# Demonstrating Lorentz Transformation Using Computer Simulation

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***Abstract***

Lorentz transformations are at the heart of Special Relativity as they are the correct description of how motion looks from moving perspectives in our universe. Lorentz transformations were developed to align with experimental observations which proved that speed of light is a constant in all frames of reference including moving ones. Spacetime diagrams - with distance as the horizontal axis and time as the vertical axis - are typically used to visualize how objects in relative motion perceive each other. To understand the perspective of the moving objective, we need to transform the spacetime diagram such that the relative velocity, represented as the angle between the curves of two objects in the spacetime diagram, stays the same. The easiest way to visualize are shear transformations where the "time" of the moving object is kept the same and the "distance" coordinate is moved to the right or left on the spacetime diagram. However, such shear transformations do not maintain the constant speed of light. Lorentz transformations were then derived to obtain spacetime transformations that maintained the constant speed of light. For high school students studying physics Lorentz transformations can be non-intuitive and difficult to understand as they require the spacetime coordinate plane to slide, rotate and stretch in the correct proportions to maintain the constant speed of light. A simple visualization of different spacetime transformation approaches can be a helpful aid. We have developed a computer simulation that explains different transformation approaches (shear, Galilean, and Lorentz). We first modeled the coordinate plane using the AutoDesk Inventor software to develop a physical apparatus that mimics Lorentz transformations could be built. We then used a Java programming language to simulate the mathematical and movement concepts.

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