CPSC 687 A1 Description

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Program description The program animates a roller coaster. It has met the full requirement and 2 bonus parts (i.e., train of cars and the realism of the scene).

Compilation [1]

1. How to Install Dependencies (Ubuntu)
   sudo apt install cmake build-essential
2. How to Build
   cmake -H. -Bbuild -DCMAKE_BUILD_TYPE=Release
   cmake –build build
3. How to Run
   (a) ./build/simple

Math /physics

1. **The curve**
   My curve is a 3rd-order B-spline parametric curve [3]. The arc-length parameterization provides a mapping between the parameter s and the position pos = B(s) which is a vec3 [2].
2. **The free fall**
   Given the current position pos = B(s), we can obtain $v = \sqrt{2 * g * (H - pos.y)}$,

where g, H, and pos.y are the gravity, maximum height, and current height, respectively. Then we update s with $s+ = v * DT$, where DT is a small constant representing the increment of time.

3. **The orientation**
   The orientation is determined by three vectors $\vec{N}$, $\vec{T}$, and $\vec{B}$.

   (a) $\vec{N} = \vec{a_\perp} - \vec{g}$ points up with respect to the car, where

   $$\vec{a_\perp} = v^2 * B''(s)$$

   is the centripetal acceleration, and $\vec{g}$ is the gravity.
   $B''(s)$ is discretized as

   $$B''(s) = \frac{B(s + \Delta s) - 2B(s) + B(s - \Delta s)}{\Delta s^2}.$$

   (b) $\vec{T} = B'(s)$ is the tangent vector pointing toward the moving direction of the car, where $B'(s)$ is discretized as

   $$B'(s) = \frac{B(s + \Delta s) - B(s)}{\Delta s}.$$

   (c) $\vec{B} = \vec{T} \times \vec{N}$.

4. **Lifting phase**
   The listing phase has a constant speed V_0. And the reference frame is calculated as the same as above.

5. **Deceleration phase**
   The deceleration happens at the last 20 units of length. The deceleration is calculated as $a = \frac{V_0 - v}{20}$, where v is the speed at the position where we start to decelerate.

Acknowledgement

Thanks for Andrew's help. The train and cart model are retrieved from https://free3d.com/3d-model/train-v1–285308.html and https://free3d.com/3d-models/obj-cart.

References

[1] Givr api, https://lakin.ca/givr/.

[2] Adam Runions Przemyslaw Prusinkiewicz Andrew Owens, Jeremy Hart. *CPSC 587/687 Assignment 1 Notes*. University of Calgary, 2020.

[3] Faramarz Samavati. *CPSC 589/689 Course Notes*. University of Calgary, 2018.