Realistic Water Simulation

Team Wavy

School of Data and Computer Science(SYSU)

July 3, 2018

Content

HOW to simulate?

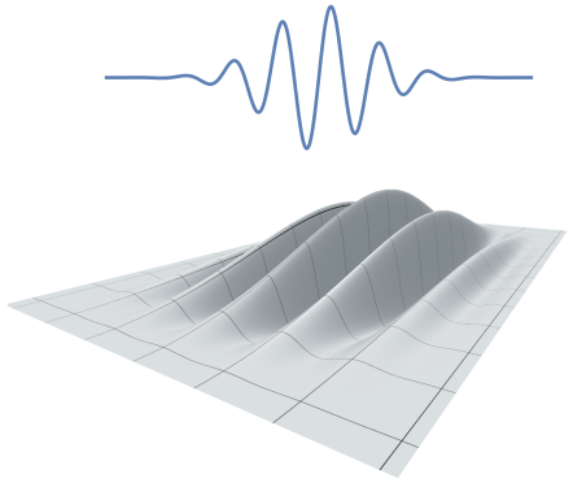
Quite difficult to deal with the **volatile** material...

- Texture-based method : minimize the calculation, wildly used in real time rendering
  - Blinn, 1978, Bump Mapping
- Construction-based method : more mathematicall
  - Cosine function superposition algorithm
  - Gerstner Wave
  - B-spline

HOW to simulate?

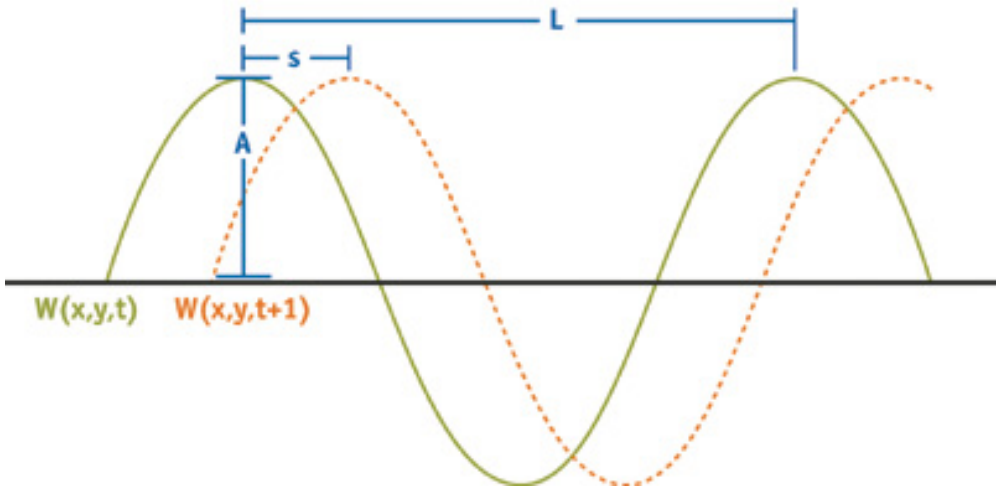
Quite difficult to deal with the **volatile** material...

- Based on physics models :
  Realistic and Lifelike(pick it!✓)



Introduction to Gerstner Wave

- Wavelength (L)
- Amplitude (A)
- Speed (S)
- Direction (D)



Introduction to Gerstner Wave

对于单个波而言，其函数表达式如下所示。

- A 振幅
- D 二维方向向量
- w 角速度
- φ 其值为 $S \times \frac{2}{L}$

$$W_i(x, y, t) = A_i \times \sin(D_i \cdot (x, y) \times w_i + t \times \varphi_i)$$

Introduction to Gerstner Wave

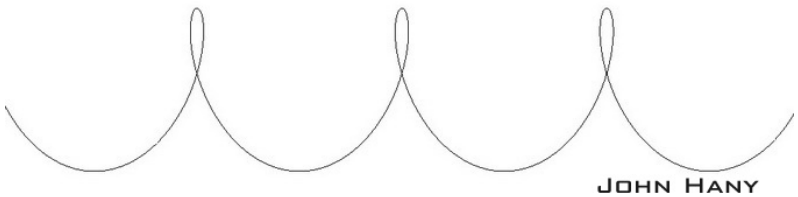
完整的 Gerstner Wave 函数如下所示。其为向量值函数。

- 输入
  网格化的坐标值
- 输入
  三维坐标系中的坐标 (x, y, z)

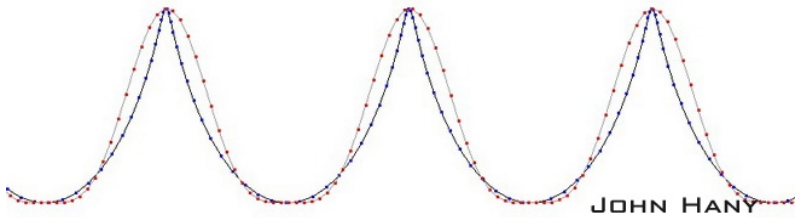
$$P(x,y,t) = \begin{pmatrix} x + \sum(Q_i A_i \times D_i[x] \times \cos(w_i D_i \cdot (x,y) + \varphi_i t)) \\ y + \sum(Q_i A_i \times D_i[y] \times \cos(w_i D_i \cdot (x,y) + \varphi_i t)) \\ \sum(A_i \sin(w_i D_i \cdot (x,y) + \varphi_i t)) \end{pmatrix}$$

参数特点

- Q 较大
  波峰尖锐，类似于真实水面
- Q 过大
  产生环，破坏波的形状
- Q 为 0
  退化为简单三角函数的叠加



The first film



The second film

Advantages

- 波峰尖锐，波谷平缓
- 允许多波产生叠加效果，交互感真实
- 参数众多，可调节性强
- 性能较高，开销较小

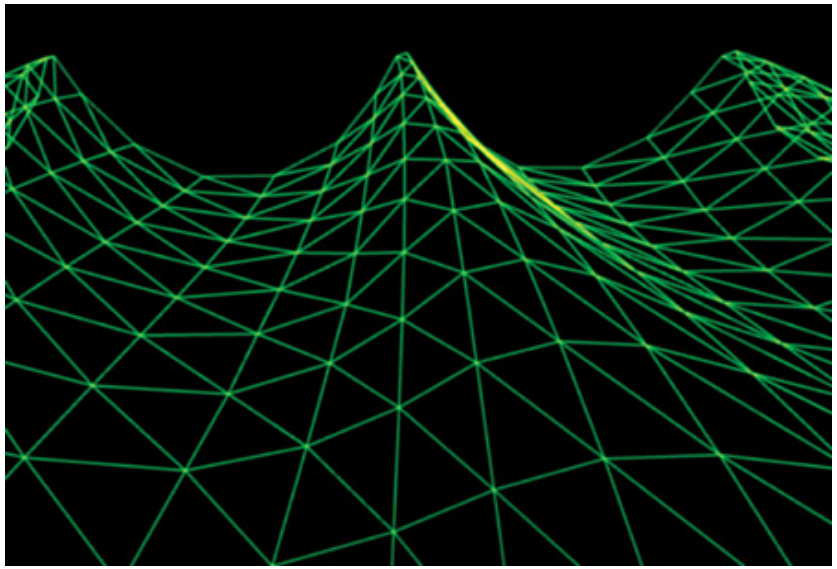


Figure: Gerstner Wave

Disadvantaged

- 水面永动，水面远处永远“自发地”泛起波纹
- 波峰低的波会产生大面积规律褶皱
- 无法仿真不同向的波间的碰撞和能量损耗。当波间相差的角度较大时，水面效果较差
- 整体上看，规律性过强

Refine

- 波随机过滤
  对小波采取随机化地去除。
- 动态修改参数
  动态地略微地修改各个波的方向、振幅等参数。

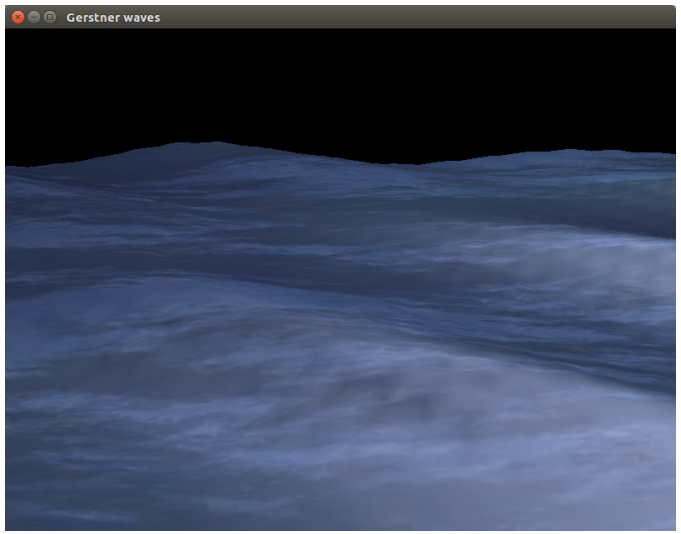


Figure: 程序运行图片