

Study of Projectile Motion: Augmented Reality

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Abstract

The traditional pedagogical approach to understanding projectile motion often relies on two-dimensional diagrams, chalkboard explanations, or at best, simple practical demonstrations. While these methods provide foundational knowledge, there is an increasing need to implement innovative teaching tools that cater to the digital age, ensuring more immersive and intuitive understanding for students. This study explores the efficacy of using Augmented Reality (AR) as a tool for teaching and learning the concepts of projectile motion in physics. Using AR, students are able to project trajectories onto their physical surroundings, change parameters like angle of projection, initial velocity, and observe the effects in real-time. The application also offers instantaneous feedback on calculations, helping students comprehend the underlying mathematical relationships.

Keywords

Augmented Reality, Projectile Motion, Physics Education, Innovative Teaching, Interactive Learning

Introduction

Technological developments in this day and age are growing so rapidly. Including its role in various sectors, such as education, agriculture, health, and others. Augmented Reality at present one of the rapidly developing Technology. AR is a technology that combines the imaginary world and the actual world where users can explore the actual world in a more interactive and interesting way. Slowly but surely AR technology has provided new options that are changing how we interrelate with each other, learn and play in the 21st century. Using AR technology for education is not something new as it has been do it for assembly training or body organ recognition. Therefore, in this research, researchers try to utilize the same technology for learning concepts in Physics subjects. If we study projectile motion, we will always be presented with illustrative vision of the parabola's motion. Currently, parabolic motion experiment equipment is still quite rare in schools. The equipment which are used for demonstrate the projectile motion are quite expensive. This condition means that not all schools have adequate equipment, especially parabolic motion experimental equipment. This causes the learning atmosphere to seem monotonous so that feedback is relatively low. And another problem is that the teaching aids provided by the school cannot be taken home by students. Therefore, we want to create an application to visualize parabolic motion using AR as a learning medium for students to learn about parabolic motion. The application used to project a real time projectile concept by receiving the input and calculated using physic formula. And with the help of AR technology, the outline of a parabola can be seen directly in the real world.

Computer Graphics

An understanding of computer graphics will be essential for creating and rendering the 3D models of the projectile and the surrounding environment. You'll utilize computer graphics techniques to ensure that the virtual elements seamlessly blend with the real-world environment, providing users with a visually immersive and realistic experience of the projectile's motion.

Computer Vision

Computer vision will take part a crucial role in accurately tracking the projectile's trajectory and motion within the AR environment. By employing Augmented Reality techniques, we can ensure that the virtual representation of the projectile aligns precisely with its real-world counterpart, allowing users to observe and analyze the projectile's path and behavior with accuracy and precision.

Sensor Fusion

The Sensor such as cameras, and motion sensor detect sensors from the various sources and sensor fusion techniques will enable us to combine it all for tracking the projectile's motion. By integrating sensor data, you can ensure that the AR application provides a seamless and synchronized representation of the projectile's motion, enhancing the overall realism and accuracy of the simulation.

Data Overlay

Data Overlay is a key feature in the AR-Projectile Tutor project. It involves displaying real-time data related to the motion of a projectile as it is launched and follows its trajectory in augmented reality. Data overlay provides students the essential information and immediate feedback, helping them better understand the physics of projectile motion

Literature Survey

Augmented Reality

Augmented reality (AR) is a modern-day interactive technology that integrates digital information, such as images, videos, or 3D models, into the real-world environment. Unlike imaginary reality, which creates entirely captivating artificial environments, AR enhances the user's consciousness of the natural world by overlaying digital elements onto it. AR has gained special attention in various fields, including education, gaming, healthcare, and manufacturing, due to its ability to provide an enriched user experience and facilitate interactive learning. AR provide us to frame fresh world experiences with the help of data layering over 3-Dimensional space. Mark Billinghurst [1] discusses how AR should provide a way to for providing the possibilities for learning, teaching, study, or creative investigation. AR uses imaginary objects or data that overlap environment or physical object to create a combine reality in which virtual objects and environments coexist in a meaningful manner to increase learning. Applying AR technology in the education sector can result in having an intelligent campus. AR has been used in different learning areas, including E-Learning, Mobile Game Applications, Game-Based Learning, and Gamification. AR helps to increase students' content understanding, motivation, interaction, and collaboration. It has a medium effect on the learning gains. AR will be a successful approach to tackling problems in physics. AR technology tools for education have been evaluated systematically, and teaching based on AR will be effective in technical, creative design courses and software editing courses for college students. The utilization of AR in educational methods may raise curiosity and give a unique way of learning projectile motion. AR itself is a combination of real-world and virtual objects. Joe Yuan Mambu et al. [2] uses the Vuforia SDK, which can meld the natural world and virtual objects. Through this application, there is a demonstration of projectile motion and its velocity in a more realistic way, has slight interaction with reality, and gets input from the user so they can learn and see the result of the parameter that they entered. The virtual objects help a user perform real-world tasks, making them a distinct example of what Fred Brooks terms Intelligence Amplification (IA): using the computer as a gadget to make a task more manageable for a human to perform. Ergi Bufasi et al. [3] have focused on fusing real and virtual images and graphics, but AR could be amplified to include sound. The user would have headphones stocked with microphones on the outside. The headphones would add industrial, directional 3-D sound, while the exterior microphones would detect approaching sounds from the environment. This would give the system a chance to cover up picked authentic sounds from the environment by initiating a masking signal that exactly canceled. Instructions might be easier to understand if they were available as 3-D drawings superposed

upon the actual equipment, revealing step-by-step the tasks that need to be done and how to do them. These superposed 3-D drawings can be animated, making the directions even more explicit. Carlo H. Godoy Jr [4] explores current mobile AR solutions like ARKit and ARCore, highlighting their capabilities in surface detection and object pinning on smartphones. On the other hand, advanced AR headsets like Microsoft HoloLens and the recently revealed Magic Leap One demonstrate enhanced capabilities by recognizing the 3D geometry of the environment and seamlessly rendering virtual overlays at 60 frames per second. Despite the surface detection proficiency of many existing AR systems, there is a notable need for improved object detection and recognition in the real world. Additionally, these systems require increased computational resources to render high-quality elements effectively.

Projectile Motion

Projectile motion is a fundamental concept in mechanics that describes the motion of an entity that is projected into the air and then moves under the effect of gravity. The motion of a projectile can be inspected by dividing it into its horizontal and vertical components. The velocity of the projectile can be divided down into its horizontal and vertical components, and the acceleration of the projectile is always directed downward due to the force of gravity. The path of a projectile is curved, and the initial velocity and the projection angle of the projectile determine the shape of the path. The greater the projection angle, the greater the horizontal range of the projectile. Awelani V et al. [5] said about common misconceptions about projectile motion, such as the belief that the direction of acceleration or force follows the direction of motion. Teachers can use these misconceptions as primary resources to develop instructional materials and experiment are helpful for students to understand the projectile motion concept. Various material available for students to explore the effects of varying the velocity and angle of projection, as well as air resistance. Teachers can design their lesson plans based on these materials and provoke discussions of projectile motion in a various contexts. The range of a projectile is known as the horizontal distance that is traveled by it before striking the ground. The range is affected by the angle of projection and the initial velocity of the projectile. The time of flight of a projectile is the amount of time spent in the air before hitting the ground. The time of flight is affected by the angle of projection and the initial velocity of the projectile. The utmost height of a projectile is the highest point reached during its flight. The maximum height is affected by the angle of projection and the initial velocity of the projectile. Chester Ian S. Pineda et al. [6] talks about projectile motion being used in a variety of real-world applications, such as ballistics, sports, and space travel.

The motion of a projectile can be modeled using mathematical equations, such as the equations of motion and the kinematic equations. Projectile motion is known as a type of two-dimensional motion, meaning that it occurs in the horizontal and vertical directions simultaneously. Ergi Bufasi et al. [3] explains the computational of projectile motion involves using computer simulations to model the movement of a particles that is thrown or launched into the air. A two-dimensional movement that has been mostly researched and studied by

various researchers. The simulation requires the user to input the initial velocity, angle, and rate of motion for the object to move. The simulation then calculates the horizontal and vertical components of the object's momentum, which influence its acceleration as it travels through the air showing parabolic movement. The simulation also shows how the object's velocity changes over time, with the horizontal velocity remaining constant and the vertical velocity decreasing due to the force of gravity. The simulation can be used to visually understand the properties of projectile motion, such as why a projectile fall after reaching a certain height. By using computational modeling, students can gain a deeper understanding of the physics behind projectile motion and how different factors, such as mass and velocity, can affect the movement of an object.

Projectile motion using AR

The traditional educational props used in teaching projectile motion are limited and cannot be used for accurate calculation. However, the utilization of AR in educational methods may raise curiosity and provide a unique way of learning projectile motion, as the motion can be seen in three dimensions. The use of smartphones in teaching physics laws be effective in engaging students and helping them learn faster. AR is a combination of real-world and virtual objects, and it can be used to simulate projectile motion and its velocity more realistically. AR provides a unique way of learning projectile motion and allows students to see it in three dimensions. Joe Yuan Mambu et al. [2] also mentions the using Vuforia SDK to blend real-world and virtual objects. Overall, using AR in teaching projectile motion can raise curiosity and provide a more engaging and interactive learning experience for students. T B Ding et al. [7] emphasizes the importance of providing students with different technique of understanding a topic, especially when it comes to essential chapters like projectile motion. It suggests that incorporating technology like AR can help switch from teacher-centered to student-centered learning environments and provide a more inclusive learning experience.

Simultaneous Localization and Mapping (SLAM)

Implementing SLAM techniques will allow to design a dynamic digital map of the physical environment and accurately position the virtual elements within it. By integrating SLAM, it can make sure that the virtual representation of the projectile interacts seamlessly with the real-world surroundings, providing users with an immersive and interactive experience that accurately reflects the projectile's motion and behavior within the physical space.

3D Modeling and Animation

3D modeling and animation are crucial for creating realistic and accurate representations of the projectile and the surrounding environment within the AR application. You'll utilize 3D modeling software to design and render detailed 3D models of the projectile, considering factors such as shape, size, and physical properties. Additionally, you'll use animation techniques to simulate the projectile's motion and trajectory, providing users with a visually engaging and informative experience of projectile motion in the AR environment.

Mathematical Modeling and Simulation

Mathematical modeling and simulation will be instrumental in accurately predicting and visualizing the projectile's motion within the AR environment. Application of mathematical equations and principles of projectile motion, considering variables such as initial velocity, launch angle, and gravitational forces, to create a dynamic simulation of the projectile's trajectory. By incorporating mathematical modeling and simulation, it can provide users with a comprehensive and insightful representation of the underlying physics governing the projectile's motion and behavior in the AR context.

ARCore

ARCore is a platform developed by Google for building augmented reality experiences on Android devices. Utilization of ARCore to integrate AR functionalities, such as motion tracking, environmental understanding, and light estimation, into application. By leveraging the capabilities of ARCore, it can make sure that the AR experience is seamlessly integrated with the user's physical environment, allows them to visualize and analyze the projectile's motion in real-time within their surroundings.

Conclusion

Using augmented reality (AR) in teaching projectile motion has shown promising results. AR provides a unique and interactive way of learning, allowing students to see the motion in three dimensions and associate with virtual objects. One study used the Vuforia SDK to simulate projectile motion and its velocity more realistically, allows students to input parameters and see the results. AR has been shown in another experiment to contribute to the development of an inclusive educational environment for children with disabilities. Overall, AR has the potential to revolutionize the way we teach and learn projectile motion, providing new opportunities for interactive and immersive learning experiences. However, there are various challenges to overcome, some of them are cost of AR technology and the proper training given to the teachers to use AR in the education effectively.

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