

# Virtual Reality

## 虛擬實境

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## 0. Course Introduction

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## 0.1 Course contents

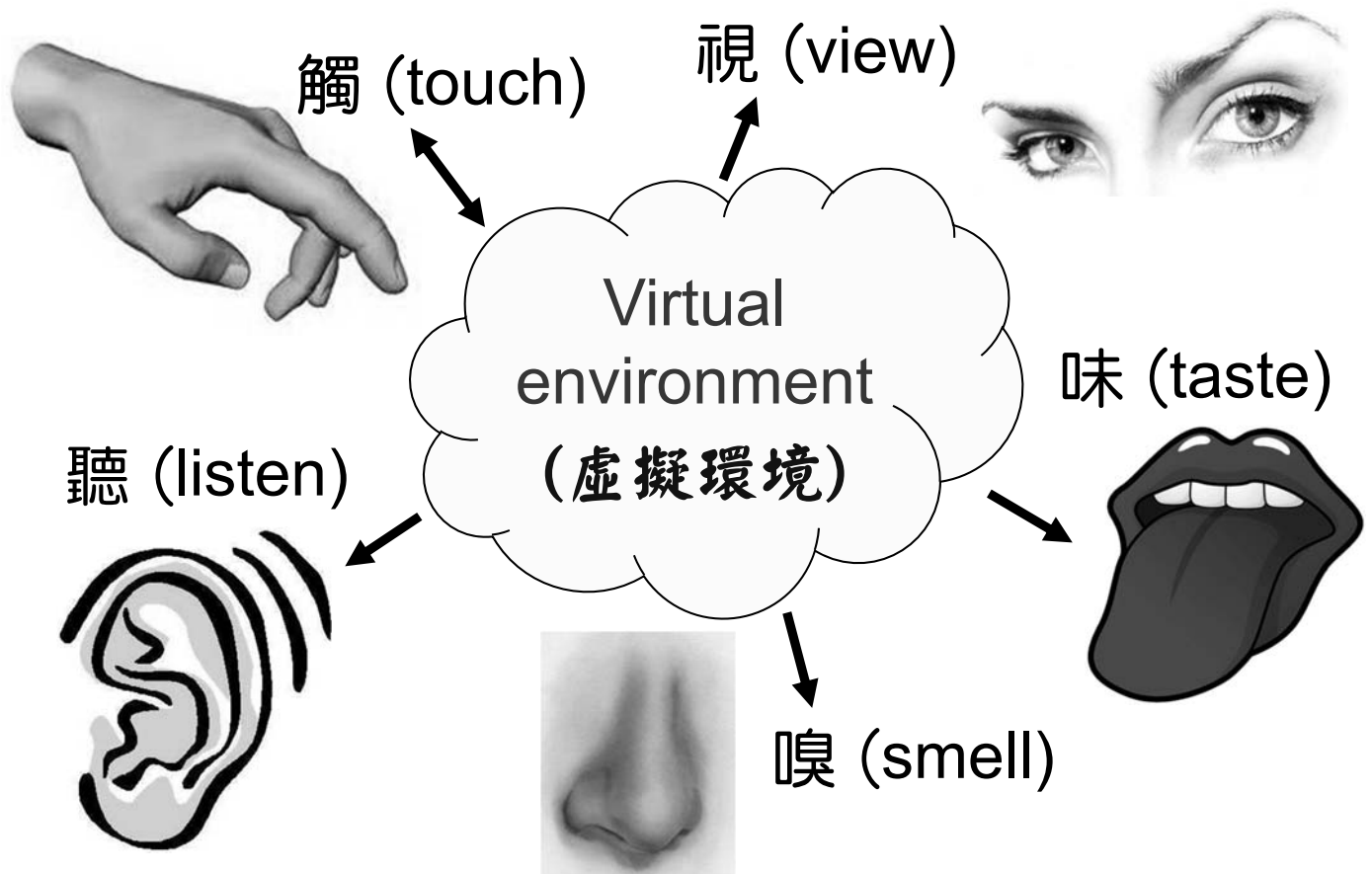
1. Introduction to virtual reality
2. Human perception system
3. Hardware devices
4. Software development toolkits
- IP 8. Image feature extraction (影像特徵擷取)
- IP 9. Image segmentation (影像區塊分割)
5. Construction of virtual environments
6. Applications of virtual reality
7. Practices on virtual reality
8. Virtual reality in the future

🌸 Is VR just like these ones ?





❁ 感覺要真實：品質 (quality) 與速度 (speed)





- ❁ 虛擬實境中最特殊的機制就是觸覺。觸覺牽扯到運動知覺 (kinesthetic) 與互動 (interaction) 功能。
- ❁ 除了各單項感覺要真實外，視、聽、觸的綜合反應與感覺更重。
- ❁ 擴增實境中最重要的是了解真實物體的方位。

## 1. Introduction to virtual reality

definition, history, related devices, software toolkits, components, and applications

## 2. Human perception system

visual system, color spaces, haptic system, and auditory system



## 3. Hardware devices

reality engine, stereo visual display, 3-D sound generator, tactile/force feedback, 3-D tracker, sensing glove, 3-D controller

## 4. Software development toolkits

*OpenGL, Open Scene Graph, PLIB, VR Juggler*

## IP 8. 影像特徵擷取

點、線、邊、角等特徵的擷取

## IP 9. 影像區塊分割

門檻值分割法、自動二值化、自動多值化、區域分割、彩色影像分割

## 5. Construction of virtual environments

geometric modeling, multiresolution modeling, rendering, geometrical transformation, animation, physical modeling, force rendering

## 6. Applications of virtual reality

entertainment, sport, education, medicine, simulation, visualization, military, aerospace, robotics, manufacturing, business, art, ..

## 7. Practices on virtual reality

flight simulation, laparoscopic surgical simulation, facial animation, plant growing animation

## 8. Virtual reality in the future

❁ 以下 10 個範例都是展示視與觸為主的綜合感覺

❁ Kinesthetic sensation



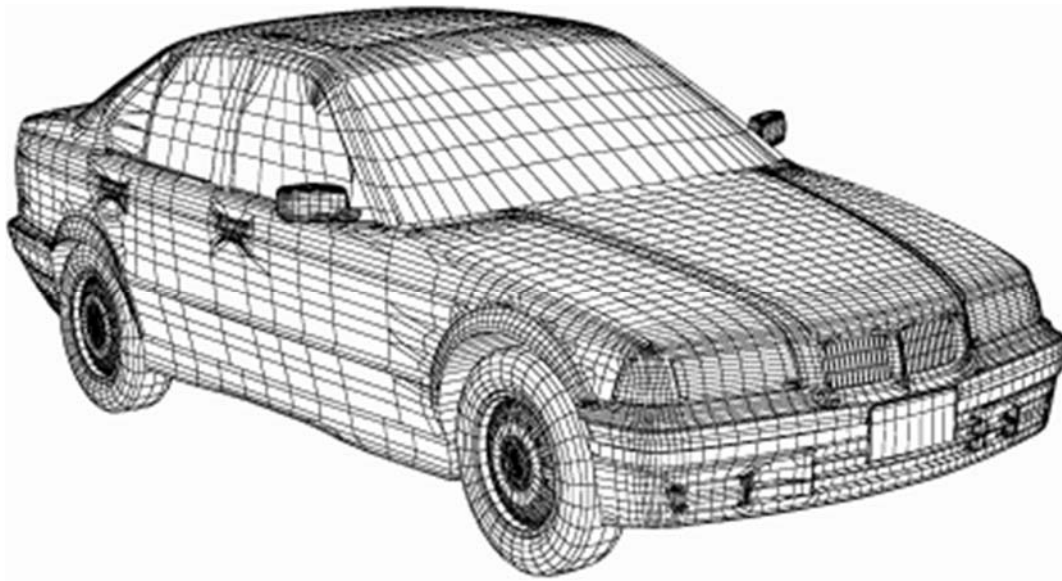
## 🌸 Kinesthetic sensation - Driving simulation



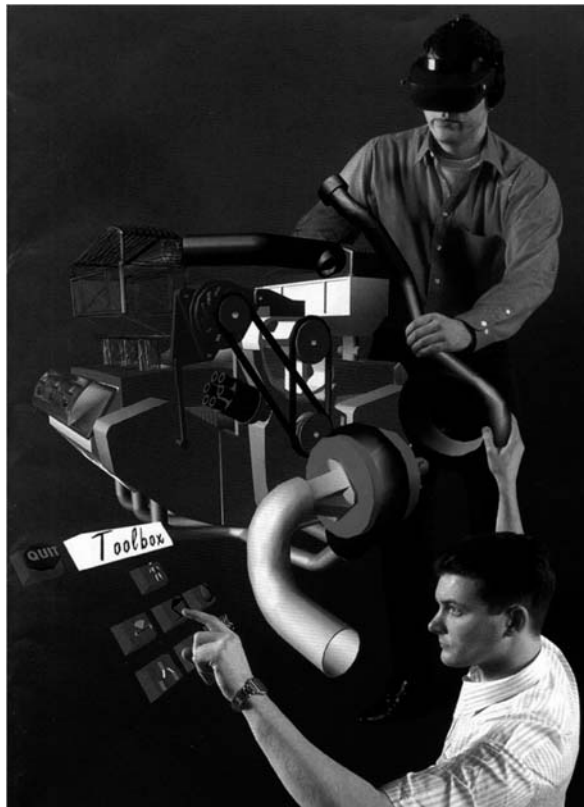
## 🌸 Kinesthetic sensation - Boeing 787 flight simulator



## 🌸 Haptic/vision sensation - Virtual car design

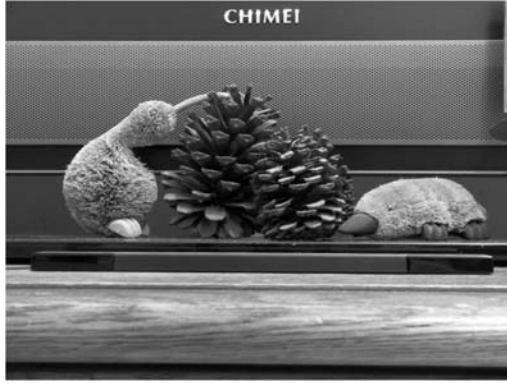


## 🌸 Kinesthetic/vision sensation – Virtual model

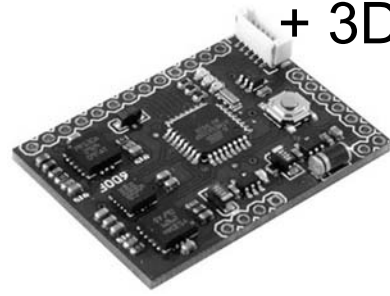




# 🌸 Nintendo *Wii* (since 2006/11)



3D accelerator  
+ 3D Gyro



Head Tracking for Desktop Virtual Reality Displays using the Wii Remote

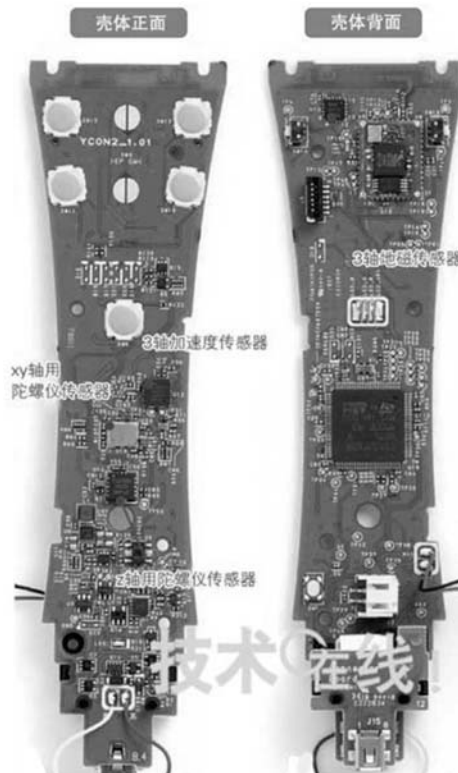
Johnny Chung Lee  
Human-Computer Interaction Institute  
Carnegie Mellon University

Low-cost Multi-Point Interactive Whiteboard using the Wiimote

Johnny Chung Lee  
Human-Computer Interaction Institute  
Carnegie Mellon University



# 🌸 Sony PlatStation *Move* (since 2010/9)



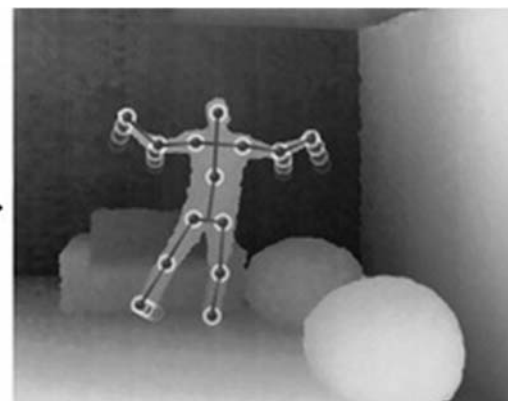
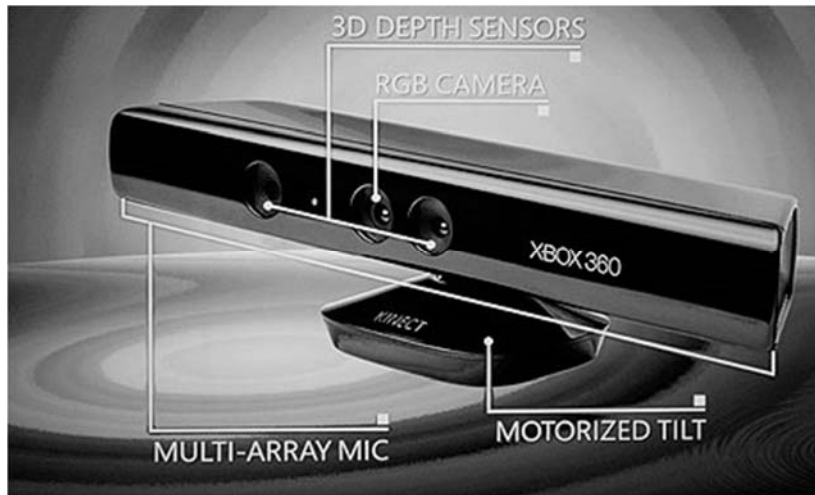
3D accelerator  
+  
3D Gyro  
+  
Magnetic sensor







# Microsoft *Kinect* (since 2010/11)





## 🌸 Nintendo *Wii* 與 Microsoft *Kinect* 的比較

### Nintendo *Wii* Sony Playstation *Move*

- 需要控制器
- 有視覺與震動回饋
- 無動作分析
- 空間解析度較高
- 準確度較高
- 使用限制較少
- 執行速度較快
- 技術層次低

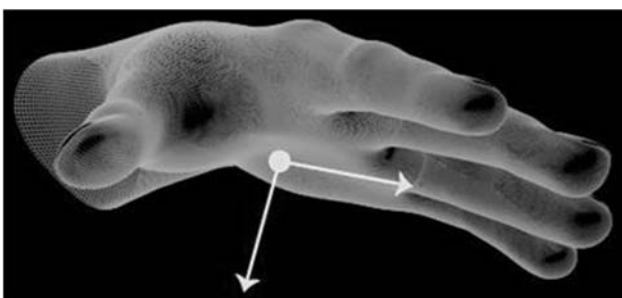
### Microsoft *Kinect*

- 不需控制器
- 只有視覺回饋
- 有人體動作分析
- 空間解析度較低
- 準確度較低
- 使用限制較多
- 執行速度較慢
- 技術層次高

## 🌸 Leap Motion



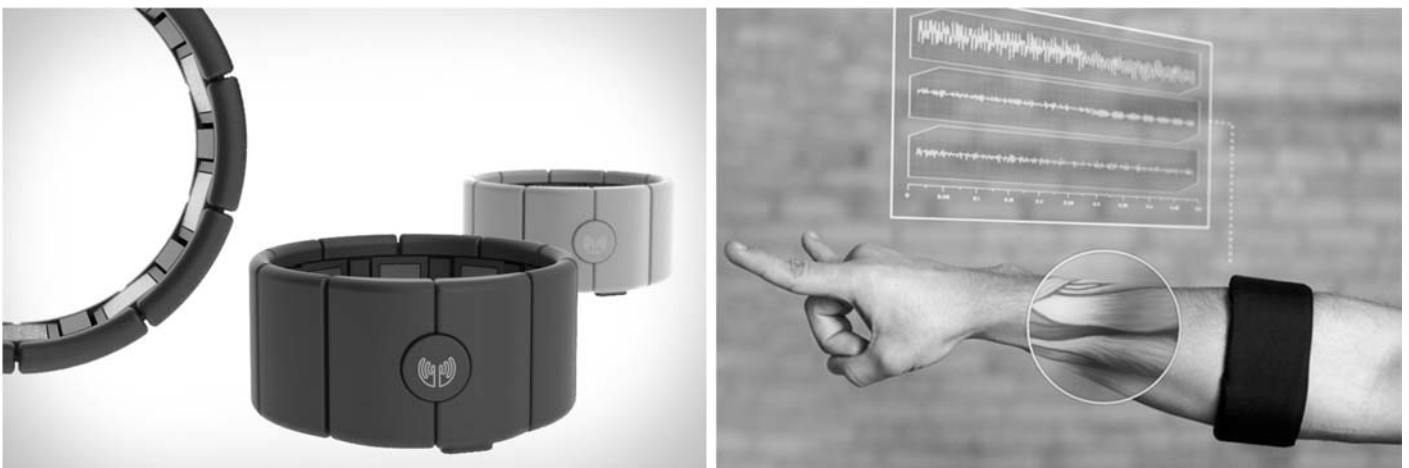
🌸 使用雙眼立體視覺 (binocular stereo vision) 的原理擷取雙手運動資訊而成的感測器。



## 🌸 MYO Armband



🌸 **MYO Armband** 手臂肌肉運動感測帶，穿戴在手臂上，能夠感測 (sense) 使用者的手臂肌肉和手指運作，並將偵測結果，透過低耗電的藍芽通訊，傳輸到電子裝置，讓電子裝置能認識你的手指動作。



## 0.2 Course purposes

- ✿ What can you get in this course ?
  - i.* You can get the concepts, basic definition, principle theorem, and related hardware/software concerning virtual reality.
  - ii.* You can learn the methods and algorithms about virtual reality.
  - iii.* You may construct and apply a virtual environment based on the concepts and techniques you have learned.

## 0.3 Learning background

- ✿ You need no background to study the basic concept and principle theorem of virtual reality; however,
  - i.* If you have learned the 3-dimensional computer graphics, you can learn more techniques of virtual reality;
  - ii.* If you can write *C* or *C++* programs and use *OpenGL*, or *Direct 3D*, or *OpenSceneGraph* toolkit, or *PLIB*, or you are able to use software development toolkits or interaction systems of virtual reality, you will get the greatest profit by taking this course.



## 0.4 Course evaluation

❁ 學期成績 = 期末考 (open book) 50% +  
一個作業 50%

❁ 作業可以是

(1) 看一篇論文，撰寫論文報告，或

(2) 找一個相關題目實做，交實做報告。

◆ 論文可以是學術論文、碩博士論文、或通俗性文章。

◆ 論文或實做題目自己找；論文檔案或實做計畫書要在 4月17日 (一) 前 email 給我確認 (論文寄給我，不是論文名稱給我而已。)



### ❁ email

1. 寄信者請用中文姓名。

2. 論文一定要有出處 (如下頁的範例)。

3. 一定要用完整論文名稱當檔名；論文名稱若為英文，第一個字母為大寫，其餘字母為小寫；例如，Technologies for 3D mesh compression

4. 給我原始檔 (pdf)，不要壓縮檔 (e.g., rar)。

5. 注意時程，不要到了最後幾天才趕交論文；論文遲交或確認沒過而造成遲交問題自行負責。

### ❁ 撰寫報告

撰寫中文或英文書面報告 (使用 MS Word)，

報告封面應註明論文名稱、作者、出處、

報告人姓名、學號、系級 (參考下頁範例)。

## ✿ 報告封面範例

虛擬實境作業報告

Technologies for 3D mesh  
compression: A survey

Jingliang Peng, Chang-Su Kim,  
C.-C. Jay Kuo

*Journal of Visual communication and  
Image Representation*, vol.16, 2005,  
pp.688-733.

系級：資工一

學號：1234567

姓名：郝仁

1234年 5月6日

## ✿ 繳交報告

檔名：個人中文姓名。

檔案或目錄請在 6月17日 (星期六) 12 pm 前上傳到 <http://ip.csie.ncu.edu.tw/> 課程 / 虛擬實境 / 上傳作業 或 email 給我。

## ✿ 成績

◆ 報告成績是依繳交

- (1) 論文性質 (難易度) 與報告內容、份量，或
- (2) 實作創意 及 實作份量而定。

◆ 實做加分，最多加總成績10%。



## ❁ 報告內容

繳交書面報告，報告內容至少要包含：

- (1) 摘要
- (2) 介紹 (用什麼觀念或方法解決什麼問題)
- (3) 方法或演算法 (怎麼做)
- (4) 結果
- (5) 討論 且/或 結論 (心得)。

注意：報告檔案是 *Word* 檔 (.doc, .docx)，  
不是 *pdf* 檔



## ❁ 實作報告

實作計畫書要在 4/17 前 email 給我確認 (A4 一整頁)  
實作一樣要繳交實作報告 (*Word* file)，6/17 前上傳。

### ❁ 實作內容範例

- i. 撰寫程式：可從立體顯示器看到或從立體音源產生器聽到且或可用相關設備操控 (例如：tracker, 3D mouse, 3D joystick, 3D sound, feedback, ...)
- ii. 撰寫程式：使用 *Open GL* 繪製 3-D 景物體；
- iii. 撰寫程式：撰寫 *VRML* 程式展示一場景；
- iv. 創新內容：構思一個新觀念或改善一個舊技術來完成某一虛擬實境的功能；例如：optical tracking, optical glove, feedback devices, voice recognition, objected-oriented programming, .....



## 0.5 School time

一般生

Monday 1:00 - 4:00 am

Lecture: 42 hours +  
Exam. 2 hours

專班生

Monday 6:30 - 9:30 pm

Lecture: 42 hours +  
Exam. 2 hours

Final examination (**open book**)

June 12, 2017 (Mon.)

1:00 - 3:00 am

June 12, 2017 (Mon.)

7:00 - 9:00 pm

## 0.6 Classroom

E6-207

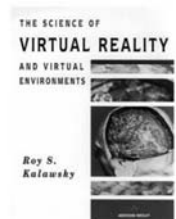
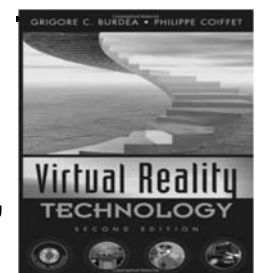
E6-203

## 0.7 Textbooks

Din-Chang Tseng, *Virtual Reality* (虛擬實境講義), 11th Ed., National Central University, Institute of CSIE, Jhongli, Taiwan, pp.836, Jan. 2017

### Reference books

- [1] Burdea, G. and P. Coiffet, *Virtual Reality Technology*, 2nd Ed., pp.464, John Wiley & Sons, NJ, June 2003, ISBN: 0471360899.
- [2] Kalawsky, R. S., *The Science of Virtual Reality and Virtual Environments*, Addison-Wesley, Wokingham, UK, 1993.
- [3] Vince, J., *Virtual Reality Systems*, Addison-Wesley, pp.388, Wokingham, England, 1995.



- ❁ [Kalawsky, 1993] 是我目前所看過的數本虛擬實境書中程度最高的一本。學術性非常高，且有最多的理論、原理、和技術，不過也是最難看的。
- 第 2 章的歷史背景介紹是所有書中最詳細的。
- 第 3 章介紹人類感官知覺的生理機能，這也是所有書中唯一介紹人因工程 (human-factor engineering) 的章節。雖然 [B & C, 1994] 的第 7 章也介紹人工因素 (human factor)，但其目的是要評估虛擬實境的效益，因此其所介紹的內容和方式有所不同。
- 第 4 章介紹虛擬實境設備及元件的原理和技術。其內容是所有書中最多、最難的。
- 第 5 章介紹虛擬實境系統發展工具。內容最深、最廣的。
- 第 6 章描述虛擬實境的未來展望。
- 第 7 章介紹虛擬實境的應用。
- 第 8 章結論。

## 0.8 References

### ❁ Books

#### Virtual reality

- [1] Blascovich, Jim and Jim Blascovich, *Infinite Reality: Avatars, Eternal Life, New Worlds, and the Dawn of the Virtual Revolution*, HarperCollins, NY, 2011.
- [2] Brice, R., *Multimedia and Virtual reality Engineering*, Newnes Press, Oxford, UK, 1997.
- [3] Craig, Alan B., William R. Sherman, and Jeffrey D. Will, *Developing Virtual Reality Applications: Foundations of Effective Design*, Elsevier, MA, 2009.
- [4] Sherman, W. R. and A. B. Craig, *Understanding Virtual Reality: Interface, Application, and Design*, Morgan Kaufmann Publishers, Amsterdam, pp.576, 2003.
- [5] Singh, G., S. K. Feiner, and D. Thalmann, Eds., *Virtual Reality Software & Technology*, World Scientific, Singapore, 1994.
- [6] Stuart, R., *The Design of Virtual Environments*, McGraw-Hill, New York, 1996.

## Computer graphics

- [1] Angel, E., *Interactive Computer Graphics: A top-down approach with OpenGL*, Addison-Wesley, Reading, MA, 1997.
- [2] Foley, J. D., A. V. Dam, S. K. Feiner, and J. F. Hughes, *Computer Graphics Principles and Practice*, 2nd edition, Addison-Wesley, Reading, MA, 1990.
- [3] Watt, A., *Fundamentals of Three-dimensional Computer Graphics*, Addison-Wesley, Workingham, England, 1989.

## Others

- [1] Barzel, B., *Physically-based Modeling for Computer Graphics: A Structured Approach*, Academic Press, Boston, 1992.
- [2] Burdea, G. C., *Force and Touch Feedback for Virtual Reality Technology*, John Wiley & Sons, NY, 1996.
- [3] Metaxas, D. N., *Physics-based Deformable Models: Applications to Computer Vision, Graphics and Medical Imaging*, Kluwer Academic Publishers, Boston, MA, 1997.

## ❁ Journals and Magazines

*IEEE Trans. Visualization and Computer Graphics*

*ACM Trans. Graphics*

*Journal of Visualization and Computer Animation*

*IEEE Computer Graphics and Applications*

*Virtual Reality Systems*

*CyberEdge Journal*

*Real Time Graphics* (Newsletter)

*Computer Graphics World* (Magazine)

*Virtual Reality Special Report*

*Virtual Reality News*

*IRIS Universe*

*IEEE Computer* (Magazine, special Issues)

## ✿ Conferences

*ACM Computer Graphics (SIGGRAPH)*  
*ACM Human Factors in Computer Systems (SIGCHI)*  
*IEEE Virtual Reality Conf. (e.g., VR 2012)*  
*IEEE Visualization Conf. (e.g., VIS 2011)*  
*IEEE Symp. on Research Frontiers in Virtual Reality*  
*Eurographics*  
*Cyberarts Conference*  
*Virtual Reality Systems Conference*  
*Medicine Meets Virtual Reality Conf., San Diego, CA*  
*Symposium on Interactive 3D Graphics*  
*Web 3D/VRML Symposium*

## ✿ 網頁

- *Open GL* <http://www.opengl.org/>
- *OpenSceneGraph* <http://www.openscenegraph.org/>
- *PLIB* <http://plib.sourceforge.net/>  
(*Portable Game Libraries*)
- *VR Juggler* <http://www.vrjuggler.org/>  
(*Open Source Virtual Reality Tools*)
- *3D Consortium* <http://www.web3d.org/>
- *IEEE* <http://ieeexplore.ieee.org/>
- *Elsevier SDOS 電子期刊* <http://sdos.ejournal.ascc.net/>
- *台灣博碩士論文資料庫* <http://ndltd.ncl.edu.tw/>
- *國科會電子期刊* <http://nr.stic.gov.tw/ejournal/>
- *國科會科學發展月刊* <http://www.nsc.gov.tw/sd/>
- *科學人雜誌* <http://www.sciam.com.tw/>