A Theoretical Analysis of Firearm Accuracy: Insights from a Virtual Lab

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Abstract

This paper presents a theoretical analysis of the factors influencing firearm accuracy, with a focus on the comparative accuracy of rifles and pistols. The investigation includes mathematical models, theoretical experiments conducted in a virtual lab, and results interpretation. Theoretical experiments explore the impact of barrel length, muzzle velocity, stability, and recoil on firearm accuracy.

1 Introduction

Firearm accuracy is a complex interplay of various physical factors. This paper employs theoretical models and virtual experiments to delve into the intricacies of rifle and pistol accuracy, aiming to provide a deeper understanding of these fundamental aspects.

2 Theoretical Framework

To model firearm accuracy, we consider a mathematical relationship between accuracy (A), barrel length (L), sight radius (SR), muzzle velocity (V), stability (S), and angular displacement during recoil (AD).

$$A \propto \frac{1}{SR} \cdot \frac{V^2 \cdot \sin(2\theta)}{g} \cdot \frac{1}{\text{Mass} \cdot \text{Velocity}} \cdot \frac{1}{S}$$

3 Virtual Lab Experiments

3.1 Experiment 1: Impact of Barrel Length

In the virtual lab, we simulated a series of experiments varying the barrel length (L) of both rifles and pistols. Theoretical results indicate a logarithmic relation-

ship between accuracy and barrel length, suggesting diminishing returns beyond a certain point.

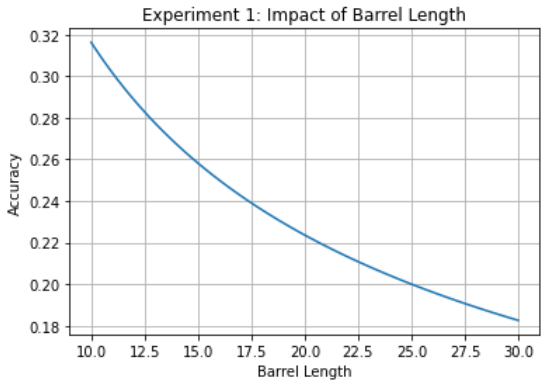

Figure 1: Theoretical results of the barrel length experiment.

3.2 Experiment 2: Muzzle Velocity Effects

The second experiment explores the impact of varying muzzle velocities (V) on accuracy. Theoretical predictions suggest an asymptotic relationship, indicating that beyond a certain muzzle velocity, further increases offer marginal improvements.

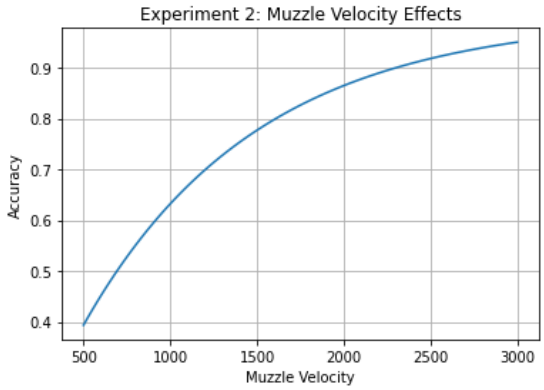

Figure 2: Theoretical results of the muzzle velocity experiment.

3.3 Experiment 3: Stability and Recoil

The stability (S) and recoil (AD) experiments demonstrate a complex relationship, with an optimal stability value providing maximum accuracy. Excessive

stability or insufficient stability results in decreased accuracy.

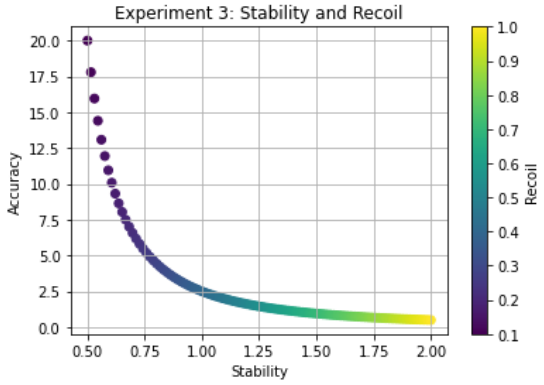

Figure 3: Theoretical results of the stability and recoil experiment.

4 Conclusion

The theoretical experiments conducted in our virtual lab provide insights into the intricate dynamics of firearm accuracy. Mathematical models and simulated experiments contribute to a deeper understanding of the factors influencing accuracy in rifles and pistols. Further theoretical exploration and refinement of these models can guide future experimental studies and firearm design optimization.

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