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# Analysis Of Pendulum Via Incorporating Design, Simulation, And Modeling

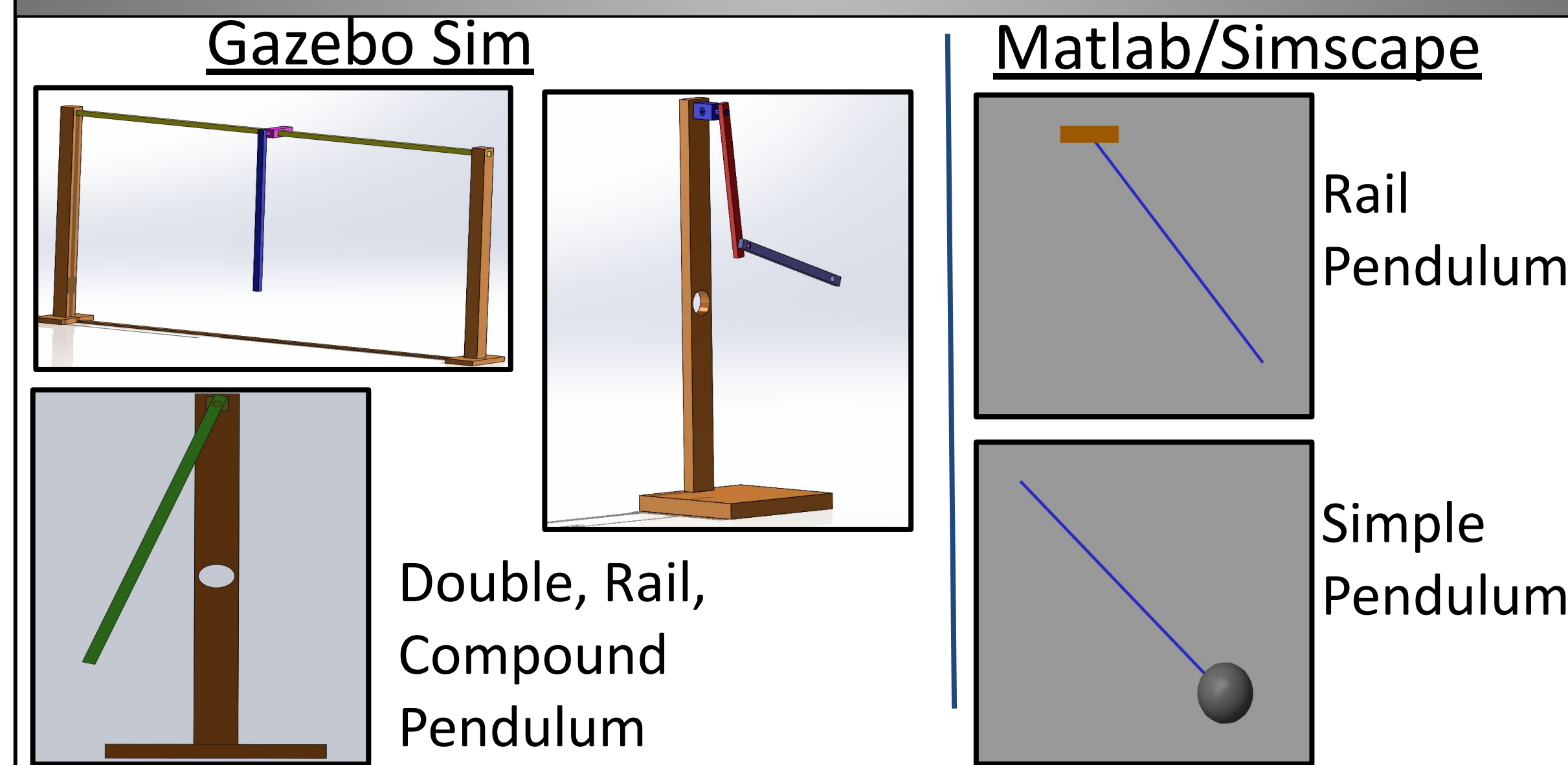
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## Introduction

Pendulums, driven by gravity's stability, offer crucial insights into mechanical systems. Researchers now use programming tools like MATLAB, Gazebo, and Simulink to simulate and analyze pendulum behavior. Understanding these dynamics leads to reliable designs for clocks, seismic detectors, and more. This knowledge drives technological advancements in mechanical areas like vehicles, machinery, and robotics.

## Models



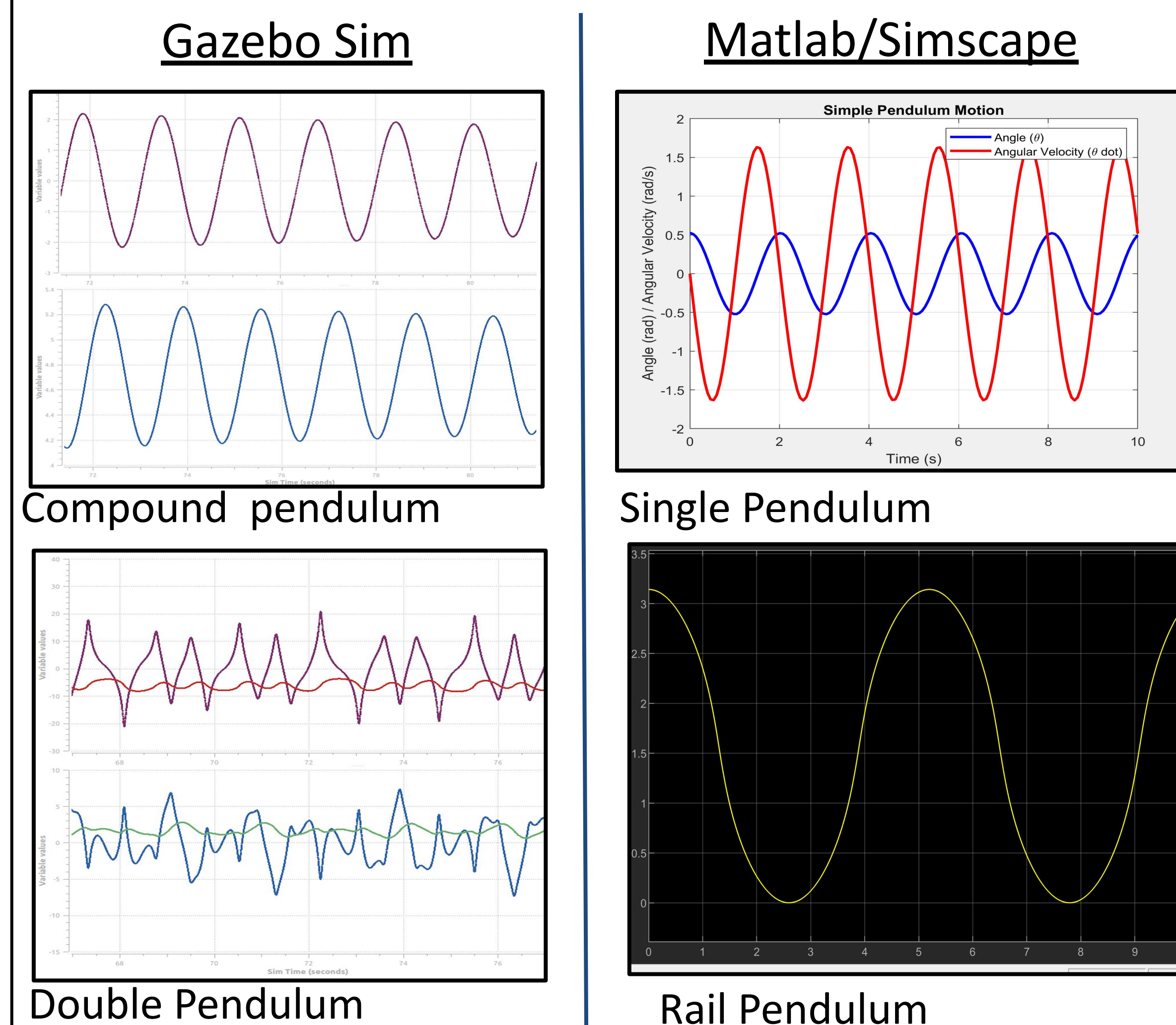
## Future Work/Conclusion

In the future, we intend to implement harmonic motion on the rail pendulum and analyze the resultant data using the same programming environments. Additionally, we are planning to collaborate on the ECLL research lab designed railing pendulum to enhance its efficacy and durability by changing the martial and weight of the body.

## Background Research

The research provides a comprehensive overview of simulations performed on four pendulums via using the Gazebo and Simscape simulator. The thorough analysis of different graphs results in the understanding of the effects of gravitational forces on the velocity and acceleration of the model, as well as the condition under which the pendulum comes to a complete stop. These simulations also take in consideration of dynamics and environmental factors that affect the model.

## Graph/Result



Visual representation of the four different systems when simulated in various programming environments

## References/Citation

CTMS. (n.d.). Inverted Pendulum: System Modeling. LSU. Retrieved from <https://ctms.engin.umich.edu/CTMS/index.php?example=InvertedPendulum&section=SystemModeling>  
MathWorks. (n.d.). Simulate Physics: Pendulum Swing. Retrieved from: <https://www.mathworks.com/help/symbolic/simulate-physics-pendulum-swing.html>

## Equations/Formulas

For the simple pendulum simulation in both Matlab and Simscape the equation of motion was derived, accounting for the kinetic and potential energy of the system:

$$\dot{x}_1 = \dot{x}_2$$

where  $\dot{x}_1$  represents the angle  $\theta$ , and  $\dot{x}_2$  represents the angular velocity  $\dot{\theta}$

$$\dot{x}_2 = -\frac{g}{l} \sin(x_1)$$

## Acknowledgment

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