Project report

Suspended mobile platform

14th July 2016

Document description

Title	Project report
Date	15/09/2016
Author(s)	Julien THOMPSON
Person in charge	Julien THOMPSON
Supervisor	David ROSSITER
Document version	1.2

Table of revisions

Revision	Date	Section(s)	Comments
1.0	17/07/2016	All	First version of the document
1.1	12/08/2016	Platform	Updated description of the section
1.2	14/08/2016	Project reminder, Winch, Controller, Use-cases	Updated presentation and description of the sections, added pictures

Table of content

Document summary

This document reports the progression of the project, by compiling the major elements of the development process. It will be updated regularly in parallel with the work progress in order to facilitate the general understanding. This report is therefore, by nature, not highly technical and some additional documents may be added in the future.

Project reminder

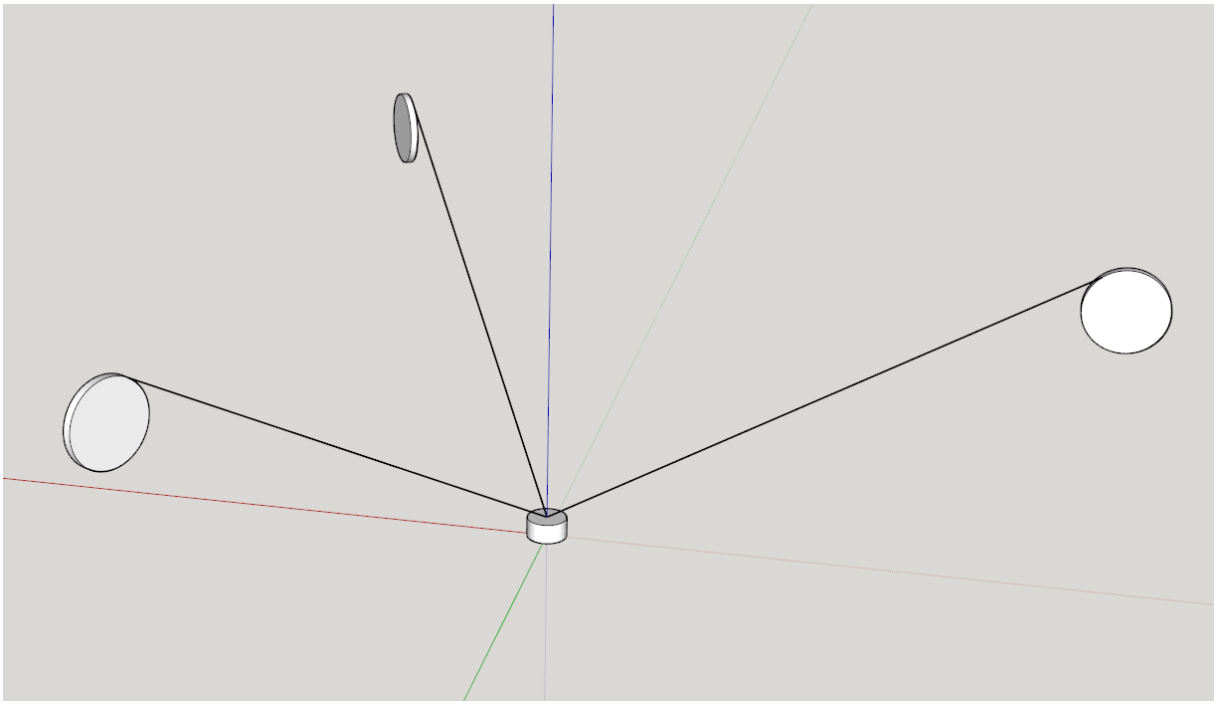


FIGURE 1 THE BASIC PRINCIPLE OF THE PROTOTYPE

The goal of the project is to conceive a suspended and mobile platform system controlled by 3 to 4 winches remotely, allowing the platform to move freely in space.

The aforementioned winches can be calibrated and piloted by simply using an emitter which can work independently and manually like a remote-control, or by connecting it to a computer equipped with a specifically designed communication driver.

The platform must be adaptable in order to be used in any kind of project requiring its capacity of movement and precision – artistic project, survey, etc. This project is therefore conceived with the idea of being a polyvalent and easy to modify base.

Project development

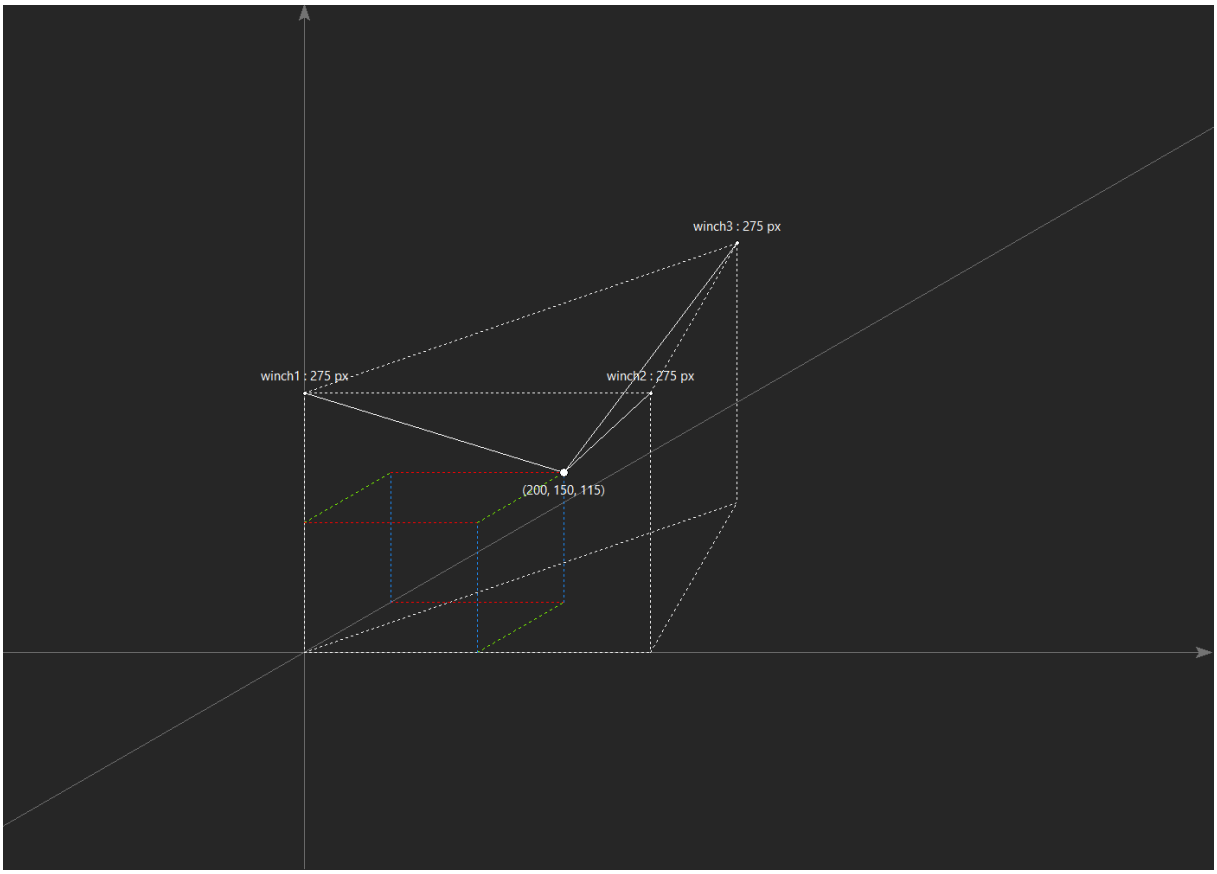
The development of this project is divided into several steps:

- Development of a visual application which presents the basic ideas of the relation between the platform and the winches ;
- Conception of the communication protocols for the pairings: controller-to-winch; PC-to-controller ;
- Conception, assembly and development of the winches, the platform and the controller. These steps can be classified into two categories :
    - Mechanical-electronical conception ;
    - Embedded system and software conception.
- Development of the PC application which uses the communication protocol to control the movement of the platform.
- Realisation of a demonstration of the prototype in a practical application, in order to produce an explanatory video of the project.

Each of these steps are detailed in the following sub-parts.

The simulation

In order to visualize how the project works, a graphical application has been developed. It demonstrates the relation between three winches forming a triangle and the suspended platform, with the cables that connect each winch to the platform.



The position of each winch is configurable, and that of the platform is updated using the keyboard controls.

The information of distance and position displayed (expressed in pixels) is used to determine the correct length of cable required depending on the movement of the platform. The inscribed operational volume covered by the winches is also displayed.

The program was developed in Python 3.5, using the embedded graphical library Tkinter. The source code is currently available in the public Git repository of the project at the following link: https://JETom@bitbucket.org/JETom/wired-drone-dev.git

In conclusion, this step validates the main operation of the project concept.

The platform

[Version 1]

A first model of a winch hook with its support has been conceived to meet the needs of the use-case for the calibration of the winches. The winch hook and the support have to be multiplied by the number of winches to be attached to the platform.

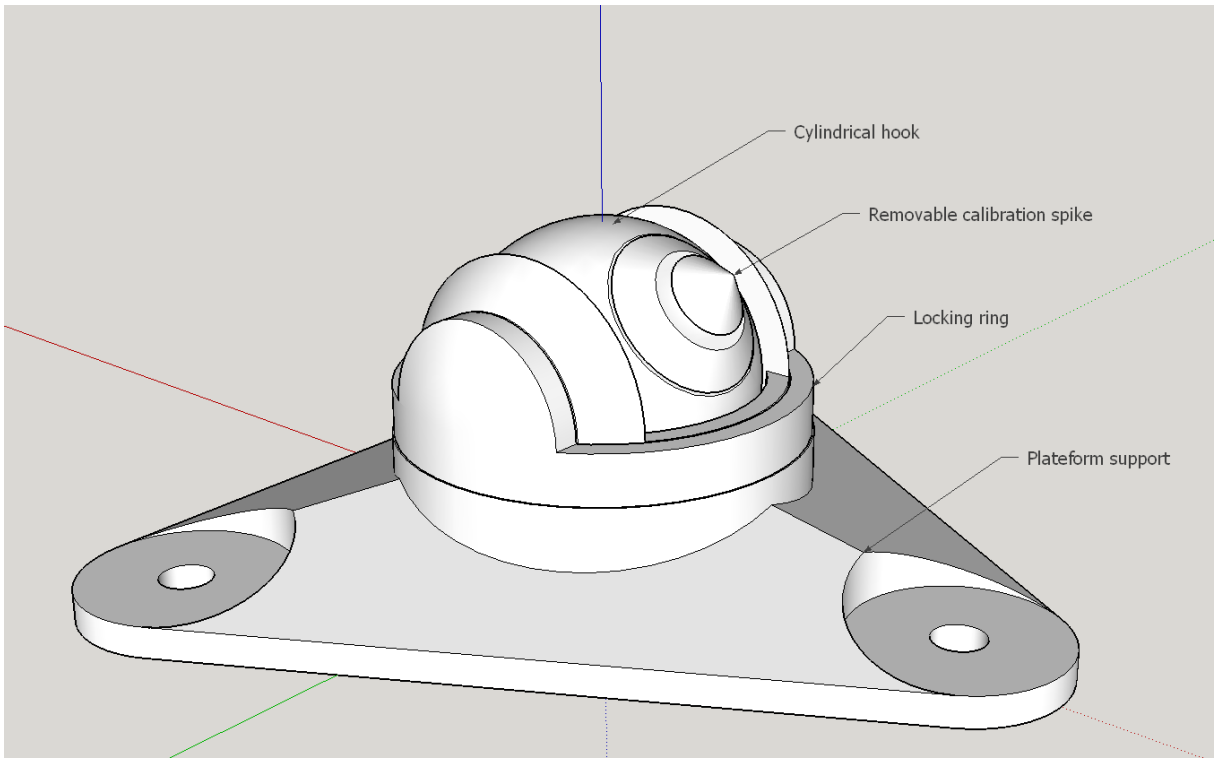


FIGURE 2 3D MODELS OF THE ELEMENTS OF A PLATFORM SUPPORT AND A WINCH HOOK

It is composed of a group a 4 elements:

- A cylindrical hook equipped with bearings ;
- A mouthpiece for the hook in the shape of a spike, used during the calibration of the winches ;
- An attachment base equipped with 3 screw holes adapted for different support platforms.
- A locking ring of the hook axis.

[Version 2]

The second version was designed to reduce the mechanical complexity of the platform.

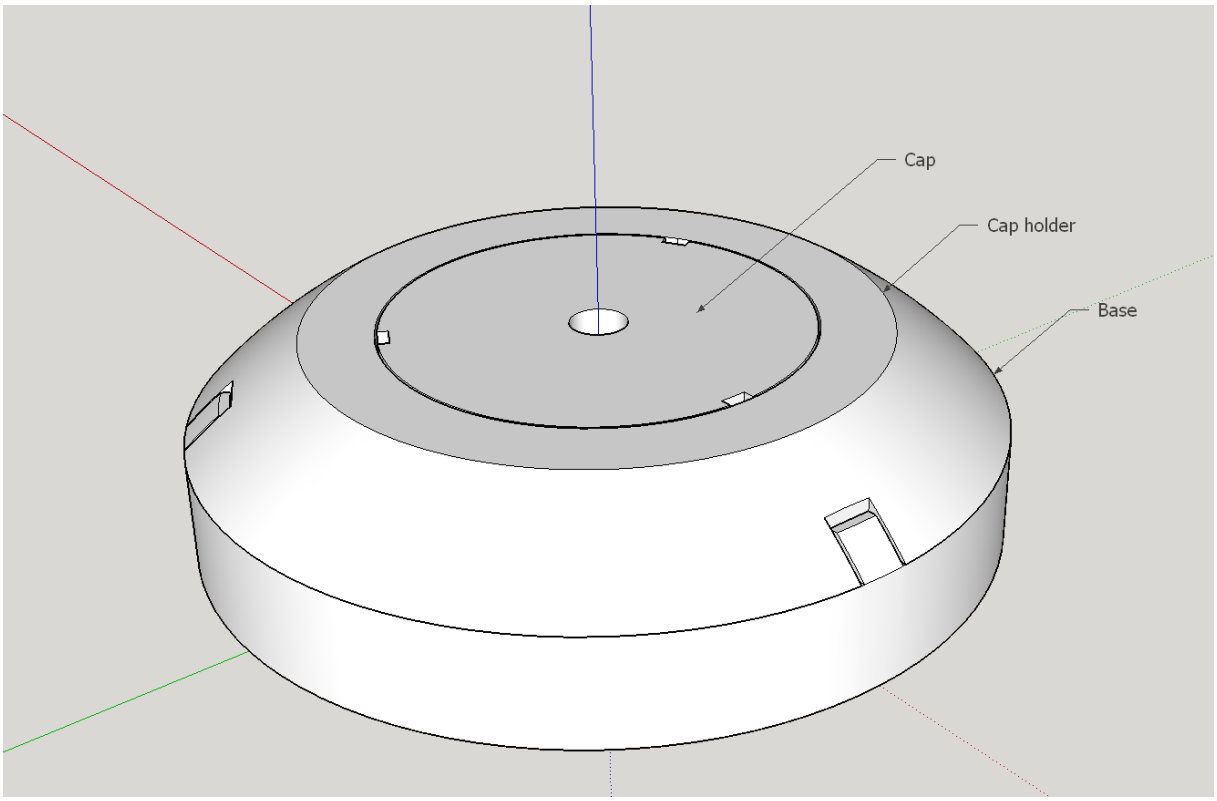


FIGURE 3 VERSION 2 OF THE SIMPLIFIED PLATFORM

This model is composed of a set of multiple pieces that close together in one block, on which it is possible to attach accessories using the screw holes.

The following pieces were designed, from down to top:

- **The base**, equipped with 3 cavities that house the hooks of the 3 winches;
- **The hooks**, attached to the extremity of each winch cable;
- **The guiding ring**, presenting a triangular hole to guide the winch cables;
- **The locking cap**, presenting the 3 holes by which the cables enter the platform.

The platform closes with a 5mm screw, running down from the cap to the base.

Below an exploded view of the different pieces that compose the platform.

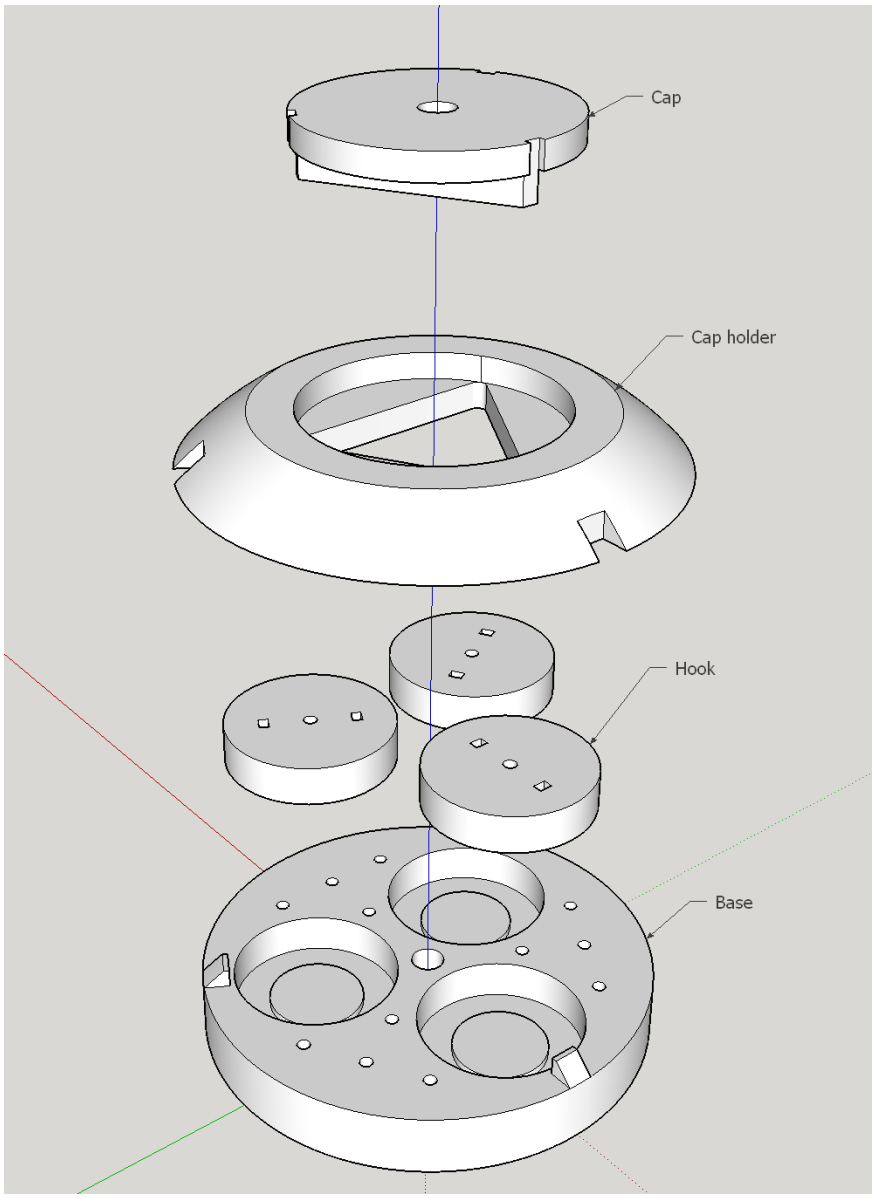


FIGURE 4 EXPLODED VIEW OF THE PLATFORM ELEMENTS

Below, the printed elements created with a 3D printer which are used for the prototype of the project.

FIGURE 5 PLATFORM 3D-PRINTED

The winches

Below is a brief presentation of the winches design. More details will be added in the next update of the document.

See the use-cases below for more details about their use.

The winch is composed of 4 elements:

- **The base**, which houses most of the electronical components;
- **The protective case**, which guides the cable (it also houses the battery, the power switch and the status light);
- **The pulley**, which coils the cable;
- **The mounting plate**, used to attach the winch on a wall.

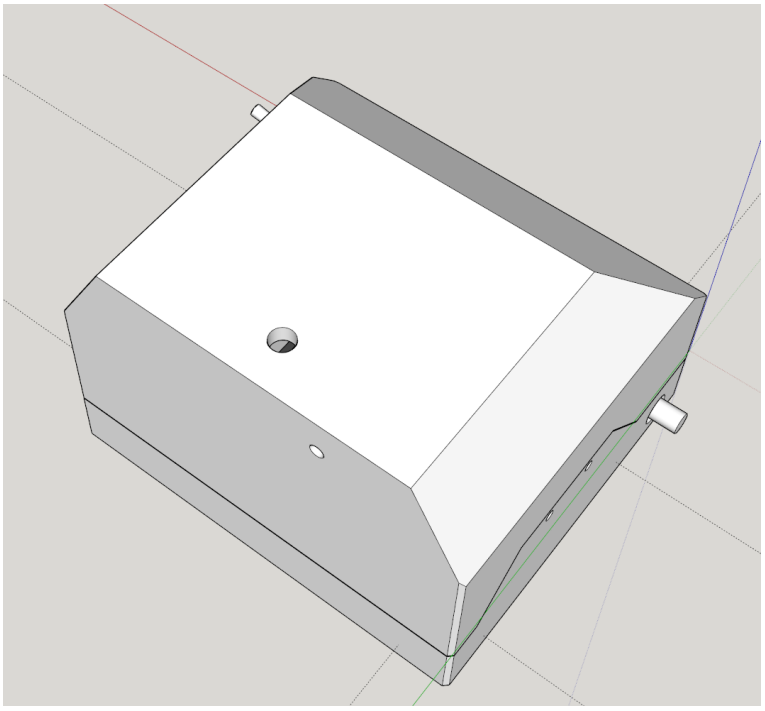


FIGURE 6 CLOSED VIEW OF A WINCH

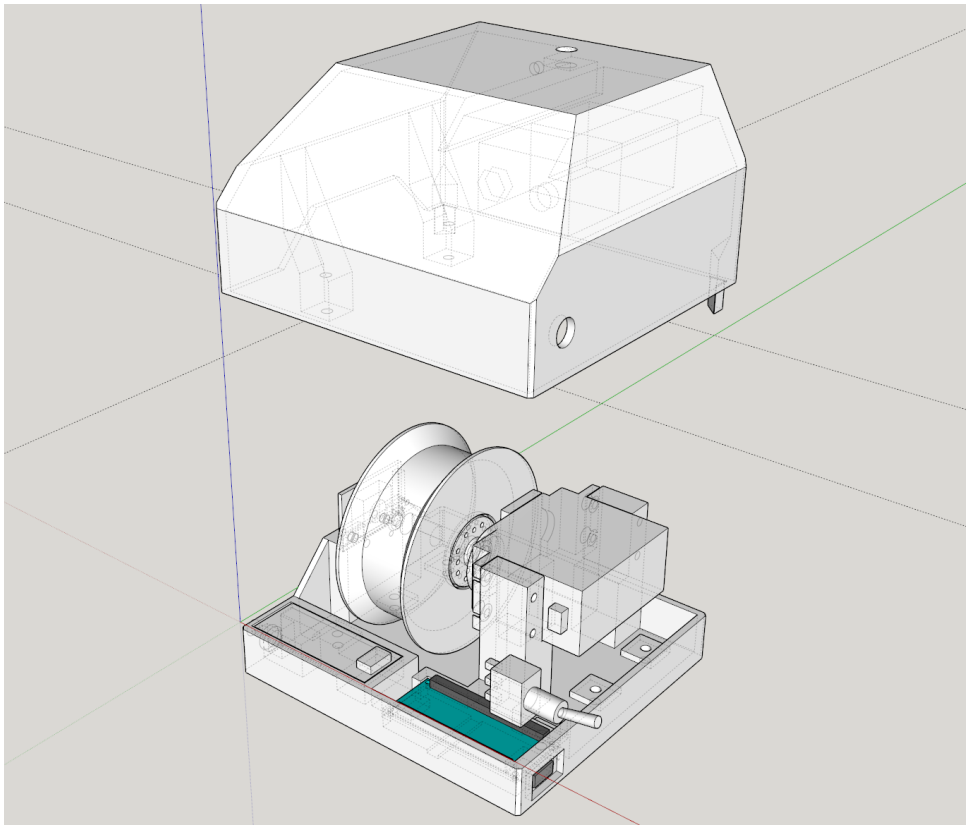


FIGURE 7 OPEN VIEW OF A WINCH

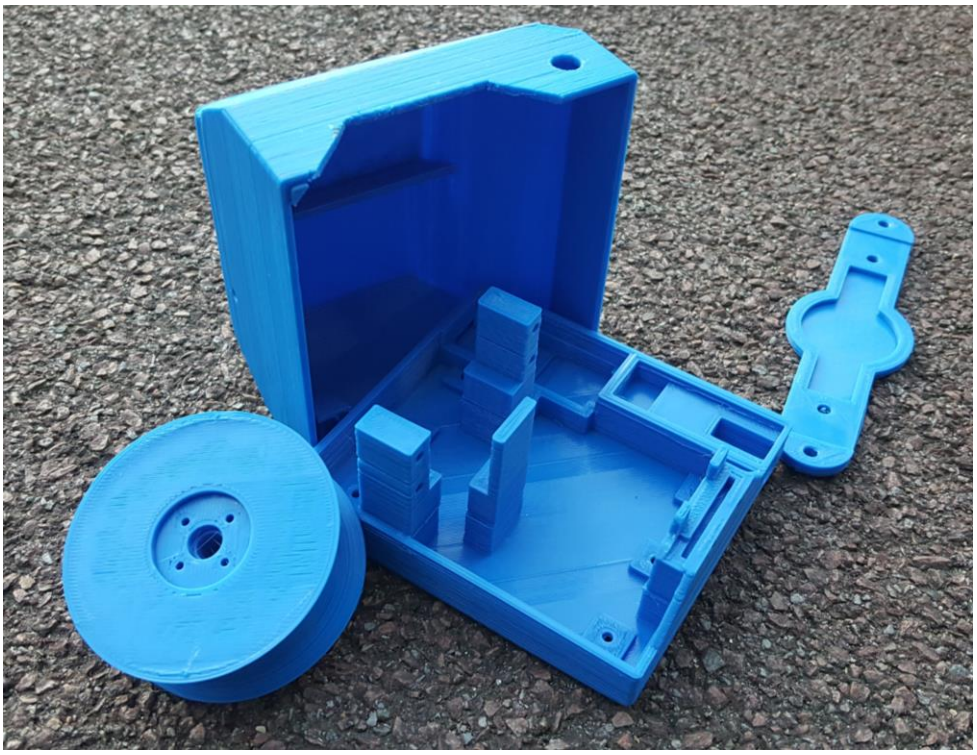


FIGURE 8 ALL THE 3D PRINTED ELEMENTS OF A WINCH

It must be noted that while all the important elements were printed, only one protective case could be printed before the 3D printed experienced technical issues. Therefore, 2 replacement arms were mounted on the remaining winches in order to fulfil the basic tasks of the original piece (as shown on the following figures).

The electronical and software design remains the same.

The following components are found inside a winch:

- An **Arduino Nano** board, used to control all the other electronical components;
- A **long range radio**, used to communicate with the controller;
- A **step motor** and it's driver board, that drives the pulley;
- An **encoding wheel** which gives the rotation of the pulley for accurate calculations;
- A **tension regulator** that powers the motor;
- A **RGB LED** used to indicate the status of the winch (waiting for connection, connected, calibration in progress, etc.).

NB: The step motors and drivers were replaced with servo motors.

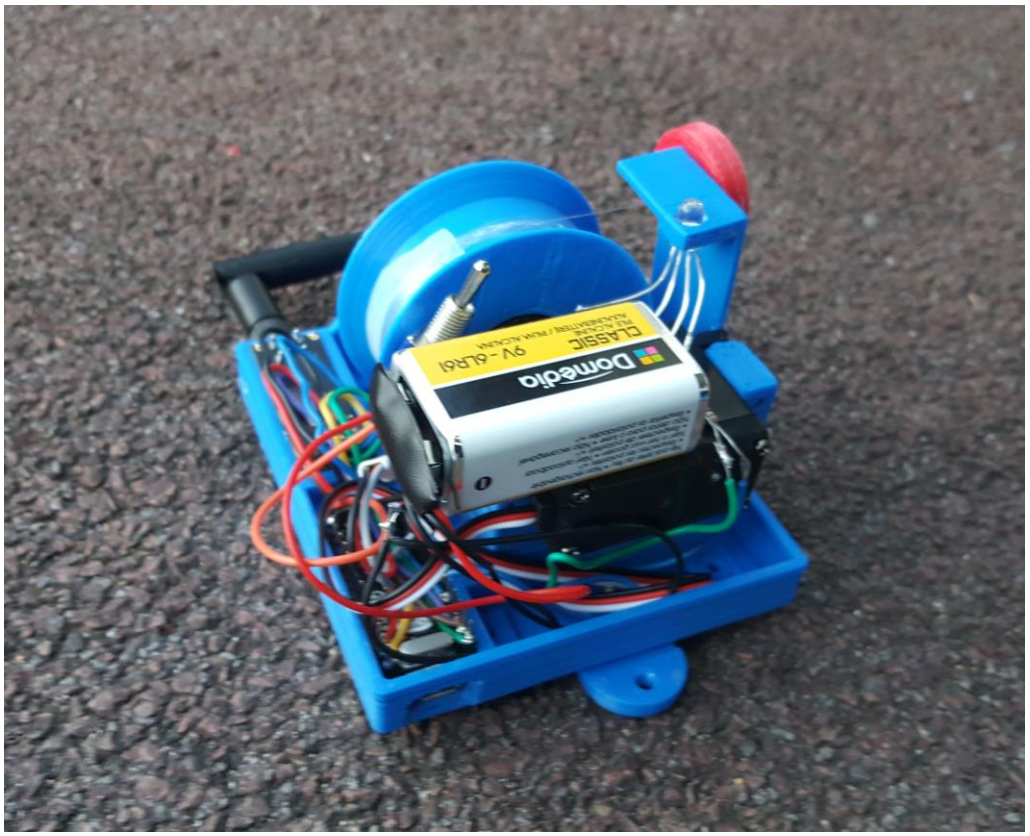


FIGURE 9 ONE OF THE 3 WINCHES, EQUIPPED WITH ITS COMPONENTS

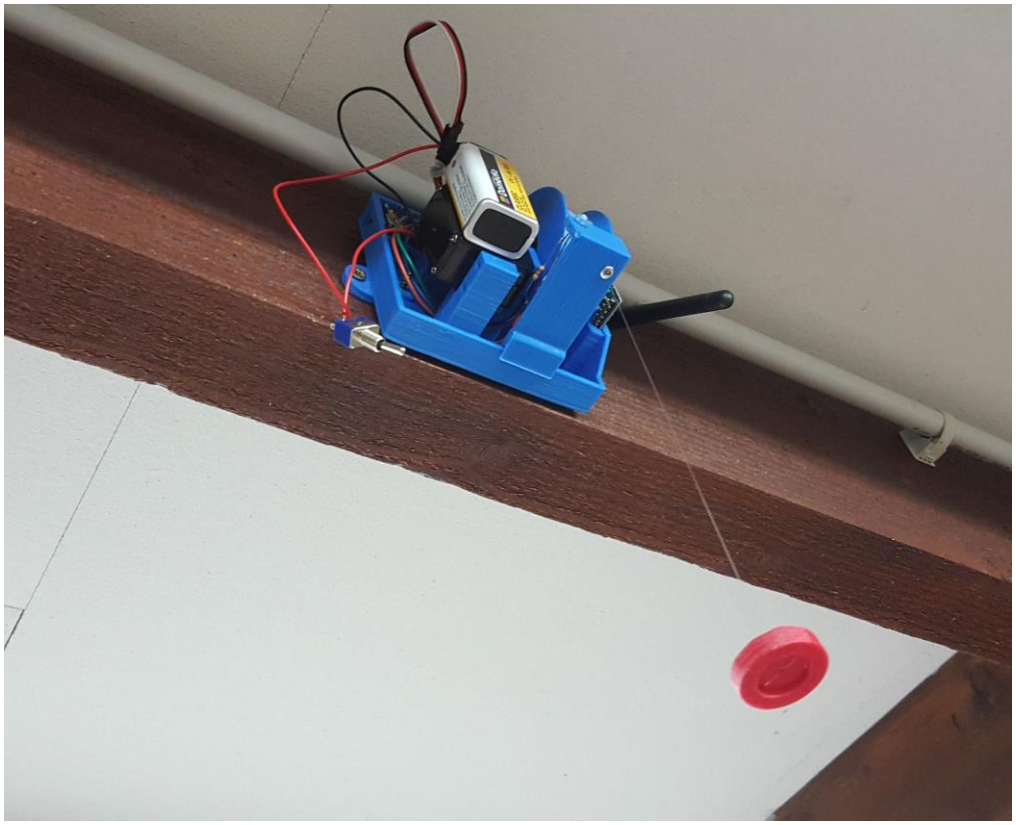


FIGURE 10 ANOTHER WINCH ATTACHED DURING ITS CALIBRATION PROCESS

The controller is designed to perform all the actions required by the system, from the connection and calibrations to the control of the platform movements.

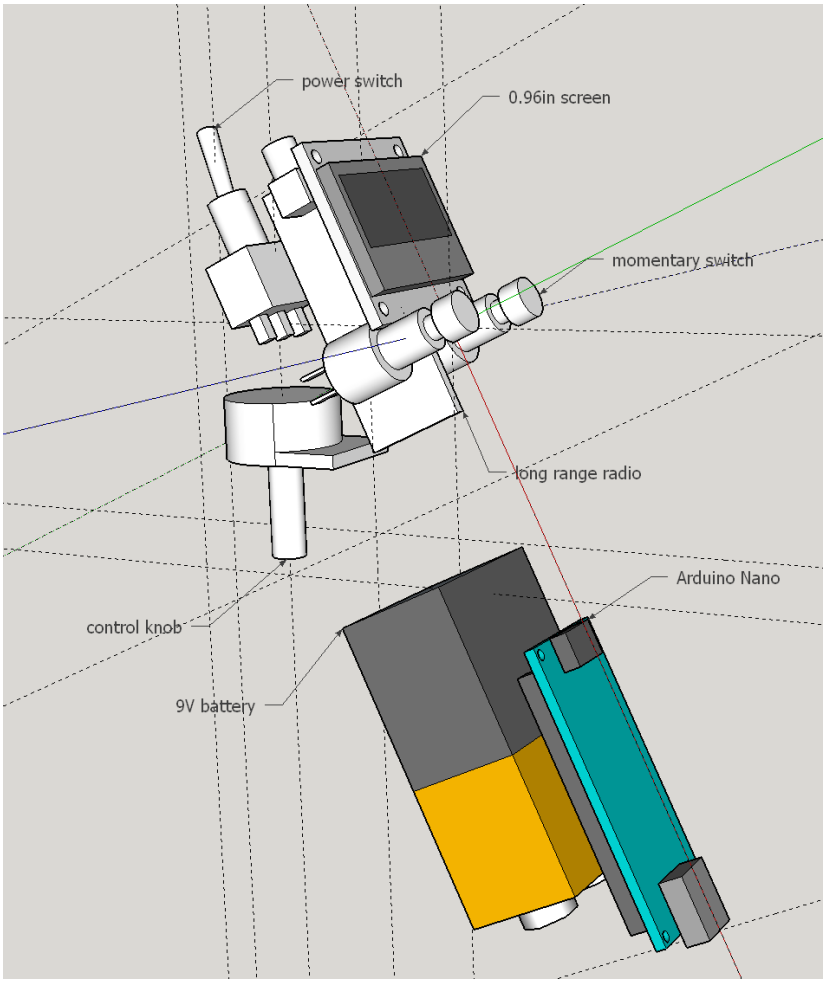


FIGURE 11 ELECTRONIC COMPONENTS IN THEIR FIRST DISPOSITION

Above is a preview of the electronic components before the conception of the protection case. This protection case is separated in 3 layers, the inner structure that hold the components together and the top and bottom outer shells.

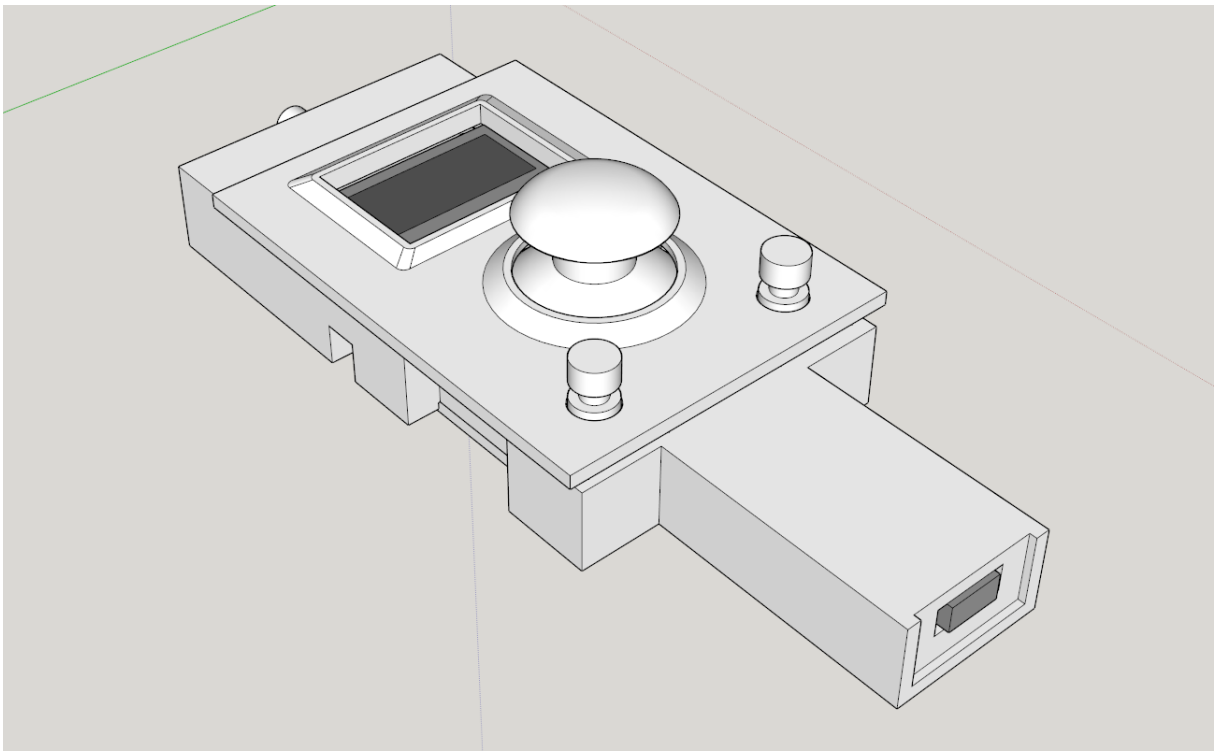


FIGURE 12 INNER STRUCTURE AND OUTER SHELL (TRUNCATED) OF THE CONTROLLER

It must be noticed that due to the same technical issues with the 3D printer mentioned previously, only the inner structure was printed.

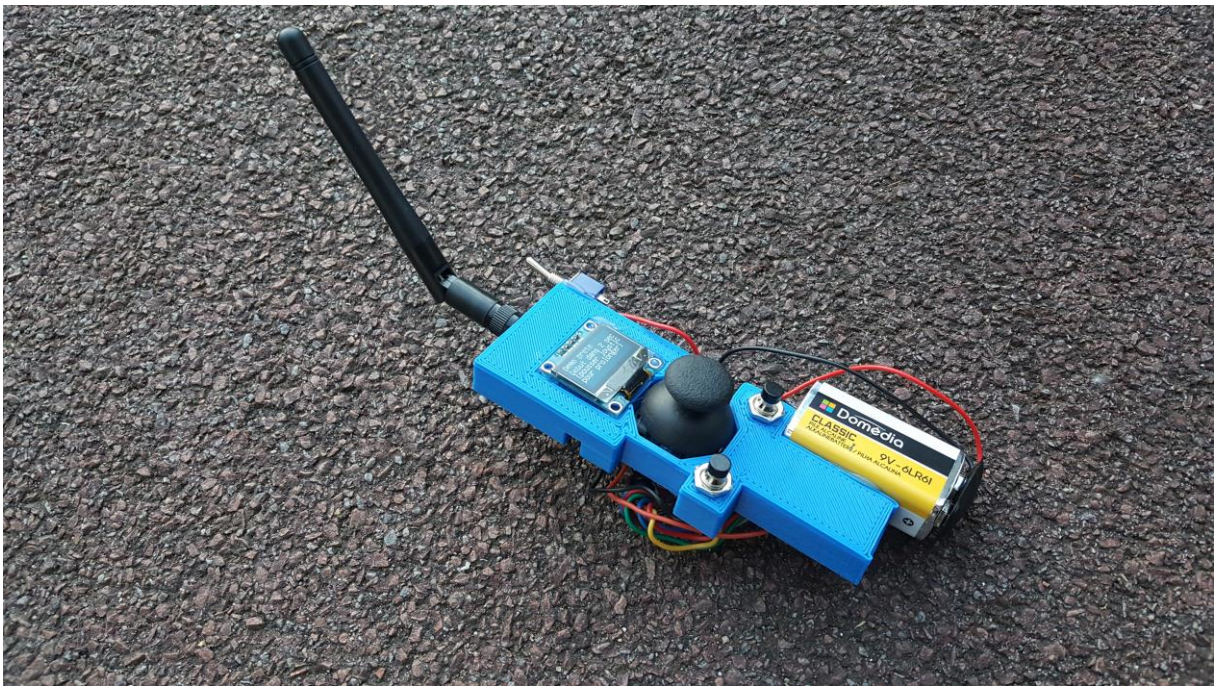


FIGURE 13 3D PRINTED CONTROLLER WITH COMPONENTS, USED FOR THE PROTOTYPE

More details about the controller will be added in the next update of the document.

Communication protocols

Controller-to-winch protocol

This section is a draft and will be detailed in a in the next version of the document. Some details are already available on the Git repository of the project.

PC-to-controller protocol

This section is a draft and will be detailed in the next version of the document.

Use-cases

Calibration of the winches

The winches can be positioned at any height and any distance from each other. For the calibration, a semi-automated procedure in order to determine the relative position of the winches using their hooks.

Height calculation

For each winch, the cable must be fully rolled up to the stop.

The cable is then unrolled to the ground vertically, the hook used as a weight. The controller is used to pilot the height of the hook. When it touches the ground, the position is marked off on the ground: the height of the winch is now known.

Relative position calculation

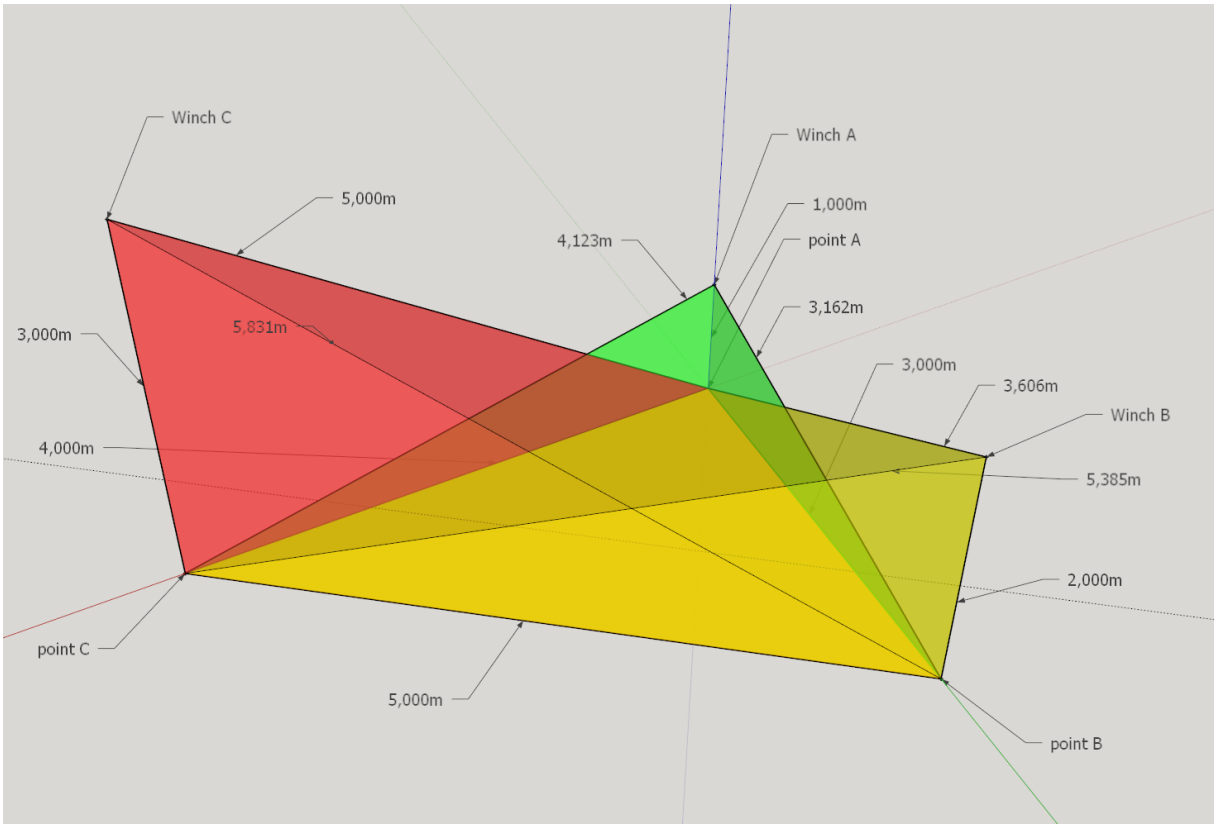


FIGURE 14 POSITION CALCULATION OF THE WINCHES USING TRIGONOMETRY

For each winch, a similar procedure is carried out, but this time the hook is placed on the position of each mark on the ground left by the height calibration of the other winches.

This procedure, once complete, enables the system to calculate by trigonometry the exact position of the winches on the 3 axes.

Note: this calibration procedure can be used only if the ground is perfectly level.

Annex

- Git repository of the project: https://JETom@bitbucket.org/JETom/wired-drone-dev.git
- Youtube playlist of the explanatory videos: https://www.youtube.com/playlist?list=PLu_p_35n6FWnPI4J2QmNwv6ncrtJxdzTU