Final Computational Physics "Paper"

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Projectile motion epitomizes many lower level physics curriculums. The applications of projectile motion and its associated kinematic equations are almost endless. Today, many sports include projectiles like soccer, football, and baseball. A lesser known projectile sport though is competitive swimming. In competitive swimming, you can model a swimmer's body leaving the starting block as a projectile flying through the air, into the water.

In this project, we sought to simply, but accurately describe the initial projectile motion involved in a start in swimming. To keep the simulations understandable and easily applicable, the python programs treat the swimmer's body as a point projectile. Various parameters like starting block height, launch angle, and starting velocity were manipulated throughout the simulations.

In the program file, ProjectileDemonstration.ipynb, we prove graphically that the ideal launch angle for a projectile is 45 degrees from the horizontal in order to achieve maximum displacement. The practicality of 45 degrees in competitive swimming, however, is unideal. Instead, the ideal launch angle for a swimming start is somewhere between 10 and 15 degrees from the horizontal that we found through outside research and analysis.

To give program users perspective on what elite swimmers' rough swimming start statistics are, we measured and recorded data from Caeleb Dressel, an American swimmer known for his powerful starting speed in his start. Users can run this program and view what his projectile motion looks like as he dives into the pool.

Some of these variables, however, have their own practical limitations with regard to standard USA and FINA swimming regulations. For example, the highest allowed starting block height by USA Swimming is a mere 0.76 meters above the surface of the water. The user of the program is free to experiment with the block height variable and see the change in the swimmer's (projectile) motion in a displayed plot.

An important limitation to our simulations is the very idea of diving off of a starting block into a pool. If you launch at too high of an angle with respect to the surface of the water, the swimmer will enter too deep and will not move as quickly as possible to the other side (which is the goal in competitive swimming). Another limitation is adjusting the starting block height. Set the height too high and the swimmer while diving even deeper again, possible at an unideal body position for water entry. To account for the block height limit, we programmed a warning message to users who set the block height past 58 meters.

This program is geared towards swimmers interested in learning physics and projectile motion in a context more friendly to them.