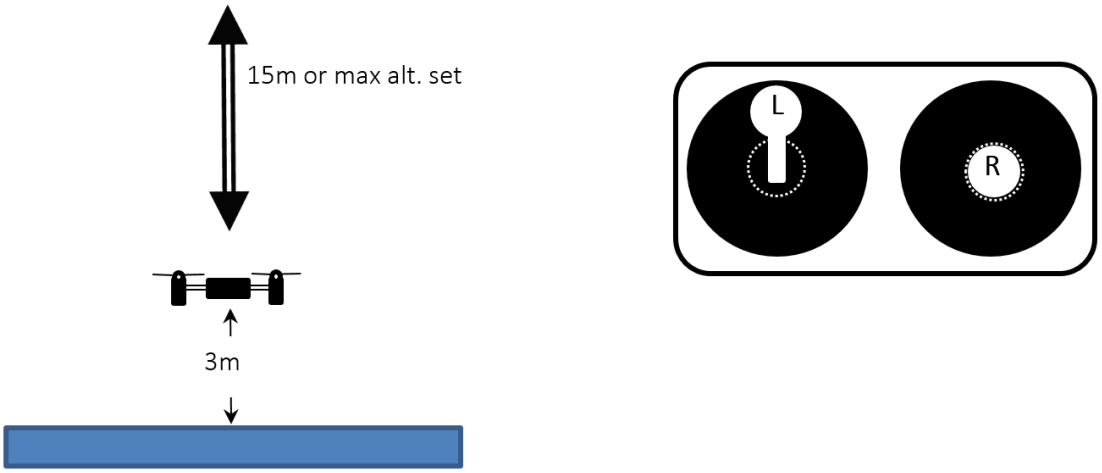


Figure 4-4 vertical translation

- Rotation on the spot to the right and to the left

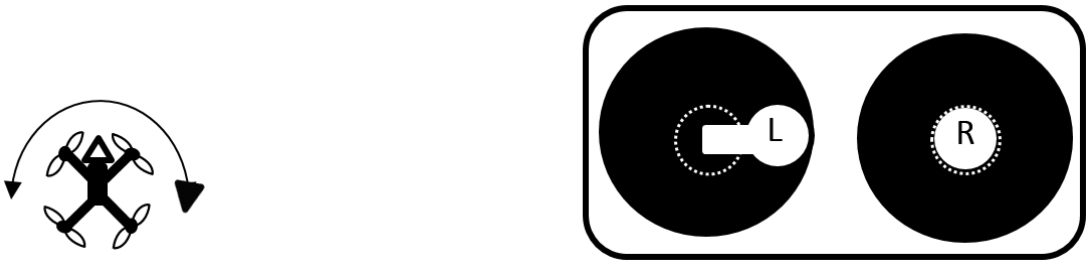


Figure 4-5 rotation on the spot

Repeat all the manoeuvres **SLOWLY**: control the sensitivity of the joysticks.

4.3 Combined flight

Centre above the take-off area

Right joystick

- Left forward: **diagonal** forward flight
- To the right in translation and backwards: diagonal backwards flight
- Other direction

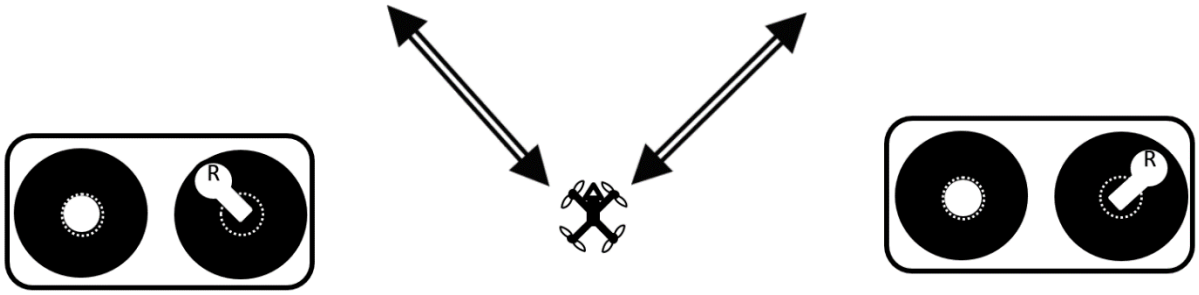


Figure 4-6 diagonal translation

Circles : move the joystick around, the drone always pointing the same direction

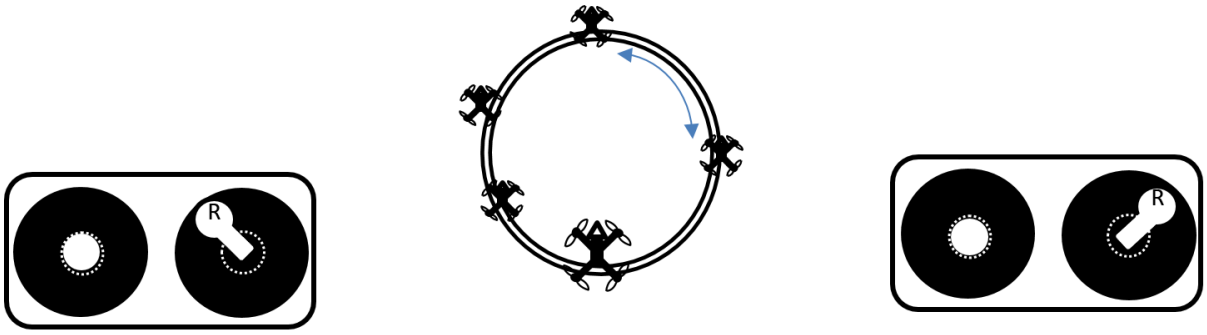


Figure 4-7 horizontal circle

Left joystick

- Up and to the right: **climb and turn** on itself
- Down and rotate to the right

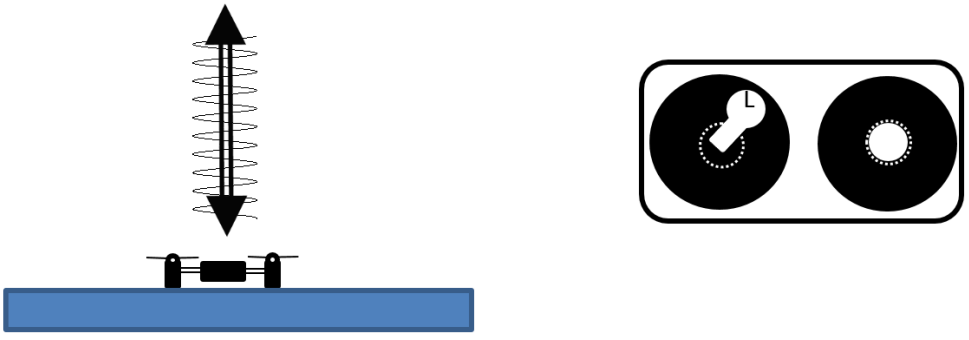


Figure 4-8 vertical and rotation

Two joysticks circle

each student does the manoeuvre individually first, making sure to control the speed of the movement

- Forward and right rotation: **arc to the right, fly "like an airplane**" CAUTION: the student must make a complete turn and control the radius by not going too fast and return to the position above the take-off area. **SLOOOOOWLY !!**
- **The drone is pointing forward**

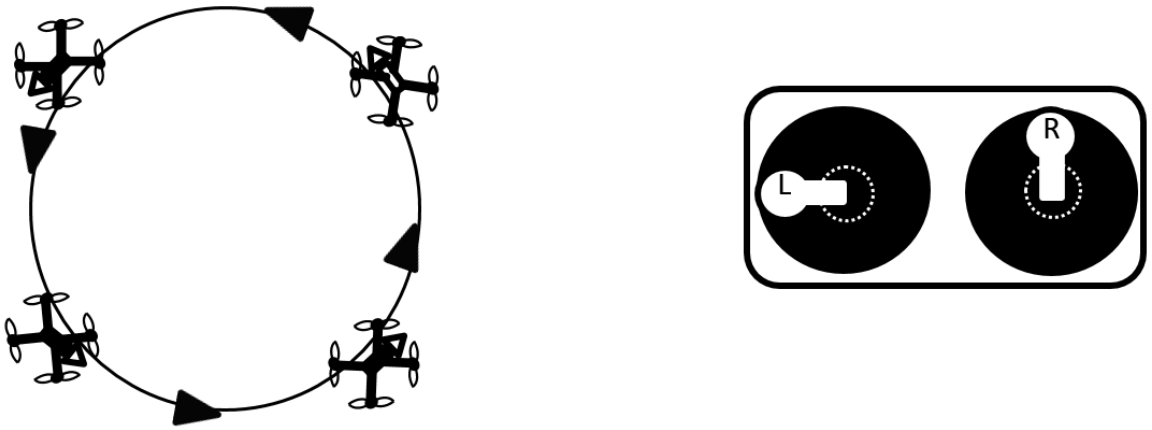


Figure 4-9 circle "like a plane"

Repeat in the other direction

Two joysticks slope

- Forward and up, backwards and down

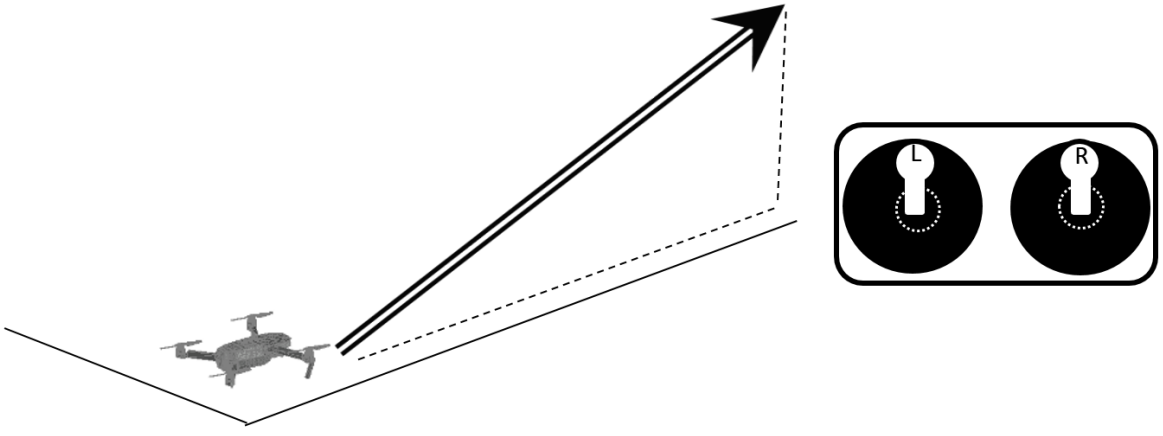
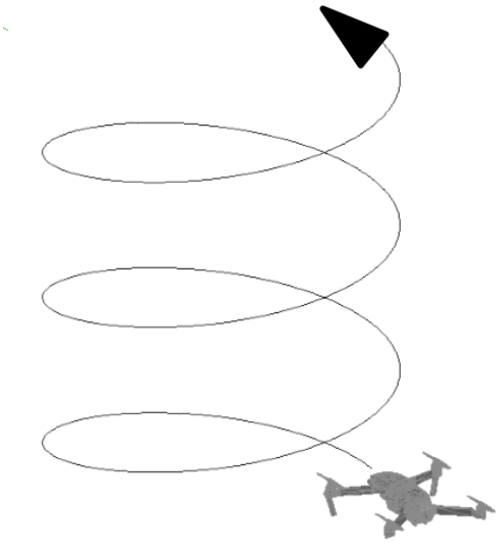


Figure 4-10 slope

Two joysticks spiral "like an airplane"

- Forward and upward and rotation: upward spiral "like an airplane"



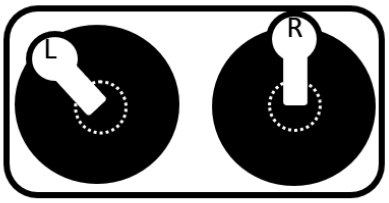


Figure 4-11 spiral

- Forward and rotation and descent: downward spiral "like an airplane"
- Other direction

IMPORTANT: you must show the difference in the drone's reactivity by changing the following parameters:

- Inclination: the more inclination you allow, the faster it goes in translation (forward/backward and right/left) 15° seems a maximum at the beginning, and in any case for our professional activity
- Rotation on itself: going towards 70 to 90°/s is a rather fast speed
- Vertical speed 3m/s is rather fast
- Try out the difference and find your own good settings
- It is important to insist on speed control: slowly at first

5. Flight control : make a circuit

5.1 General exercises

These exercises are not specifically dedicated to the work in construction or civil engineering but allow students to acquire a general mastery of the flight controls. These exercises require the instructor to position markers on the ground: the best is cones with a surveyor's marker stick (visible and high).

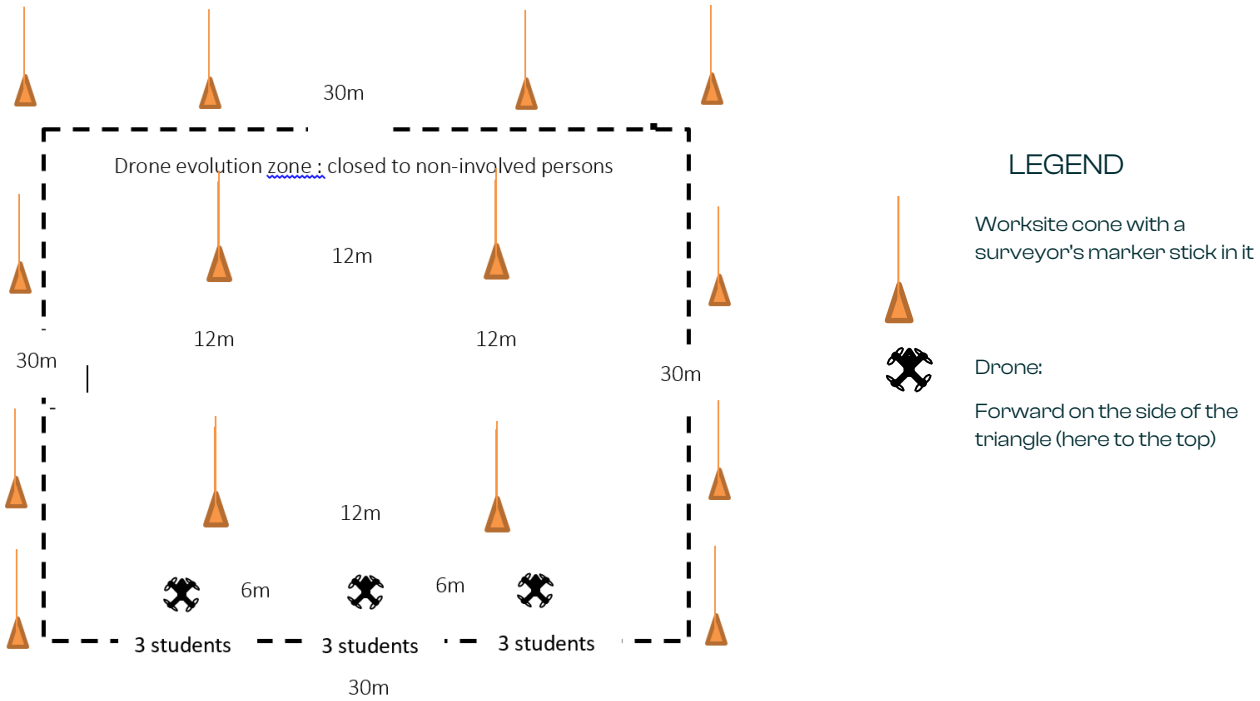


Figure 5-1 secured evolution zone with 4 flight markers

to avoid collisions:

Remember to give different altitudes to each drone (3 m separation minimum) !
All drones in the same direction !
If impossible, if the pilots can not respect the rule, then one after the other
Always come back to the ground at the end of a turn, then change student, take-off and go !

Following the sides:

1. Fly around the sides with the **horizontal flight controls.**
   Drone always pointing the same direction

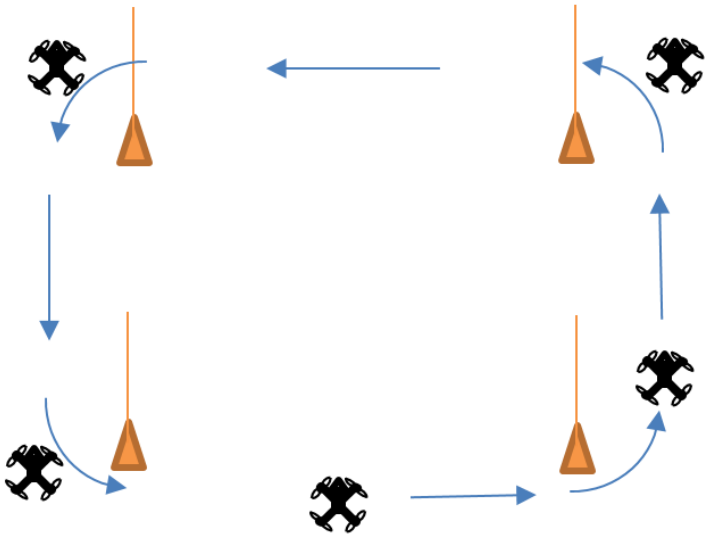


Figure 5-2 square translation

2. Fly along the sides "like an airplane" (forward and rotate the drone on each corner)
   Drone always pointing forward, in the direction of travel "like an airplane"

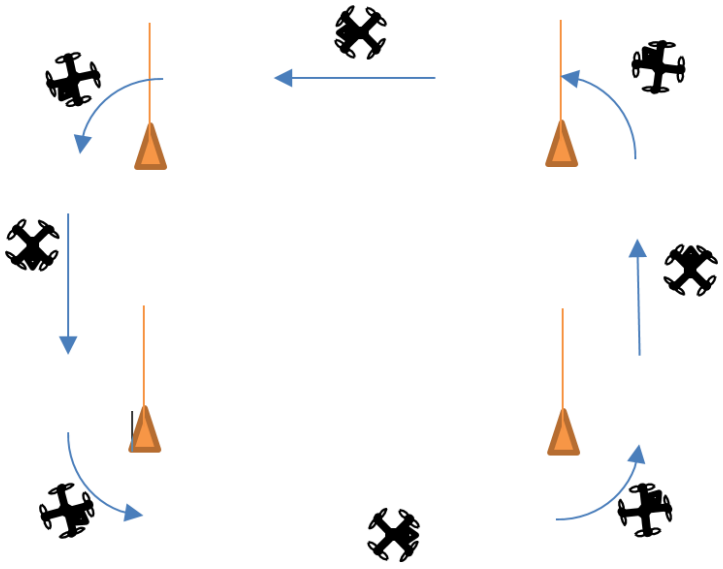


Figure 5-3 square flight pointing forward

Sides and centre: make an "8"

1. With the horizontal flight controls.µ
   Drone always pointing the same direction.

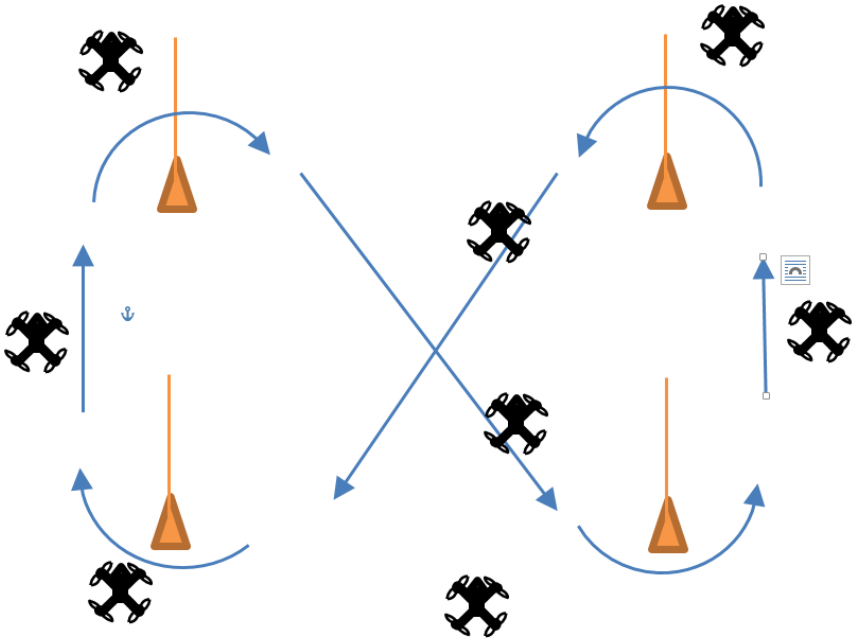


Figure 5-4 making an "8" in translation.

2. Flying "like an airplane ».
   Drone always pointing forward "like an airplane".

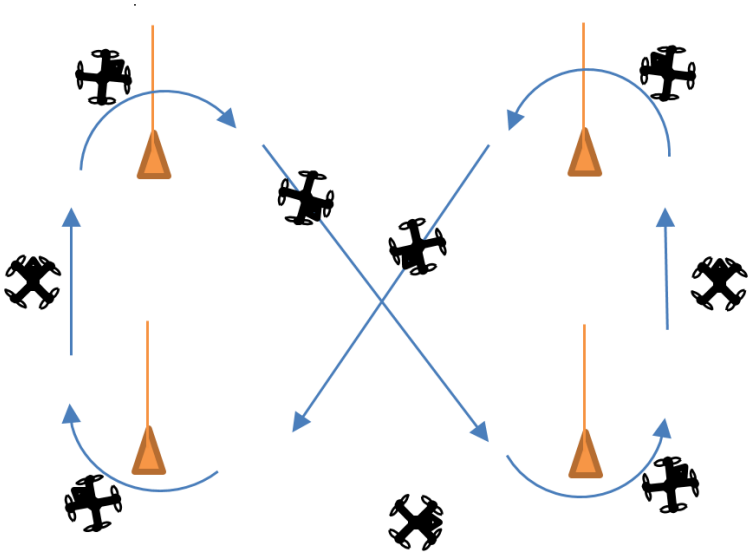


Figure 5-5 making an "8" pointing the direction of travel.

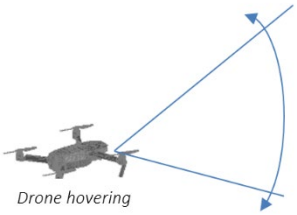
5.2 Camera use exercises

Here we pilot both looking at the drone AND looking at the screen to stay centred.

- It is interesting to display the 3x3 grid on the control display.
- Camera settings
- Movie mode MP4 automatic focus and exposure
- Photo mode maximum possible resolution, all automatic (at first)
- Horizon hold

Manoeuvring the camera alone

- Facing a vertical element, move the optical axis up and down with the joystick control (the "camera tilt") along the object, stopping on a precise element that must be centred
- Press the shutter button in video mode and film the sequence
- Switch to photo mode and take several shots



Camera up and down

Film capture

Pictures

Figure 5-6 camera tilt

360° around a point manoeuvre

Camera pointed on the centre: you must act on the two levers in opposition

Left stick causes the rotation which points the camera towards the centre

Right stick causes the lateral movement

One lever to the right, the other to the left, in opposition (or one towards the other for the other direction)

The action of the two simultaneously creates a circle with the camera always pointed at the centre.

You have to find the right setting with your fingers so that the camera remains pointed towards the centre

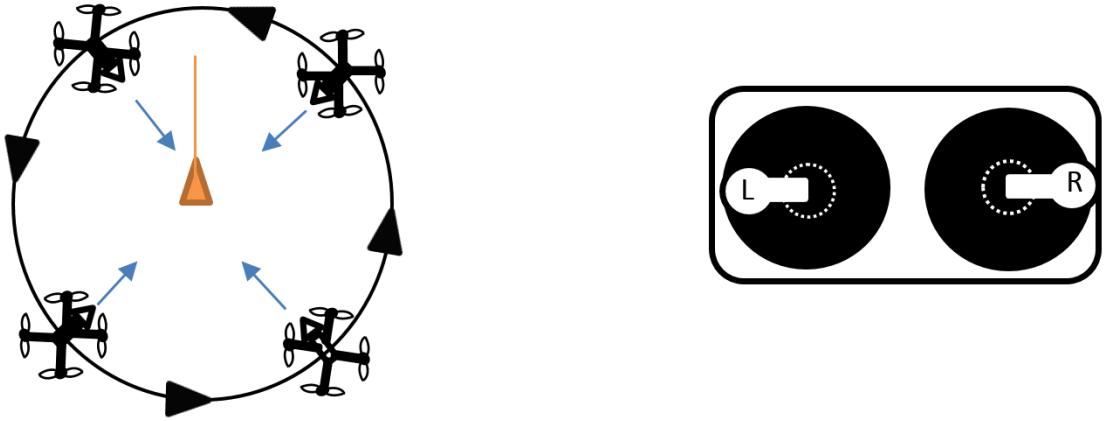


Figure 5-7 flying around a spot

Point-of-interest manoeuvre

Move forward in front of an object on the ground while lowering the camera to keep it centred

Once filming, once taking several pictures manually

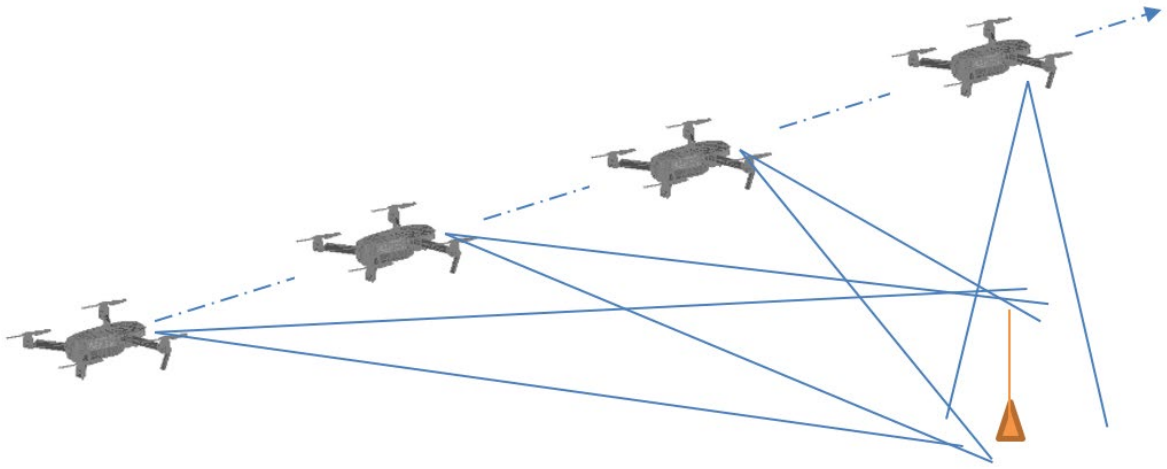


Figure 5-8 slope and camera tilt

Ascend in front of an object on the ground while lowering the camera to keep it centred

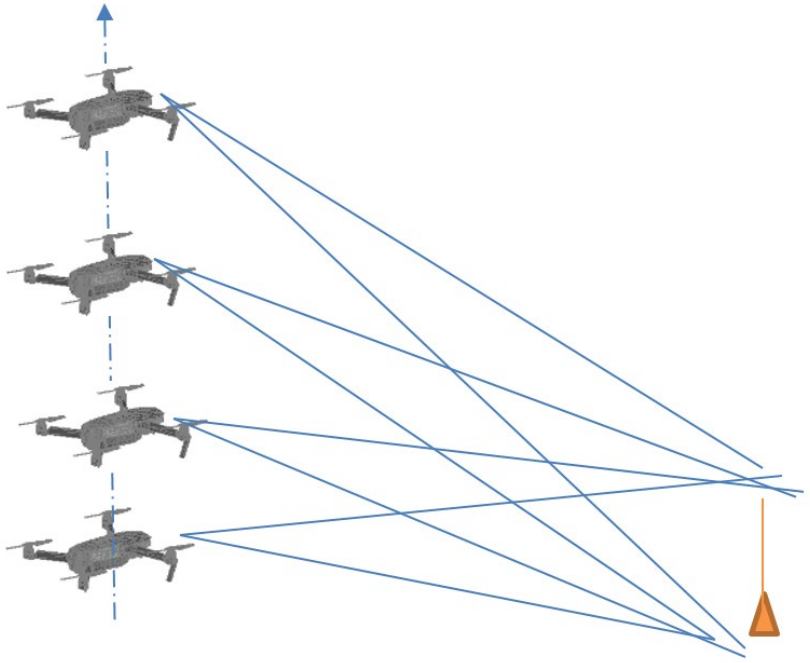


Figure 5-9 ascent and camera tilt

6. Technical flight: civil engineering context

Here we pilot both looking at the drone AND looking at the screen to stay centred

6.1 Façade survey: photogrammetry, Lidar or thermography

For all these tasks, it is necessary to make a grid in front of the building.

For photogrammetry, photos must be taken with 80% overlap in width and height.

For Lidar or thermography, an overlap of 20% is a minimum to ensure good point cloud or photo stitching.

See also MODULE 7 for a complete lesson about photogrammetry. Here only some flight learning tips.

Slow speed: adjust for example the drone inclination to 2 to 5° maximum to limit the speed to avoid motion blur on the pictures.

It is necessary to pilot manually for the facades, no direct programmed flight (a technique by superimposed Waypoints exists, see module 7, but not on all drones)

- Stand 10 to 15 m in front of a building facade, altitude 3m, fly facing the facade, horizontal camera axis perpendicular to the façade

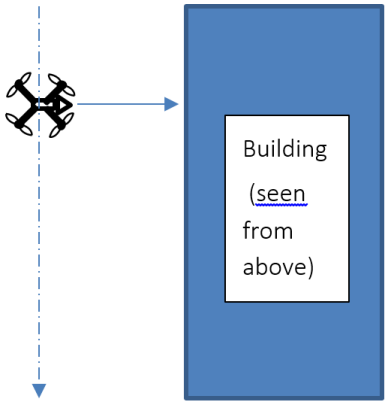


Figure 6-1 traveling face to a building

- Flight path in horizontal translation perfectly parallel to the facade. Fly 20 to 30m.

Figure 6-2 pictures of a building for façade survey

- Go up vertically by 5m at the end of the facade
- Repeat a passage in the other direction, at 8m high
- Etc.

Figure 6-3 façade survey

Pictures with overlap:

Manually (example for photogrammetry) : look in the display, use the grid to detect when you have move about 20% away from the previous picture. Press the trigger, move, press... you must ensure 80% overlapping.

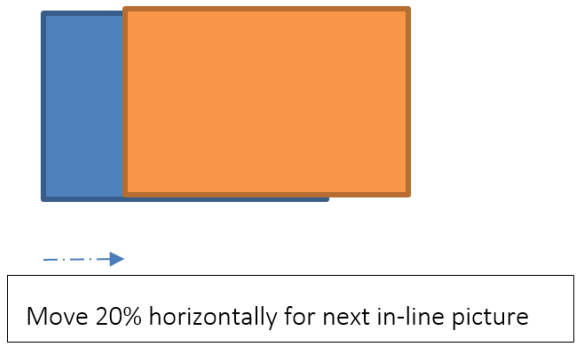


Figure 6-4 horizontal photogrammetric overlap

CAUTION: do the same when going UP: only 20% more:

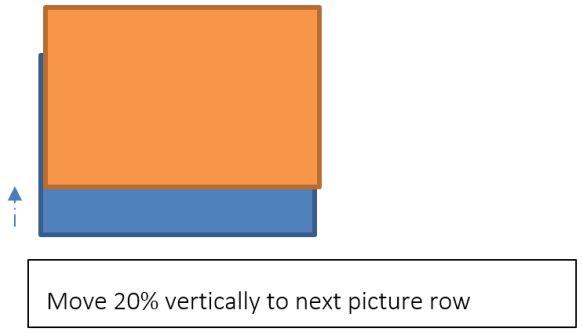


Figure 6-5 vertical photogrammetric overlap

For Lidar or Thermography, adjust the overlap to 20%. Move 80% away from the first photo framing.

Automatic photo triggering:

Depending on the capacity of the drone, it is usually possible to use at last 2 automations

- **Time-lapse**: a photo is taken every 2 or more seconds, just move at the right speed to obtain overlapping.
    - TIP : use the "tilt" setting and make a test-row for instance at 10° with the joystick to the end (which is easy) and check the overlapping on the pictures, modify the tilt to adjust speed.
- **GPS-lapse**: a photo is taken every "x" meter flown by the drone. Adjust the distance "x" to get a proper overlapping. Normally the distance is calculated in 3D so it works also when going up.
    - **The speed may be faster than time-lapse** but not too much to avoid motion blur.

NB: it is not a problem to have a big overlapping (95% for instance).

6.2 Field photogrammetry or Lidar: grid over the field

The programmed flight is the standard, the following exercise allows to do it manually.

Same precautions as for façade shooting: 80% overlap in all directions.

- Choose before take-off a scanning pattern of the area: the "zig-zags" that you will make over the terrain
- Climb to 25m AGL, tilt the camera down
- Slowly make a line over the edge of the field, without being too close so as not to risk encroaching on the neighbour's house or falling on his house in case of a breakdown
- At the end of the line, turn 90°, move forward several meters, turn 90° again and make a parallel to the first line
- Take manual photos, or time-lapse or GPS-lapse with the good speed for overlapping.

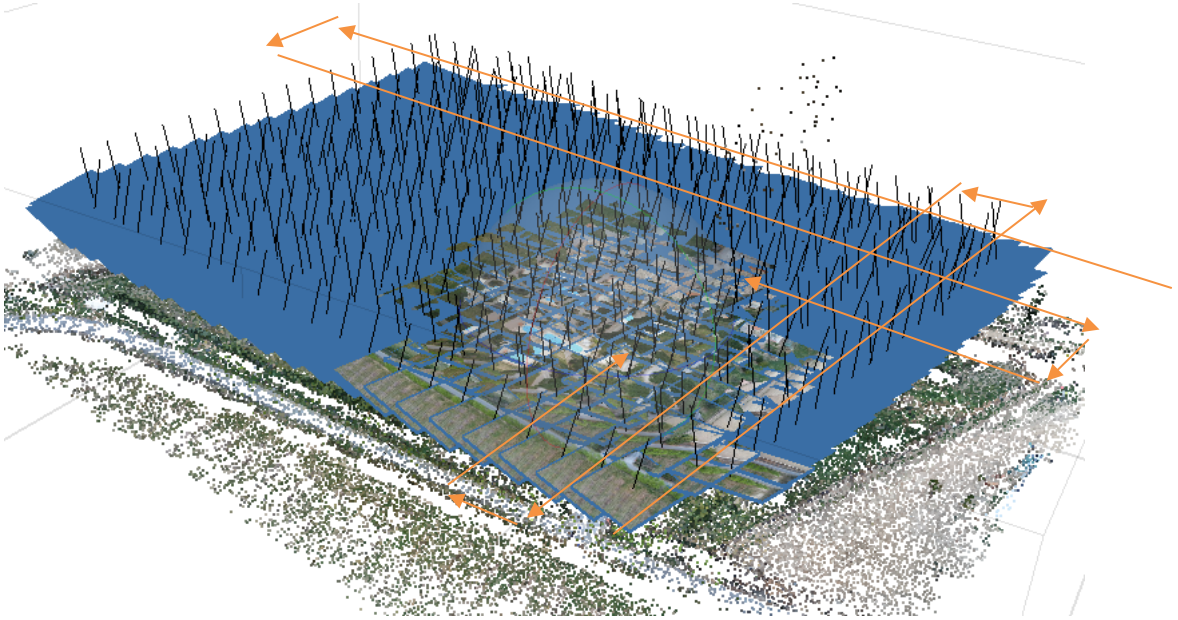


Figure 6-6 terrain photogrammetry from above

6.3 Building or volume survey: circular flight

With the camera always pointed towards the object (building, dam, bridge, monument...)

It is possible to program an automatic 360°, this exercise does it manually

- Left stick causes the rotation that points the camera towards the centre
- Right stick causes the lateral movement
- One joystick to the right, the other to the left, in opposition
- The action of the two simultaneously creates a circle with the camera always pointed at the centre.
- You have to find the right setting with your fingers so that the camera remains pointed towards the centre

Figure 6-7 traveling around a building for 3D photogrammetry

6.4 Monitoring of structures, expertise, thermography or local lidar

See module 10: PICTURES FOR EXPERTISE

Skill exercises:

- Get as close as possible to any element, up to 50cm, delicately
- Stay steady, very slow
- Watch the framing to aim at a particular place
- Horizontal camera, from the front
- Camera tilted down, from above: 90° and other angles
- Camera tilted up, from below: 90° and other angles
- Take pictures or movies to view and analyse

List of figures