MAE263F Homework 2

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This report presents the simulation of an elastic rod under gravity using the Discrete Elastic Rods (DER) algorithm. The rod is modeled as a series of nodes connected by elastic elements that can bend, twist, and stretch. The physical behavior is simulated over time using an implicit time integration method to determine the effects of gravity on the deformation of the rod, including stretching, bending, and twisting. The z-coordinate of the last node is tracked throughout the simulation to assess the rod's deformed shape and the steady-state configuration under gravitational loading.

I. Introduction

This report presents the simulation of an elastic rod under gravity using the Discrete Elastic Rods (DER) algorithm. The rod is modeled as a series of nodes connected by elastic elements that can bend, twist, and stretch. The physical behavior is simulated over time using an implicit time integration method to determine the effects of gravity on the deformation of the rod, including stretching, bending, and twisting. The z-coordinate of the last node is tracked throughout the simulation to assess the rod's deformed shape and the steady-state configuration under gravitational loading. The purpose of this report is to analyze the deformation of an elastic rod under gravity using the DER algorithm. The rod is represented as nodes connected by elastic forces, allowing bending, stretching, and twisting. The implicit time integration ensures stability and accuracy. The simulation tracks the position of the last node to evaluate the rod's deformed configuration.

II. Pseudocode

1. **Initialize**
   - 1.1. Set an initial guess for the next time step
   - 1.2. Set iteration counter to one
2. **Iterate Until Convergence**
   - 2.1. **While** the error is greater than the tolerance **do**
     - 2.1.1. Compute the reference frame for the next time step using the current guess
     - 2.1.2. Compute the reference twist for all internal nodes
     - 2.1.3. Compute the material frame for the next time step
     - 2.1.4. Compute the force and the Jacobian matrix using the equations from the DER algorithm
     - 2.1.5. Extract the free components of the force
     - 2.1.6. Extract the free components of the Jacobian matrix
     - 2.1.7. Solve for the change in the free degrees of freedom
     - 2.1.8. Update the free degrees of freedom
     - 2.1.9. Update the error based on the free components of the force
     - 2.1.10. Increment the iteration counter
3. **Update Values at the Next Time Step**
   - 3.1. Set the degrees of freedom at the next time step to the final iteration value
   - 3.2. Compute the new velocities based on the change in the degrees of freedom
   - 3.3. Set the reference frame at the next time step
4. **Return**
   - 4.1. Degrees of freedom, velocities, and reference frame at the next time step

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III. MATH

- *Problem 1*