# EECE 478

Game Physics

## Game Physics

*Collision Detection*
- Object/Environment
- Object/Object
- Optimization
- Recursive dimensional clustering

Chap. 8 *Math for 3D…*

*Dynamic Simulation*
- Eqns of motion
- Differential eqns
- Projectiles
- Friction
- Rotational forces

Chap. 10&11

## Collision Detection

Determine time and location of collisions, given:
- Moving objects
- Stationary environment

## Object Models

Objects are collections of primitives
- Spheres
- Boxes
- Planes

Objects are articulated and hierarchical
- Nested bounding volumes
- Transform chains



## Environment Model

Terrain and static elements
- 2D+ spatial organization
- Only small changes

Therefore:
- Can preprocess for optimization
- Use quad/oct-trees or BSP trees
- Object volumes compared to tree to determine possible collisions



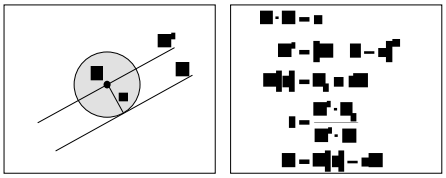
## Object/Environment Collisions

- Use spatial partitioning to simplify
- Identify possible collisions of dynamic object with static environment
  - Dynamic sphere vs. static plane
  - Dynamic box vs. static plane

## Sphere vs plane

Plane = any surface with constant normal

- Move plane by $r$ and intersect w/point

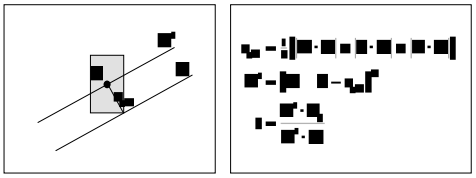




## Box vs plane

Determine *effective* radius $r_{\text{eff}}$ of box

- Box defined by vectors $\mathbf{R}$, $\mathbf{S}$ and $\mathbf{T}$





## Object vs Object

Two moving objects with $\mathbf{V}_1$ and $\mathbf{V}_2$

= Stationary object

+ Moving object with $\mathbf{V} = \mathbf{V}_1 - \mathbf{V}_2$

⇒ Only need moving + stationary

## Sphere vs Sphere

Two spheres $(\mathbf{P}_1, r_1, \mathbf{V}_1)$ and $(\mathbf{P}_2, r_2, \mathbf{V}_2)$

- Find t where $|\mathbf{P}_1(t) - \mathbf{P}_2(t)| = r_1 + r_2$



## Rigid Body Motion

*Math for 3D Game Programming*
*Chap. 10 & 11*

*Game Programming Gems*
*Chap. 2.2*



## Kinematics: T and R

*Kinematics* models the motion of objects

Objects have

- *Center of mass* $\mathbf{r}_{\text{cm}}$
- *Principle axes* $\mathbf{R}^0$, $\mathbf{R}^1$, $\mathbf{R}^2$
- *Velocity* $\mathbf{v} = d\mathbf{r}/dt$
- *Acceleration* $\mathbf{a} = d\mathbf{v}/dt$
- *Angular velocity* $\boldsymbol{\omega} = d\boldsymbol{\theta}/dt$

# Dynamics: F and A

Dynamics models the actions created by application of forces

- *Momentum* $\mathbf{p} = m\mathbf{v}$
- *Force* $\mathbf{F}_{\text{net}} = m(d\mathbf{v}/dt)$
- *Angular momentum* $\mathbf{L} = \mathbf{r} \times \mathbf{p}$
- *Torque* $\mathbf{N}_{\text{net}} = \mathbf{r} \times d\mathbf{p}/dt$