UNIVERSAL TRAJECTORIES AND COMMON TARGETS IN PUTTING

Robert D. Grober
Nissequogue Golf Club, Nissequogue, NY, 11780
email: bob.grober@gmail.com

Introduction

This talk concerns the trajectory of a golf ball as it rolls across a tilted, planar putting surface, which is often a reasonable approximation within 10-15 feet of the hole. The talk is summarized as two results. The first is that all possible trajectories can be represented mathematically in terms of a single universal trajectory, which greatly simplifies the calculation of putt trajectories. This mathematics is then used to discover families of putts which share a common target. Understanding how putts can be organized into families which share a common target suggest intuitive, non-mathematical methodologies both to practice making short, breaking putts and to better read putts while playing golf.

This talk extends the work previously reported in a previous paper by this author, "Geometry of Putting on a Planar Surface" [1], and in the video at [2].

Category

Late-Breaking Abstract, either a talk or a poster. I would also be happy to set up an interactive demonstration on a putting green, if such an opportunity existed.

Methods

This paper is based on mathematical analysis of the equations of motion of a ball as it rolls across a tilted, planar surface subject to a constant drag force. This is often a reasonable approximation to that of a golf ball rolling across a putting green, especially when near to the hole. The non-linear equations of motion which describe this problem are well known [3] and are usually solved by numerical integration. In this talk, an analytic solution to these non-linear equations of motion is described which reveals that all possible putt trajectories are derived from a single universal trajectory. This trajectory is shown to depend only on the ratio of two forces: the gravitational force projected into the plane, and the drag force of rolling friction.

Results and Discussion

The mathematics of the universal trajectory greatly simplifies the calculation of putt trajectories. Using this tool, the talk revisits H.A. Templeton's original idea that all putts equidistant from the hole share a common target [3]. Indeed it is found that putt trajectories on a tilted surface can be organized into families of putts which share a common target and which are meant to roll the same distance past the hole. The properties of these families of putts are summarized as follows: 1) the target points are located directly uphill a distance T from the hole; 2) all putts which share this target point are reasonably approximated to originate on a circle; and 3) the center of the circle is located downhill a distance 1.5-2T from the hole, depending on how far past the hole the ball is meant to roll.

Knowing only these facts, there is an intuitive, non-mathematical protocol for discovering this geometry on a putting green and then using it to practice putting, as is demonstrated in [2]. An advantage of this methodology is that the golfer obtains immediate feedback on the reason for a missed putt; whether it was the wrong initial direction, or incorrect initial speed, or both.

Finally, this understanding informs a methodology for reading putts while playing golf. In particular, instead of just considering the putt at hand, the golfer should also consider adjacent putts along an arc roughly +/- 30 degrees from the actual putt. By making a best guess as to the target point for several putts in this family of putts, and then taking the average target point from this sample, the golfer should be able to reduce the standard error in the prediction of the target point.

Significance

This talk takes a deeply mathematical observation about putt trajectories on tilted, planar surfaces and reduces it to intuitive, non-mathematical methodologies for practicing short, breaking putts and for reading putts while playing golf.

Acknowledgments

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References

[1] R. D. Grober, The Geometry of Putting on a Planar Surface, arXiv:1106.1698:
[2] R. D. Grober, The Geometry of Putting on a Planar Surface, https://youtu.be/YonCRBn0DiE
[4] A. Domenech, T. Domenech, and J. Cebrian, Introduction to the study of rolling friction, Am. J. Phys. **55**(3), 231 (1987).
[3] H.A. Templeton, Vector Putting, Vector Putting, Inc., Fort Worth, Tx., 1984