Drone fastening for ball suspension

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The aim of the system is to hold and carry a soft ball through a Phantom DJI Pro 4.
The given project requirements were:

- Mechanical resistance to loads due to air drag and gravity on the soft ball;
- Weight not exceeding 0.5 Kg;
- To avoid considerable displacements of Drone CG;
- To allow safe landing;
- To keep out of sensors' field of view.

The initial idea was to block a horizontal carbon rod at drone legs, suspending a vertical rod, linked at the bottom to the soft ball, through a cylindrical joint (see Figure 1).

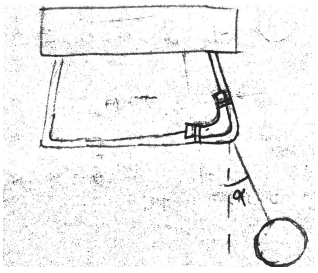

Figure 1: Beginning Sketch

The practical resolution consisted of the assembly of six main components (see Figure 2):

1. Central rod;
2. Cylindrical joint;
3. End of stroke rod;
4. Inclined rod;
5. Support;
6. Wrapper;

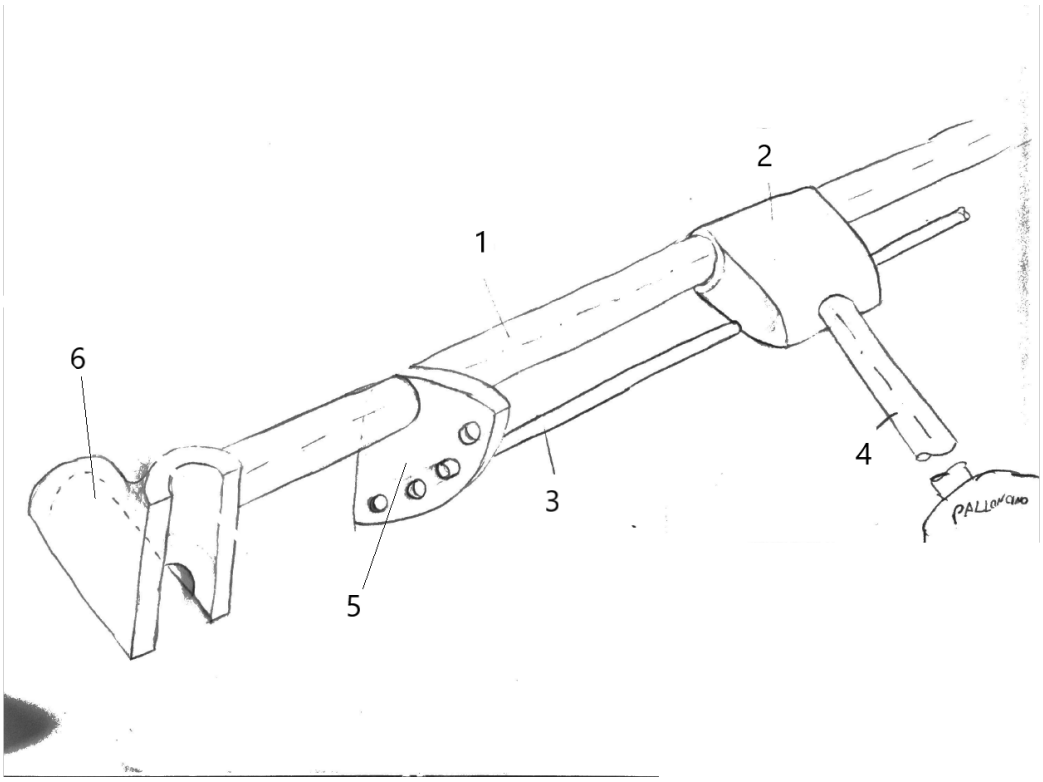

Figure 2: Assembly Sketch

Parts 1 and 6 (fixed together) are the frame, and are fixed with respect to the drone leg. Parts 5 have the function of constituting a mechanical end

of the stroke, with the aim of avoiding ball invasion of sensors' field of view. To realize this idea two carbon rods (3) are put in parts 5 holes. Component 2 is a simple joint (3D printing plastics) with a linkage function.

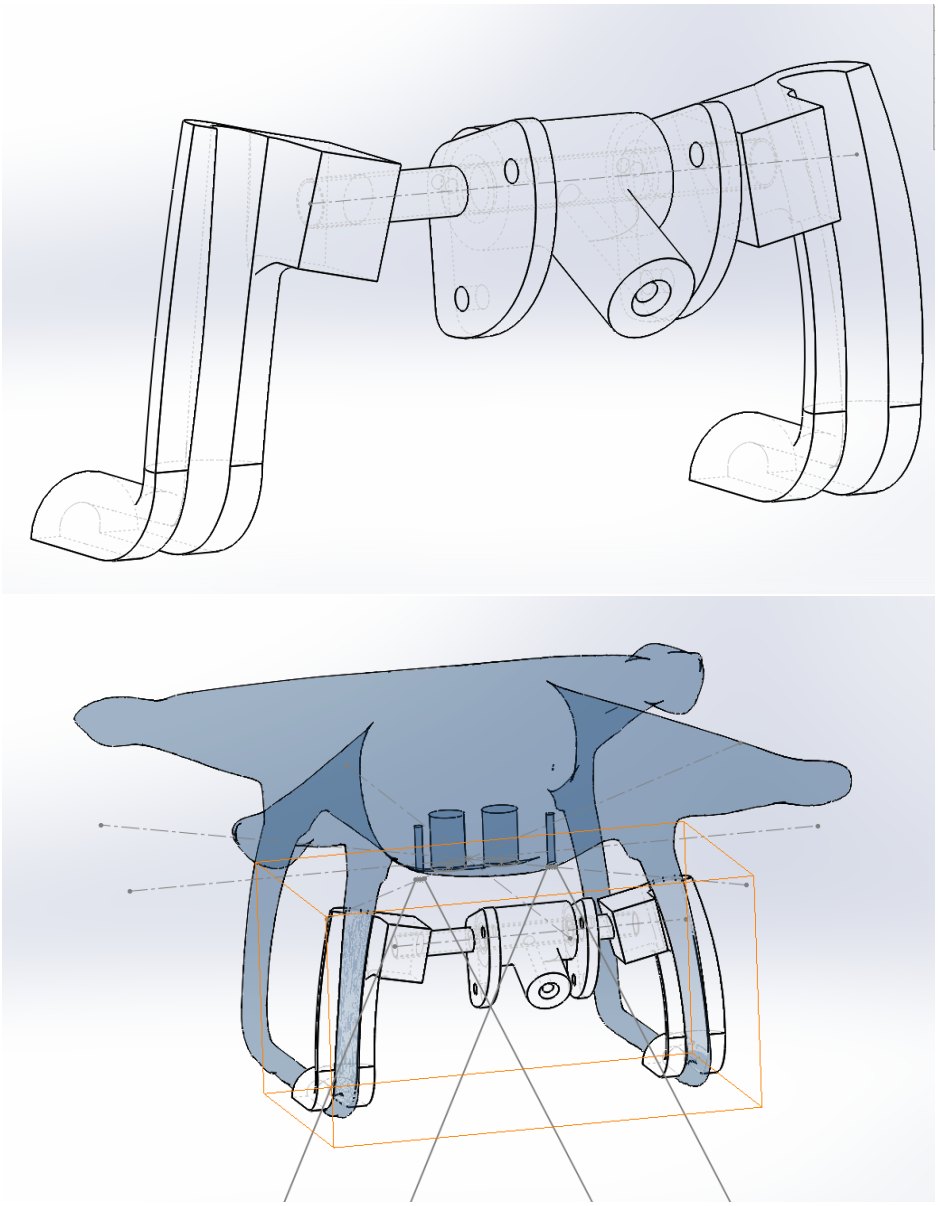

Figure 3: Final assembly

To also have an analytical approach calculations of the forces involved have been done. Calculations consist in a balance of moments. For sim-

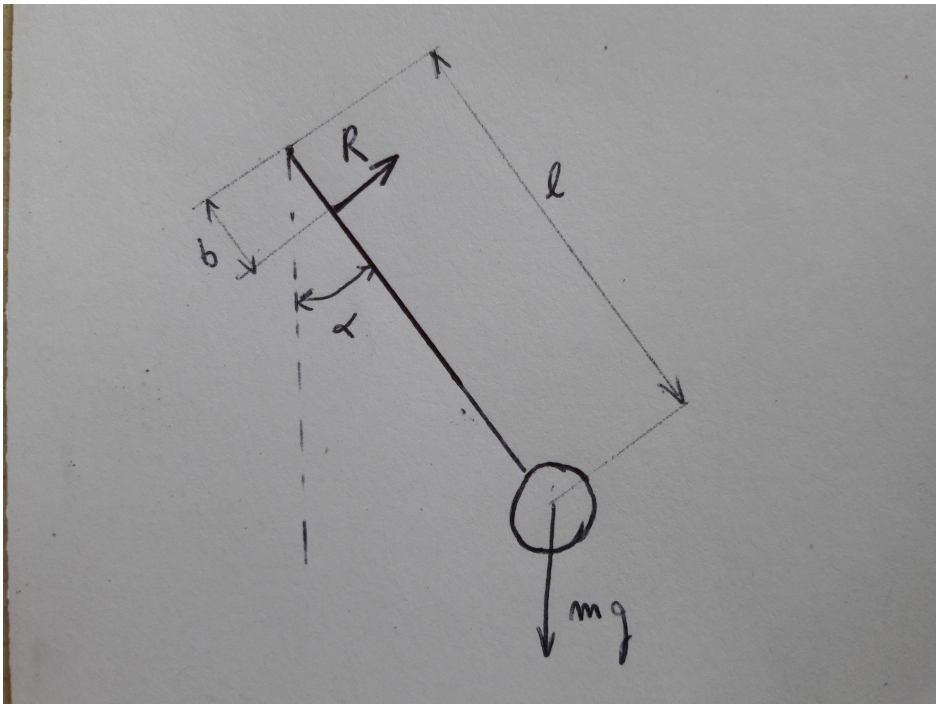

Figure 4: Rod 4 free body scheme

plicity side of rod 4 in contact with joint 2 is taken as moment pole. As shown in figure 4, load consists in ball weight and unknown variable is reaction constraint due to contact between rod 4 and rod 3. Balance equation becomes:

$$Rb - mglsin(\alpha) = 0$$

Knowing resistance parameters of carbon fiber, it is possible to size the system.

After various step of 3D modelling using SolidWorks, a final assembly was completed and sent to Sant'Anna Biorobotics Institute. Plastic components were printed with a localized cured technology, allowing to achieve higher precision and to reduce wasted material. The system was mounted onto the drone and finally linked with hot glue.

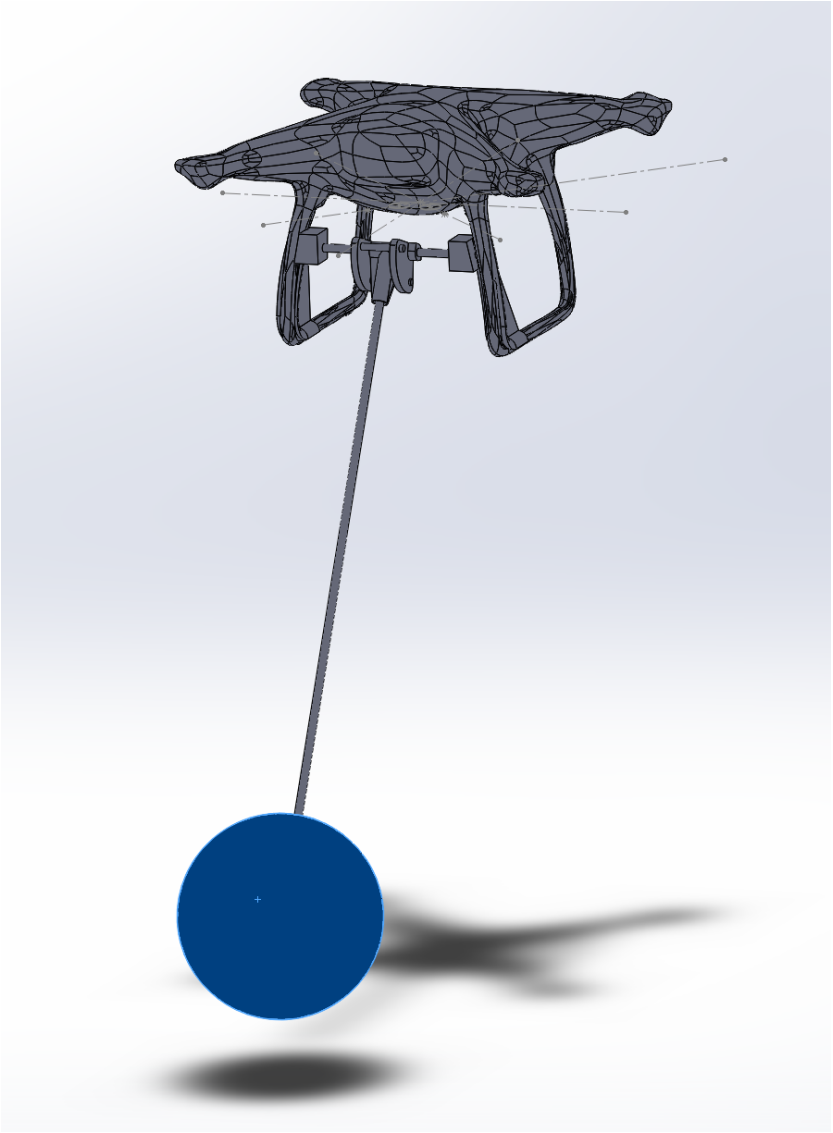

Figure 5: Assembly on drone model

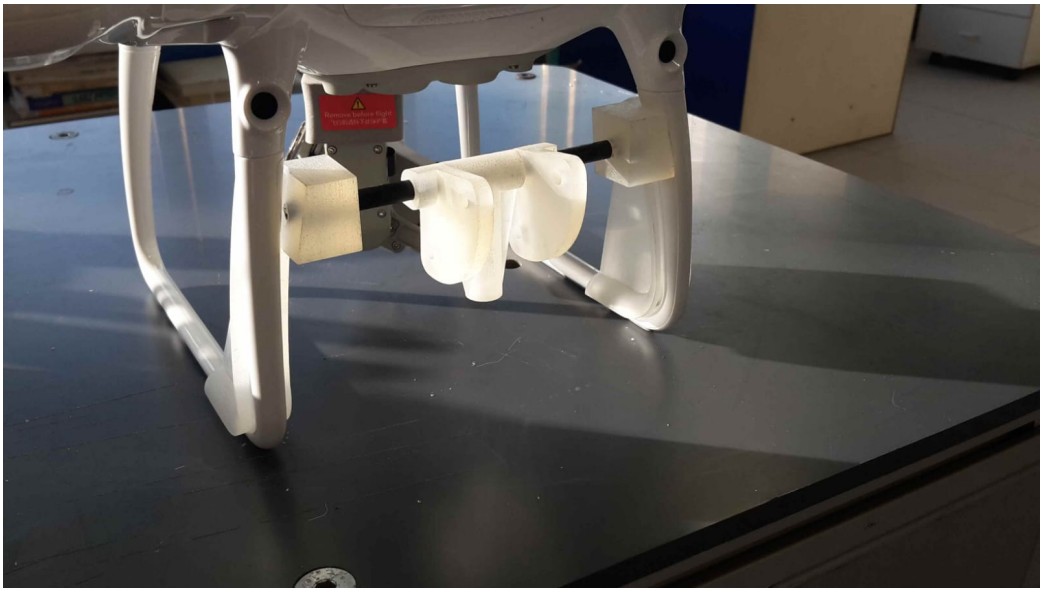

Figure 6: Final result

At the end one last big change has been applied. Joint 2 has been replaced with a ball joint. In fact bending load on rod 3 was too heavy and observations tried that sensors' field of view was not disturbed.