Computer Graphics

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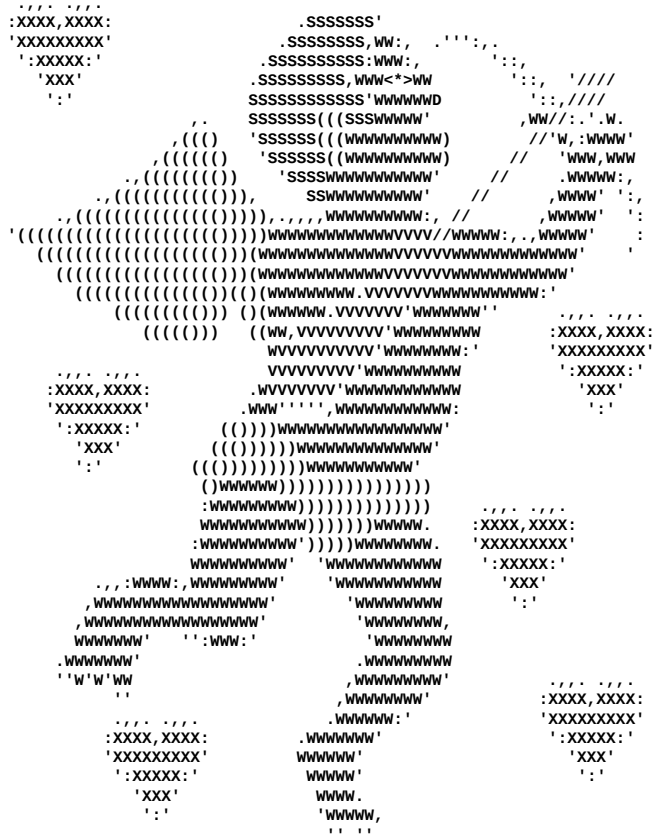
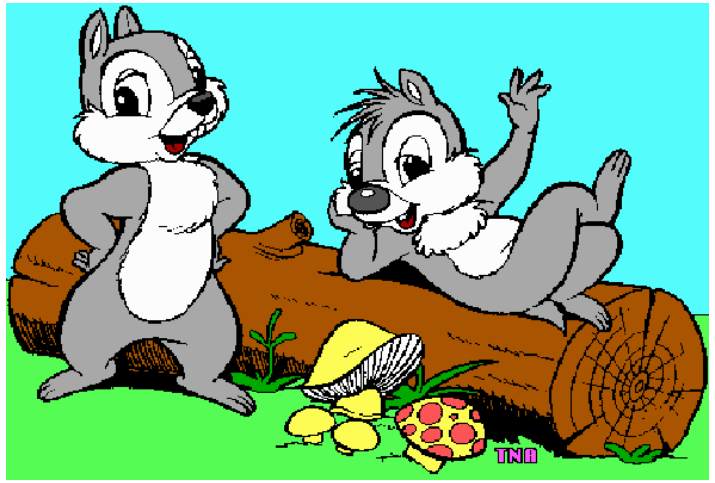
- 컴퓨터 그래픽스 분야
  - CG Design
  - CG Programming

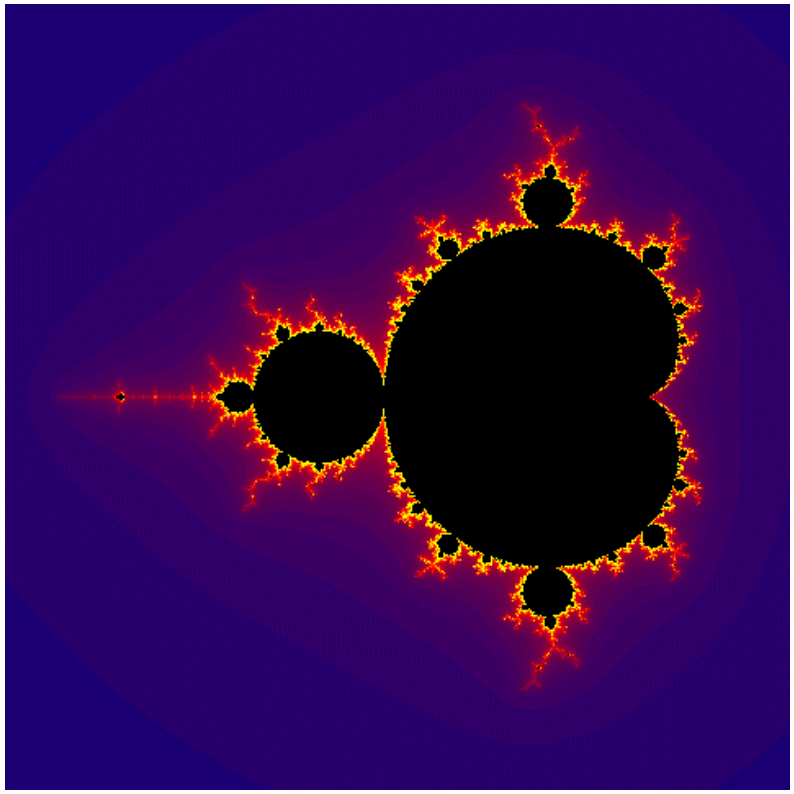
컴퓨터그래픽스의 응용

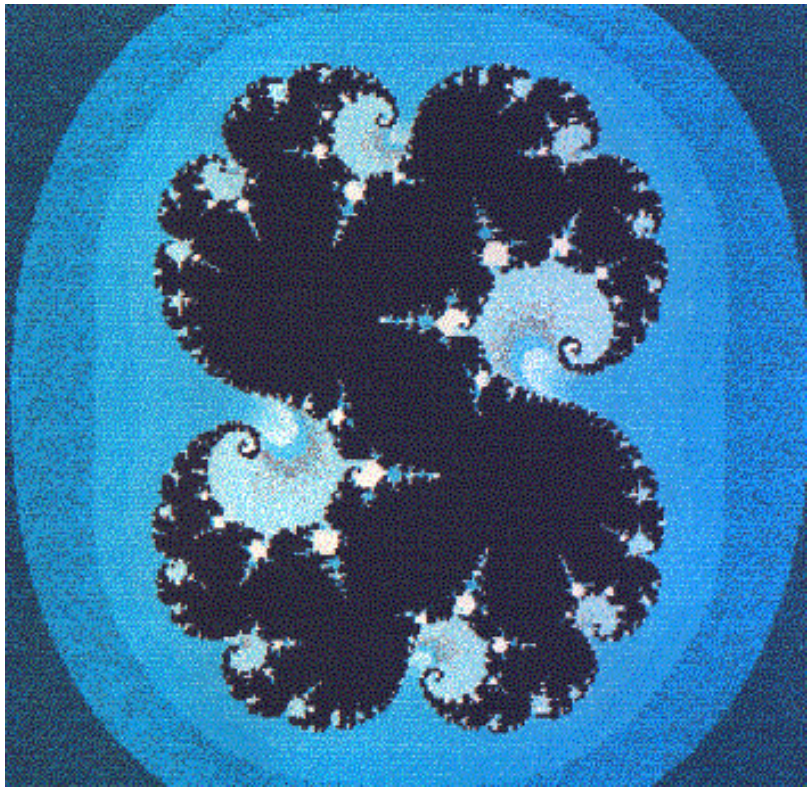
- CG의 응용 분야
  - science,
  - engineering,
  - medicine,
  - business,
  - industry,
  - government,
  - art,
  - entertainment,
  - advertising,
  - education and training

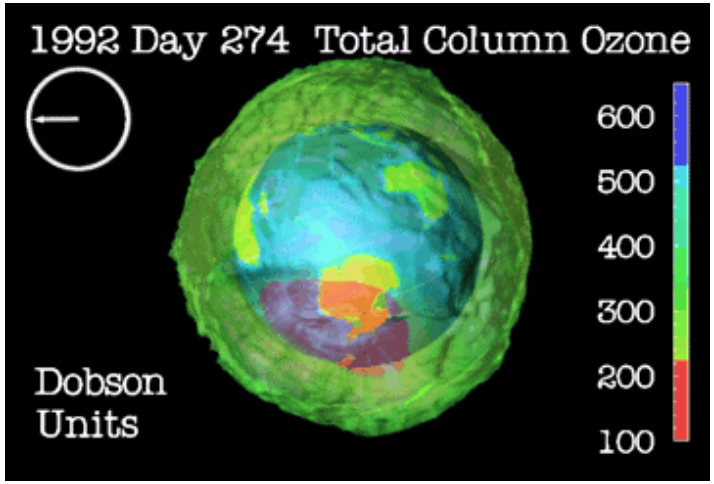


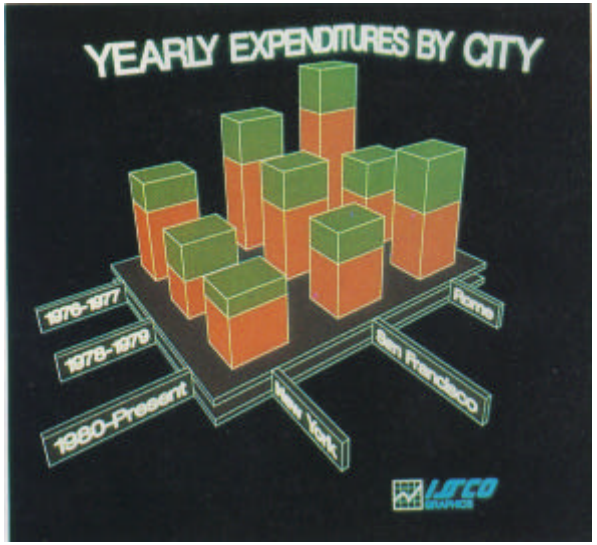

TNA

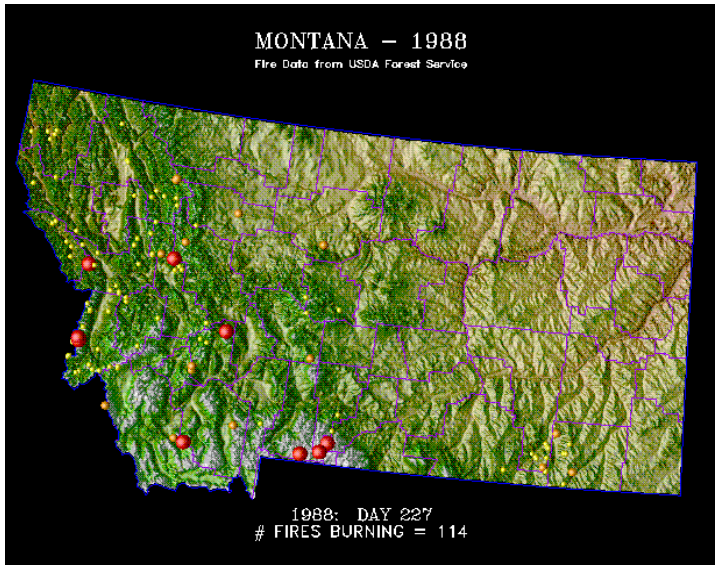

FRIEND
SW96
NEW YORK

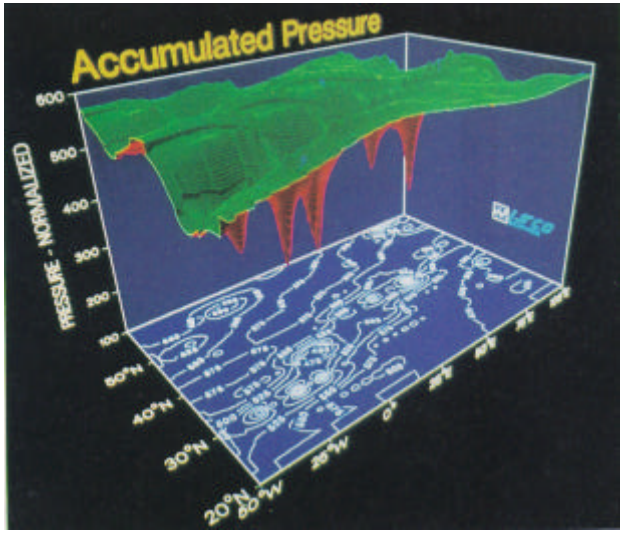


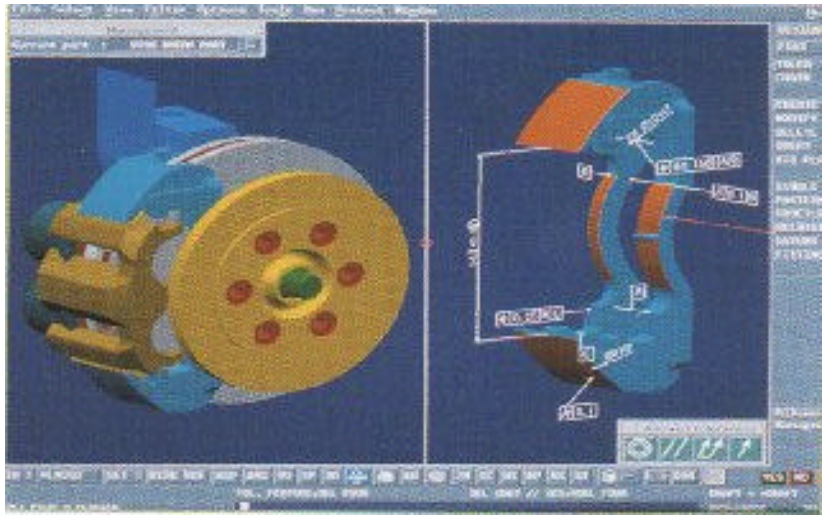


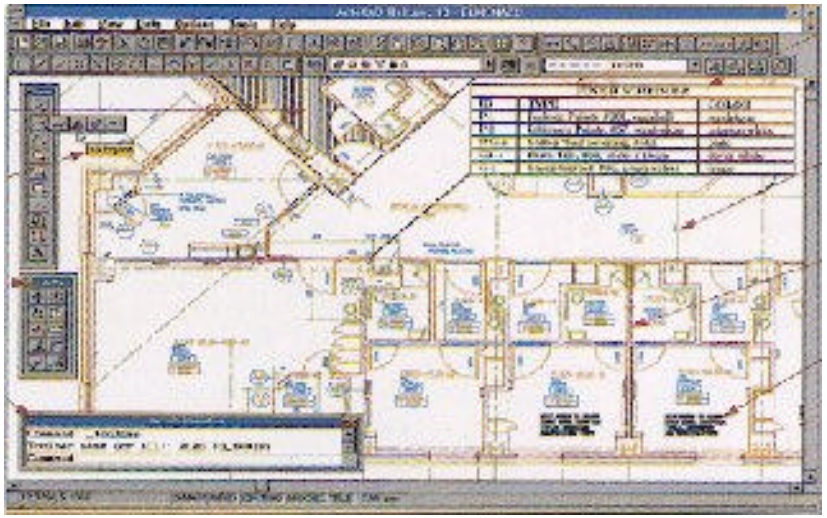

1992 Day 274 Total Column Ozone
600
500
400
300
200
100
Dobson
Units

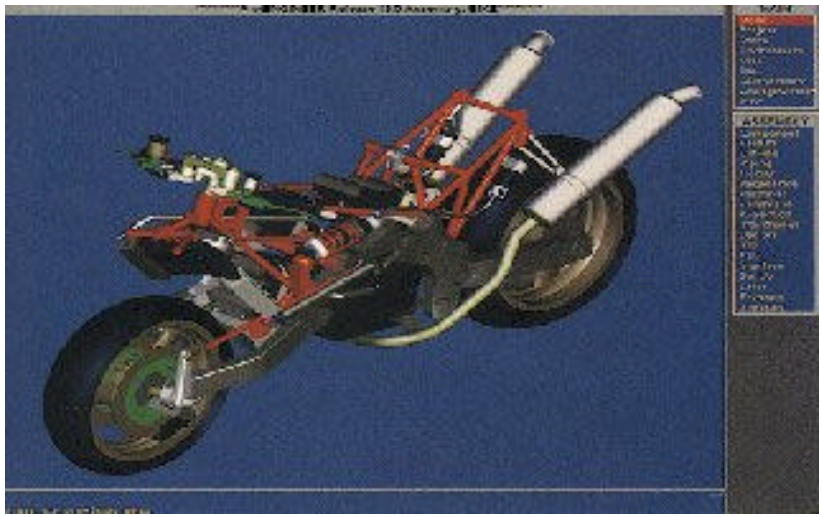

YEARLY EXPENDITURES BY CITY
1976-1977
1978-1979
1980-Present
Paris
San Francisco
New York

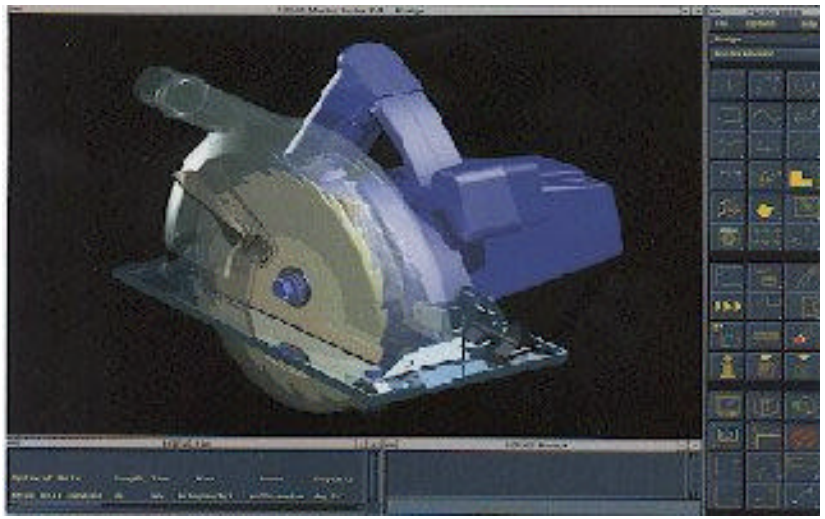

MONTANA - 1988
Fire Data from USDA Forest Service
1988: DAY 227
FIRES BURNING = 114

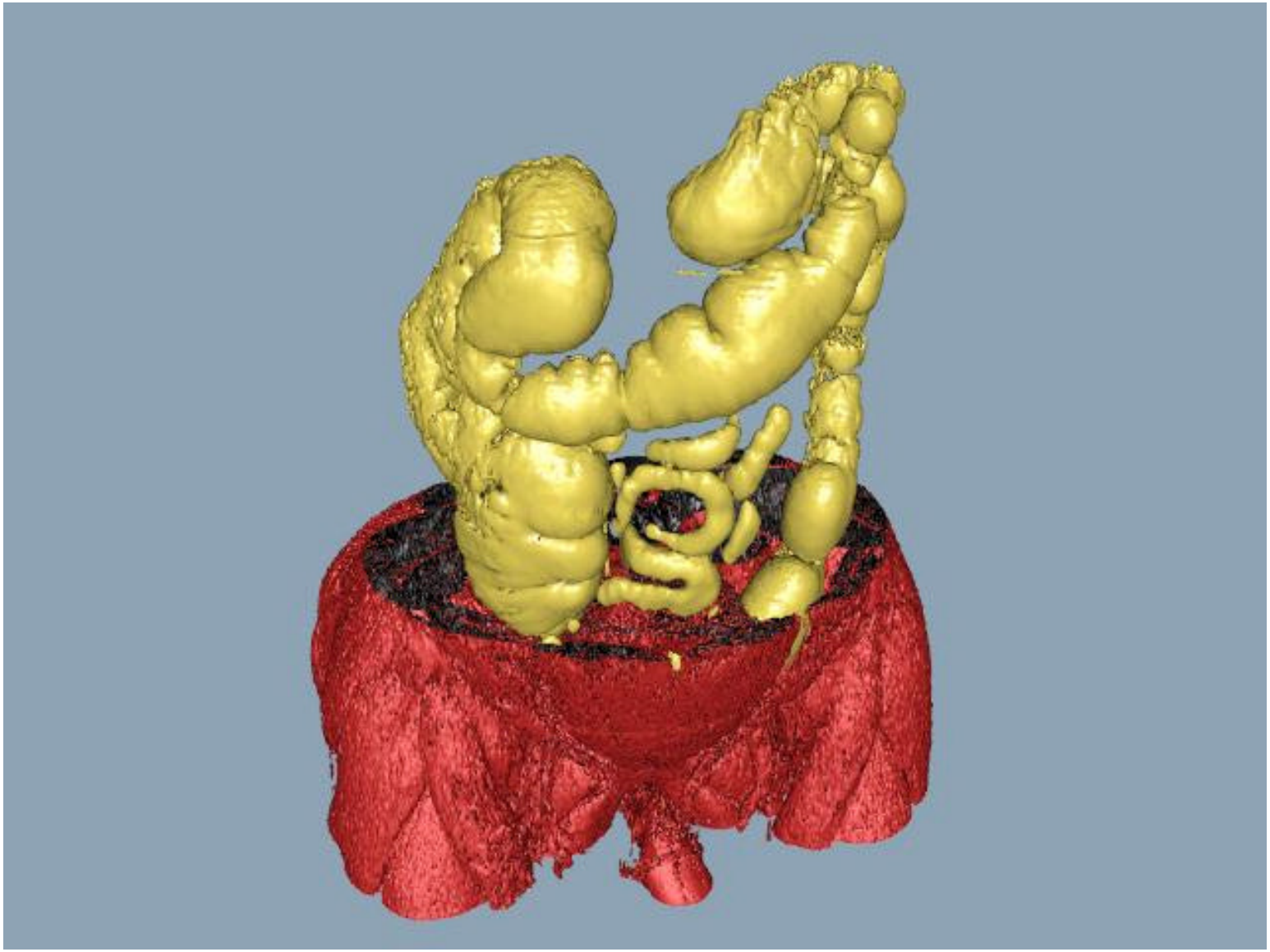

Accumulated Pressure
PRESSURE - NORMALIZED
600
500
400
300
200
100
50°N
40°N
30°N
20°N
50°W
25°W
0°

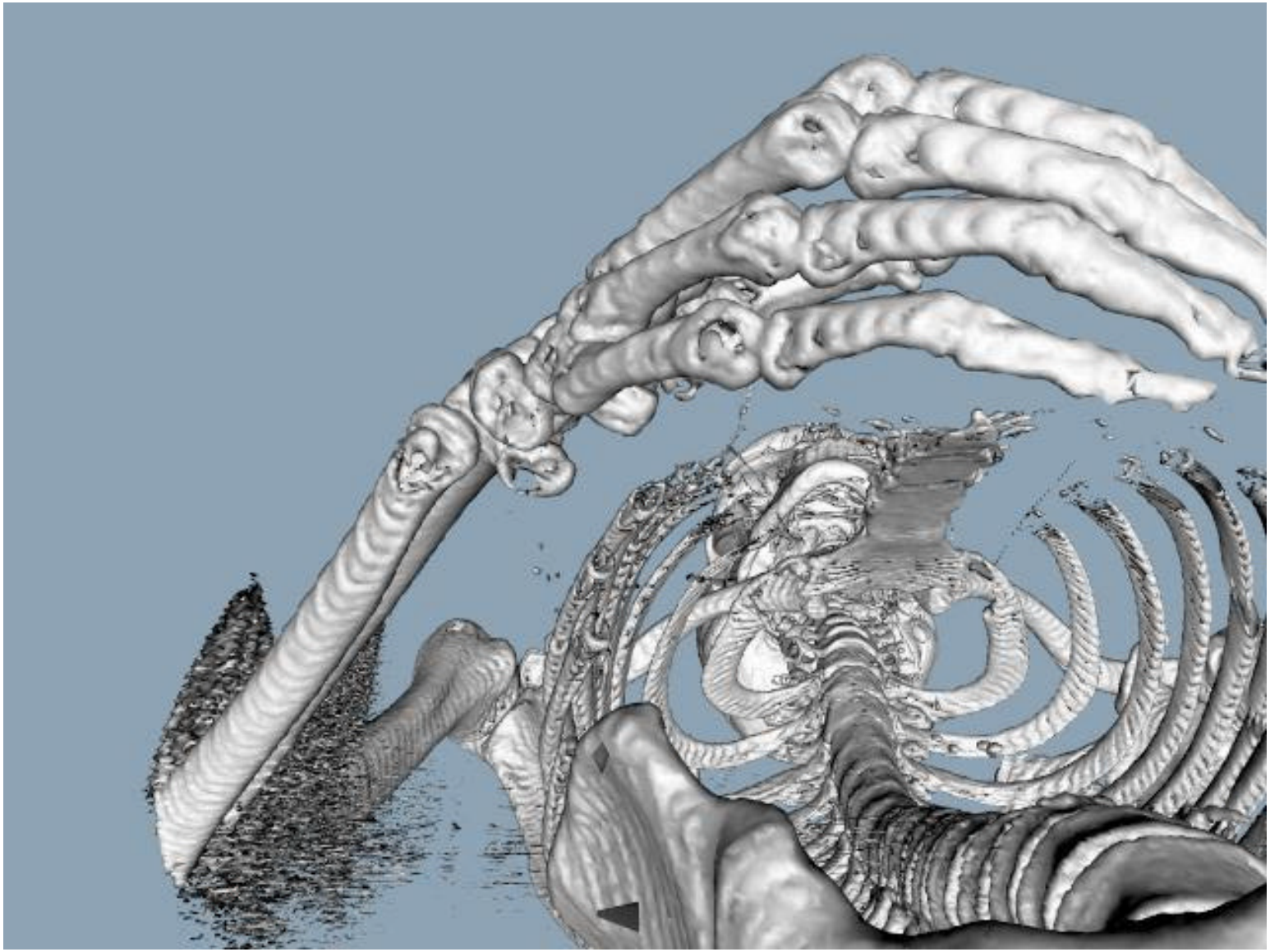


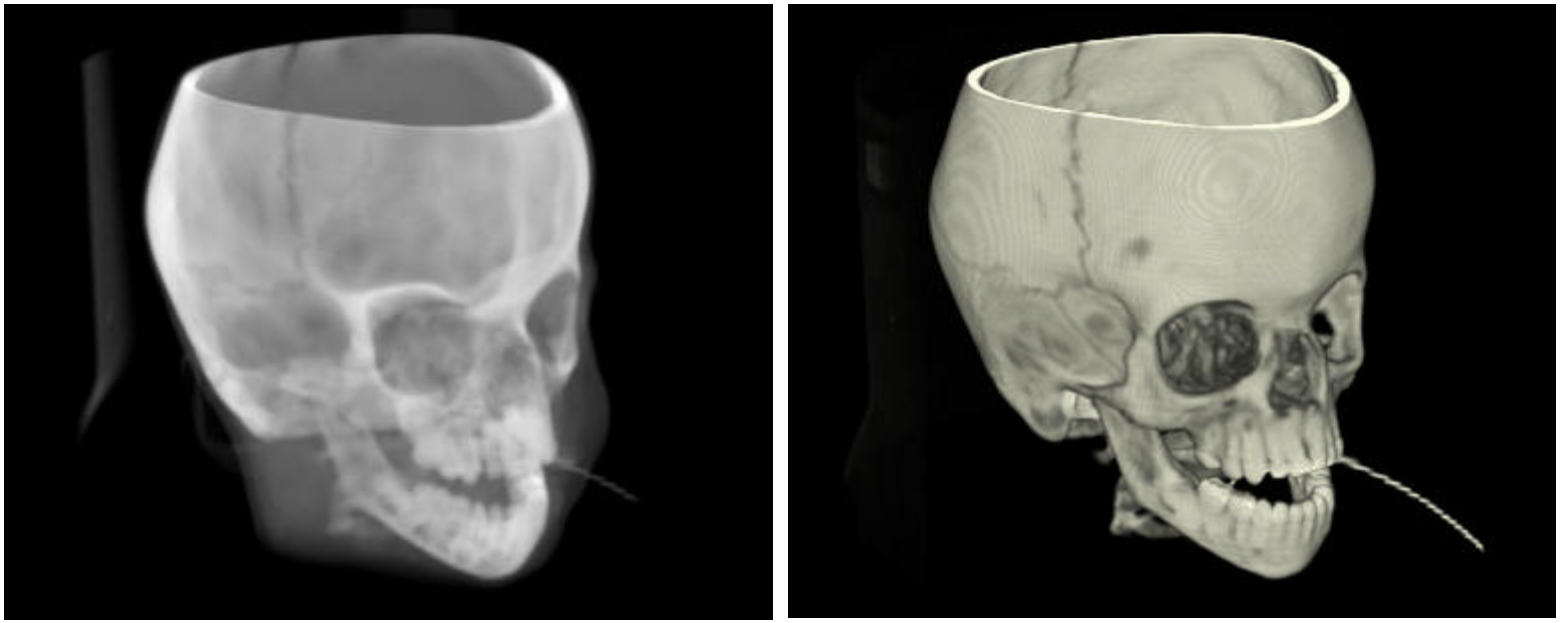


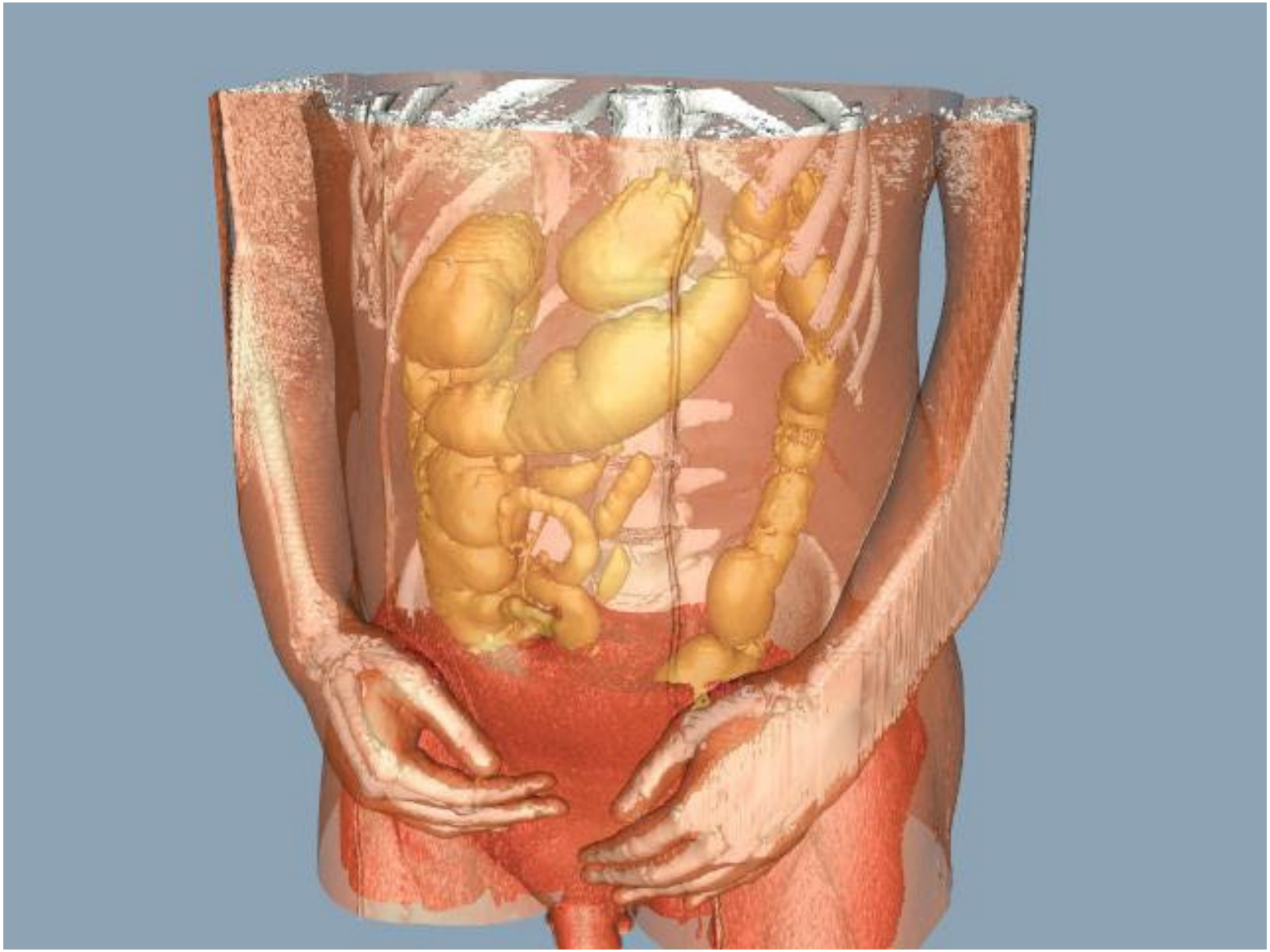


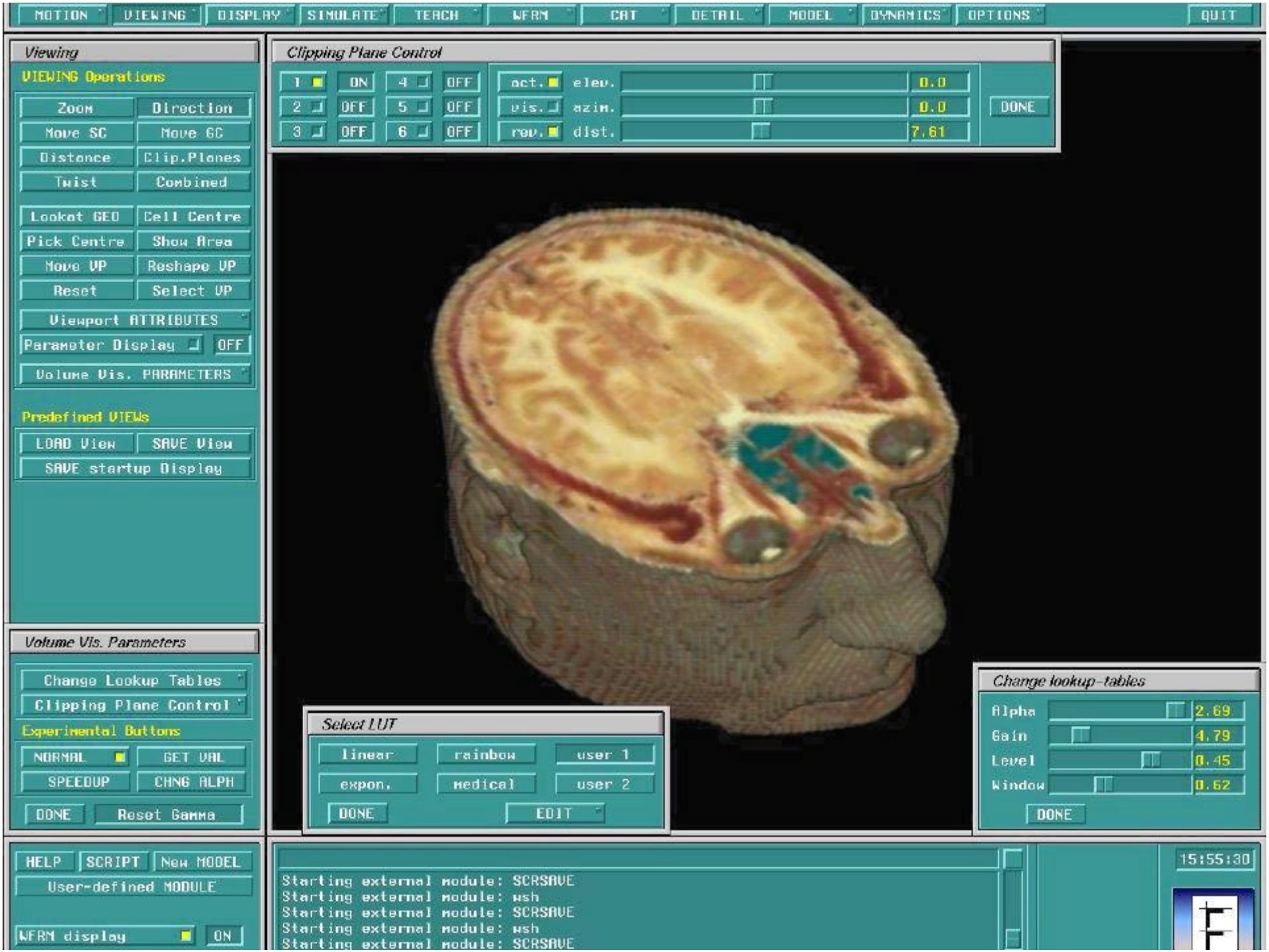











MOTION
VIEWING
DISPLAY
SIMULATE
TEACH
WFRM
CAT
DETAIL
MODEL
DYNAMICS
OPTIONS
QUIT
Viewing
VIEWING Operations
Zoom
Direction
Move SC
Move GC
Distance
Clip.Planes
Twist
Combined
Lookat GEO
Cell Centre
Pick Centre
Show Area
Move VP
Reshape VP
Reset
Select VP
Viewport ATTRIBUTES
Parameter Display
OFF
Volume Vis. PARAMETERS
Predefined VIEWs
LOAD View
SAVE View
SAVE startup Display
Clipping Plane Control
1
ON
2
OFF
3
OFF
4
OFF
5
OFF
6
OFF
act.
vis.
rev.
elev.
azim.
dist.
0.0
0.0
7.61
DONE
Volume Vis. Parameters
Change Lookup Tables
Clipping Plane Control
Experimental Buttons
NORMAL
GET VAL
SPEEDUP
CHNG ALPH
DONE
Reset Gamma
Select LUT
linear
rainbow
user 1
expon.
medical
user 2
DONE
EDIT
Change lookup-tables
Alpha
2.69
Gain
4.79
Level
0.45
Window
0.62
DONE
HELP
SCRIPT
New MODEL
User-defined MODULE
WFRM display
ON
Starting external module: SCRSAVE
Starting external module: wsh
Starting external module: SCRSAVE
Starting external module: wsh
Starting external module: SCRSAVE
15:55:30

Observation

- Any differences among examples?
  - Yes !!!
- Then, what?
  - Well, …
- Why graphics?

Characterization

- **end / means**
- **realism**
- **interactivity**
- **presence**

Why Computer Graphics?

- How can you better explain without pictures?
- Seeing is believing !!!

컴퓨터그래픽스의 정의

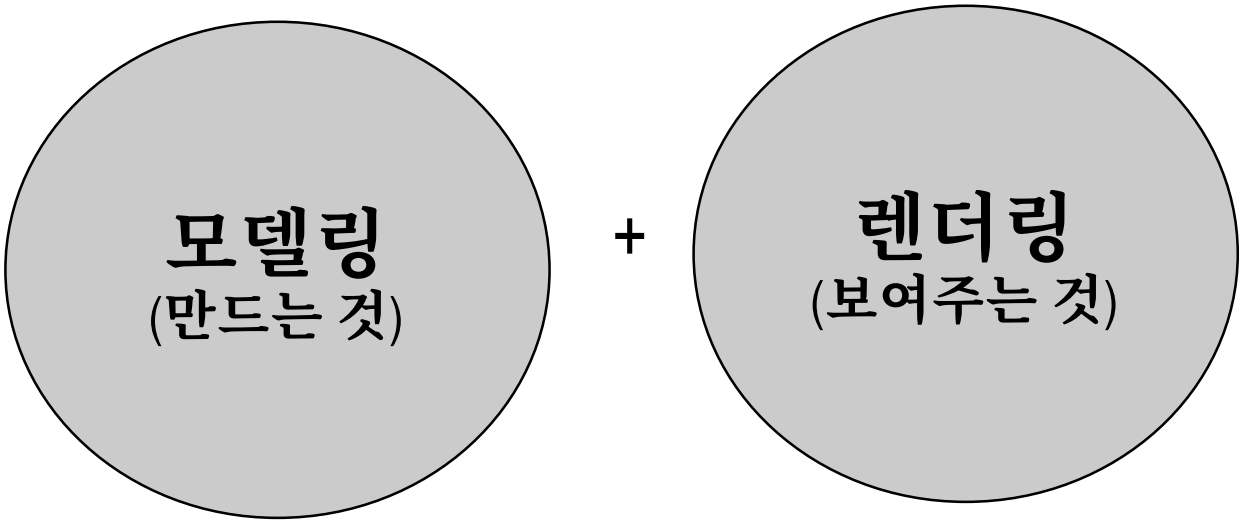
- What is Computer Graphics ?
  - Method and Technologies for converting data to and from a graphics display via computer
  - *the most powerful means of communication between a computer and a human being.*

컴퓨터그래픽스의 정의

- Computer Graphics
  - Modeling
    - 가상의 공간에 2차원 또는 3차원 물체를 생성하는 과정
    - 건축, 토목, 공장, …
    - 컴퓨터 내부 자료 구조로 형성되어 있음
  - Rendering
    - 모델링 된 물체를 2차원 컴퓨터 화면에 현실감 있게 표현하는 과정
    - 빛의 효과, 그림자, 재질 표현, 투명도, 색상, …
    - 사진

컴퓨터그래픽스의 정의

- Computer Graphics



Computer Graphics

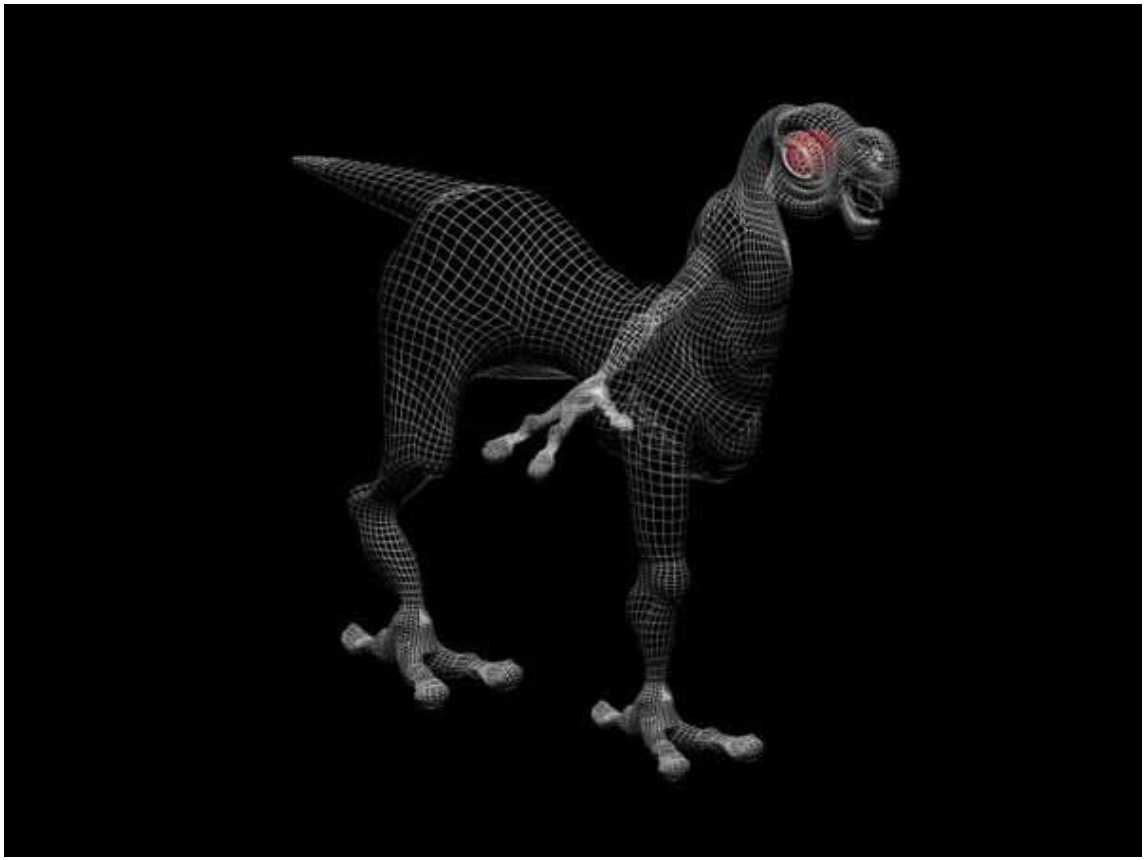
- Computer Graphics
  - Modeling
    - Wire Frame Model
    - Surface Model
    - Solid Model
  - Rendering
    - Shading
    - Ray-tracing
    - Radiosity
    - Global Illumination
    - Volumn Rendering

Computer Graphics

- Computer Graphics
  - CG Design
    - Photo shop, Illustrator
    - 3D Studio Max
    - Maya
  - CG Programming
    - C or C++
    - OpenGL
      - World Tool Kit

CG Design

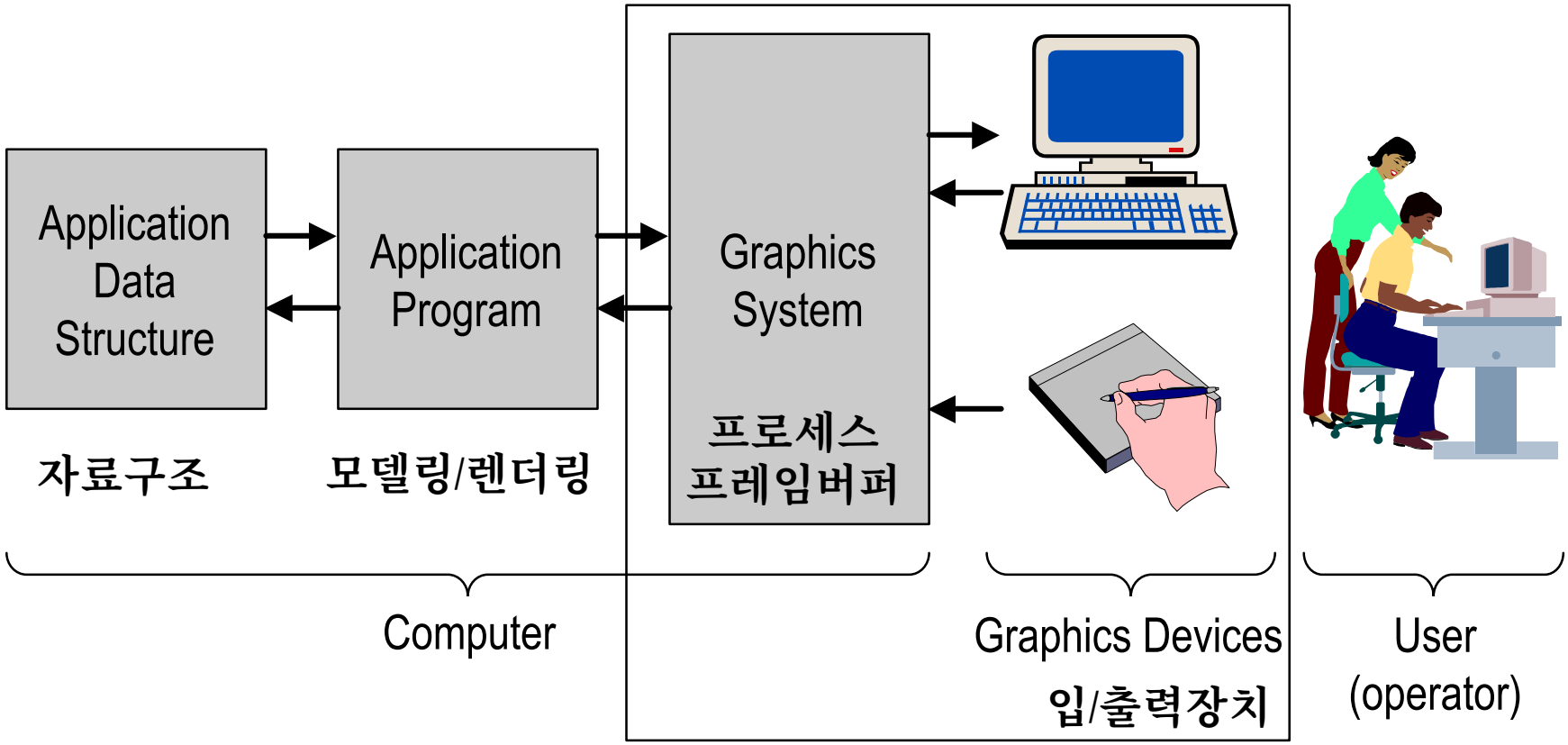
- CG Design : 3D Studio Max



CG Programming

- CG Programming
  - CG Design에 사용되는 핵심기술 연구
    - Modeling
      - Solid modeling, Surface modeling
      - FFD, Morphing, Warping, Image Based Rendering, …
    - Rendering
      - Camera, material, light, …
    - Virtual Reality
  - Open GL, C/C++ 언어 사용

그래픽스 시스템


Application Data Structure
Application Program
Graphics System
프로세스
프레임버퍼
자료구조
모델링/렌더링
Computer
Graphics Devices
입/출력장치
User (operator)
그래픽스 시스템

구현 과정 (예)

문제	정면에 보이는 특정 부분을 컴퓨터 그래픽스를 이용하여 실제 모습처럼 표현하시오.

구현 과정(1)

Application Data Structure

책상 : 육면체 형태
- **8개의 점, 12개의 선분, 6개의 면**
- **점** : P(x, y, z)
- **선분 : 이웃하는 두 점** P(x,y,z) -> Q(x,y,z)
- **면 : 한 면을 형성하는 선분들의 리스트**

구현 과정(2)

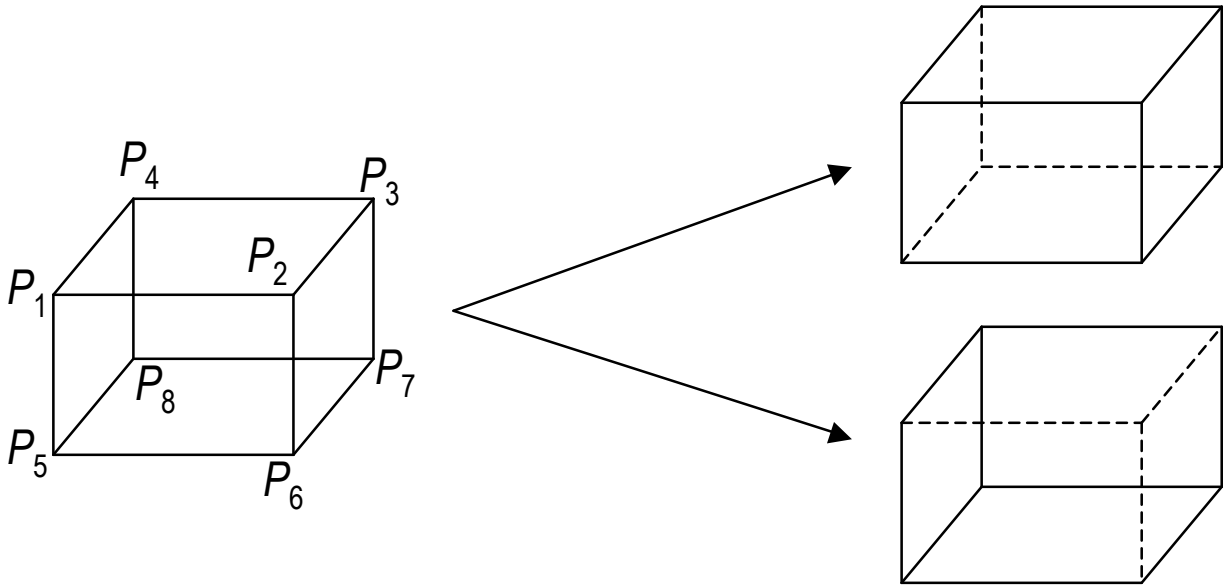
Application Program

모델링 : wire-frame / Solid / Surface Models
렌더링 : **빛 처리**, **재질 효과**, **투명/불투명**
Raytracing / Radiosity

1. **좌표 변환**
2. **특정 영역 절단**
3. **투영** : 3**차원 물체를** 2**차원 면에 투영**
4. **래스터화** : **프레임 버퍼 안에 화소들로서 표현**

구현 과정(3)

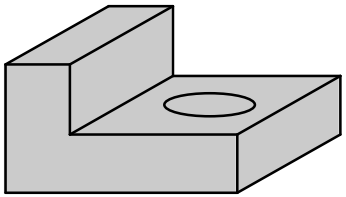
모델링: Wire-Frame



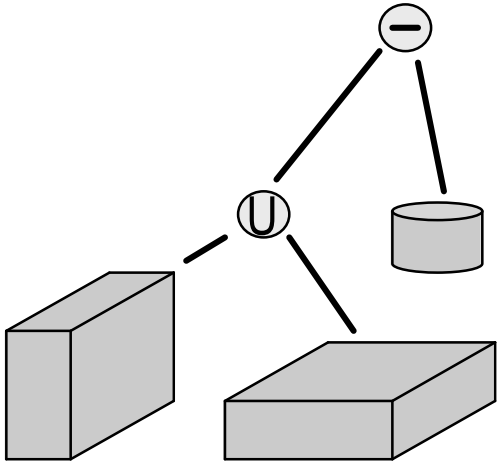
Simple and efficient
Ambiguous

구현 과정(4)

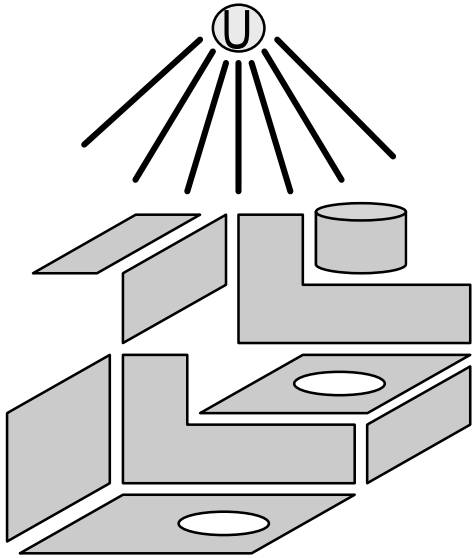
모델링: Solid Model



Solid



A CSG representation

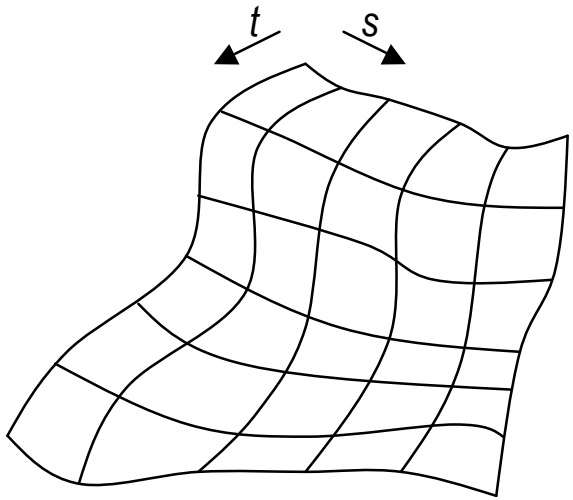


A Boundary representation

Shading & hidden line removal
Mass properties calculation
Interference test

구현 과정(5)

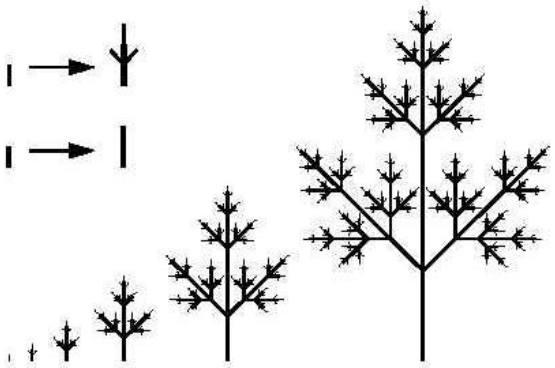
모델링: Surface Model



구현 과정(6)

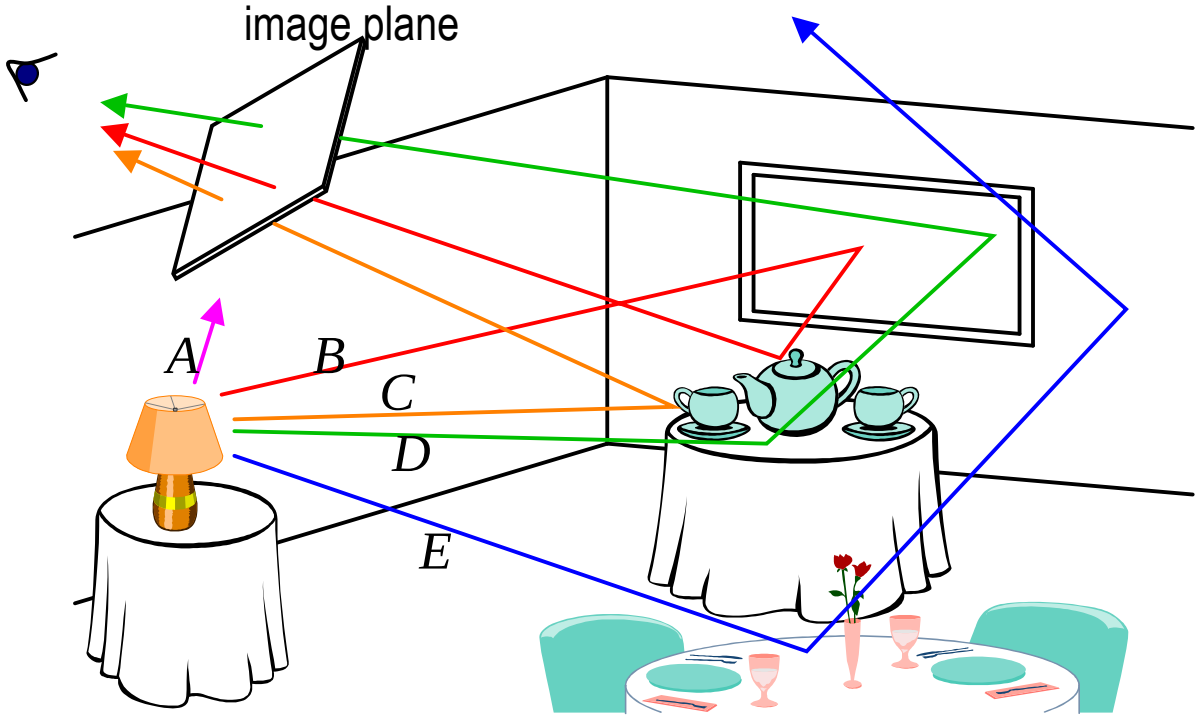
모델링: 자연현상물

Figure 14: A model of the date palm (*Phoenix dactylifera*). This image was created using an L-system with the general structure specified in Equation 5.



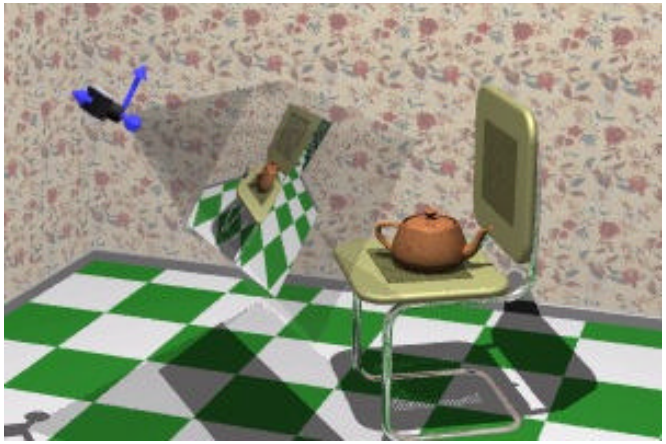
구현 과정(6)

렌더링: Ray-tracing



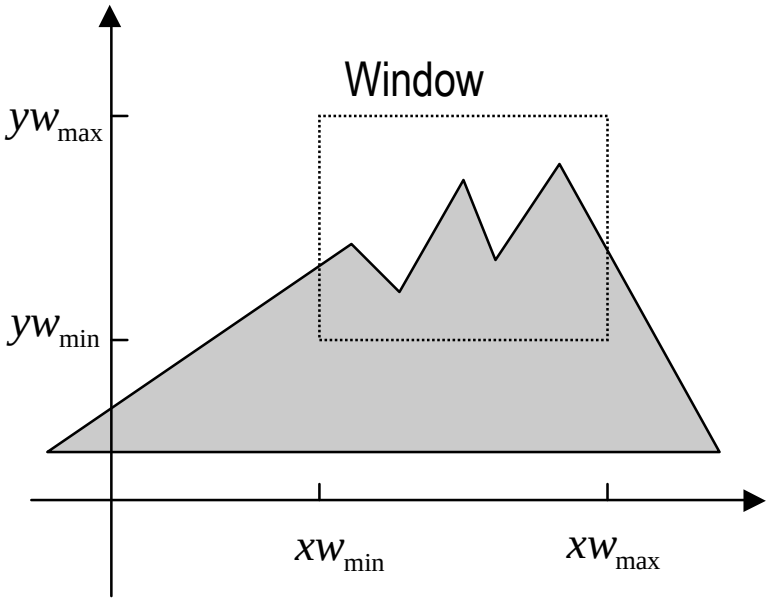
구현 과정(7)

변환

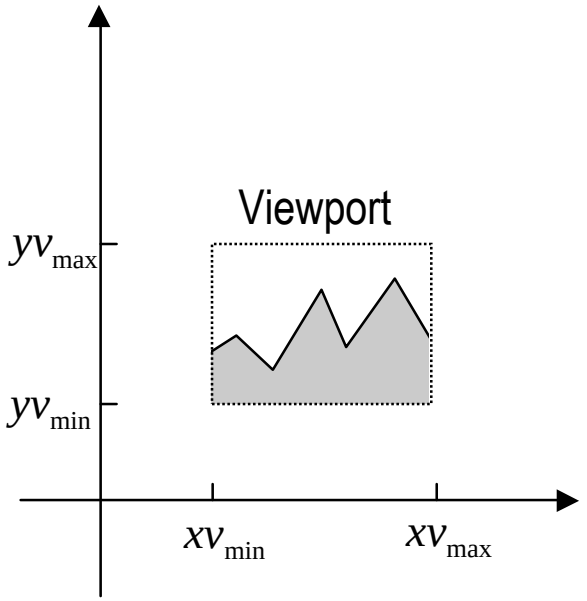


구현 과정(7)

2D 좌표 변환 / 절단



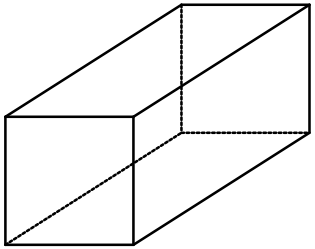
World Coordinates



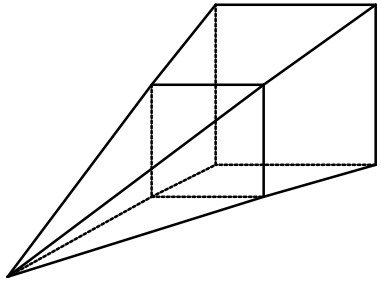
Device Coordinates

구현 과정(8)

3D 관측공간



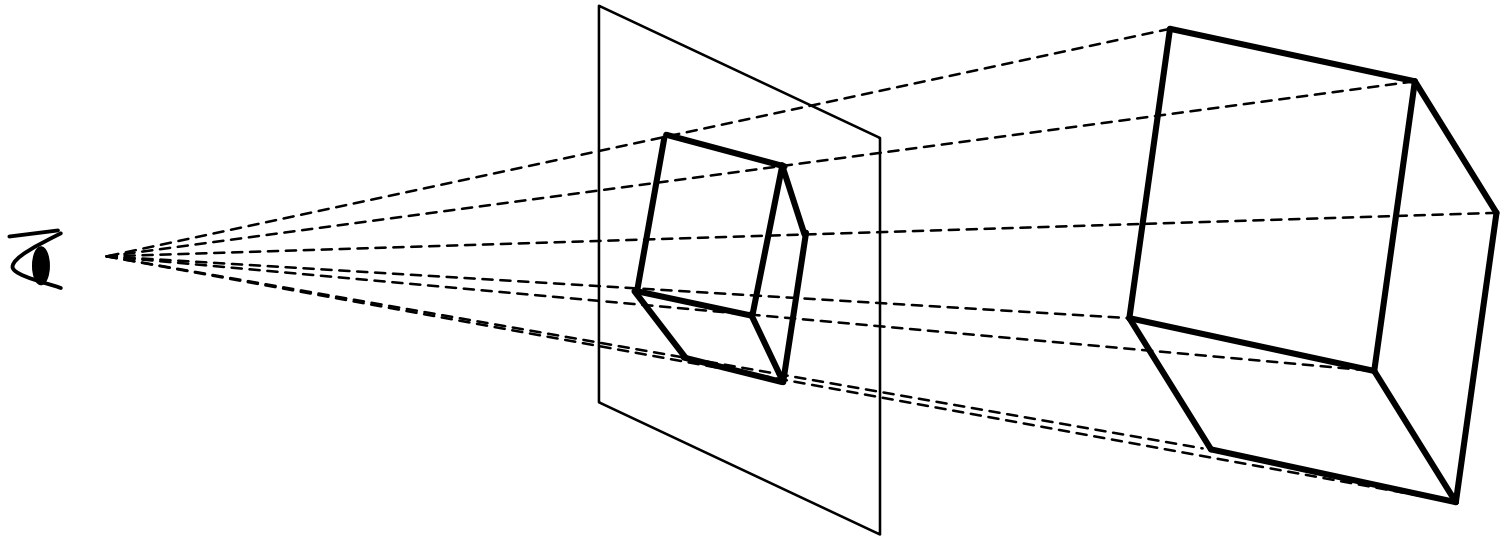
Parallelepiped



Truncated Pyramid

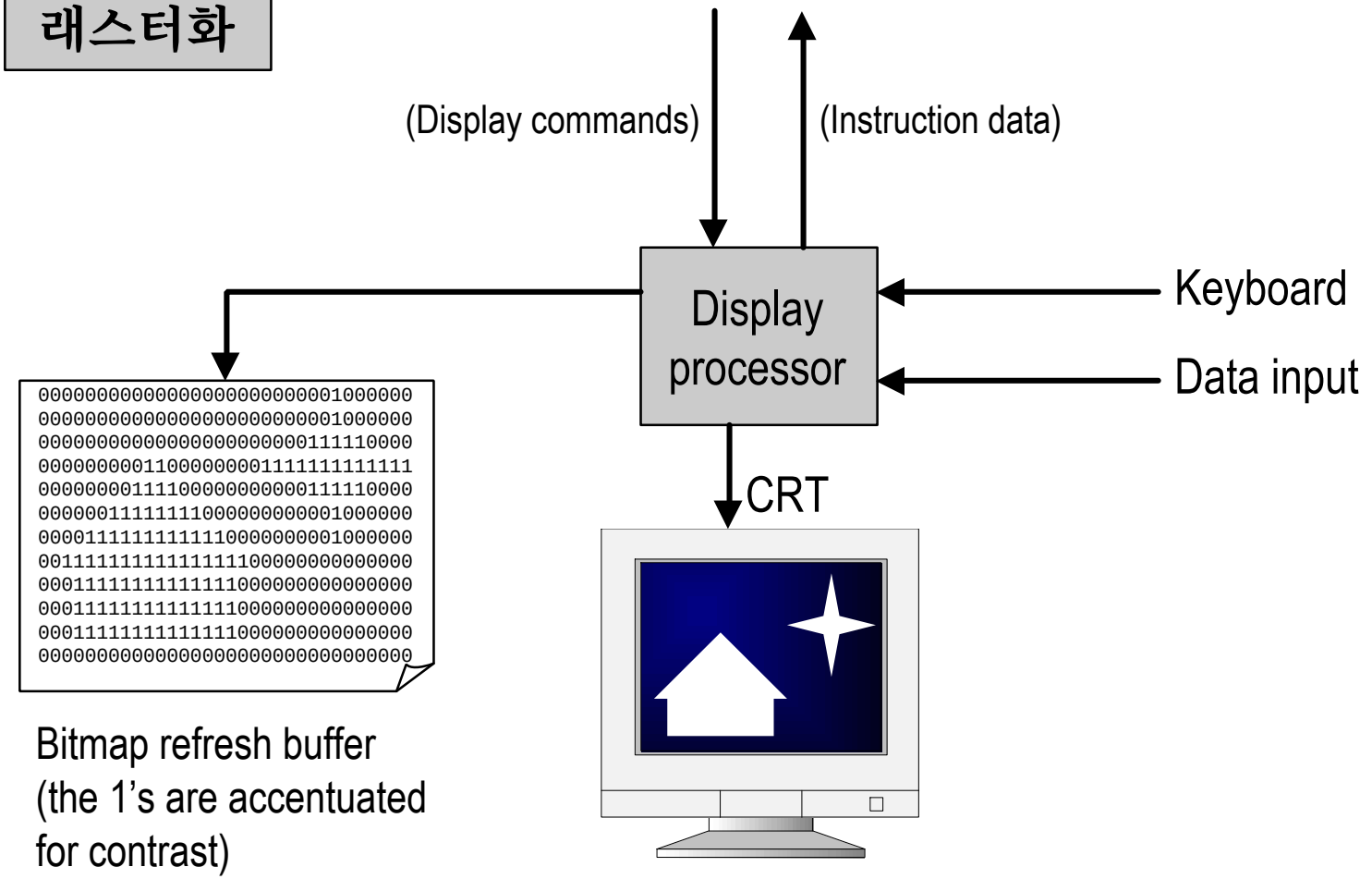
구현 과정(9)

3D 절단/ 투영



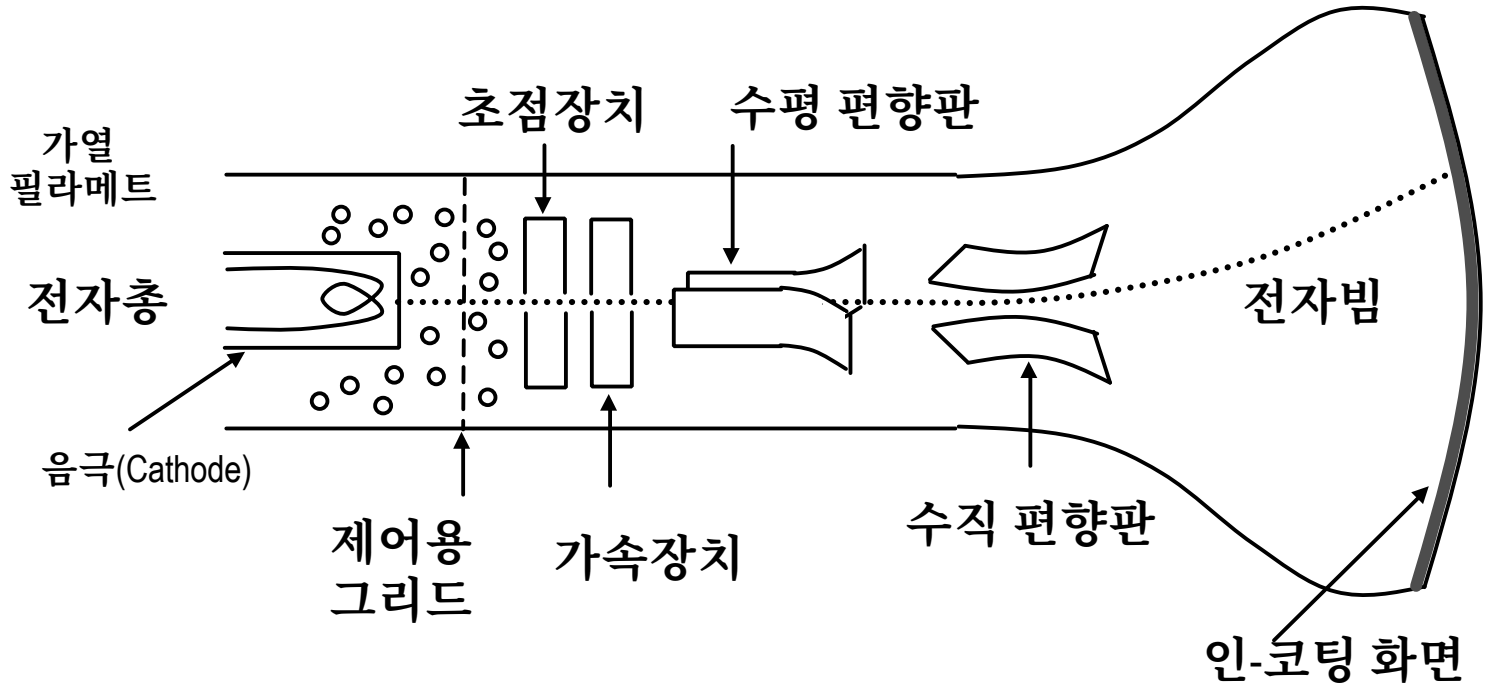
구현 과정(10)

래스터화


(Display commands)
(Instruction data)
Display processor
Keyboard
Data input
CRT
00000000000000000000000001000000
00000000000000000000000001000000
00000000000000000000000111110000
00000000011000000001111111111111
00000000111100000000000111110000
00000011111111100000000001000000
00001111111111110000000001000000
00111111111111111100000000000000
00011111111111111100000000000000
00011111111111111100000000000000
00011111111111111100000000000000
00000000000000000000000000000000
Bitmap refresh buffer
(the 1's are accentuated
for contrast)

Display Device (표시장치)

음극선관(CRT)
(Cathode-Ray Tube)



Display Device (표시장치)

음극선관

- 화면의 빛 : 전자비임 + 형광물질
- 잠시 후 소멸
- 화상을 유지하는 방법 필요

재생음극선관

- 같은 지점에 전자비임을 빨리 다시 보내는 방법
- 화상을 되풀이해서 반복적으로 그리는 방법
- 형광물질 : 색상 + 지속성

지속성

- 원래 밝기의 1/10로 줄어들 때까지의 시간
- 저 지속성 : 애니메이션, 많은 깜빡임
- 고 지속성 : 복잡한 정지 화상 표시에 유용

편향장치

- 자기장 or 전기장
- 전자비임은 전압이 높은 쪽으로 휨
- 수평 편향판 : x 좌표 결정 / 수직 편향판 : y 좌표 결정

초점장치

- 전자비임이 형광물질에 부딪힐 때 조그만 점으로 모으는 장치

초점장치

- 화상의 밝기 조절 : 전압의 세기

주사방식

해상도
(resolution)

- 음극선관에서 서로 겹치지 않고 표시될 수 있는 점들의 최대 정수
- 수평, 수직으로 cm당 표시될 수 있는 점의 수
- 음극선관의 해상도 : 형광 물질의 종류, 초점장치, 편향장치

종횡비
(aspect ratio)

- 비디오 모니터의 중요 성질
- 화면 상에서 같은 길이의 선을 형성하는데 필요한 수평 방향 점의 개수에 대한 수직 방향 점의 개수
- 3 / 4 , 12 / 16

임의 주사 방식

- 벡터 주사 방식(한 번에 직선 한 개씩을 그림)
- 그리고자 하는 위치에만 전자 비임이 주사되는 방식

래스터 주사방식

- 화상의 정의에 따라 비임의 세기를 조절하면서 화면상의 모든 점(픽셀)에 전자 비임을 주사하는 방식
- 주사선(scan line) : 픽셀들의 행
- 래스터(raster) : 주사선들의 집합

주사방식

임의주사

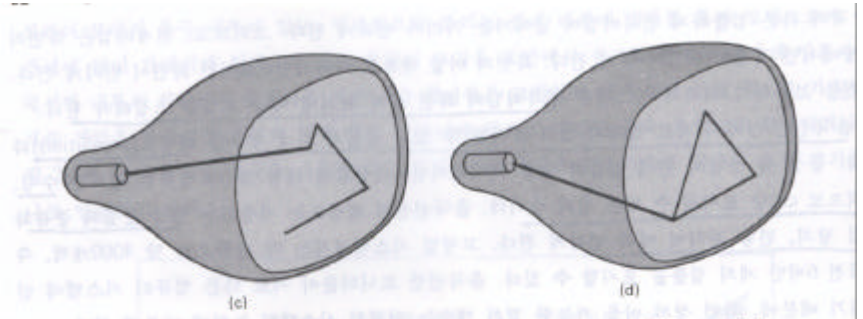
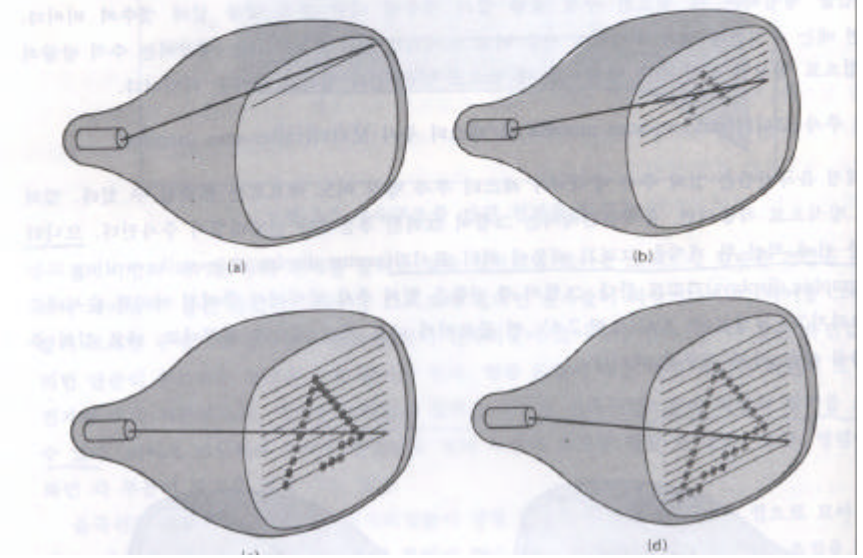
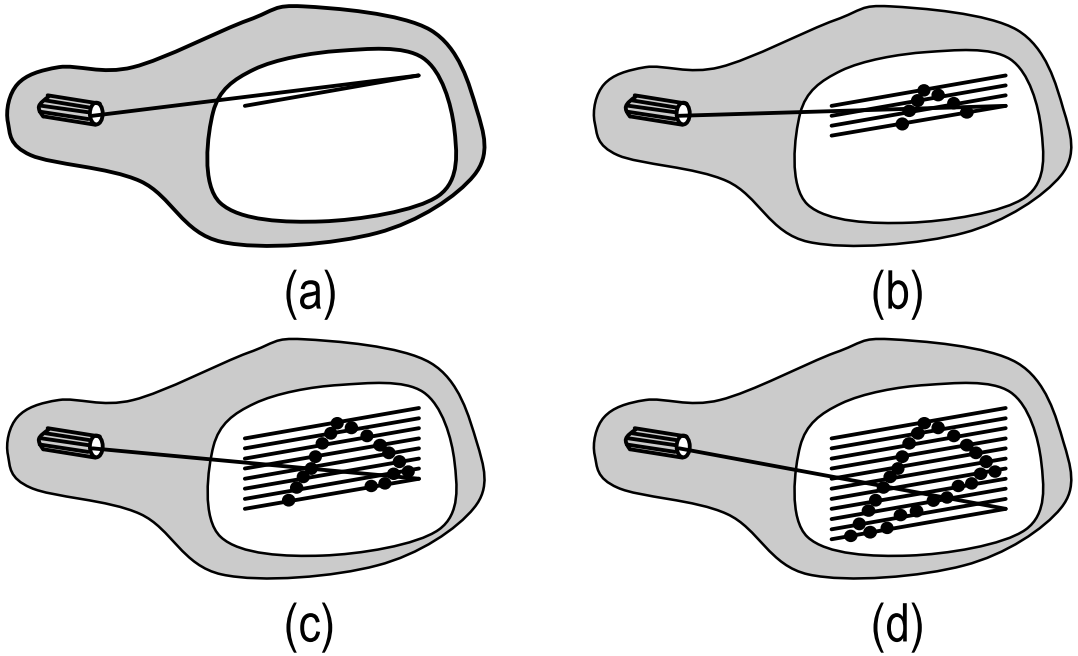


그림 2-6 임의 주사 방식에서는 정해진 순서대로 화상의 각 선분을 그린다.

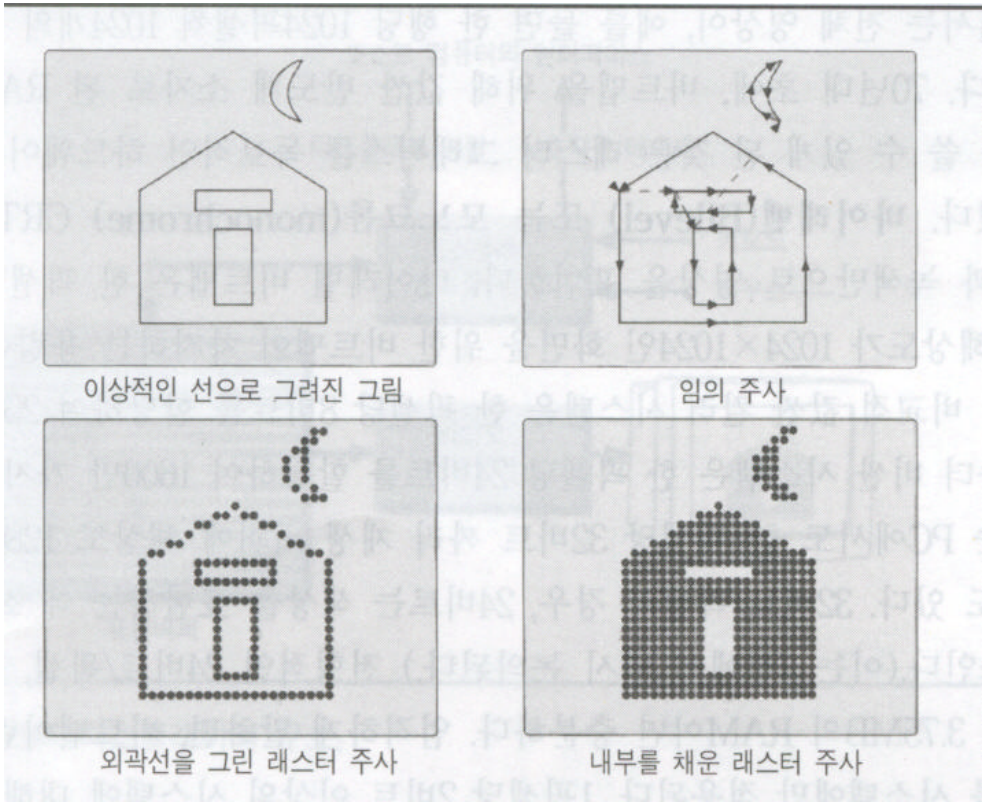
래스터주사



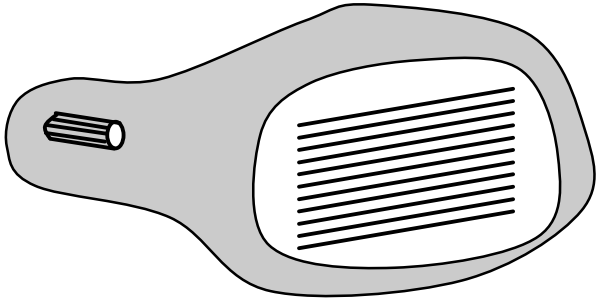
주사방식

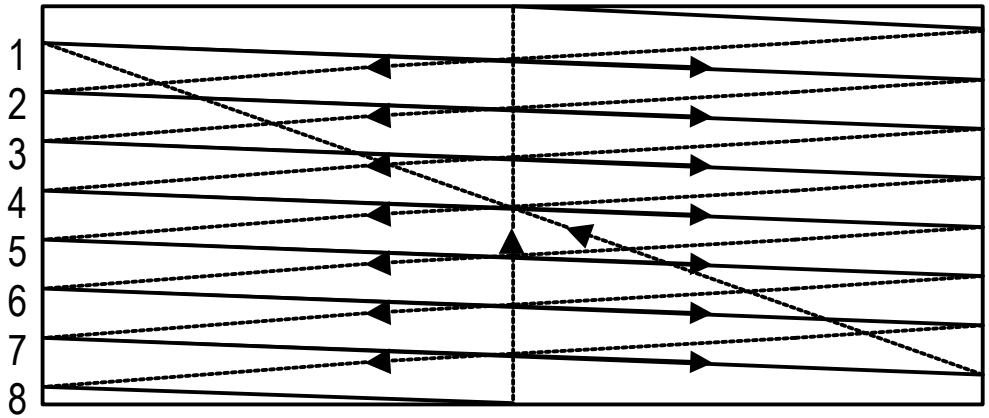


주사방식

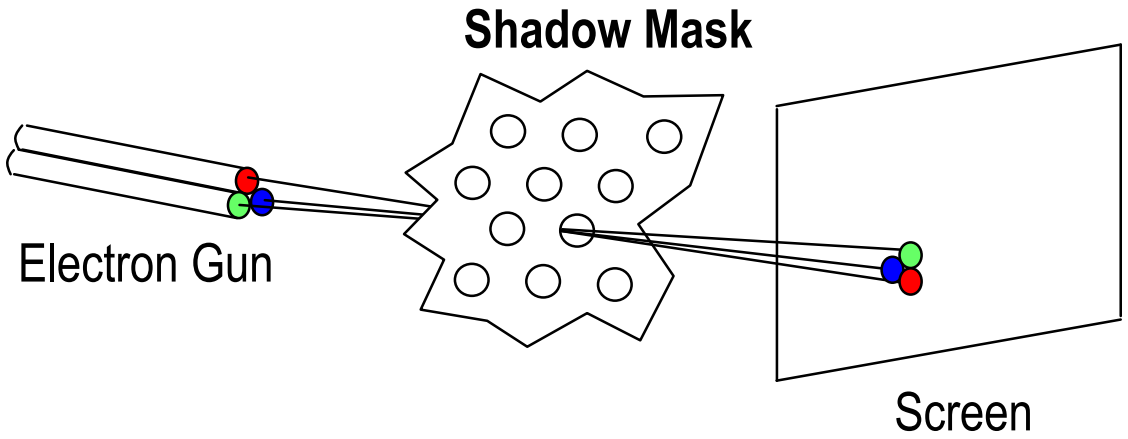


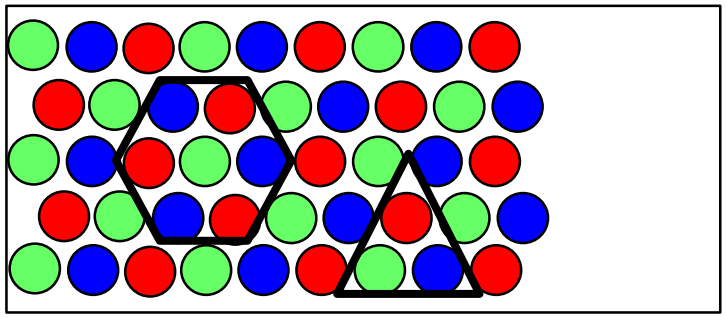
비월 주사





Color CRT

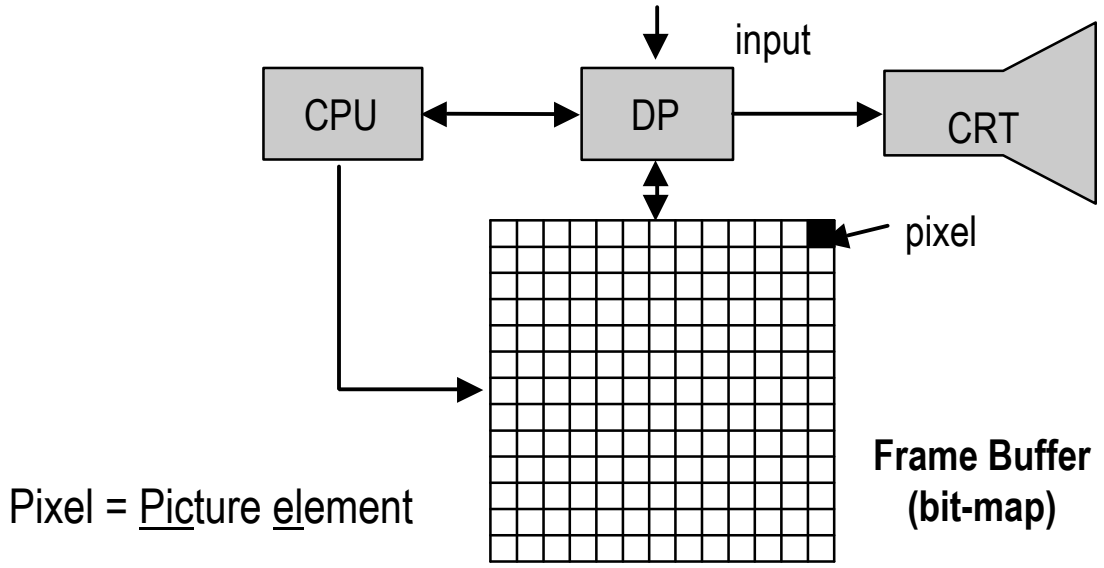




Phosphor dot pattern

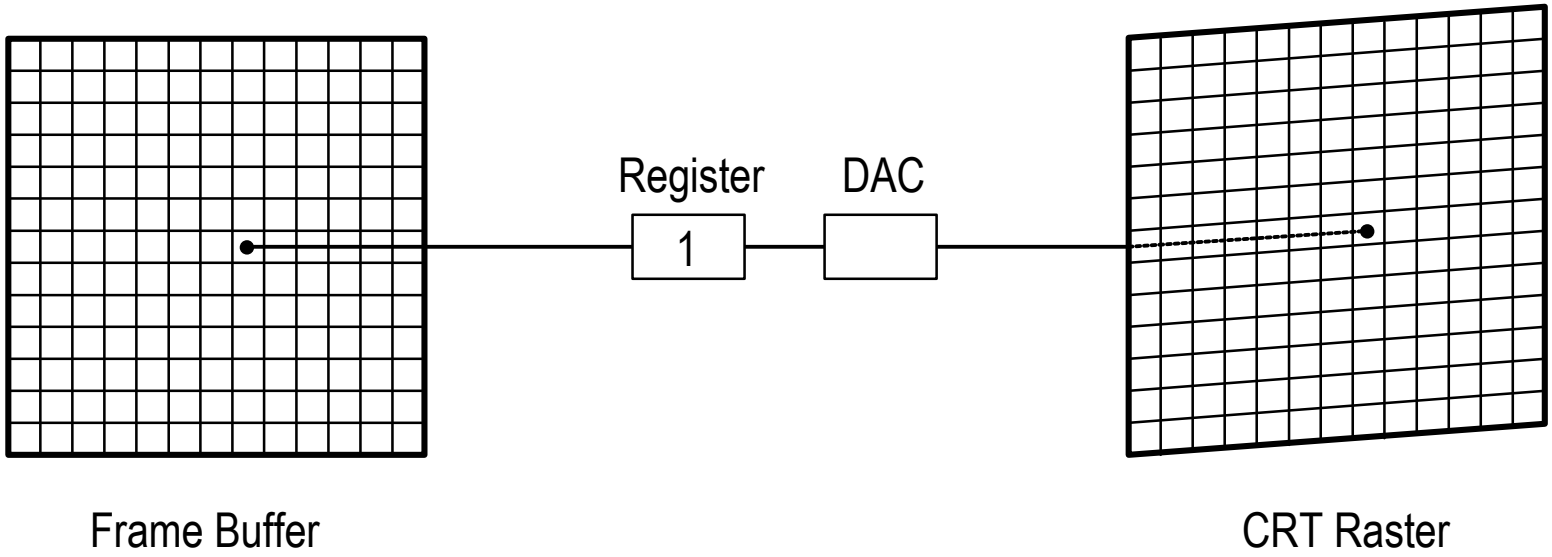
Different phosphor for each color !!!

Raster-Scan Display

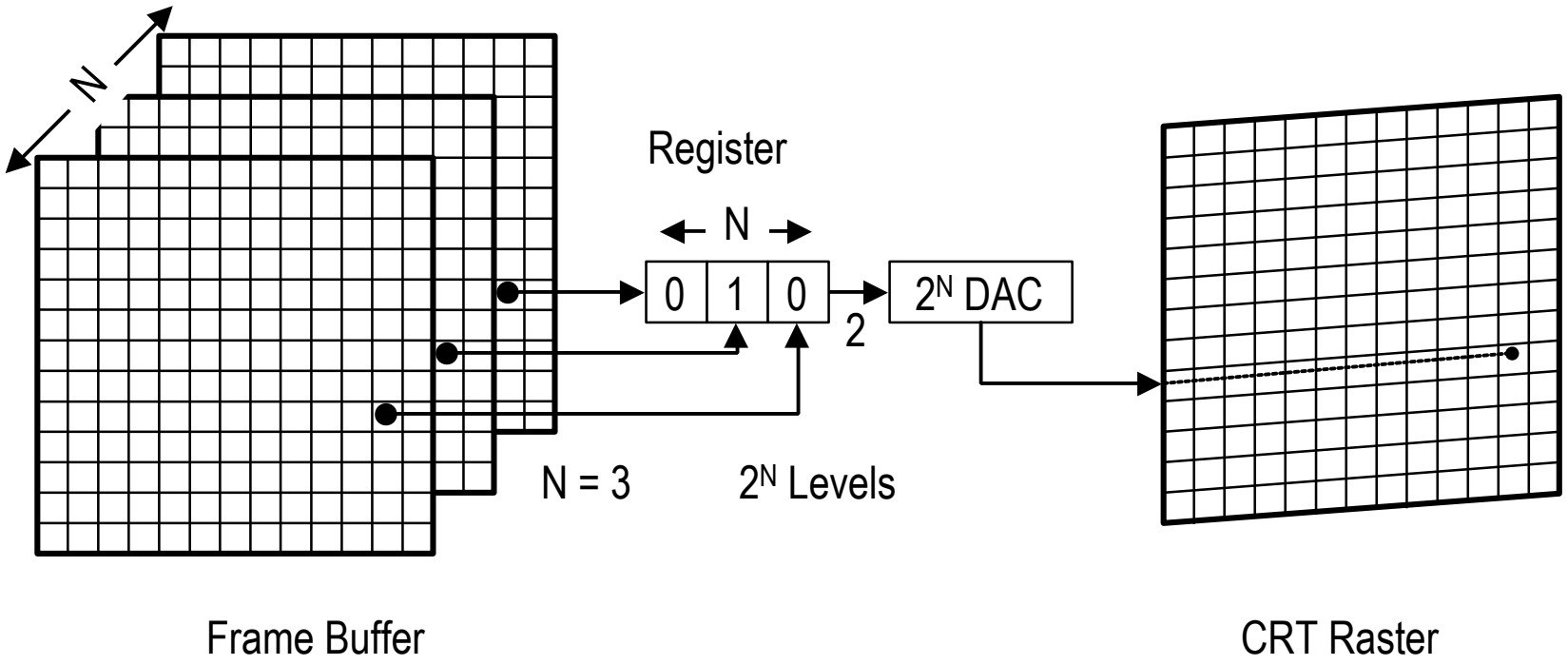


Selective erasing
Fixed frame buffer size
Independent picture complexity

Raster-Scan Display

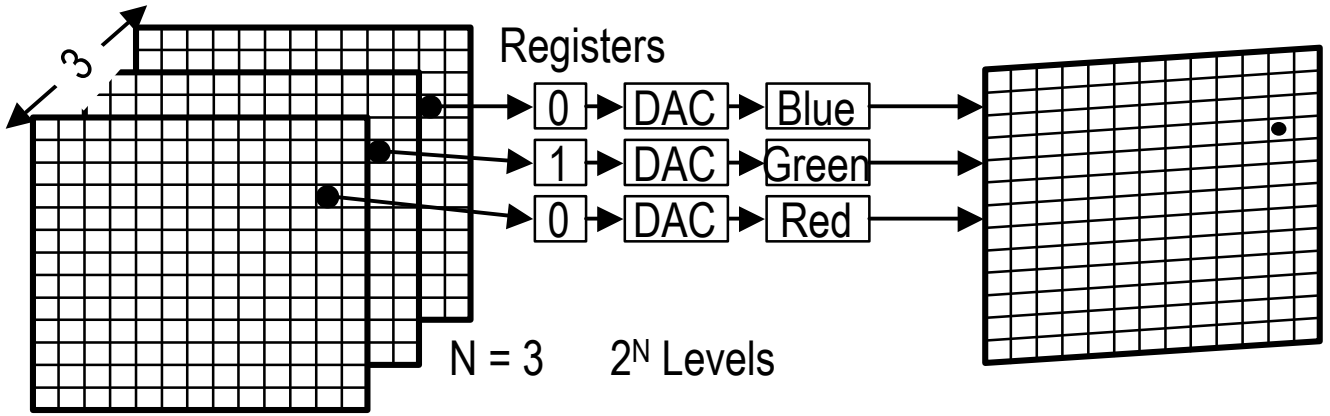


Raster-Scan Display



Raster-Scan Display

	Red	Green	Blue
Black	0	0	0
Red	1	0	0
Green	0	1	0
Blue	0	0	1
Yellow	1	1	1
Cyan	0	1	1
Magenta	1	0	1
White	1	1	1



Frame Buffer

CRT Raster