Applications of Hyperdimensional Linear Algebra and Complex Analysis

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How is it possible to calculate the direction of the reflection of an arbitrary ray of light off of a surface existing in any number of dimensions without the use of trigonometry? This project explores the reflection of a ray off a surface in two-space, three-space, and up to any number of dimensions desired. First, the specific case of reflection of a ray of light parallel to a selected axis is determined. This is done by finding the point of intersection of a ray on a surface of interest. Next, constrain a symmetric parabolic shape to be equal to that point and with equivalent first order derivatives at that point. To generalize the solution to an arbitrary ray, a transformation into complex space is done using the specific case as a reference. This process can be used to find the reflection of an arbitrary light ray in any number of dimensions. This transform into complex space is a new approach allowing for simple rotation without the need for measuring angles thereby circumventing the need for trigonometry. Also stemming from this work is a Theorem of Reflection, which states: “a reflected line is the locus of the foci of the set of all parabolas tangent to a point on at the point of reflection with equivalent first order derivatives.” The ability to represent reflection without the use of trigonometry can improve computational efficiency and accuracy in several applications: computer graphics, object modeling and imaging, satellite communications, and Lorenz Transformations.

Awards Won:

Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category

American Mathematical Society: Certificate of Honorable Mention