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P3_7 Catching Cars

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Abstract

This paper examines the final stunt in the film *2 Fast 2 Furious* where a car, treated as a projectile, drives off a ramp and collides with a speeding yacht. It is calculated that the car travelling at 120*mph* would travel a distance of 286*m*. The duration of the flight is calculated to be 6.97*s*. In order for this car to collide with a yacht during its motion, the yacht would need to be travelling at 33.9ms^{-1}. Only the fastest yachts can reach this at their top speed, and due to the fact that the yacht in this scenario has just turned a corner, this is deemed very unlikely.

Introduction

"2 Fast 2 Furious" (2003) was the highly anticipated second film in the popular *Fast and Furious* franchise. In the final scene of this action-packed film, O'Conner and Pearce launched their car off a ramp onto the yacht of the bad guy, Verone, who was trying to sail away [1]. This paper will analyse this scenario and judge the feasibility of this happening. Initially we shall consider the motion of the car, a *Chevrolet Yanko Camero 1969*, determining how far the car will travel during flight. We will then calculate the speed required of the yacht, a *72' Discovery* yacht [2], to collide with the car.

How Far Will the Car Go?

If we treat the motion of the car as a projectile we can calculate the distance it will travel. The vertical motion of the car can be described by the following equation;

$$s_y = u_y t + \frac{1}{2}at^2, \qquad (1)$$

where s_y is the vertical displacement of the car, u_y is the vertical component of the cars velocity v_0, a is vertical acceleration and t is the time taken for the car to make this displacement [3]. Rearranging (1) using the quadratic formula, an expression for t was found:

$$t = -\frac{u_y}{a} \pm \sqrt{\frac{u_y^2}{a^2} + \frac{2s_y}{a}}. \qquad (2)$$

This is the total time of flight and can be used to calculate the horizontal range. In the horizontal direction there is no acceleration, hence the car moves at constant speed in this direction; thus the horizontal displacement is

$$s_x = u_x t = -\frac{u_y u_x}{a} \pm u_x\sqrt{\frac{u_y^2}{a^2} - \frac{2s_y}{a}}, \qquad (3)$$

where s_x is the horizontal range and u_x is the horizontal component of the cars velocity. If the cars initial velocity is u, then $u_y = u \sin\theta$ and $u_x = u \cos\theta$, where ϑ is the launch angle.

How Fast Does the Yacht Need to Go?

Within the film it can be seen that initially, the car and yacht are racing parallel to one another. At a certain point, the car turns towards the ramp as the yacht turns with the coast. We have assumed that the separation between the two x, remains constant, however the car ends up being directly behind, so its direction of motion is towards the yacht.

For the yacht to be hit by the car, there would be a separation of s_x-x after time t. Considering the yacht moving at a constant speed v_b, this could simply be calculated using the equation

$$v_b = \frac{s_x - x}{t}. \quad (4)$$

Hence from using the values of t and d found in (2) and (4), it was possible to determine the speed the yacht would need to be moving to be hit by the car.

Discussion

In the final moments before the car reaches the end of the ramp, we are shown an image of its speedometer showing 120*mph*, equal to 53.65ms^{-1}. We will assume the launch angle is 40°, as estimated from film footage[1]. We will also assume there is no loss in speed as the car mounts the ramp, hence u = 53.65ms^{-1}. The vertical acceleration of the car, a, is the acceleration due to gravity, $-g$. The vertical displacement is the height difference between the top of the ramp and the boat, which we estimated to be 2m. Substituting these values into (2), the total time of flight was calculated to be 6.97s. From equation (3), the range of the car was calculated to be 286m.

The initial separation between car and yacht x was assumed to be 50m; estimated from the film footage. Inputting this, as well as the calculated values for t and s_x in to (4), a value of 33.9ms^{-1} was found for velocity of the boat, which is equal to 65.89*knots*. Only the fastest, most expensive yachts can reach these speeds[4]; so for this jump to be feasible, Verone would have to own one of these. Judging by his character in the film, this is quite likely. The actual yacht used in the film was a type of "mega yacht" costing 3.5 million dollars[2], so the feasibility of it travelling this fast is in fact possible, although unlikely.

However, despite the fact that the yacht could in fact move this fast does not mean it would have been at the moment the car crashed in to it. As previously mentioned, both the yacht and the car have turned a corner moments before the car launches off of the ramp. This effectively means that if 66.89*knots* is in the range of the yacht's top speeds, it cannot be going this fast just after turning a corner due to the deceleration it must make. If this is true, it may not be travelling fast enough to "catch" the car, resulting in O'Conner and Pearce landing directly in the water.

The car's calculated flight time and range could be said to be optimistic values. When mounting the ramp, the car would lose speed, as well as it being slowed down due to air resistance during flight. These effects would reduce the required velocity of the yacht.

It must also be noted that ϑ and s_y are estimates made from observation of film footage, and may in reality be different to what we assumed here. If this is the case, calculated values of t, s_x, and v_b would be affected.

Conclusion

The calculated values of the distance and time of flight of the car seem reasonable given the limited data collected. However, the yacht must be moving at 66.89*knots* for the car to collide with it; this is unlikely due to the fact that the yacht has just decelerated around a corner. The exclusion of air resistance and the movement of the car up the ramp however could explain this high result.

Further developments from this paper could include the input of air resistance and friction of the ramp to see what effects these parameters have on the distance and duration of the car's projectile motion. In addition, the impact of the car on the yacht could be investigated to see what forces have been inflicted on the yacht by the car's flight, and whether O'Conner and Pearce would in fact survive this.

References

[1]"*2 Fast 2 Furious*" (2003) Directed by John Singleton.
[2]*http://www.horizonmarineservices.net/projects.php* accessed on 29/10/2013
[3]*"Physics for Scientists and Engineers"* 6th Edition, P.A. Tipler and G. Mosca
[4]*http://www.boatinternational.com/yachts/the-register/top-20-fastest-yachts/* accessed on 29/10/2013