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P3_9 Kweh! A Flying Chocobo

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Abstract

This paper investigates whether the fictional chocobo from Final Fantasy games could fly in reality and carry a person on it whilst flying. It was found that the chocobo with and without a passenger would need to flap its wings, 38 times a second and 22 times a second respectively. By taking a more reasonable estimate for flapping frequency of 2Hz it was found the chocobo would have to run at 154kmhr^{-1}. It was therefore deemed that the chocobo could not fly.

Introduction

A recurring animal throughout the Final Fantasy series of games is the chocobo, as shown in figure 1, a large and typically yellow bird. In various entries to the series chocobos can be ridden by people and in some even flown. This article aims to find the conditions under which a chocobo could fly and whether it could feasibly carry a passenger.

Theory

A chocobo will, for the purposes of this model, be considered to be the upper limit of an ostrich in size, in order to be capable of carrying a human on its back. This gives a height of 2.7m, mass of 160kg and running speed of 70kmhr^{-1} [1] (19.4ms^{-1}).

In order to be able to fly, a bird must be able to produce sufficient lift to overcome gravity. The wings of the chocobo will be modelled as aerofoils; however the effect of flapping the wings will also be taken into consideration. By considering this the following equation is obtained

$$F_L + F_B > F_G, \quad (1)$$

where F_L is the lift force, F_B is the buoyancy force from flapping the wings and F_G is the gravitational force.

The buoyancy force can be used for this case because when a wing is flapped down

Figure 1: A chocobo as depicted in the game Final Fantasy XIII [2].

the fluid, air, underneath the wing is displaced which according to the Archimedes principle, produces an upward force on the bird equal to the weight of the displaced fluid. This idea of buoyancy force applied to flying has been used in a previous edition of the journal [3], to find if Thumbelina can fly, however in that article only a stationary take-off was considered.

The equations for lift and buoyancy force are

$$F_L = \frac{n}{2}\rho v^2 A C_L \quad (2)$$

and

$$F_B = n\rho V g \quad (3)$$

[3] respectively. In these equations ρ is the density of air, v is the velocity of the chocobo, A is the area of the wing, C_L is the lift

coefficient, g is the acceleration due to gravity, n is the number of wings and V is the volume of air displaced.

It is worth noting that the estimation for the buoyancy force created by the wing is likely to be an underestimation, as birds do not simply flap their wings up and down, but instead make complicated movements to increase the efficiency of flight [4]. For a better approximation, a detailed model of the chocobo's wing as an aerofoil would need to be employed, considering air flows around the bird and how the wing shape varies during each flap. Additionally the effect of a bird flapping its' wings on the lift force provided by an aerofoil is not considered and the effect of air in the birds lungs is neglected.

Substituting equations 2 and 3 into equation 1 gives a final equation for the minimum requirements for the chocobo to take-off to be

$$\frac{n}{2}\rho v^2 A C_L + n\rho V g = mg \; . \qquad (4)$$

It is assumed that in the process of flapping, the wing moves through an angle, ϑ, of 60^o, with a length, r, of 2m, a width, w, of 0.5m and is a cuboid. Therefore the volume of air displaced in a flap can be found by using

$$V_d = \frac{\pi r^2 \theta w}{360} \; . \qquad (5)$$

Discussion

By rearranging equation 4 for volume, then substituting in values of 1 for the lift coefficient based on a bird's wing [5], 2 as the number of wings, 1.225kgm^{-3} as air density and 19.4ms^{-1} as velocity, a value of 46.1m^3 was obtained.

The volume displaced in a single flap was calculated using equation 5 to be 2.09m^3, from this it was found that 22 flaps per second were necessary in order for the chocobo to take-off.

If the weight of a person, taken to be 80kg, is added to this, the total mass would be 240kg. By applying this mass to the previous calculation, it was found that 38 flaps per second are needed to take-off.

By assuming a more realistic rate of flapping of 2 flaps per second, displacing 4.18m^3 of air, and using equation 4, the velocity needed for take-off with a passenger was found to be 42.8ms^{-1} (154kmhr^{-1}).

Conclusion

In conclusion the chocobo would not be able to fly when carrying a passenger, unless it ran at a very fast speed, faster than a cheetah which runs at 109kmhr^{-1} (68mph [6]). For comparison, a hummingbird which is renowned for flapping its wings very quickly, will flap its wings up to 53 times a second [7], only slightly higher than the rate a chocobo would require in order to carry a person.

References

[1]http://animals.nationalgeographic.com/animals/birds/ostrich/ accessed on 13/11/2012.

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