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P2 4 Barry Steakfries and the Jetpack Joyride

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Abstract
We investigate the feasibility of using a twin machine gun jetpack for controlled flight as seen in the mobile game Jetpack Joyride. Utilizing two lightweight M134s, weighing 19 kg each, we found that this jetpack would support the weight of the average adult male and a stabilising counterweight, but would only have a flight time of 15 seconds.

Introduction

In the 2011 mobile game developed by Half-Brick games titled "Jetpack Joyride", salesman Bareth McSteakington Friesenhausen (Barry Steakfries) steals a dual machine gun powered jetpack from a secret laboratory [1]. In game, the player controls Barry as he flies through this laboratory on his stolen jetpack, dodging laser beams, missiles and walls of electricity in order to reach the furthest distance [2]. In this paper, we explore the mechanics of this form of transportation to see if Barry's jetpack would really allow for flight.

Figure 1: Barry Steakfries and the machine gun jetpack. [1]

Theory

When a bullet is fired from a gun at high speeds, a force is exerted by the bullet onto the gun, opposing the direction of motion in the form of recoil. This is due to Newton's 3rd Law which states that every force has an equal and opposite reaction force. In this case, the force generated in order to fire the bullet out of the gun must also generate a reacting force against the gun. If this gun was therefore aimed towards the ground, the resulting recoil force generated would be an upwards acting force. With multiple bullets being fired, this force can be represented by Equation 1:

$$F = n(m_B \Delta v) \tag{1}$$

The momentum of a single bullet is represented by its mass m_B multiplied by its change in velocity when exiting the gun's barrel Δv. Multiplying by the fire rate n gives the resultant force F generated.

In order for a gun-jetpack to fly, this resultant upwards force must be greater than the force of weight of the jetpack when affected by gravity (9.81 ms^{-2}), as shown below:

$$n(m_B \Delta v) > mg \tag{2}$$

For this to be true, the rate of bullets fired will need to be high enough to support the total system's weight as shown in Equation 3:

$$n > \frac{mg}{m_B \Delta v} \tag{3}$$

Additional factors such as the mass of the jetpack operator and the weight of the bullets must also be accounted for.

If someone is operating this jetpack, an important factor to consider is the distribution of weight and centre of gravity. This is because the addition of the mass of the rider at the front creates an uneven distribution in this system. The jetpack will now be unstable and rotate around its centre of gravity, rather than traveling straight upwards as seen in game. For stable motion, the centre of gravity needs to be in line with the plane of force coming from the guns. To account for this, a counter weight must be attached to the back of the jetpack to even out the mass of the rider, as shown below:

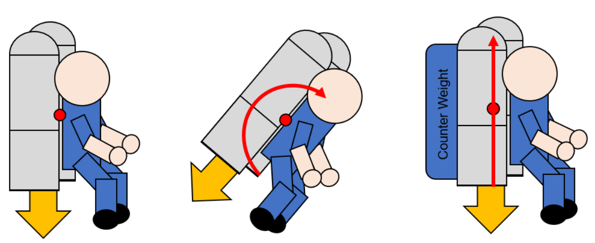

Figure 2: Diagrams showing centre of Gravity. Left: The jetpack and Barry's centre of mass. Middle: The resultant rotation from the jetpack's downward force. Right: The centre of mass positioned back onto the jetpack when a counter weight is connected.

Results

For the type of gun used, we assume a M134 Minigun as this is one of the most common. This gun has a lightweight model with a mass of 19 kg and a muzzle velocity Δv of 853 ms^{-1} [3]. Assuming an average mass for Barry as 60 kg means the total mass of two M134s, Barry and a counter mass equal to Barry's mass comes to 158 kg, creating a downward force to be supported of around 1550 N.

The M134 uses 7.62x51mm NATO bullets that have a mass of 0.011 kg [4]. Inputting this value into Equation 3 along with the Δv of 853 ms^{-1} gives a value for the minimum fire rate required for sustained flight for the 1550 N system as just over 165 bullets per second. The fire rate of a M134 has a maximum value listed as 100 rs^{-1} (6000 rpm) [3], meaning that with a two gun jetpack totalling 200 rs^{-1}, a sufficient amount of force would be generated to sustain the flight of this system.

The total time this system could stay airborne is dependant on the amount of bullets that can be carried. By inputting 200 rs^{-1} into Equation 3 and working backwards, the maximum mass of entire system that can be supported comes out to be 191 kg. This would allow for an additional mass that can be carried for bullets as 33 kg which is the equivalent of 3000 bullets. Dividing this total by 200 rs^{-1} gives the value for flight time at a total of 15 seconds.

Conclusion

With two lightweight model M134s and 3000 rounds of ammunition, Barry Steakfries would in fact be able to fly and control this jetpack for an exciting journey. If Barry was strong enough to support the almost 100 kg jetpack system, then he would indeed be able to have his Jetpack Joyride, albeit only for a measly 15 seconds.

References

[1] https://jetpackjoyride.fandom.com/wiki/Barry_Steakfries [Accessed 4 November 2023]

[2] https://jetpackjoyride.fandom.com/wiki/Jetpack_Joyride [Accessed 4 November 2023]

[3] https://en.wikipedia.org/wiki/M134_Minigun [Accessed 4 November 2023]

[4] https://en.wikipedia.org/wiki/7.62%C3%9751mm_NATO [Accessed 4 November 2023]