TECHNICAL REPORT ON THE PROJECT OF A FIXED-WING DRONE FOR THE TRANSPORT OF PARCELS

INTRODUCTION

The project involves the construction of a fixed-wing drone for the transport of packages, with a maximum total weight of 10 kg with a payload of at least 1.25 kg considering structural mass around 35-50% of the maximum weight. The drone will have to take off and land in an area of 10x10m and fly for at least 15 minutes with a residual of 20% of the battery capacity. The maximum speed required is 50 knots (about 90 km/h), with the aim of optimizing the payload to the maximum transportable mass, my task was to study which engine allowed me to perform this task in the best possible way with maximum efficiency between power, autonomy and weight. Connected directly to the motor, it was necessary to establish which and how many batteries guaranteed the correct functioning of my motor smoothly with the right voltage required by the motor. The final step was to build and design a wing that would allow mine to go at the most suitable speed for the necessary time required and to facilitate the take-off and landing phase of the drone.

PROPULSION

As for the choice of motor, after analysing various motors and checking the technical specifications, I concluded that the most optimal choice for the type of drone to be built, the indicated characteristics and the tasks required is the T-Motor AT5330 KV220 weighing 685g. This type of motor delivers up to 3.6kW of continuous power, which is sufficient for the payload and flight duration requirements. It works efficiently by delivering high thrust while keeping power consumption manageable. This type of motor provides a good thrust in relation to the weight of the drone especially during take-off having a constraint of an area of 10x10m. The motor supports Lipo battery pack configuration with a voltage range of around 42-50V. Lippo batteries are called lithium-polymer accumulators, they have a flexible and foldable sheet structure, they do not require a metal container so the battery can be lighter as it needs to take up less space. To make my motor work at its best I chose to use two 8000mAh Lipo batteries (6s) with a voltage of 22.2V each and a weight of 1086g for a total of 16000mAh 44.4V and 2172g for both batteries, The use of two batteries of this type would better balance the duration of the flight with the power needs, leaving 20% capacity as required after landing. The total weight between battery pack and motor is therefore 2857g.

CALCULATION OF THE POSITION OF THE CENTER OF GRAVITY

The centre of gravity is essential for maintaining stability in flight. Assuming a symmetrical weight distribution, with 40% of the structural mass distributed around the fuselage and the payload centrally positioned, the CG should typically be at 25-30% of the wing chord.

WING

The calculated wing area is 1.23m^2 given by its mass of 10kg and its wing loading of 8.1 kg/m^2, the aspect ratio for such a drone is 8 and its wingspan is 3.14m. The inertia tensor is calculated with respect to the main axes of the drone (x,y,z) and determines how difficult it is to rotate around each of these axes.

CALCULATION OF THE STABILITY MARGIN

The margin of stability is one of the most important parameters in aircraft design, because it guarantees longitudinal stability and flight safety. The essential parameters for analysing the stability margin are CG and CA since the MS represents the distance between the centre of gravity and the aerodynamic centre. If the CG is in front of the CA, the aircraft will be stable and after a disturbance it will tend to return to the initial attitude (stability margin >0), if the CG is behind the CA, it will be unstable behaving in an unpredictable way (stability margin <0). geometry of the wing and mass distribution, allowing the drone to fly efficiently and stably and complete the required operations.

FLAP DESIGN

Depending on the wing we have chosen, the design of the flaps must absolutely be considered: the flaps tend to cover 30% of the wingspan and are 25% of the length of the wing chord. The flaps are extremely important both in the landing and take-off phase where they have a deflection angle of 15%. They have particularly important aerodynamic effects as they increased the lift coefficient and drag coefficient, thus allowing a stall speed lower than it would be and there were no flaps. The stall speed is the minimum at which a drone/aircraft can fly while maintaining the lift necessary to sustain itself in flight, this concept is especially important during take-off, landing and low-speed manoeuvres creating greater stability at critical moments.

CHOICE OF WING AND AIRFOIL

The type of wing chosen for this drone is trapezoidal, this shape best reflected all the characteristics that the drone needs to complete its task. This wing, however, was chosen to put it in an high position because: I have greater stability and the drone is less prone to skidding or rolling, landing and take-off in a small space and avoiding problems of collision with the ground. The air foil chosen is a NACA0012 air foil because for a speed for the chosen route between 35 and 50 knots it is effective because it reduces drag while maintaining a sufficient lift coefficient, good stability, aerodynamic flexibility, it is the best air foil for a drone of this type with the tasks it has to perform.