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A1_5 Welcome to The Fraternity

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Abstract

In the film Wanted, a secretive organisation of assassins perform amazing feats of marksmanship. Capable of altering the path of their shots from a straight trajectory to a curve, hitting targets behind obstacles or around corners. This paper analyses the possibility of these shots, finding them to be impossible, and also calculates the wind speed necessary to produce similar effects. The gyroscopic spin drift was calculated to be 2.13x10^{-4}m during the flight, which would not cause the bullet to curve as shown in the film. The velocity of wind required to replicate the path of the bullet, was found to be 15.18ms^{-1}.

Introduction

In the 2008 film, Wanted, the protagonist Wesley Gibson (James McAvoy) feels like a failure in life, suffering from anxiety and projecting his feelings of inadequacy as the cause of his father's disappearance when he was a child. One evening he meets a woman, Fox, who takes him to The Fraternity, a thousand-year-old secret society of assassins, where he finds out his father worked and was recently killed by a man called Cross. He joins The Fraternity to get revenge, and is trained to become an assassin, including being taught to bend bullets [1]. We aim to see if a bullet would actually be able to bend like it did during Wesley's first curved shot, and how strong the wind would have to be in order to produce the same effect.

Theory

A bullet in flight is mainly acted on by gravity, drag, and wind forces. A method used to improve stability is spinning the bullet around its length axis [2] by lining the inside of the barrel with spiralling grooves [3].

In this paper, we will be considering gyroscopic drift as the primary cause of bullet bending. Gyroscopic drift is experienced by spinning projectiles receiving a spin-induced sideways component. Rotating objects have an applied torque vector making the bullet's axis of symmetry have components in the horizontal and vertical axes. This causes the bullet to slightly deflect up and in the direction of rotation (right or left). This small inclination means there is a continuous air stream, deflecting the bullet towards the direction of rotation [2].

In order to calculate the gyroscopic drift (D_G) [4] we used

$$D_G = 1.25(G_S + 1.2)t^{1.83}, \qquad (1)$$

where G_S = Gyro Stability factor (1.35) and t = time of flight (0.0389s). G_S was calculated using an online calculator [5] (this value is usually given with a gun) for a USP Compact .40 S&W bullet [6] (10.8mm caliber, 9g weight, 28.8mm length, 0mm tip length, 360ms^{-1} muzzle velocity, 16in barrel twist, 20°C temperature, 1013.25mb pressure [7]). The time was found by dividing the estimated shot distance (14.0m) by the bullet speed ($v_B = 360\text{m}s^{-1}$). The distance was estimated by multiplying the average velocity of walking [8] by the time it took Fox to walk to the centre of the room multiplied by two [9].

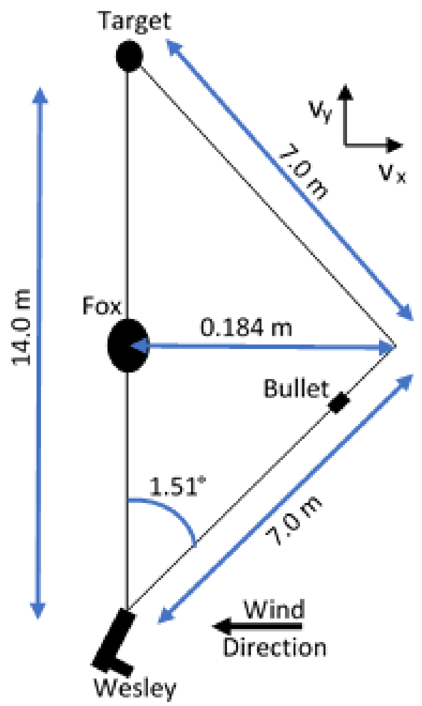

Figure 1: Simple diagram of the shot in question.

In order to find the wind speed that would be required to deviate the bullet from its trajectory, the horizontal component of the velocity (v_x) was calculated using

$$v_x = v_B \sin(\theta), \tag{2}$$

where $\theta = 1.51°$ (calculated using trigonometric formulae).

We calculated the acceleration, a, necessary to decelerate the bullet's x-direction velocity to 0ms^{-1} during half the path length.

$$a = \frac{2v_x}{t}, \tag{3}$$

This acceleration would cause the bullet to be realigned with the y-axis by the end of its trajectory.

$$F_W = \frac{1}{2}\rho v_W^2 A = ma \tag{4}$$

Equation 4 equates the wind force [10], to the force required to realign the bullet. Rearranging to calculate the velocity of the wind, v_W, gives,

$$v_W = \sqrt{\frac{2ma}{A\rho}} \tag{5}$$

where $m = 9\text{x}10^{-3}$g, $A = 3.11$ x 10^{-2}m^2 [7] and $\rho = 1.225\ \text{kgm}^{-3}$ (the density of air).

Results

We calculated the gyroscopic drift to be $8.38\text{x}10^{-3}$in (in units provided by the calculator), equivalent to $2.13\text{x}10^{-4}$m. Comparing this to the 0.184m horizontal distance of the bullets trajectory, this would not cause the bullet to bend as it did in the film. When we calculated the horizontal component of the velocity, v_x, we got 9.49ms^{-1}. This lead to the acceleration, a, being 487.9ms^{-2}, making the velocity of wind, required to bend the bullet from its path, 15.18ms^{-1}.

Discussion

We made a number of assumptions throughout this paper. One was that only the gyroscopic drift was affecting the bullet; we chose to neglect the Magnus and Poisson effects because compared to gyroscopic drift their impact is negligible. Another two of these effects, the Coriolis and Eötvös effects are generally insignificant to short ranged shots by small arms, considered here, as opposed to long range sniper rifles [2].

References

[1] `http://imdb.to/2ehSQXX`accessed 07/11/16

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[4] `http://bit.ly/2fLLAmP` accessed 07/11/16

[5] `http://bit.ly/2ehTi8G` accessed 07/11/16

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[8] `http://bit.ly/2dx9G1L` accessed 07/11/16

[9] `http://bit.ly/1LlqTT2` accessed 07/11/16

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