Bachelor of Software Engineering - Game Programming

GD2P02 – Physics Programming

Penalty Methods and Springs

MEDIA
DESIGN
SCHOOL
GAME
DEV

Overview

- Penalty Methods and Springs
  - Penalty Methods
  - Mass-Spring System
    - Blobs

MEDIA
DESIGN
SCHOOL
GAME
DEV

Penalty Methods

- These are temporary springs for springy behaviour.
  - We create a set of constraints to represent a problem.
    - If the constraints are violated, an error is produced.
    - We use this error to add forces to the system in order to cancel the error and fix the constraint.

  Example:
    - An object moving downward penetrates the ground, the penetration depth can be used to apply an upward force to push the object out of the ground.

Penalty Methods: Example

- The penalty force will be pushing the object out.
  - F = ma = kx
  - a = kx/m

Penetration Depth (x)
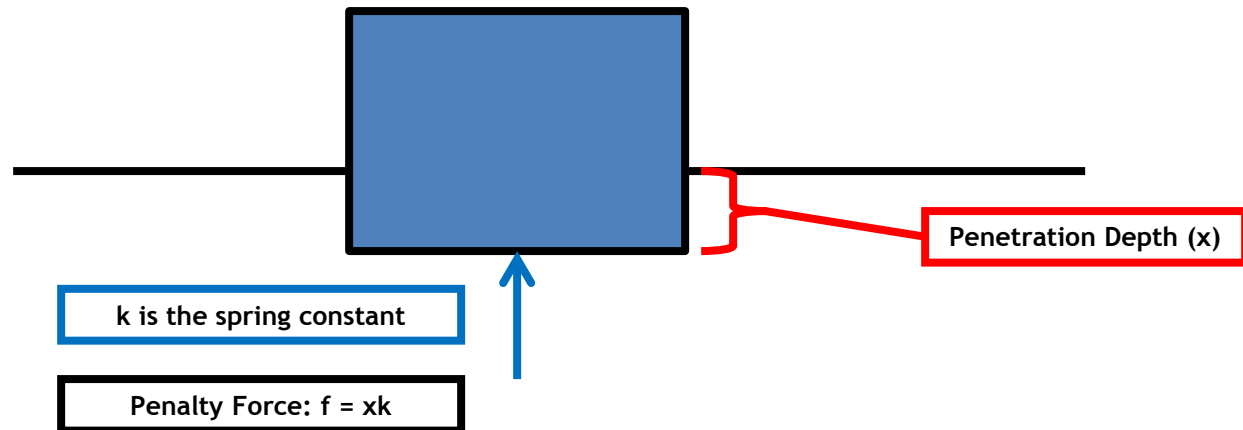
k is the spring constant

Penalty Force: f = xk

Fig 6: Applying a penalty force to resolve the penetration with the ground.

Penalty Methods: Example

- Example of rigid bodies with penalty springs:
- Penalty Method:
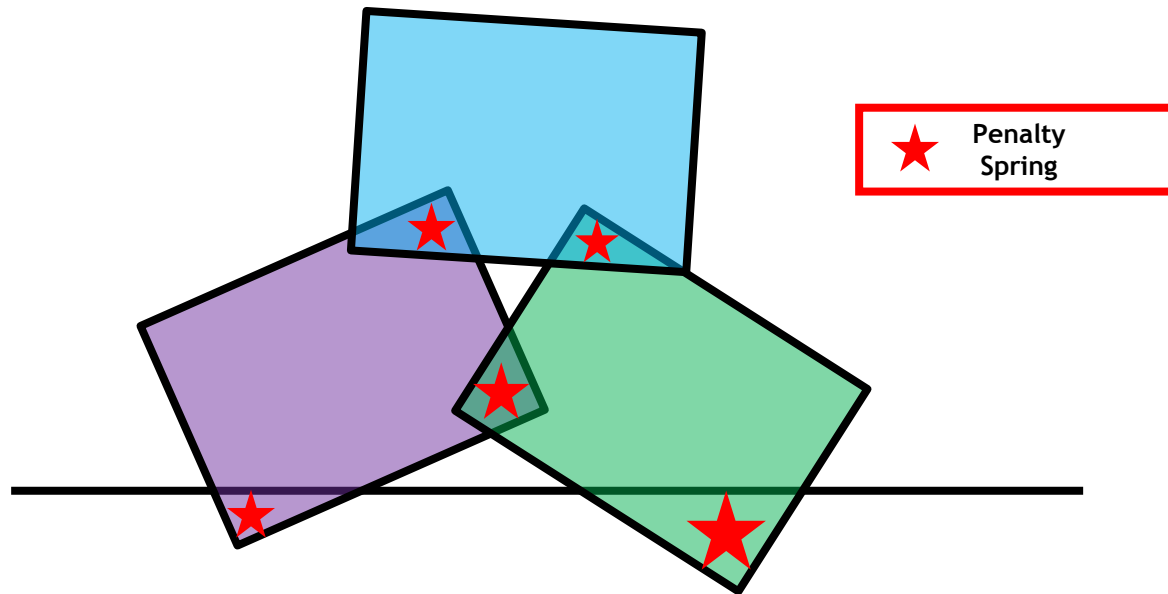 - x = penetration depth * contact normal.
  - k = spring constant.

Fig 7: Penalty springs created to fix penetration between bodies.

Springs and Damping

- Let us assume two objects are tied together with a spring…

  $$\mathbf{F} = -k(|\mathbf{x}|-d) - b\mathbf{v}$$

  – The equilibrium length (resting length): d
  – Fully extended: $(|\mathbf{x}|-d) > 0$
  – Fully compressed: $(|\mathbf{x}|-d) < 0$
  – Damping: $b\mathbf{v}$
    - b : the coefficient of damping
    - v : relative velocity between the ends of spring

Springs and cameras

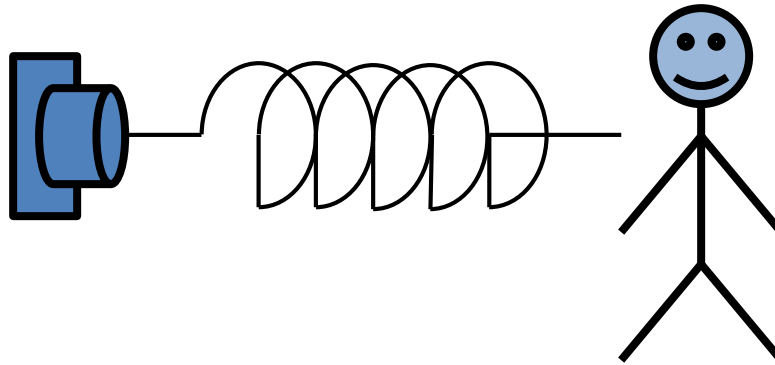- Use a spring to control the camera as it follows the player!

Fig 8: The game's camera attached to a spring, following the player avatar.

Springs and Bridges

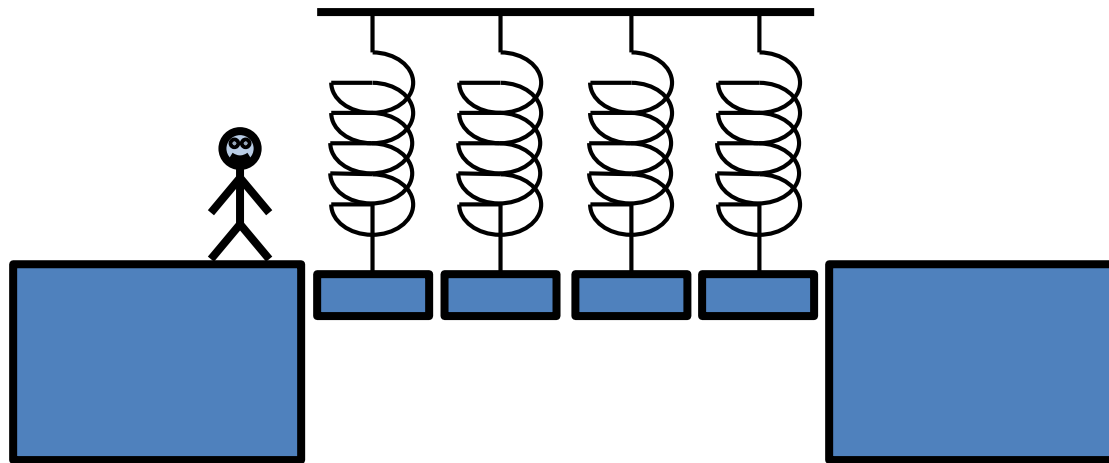- Anchor from a fixed point in space to the panels that make up the bridge.

Fig 9: Bridge made from spring.

Springs and User Interface Elements

- A spring can be used to scale the buttons.

Fig 10: Asylum Runner (GDMAR09, 2009) main menu.

Mass-Spring System

- A system composed of masses connected by springs…

- Properties of the springs in the system:
  - The equilibrium length (resting length)
  - Maximum length: fully extended
  - Minimum length: fully compressed
  - Spring coefficient (k, and F = kx)

Blobs

Fig 12: *LostWinds 2: Winter of the Melodias* (Frontier, 2012)

Fig 14: Gish (Cryptic Sea, 204) screenshot.

Fig 13: Loco Roco (Japan Studio, 2006) screenshot.

Fig 12: http://lostwinds.frontier.co.uk/gallery/
Fig 13: http://media.gamingexcellence.com/screenshots/locoroco/12017.jpg
Fig 14: http://gamespot.com/gish/

Mass-Spring System: Blobs

- Blobs are deformable structures like soft bodies.

- Circular Spring Mass System...
  - Skin layers and structure
    - Outer circle, inner circle
    - Thickness of the skin
    - Central rigid body point
    - Strength of the springs
  - Number of segments in the structure
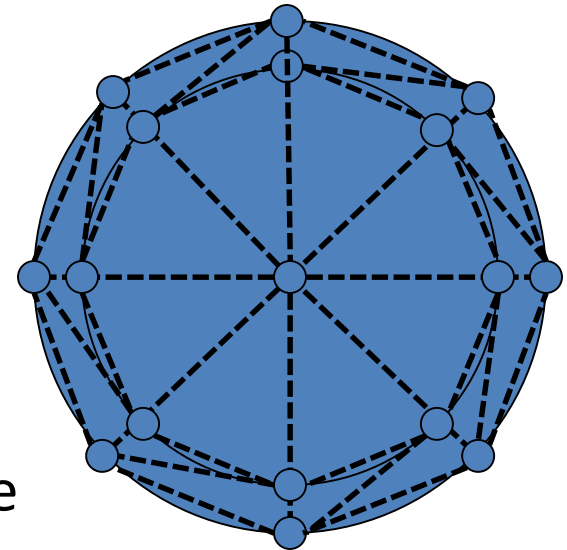 effects the behaviour of the body.

Fig 11: Deformable blob constructed from spring-mass system.

Exercise 1: Springy Menu Interface

- ## Springy Menu Interface
  - Create a simple interface similar to Asylum Runner (GDMAR09, 2009).
  - Four menu options, one selected.
  - Allow the user to change between the selected menu option.
  - Movement between selected options causes scaling in a spring-like fashion.

Exercise 2: The Blob

- ## The Blob
  - Create a blob with the structure below
    - Central point, inner circle, outer circle.
    - Spring connections.
      - Min length (compression).
      - Max length (extension).
  - Bounce the blob off the edges of the window.
    - Apply force! (Start with gravity)
  - Render the wireframe to show the segments.

MEDIA
DESIGN
SCHOOL
GAME
DEV

Summary

- Penalty Methods and Springs
  - Penalty Methods
  - Mass-Spring System
    - Blobs