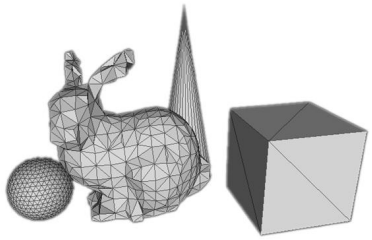
# Introduction to Computer Graphics



Introduction

# Contents(本节内容）

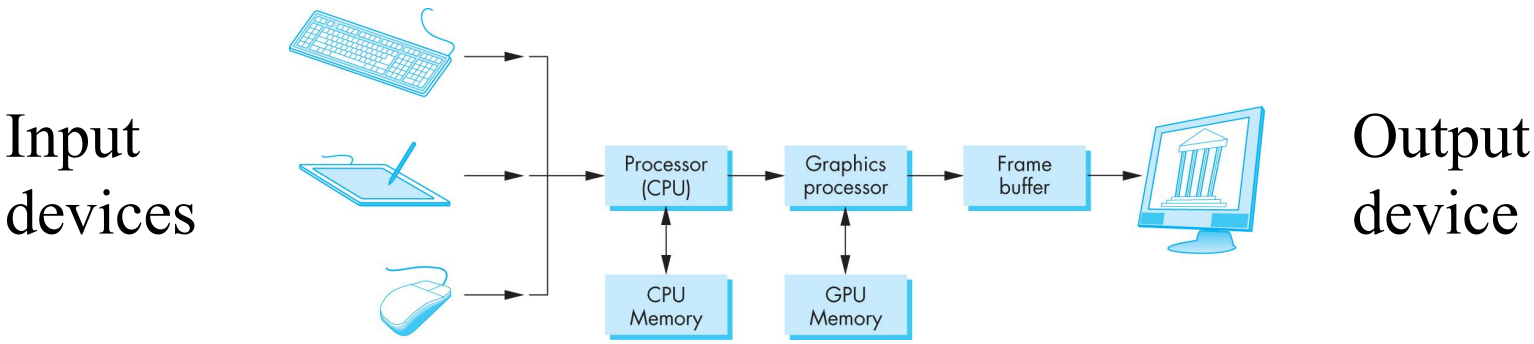
- What is CG (computer graphics)? 图形学是什么？
- Development History 历史发展
- Application areas 应用领域

# Contents(本节内容)

- What is CG (computer graphics)? 图形学是什么？
- Development History 历史发展
- Application areas 应用领域

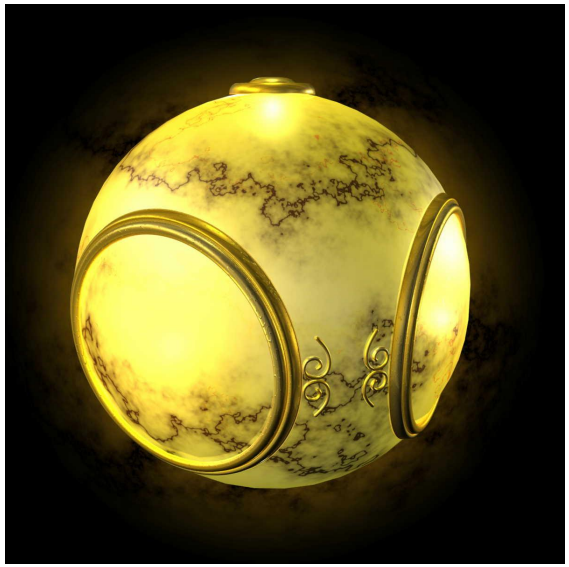
# Computer Graphics

- *Computer graphics* deals with all aspects of creating images with a computer (研究利用计算机生成图像的方法)
  - Hardware 硬件
  - Software 软件
  - Applications 相关应用



# Example

- How to create this image?



- What hardware/software did we need to produce it?

# Preliminary Answer

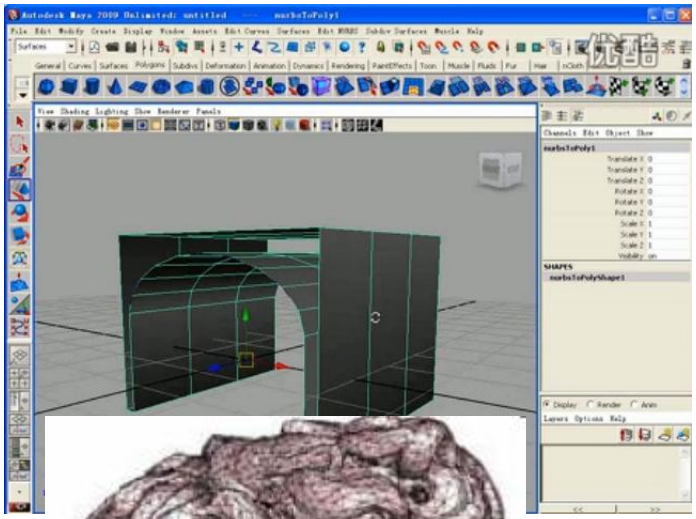
- **Software**: Maya for modeling and rendering but Maya is built on top of OpenGL
- **Hardware**: PC with graphics card for modeling and rendering

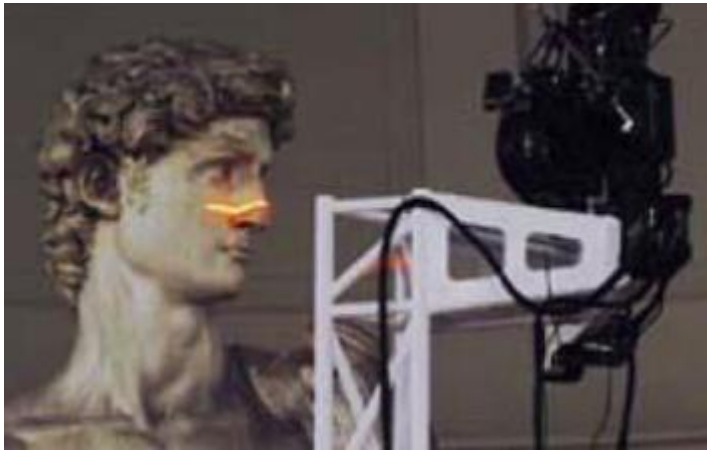
# Main Research Contents (主要研究内容)

- Modeling（建模）
  - Create the 3D Objects (draw what)
- Rendering (绘制、渲染）
  - How to draw a image
- Animation (动画）
  - How to generate the moving/deforming objects
  - How to draw the object's motion

# Modeling (建模)

- Create the 3D geometry
  - Generate
  - Reconstruct





# Rendering （绘制）

- Creating the image
  - As realistic as possible
  - As cartoonlike as possible
  - …

# Animation （动画）

- Generating the image of moving objects
  - How to generate the moving/deforming objects
  - How to draw the object's motion
  - Obey the physics rules

顽皮跳跳灯(Luxo Jr), Pixar, 1986

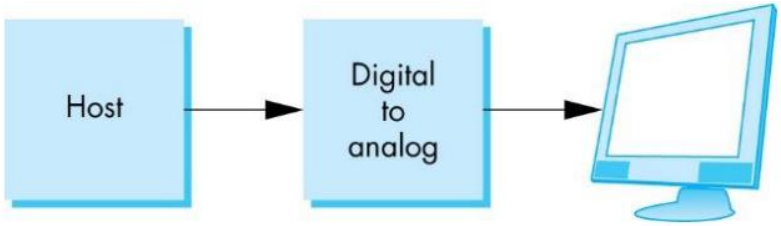
# Contents(本节内容)

- What is CG (computer graphics)? 图形学是什么？
- Development History 历史发展
- Application areas 应用领域

# Computer Graphics: 1950-1960

- Computer graphics goes back to the earliest days of computing
  - Strip charts 条形图
  - Pen plotters 笔式绘图仪
  - Simple displays using A/D converters to go from computer to calligraphic CRT

    画线CRT显示器（矢量CRT显示器）



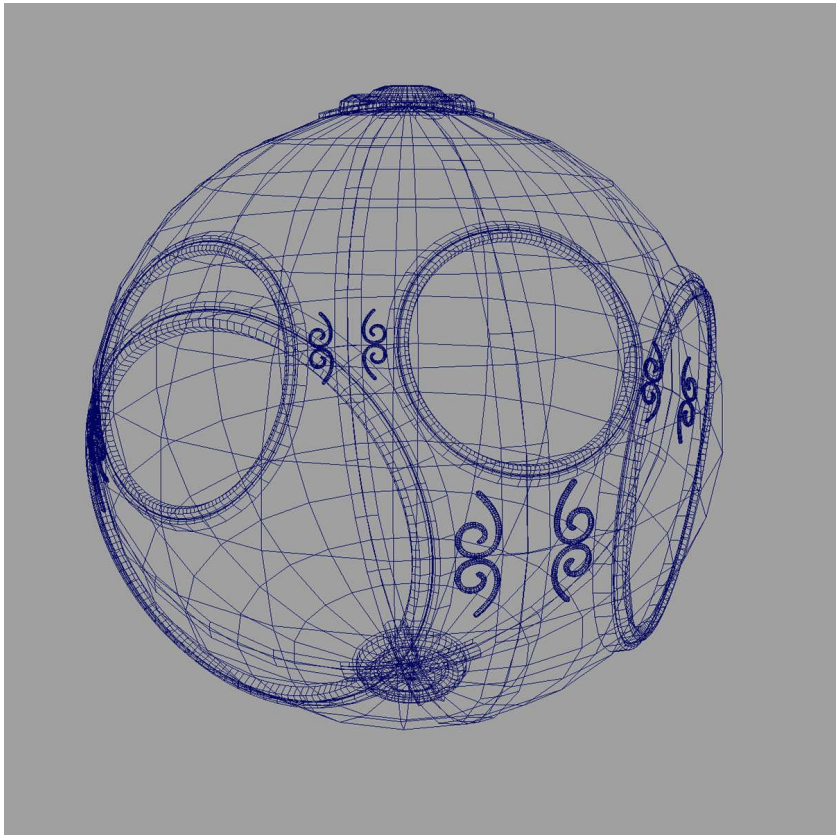

- Cost of refresh for CRT too high
  - slow, expensive, unreliable

# Pen plotters 笔式绘图仪

# Computer Graphics: 1960-1970

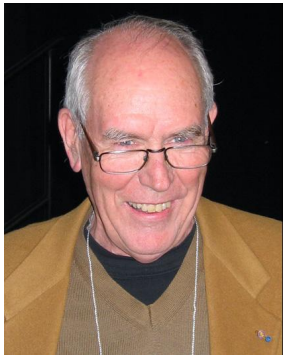
- *Wireframe* graphics
  - Draw only lines
- Sketchpad
- Display Processors

wireframe representation
of sun object



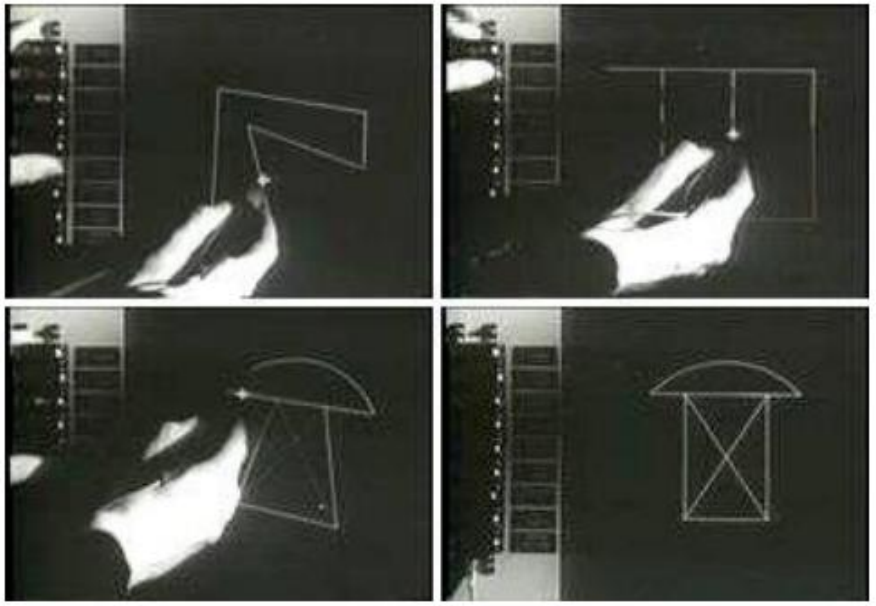
# Sketchpad

- ***Ivan Sutherland***'s PhD thesis at MIT
  - Recognized the potential of man-machine interaction
  - Loop
    - Display something
    - User moves light pen
    - Computer generates new display



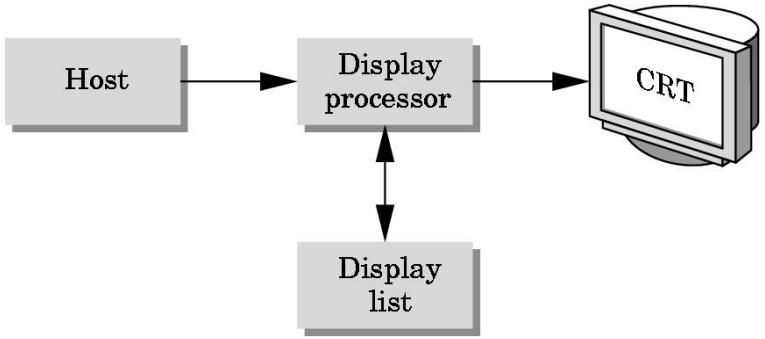
  - Sutherland also created many of the now common algorithms for computer graphics

# Sketchpad



# Display Processor

- Rather than have the host computer try to refresh display use a special purpose computer called a *display processor* (DPU)



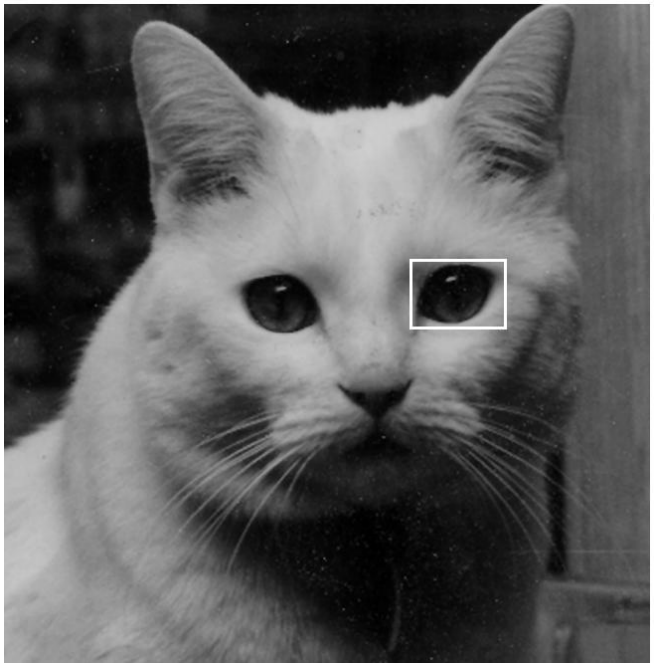

- Graphics stored in display list (display file) on display processor
- Host *compiles* display list and sends to DPU

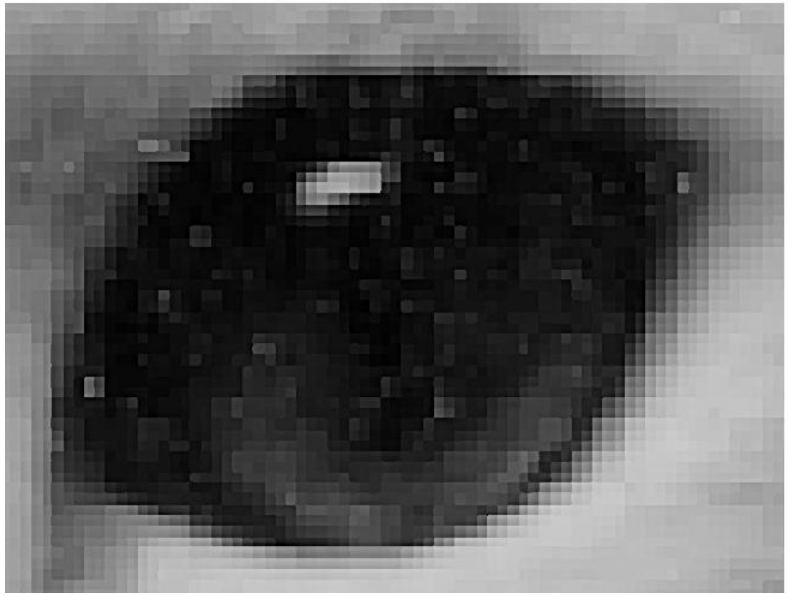
# Computer Graphics: 1970-1980

- Raster Graphics 光栅图形学
  - Compare with vectorised graphics
- Beginning of graphics standards
  - GKS: European effort
    - Becomes ISO 2D standard
  - Core: North American effort
    - 3D but fails to become ISO standard
- Workstations and PCs

# Raster Graphics

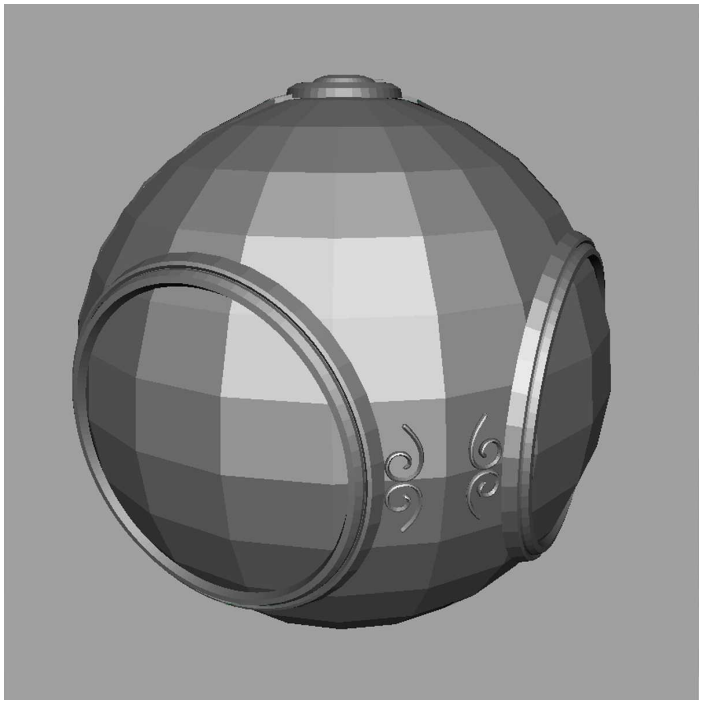
- Image produced as an array (the *raster*) of picture elements (*pixels*) in the *frame buffer*





# Raster Graphics

- Allows us to go from lines and wire frame images to filled polygons

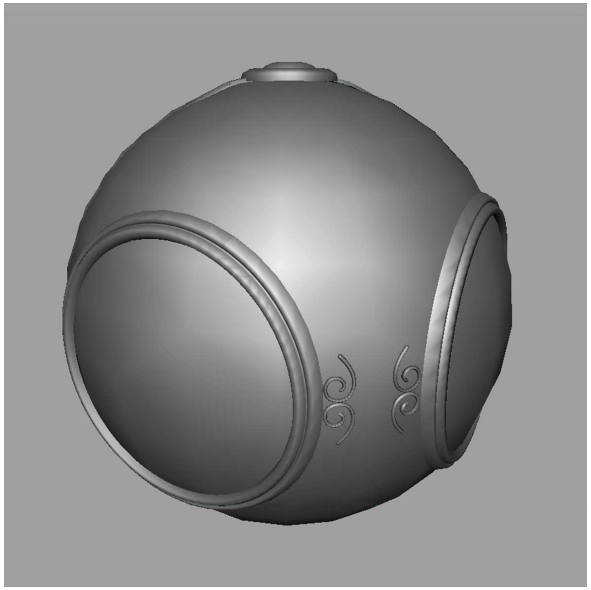


# PCs and Workstations

- Although we no longer make the distinction between workstations and PCs, historically they evolved from different roots
  - Early workstations characterized by
    - Networked connection: client-server model
    - High-level of interactivity
  - Early PCs included frame buffer as part of user memory
    - Easy to change contents and create images

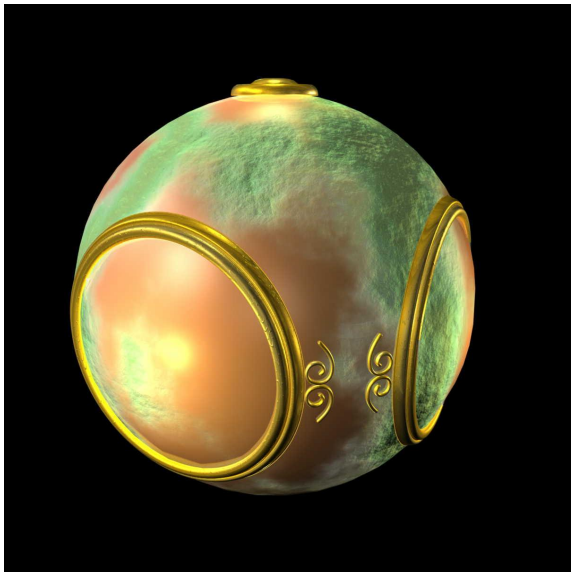
# Computer Graphics: 1980-1990

Realism comes to computer graphics



smooth shading

environment mapping



bump mapping

# Computer Graphics: 1980-1990

- Special purpose hardware
  - Silicon Graphics （Silicon Graphics, Inc. SGI） geometry engine
    - VLSI implementation of graphics pipeline
- Industry-based standards
  - RenderMan (皮克斯公司)
- Human-Computer Interface (HCI)

# 2020 Turing Award Winners

Catmull 和 Hanrahan

# Computer Graphics: 1990-2000

- OpenGL API
- Completely computer-generated full-length movies (Toy Story) are successful
- New hardware capabilities
  - Texture mapping
  - Blending
  - Accumulation, stencil buffers

# Computer Graphics: 2000-

- Photorealism
- Graphics cards for PCs dominate market
  - Nvidia, ATI
- Game boxes and game players determine direction of market
- Computer graphics routine in movie industry: Maya, Lightwave
- Programmable pipelines
- GPGPU

# Contents(本节内容)

- What is CG (computer graphics)? 图形学是什么？
- Development History 历史发展
- Application areas 应用领域

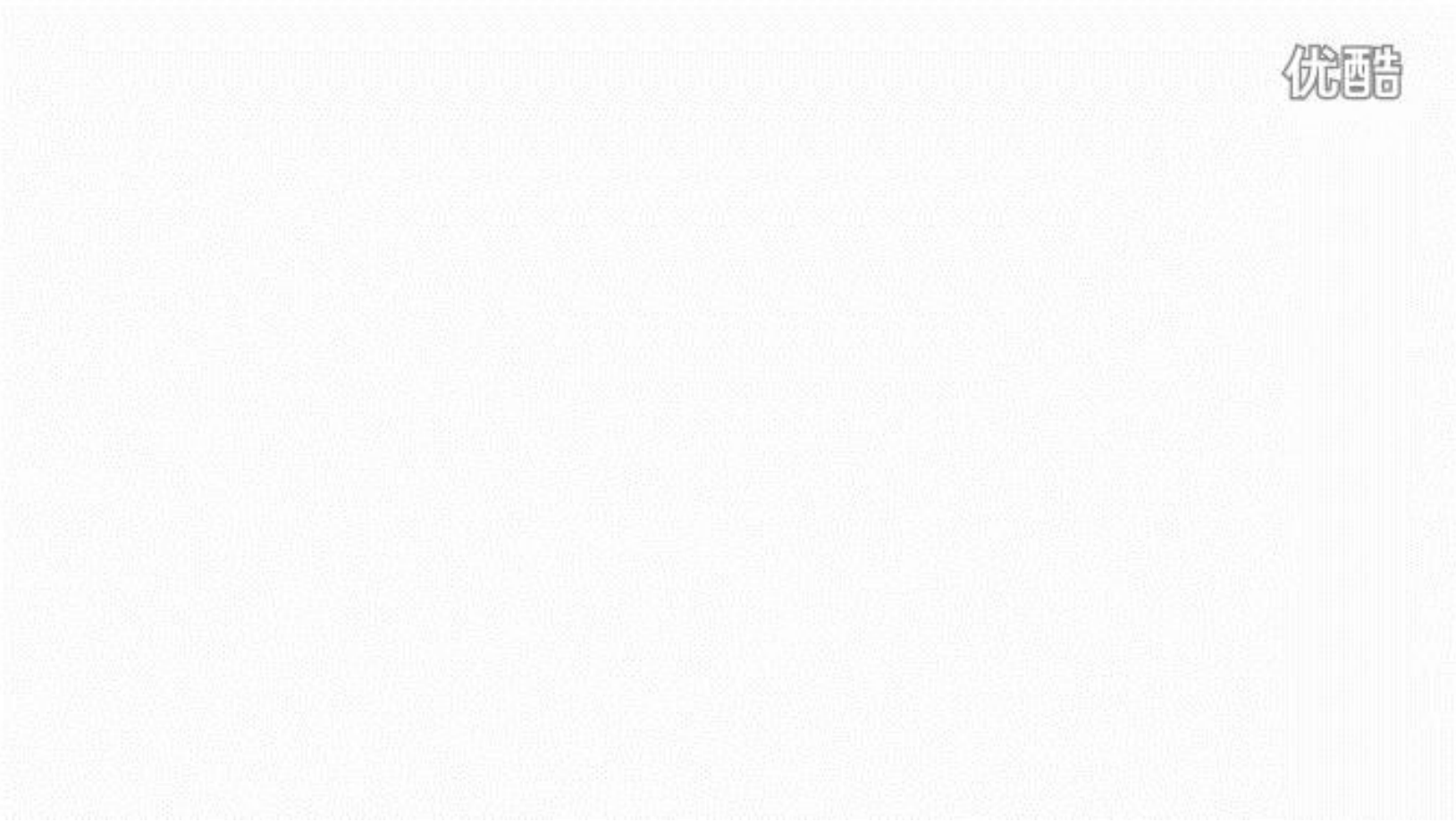
# Applications

- Visualization of Information (信息可视化）
- Design （设计）
- Simulation and Animation （模拟与动画）
- User Interface (用户界面）

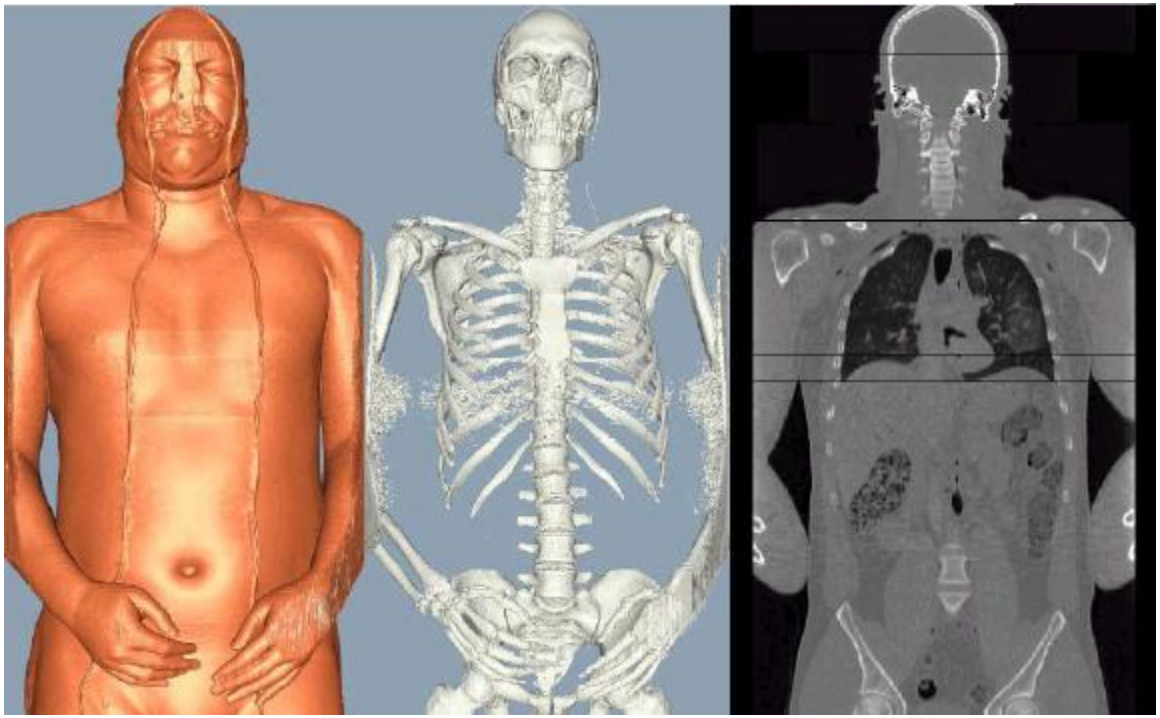
# Digital Earth and Digital Urban (数字地球与数字城市)

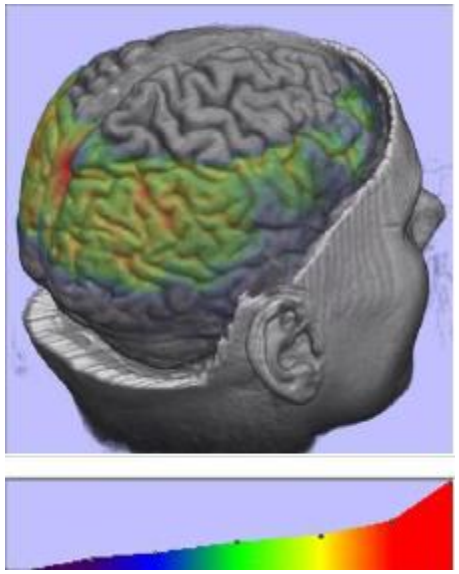
- Google earth
- Bing maps (previously Microsoft Virtual Earth)

# Google Earth: 3D Urban



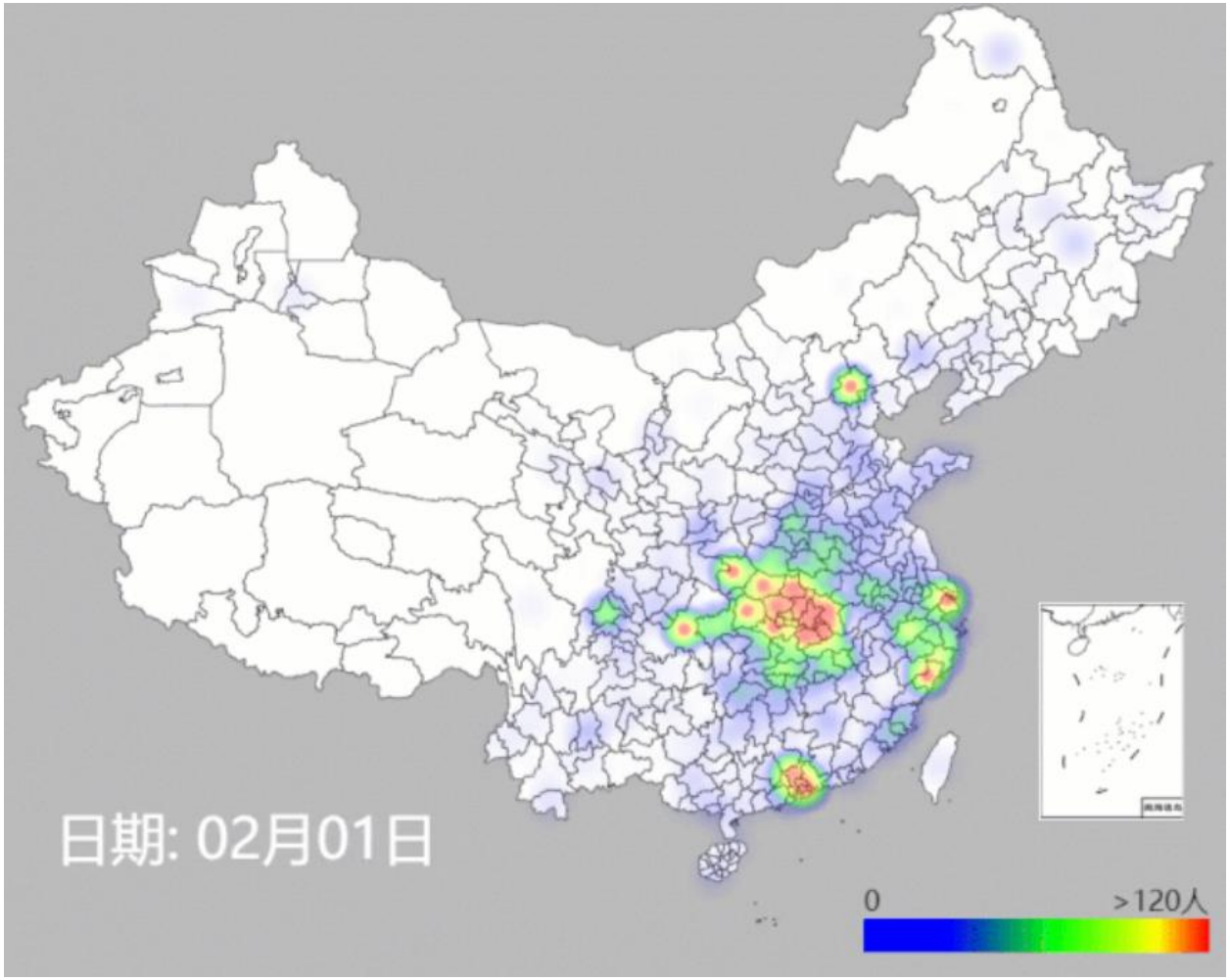
# Medical Image (医疗图像)





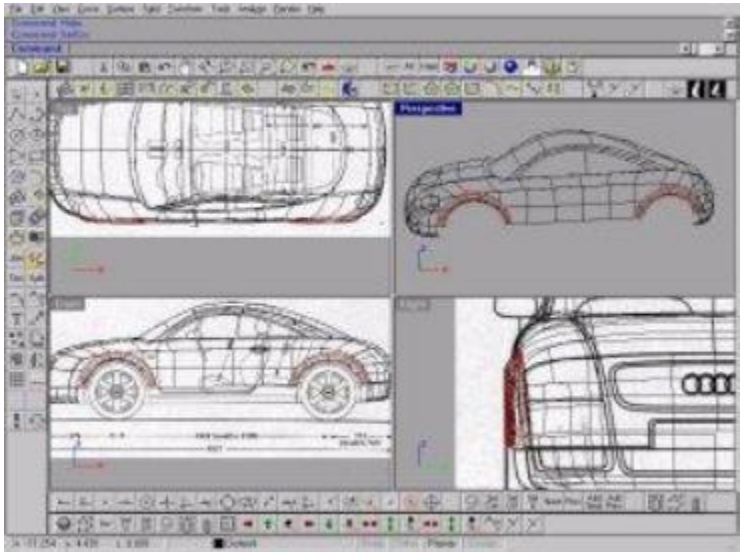
# Visualization of Big Data

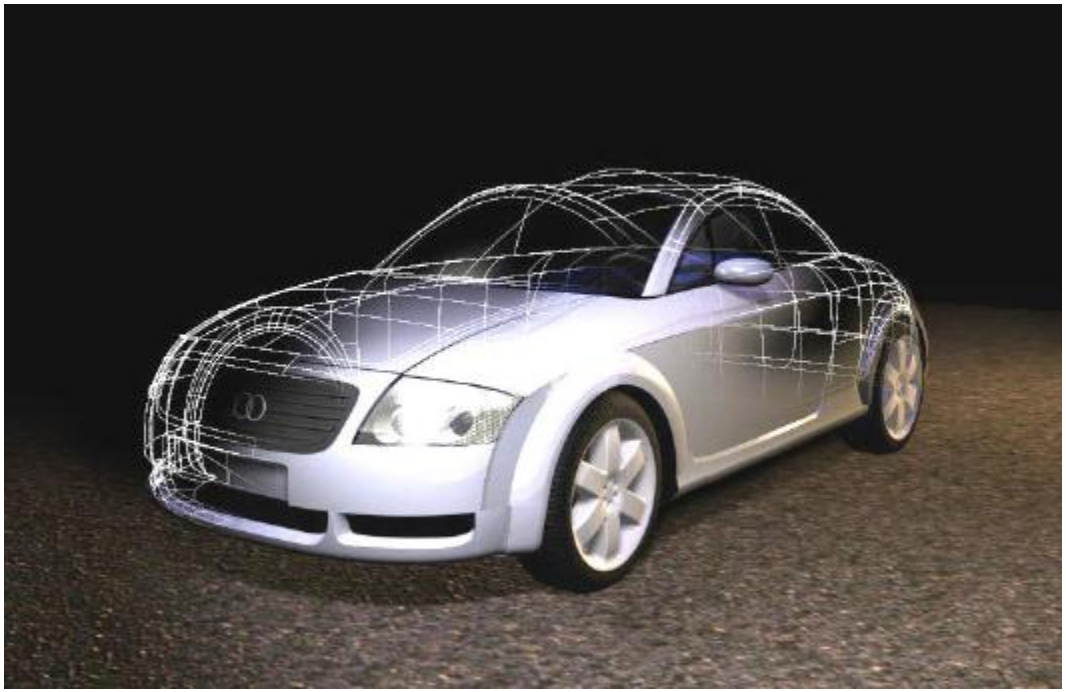
# Visualization of Big Data



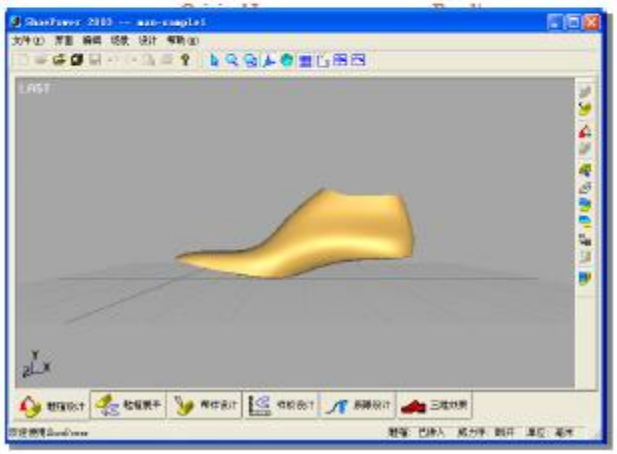

北大陈宝权教授团队

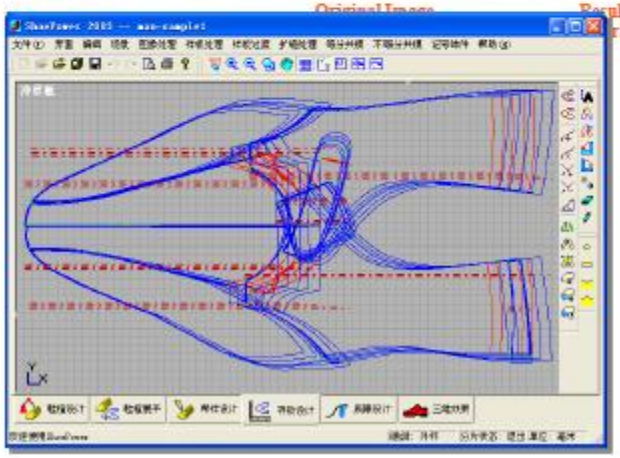
# Design of Cars





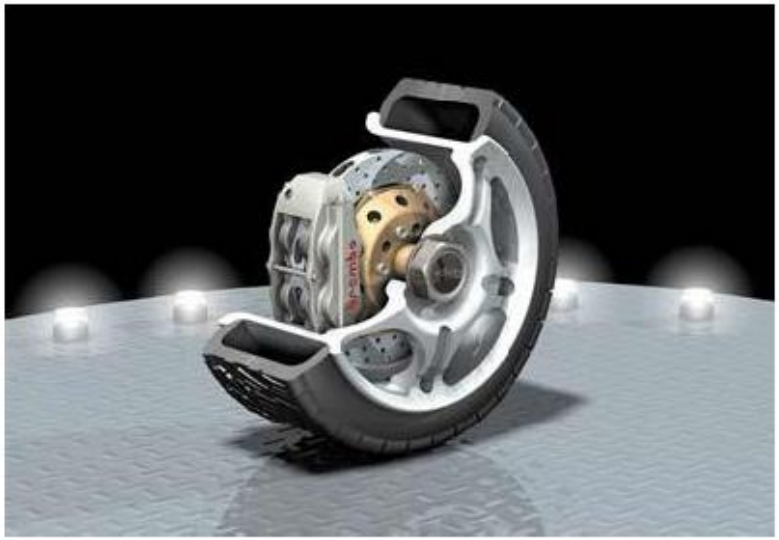
# Virtual Design





# Virtual Try-on

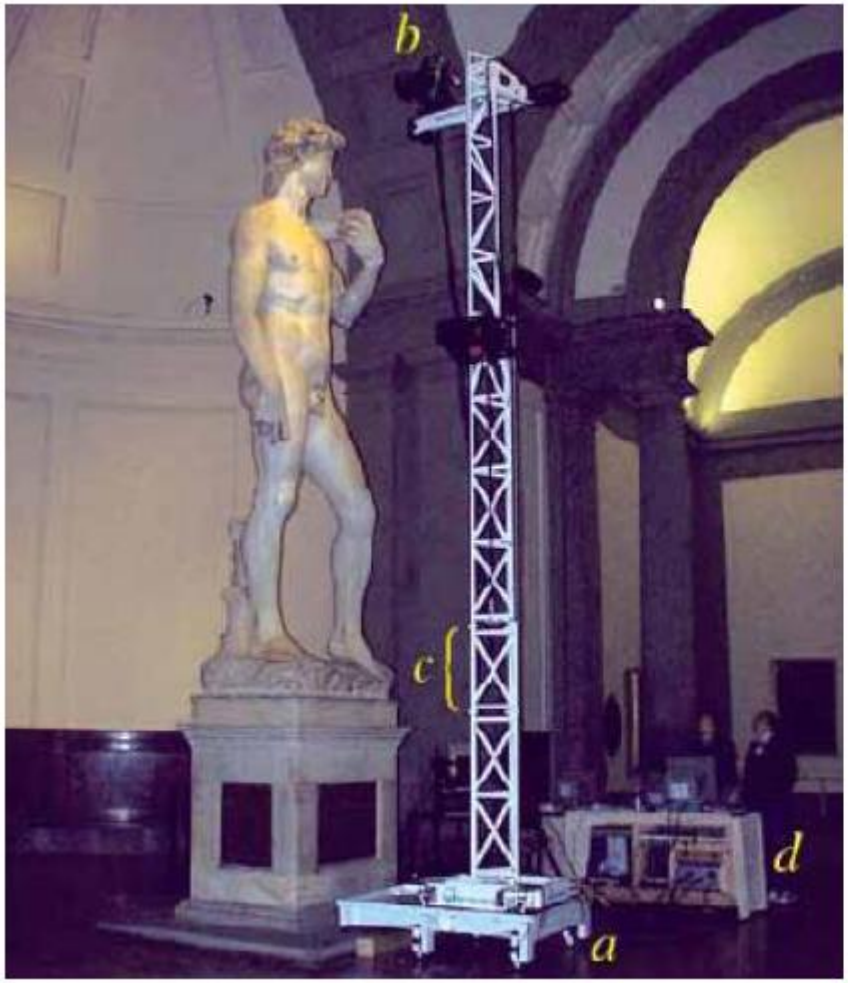
# CAD/CAM

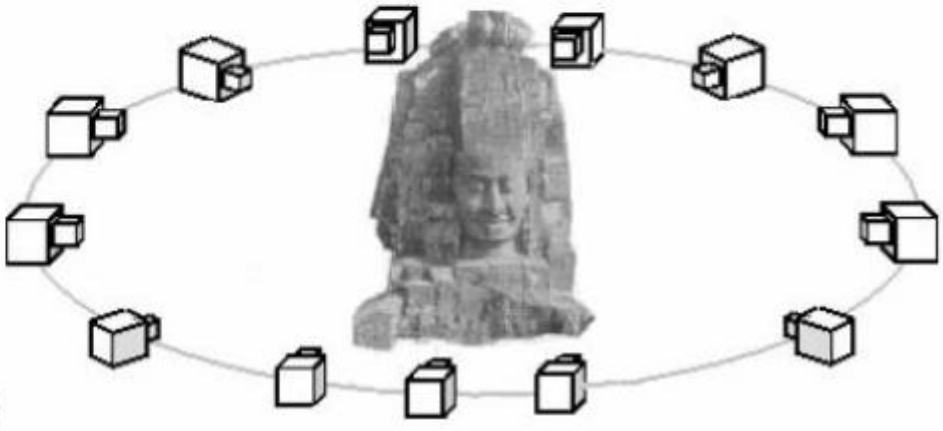




# Computer Arts


# Digital Heritage



# Virtual Reality

# Virtual Reality

# Augmented Reality

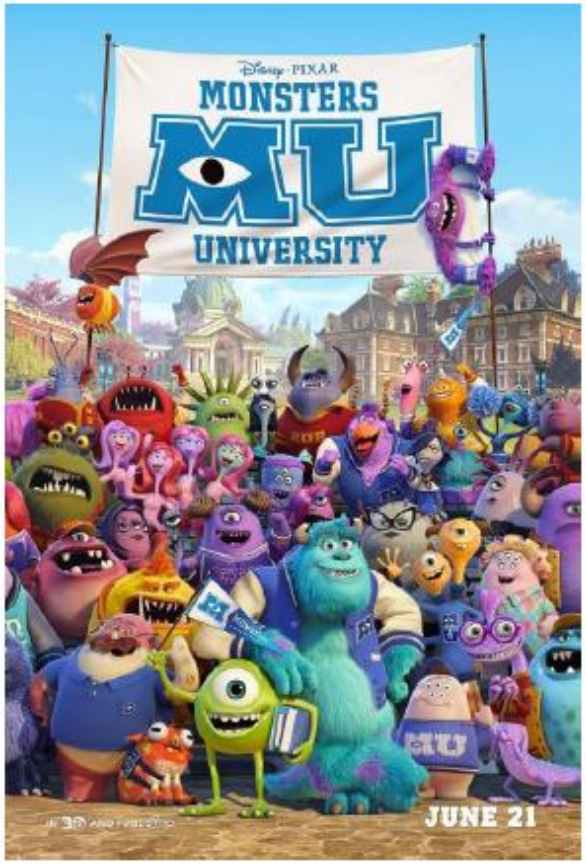
- Microsoft's HoloLens

# Computer Games


# Animation


PIXAR
PRESENTS
Geri's game


DREAMWORKS
PRESENTS
THE CROODS
MARCH 22 IN 3D


Disney · PIXAR
MONSTERS
MU
UNIVERSITY
JUNE 21

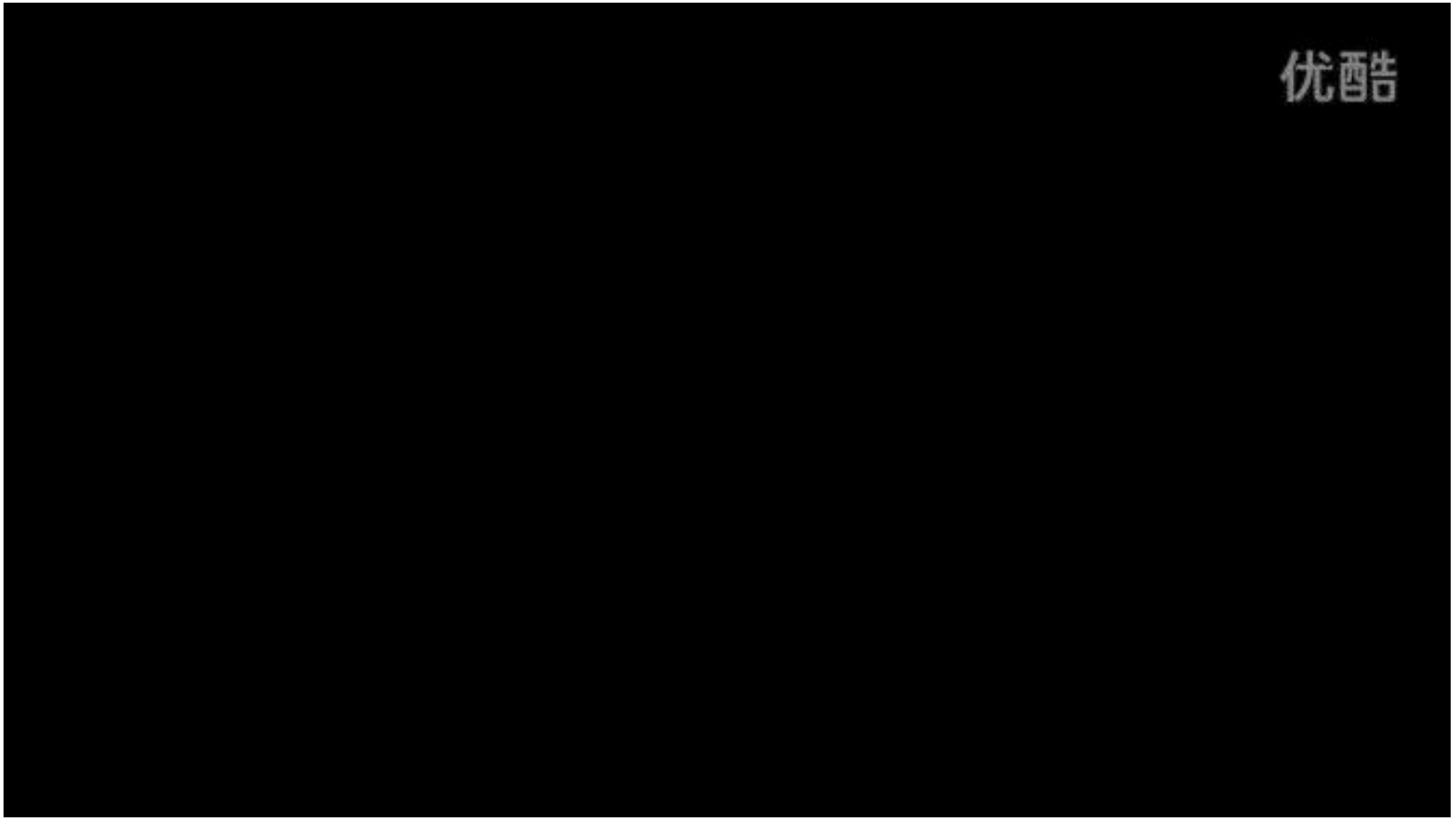
# Movies


FROM THE DIRECTOR OF TERMINATOR 2 AND TITANIC
JAMES CAMERON'S
AVATAR
EXPERIENCE IT IN IMAX 3D

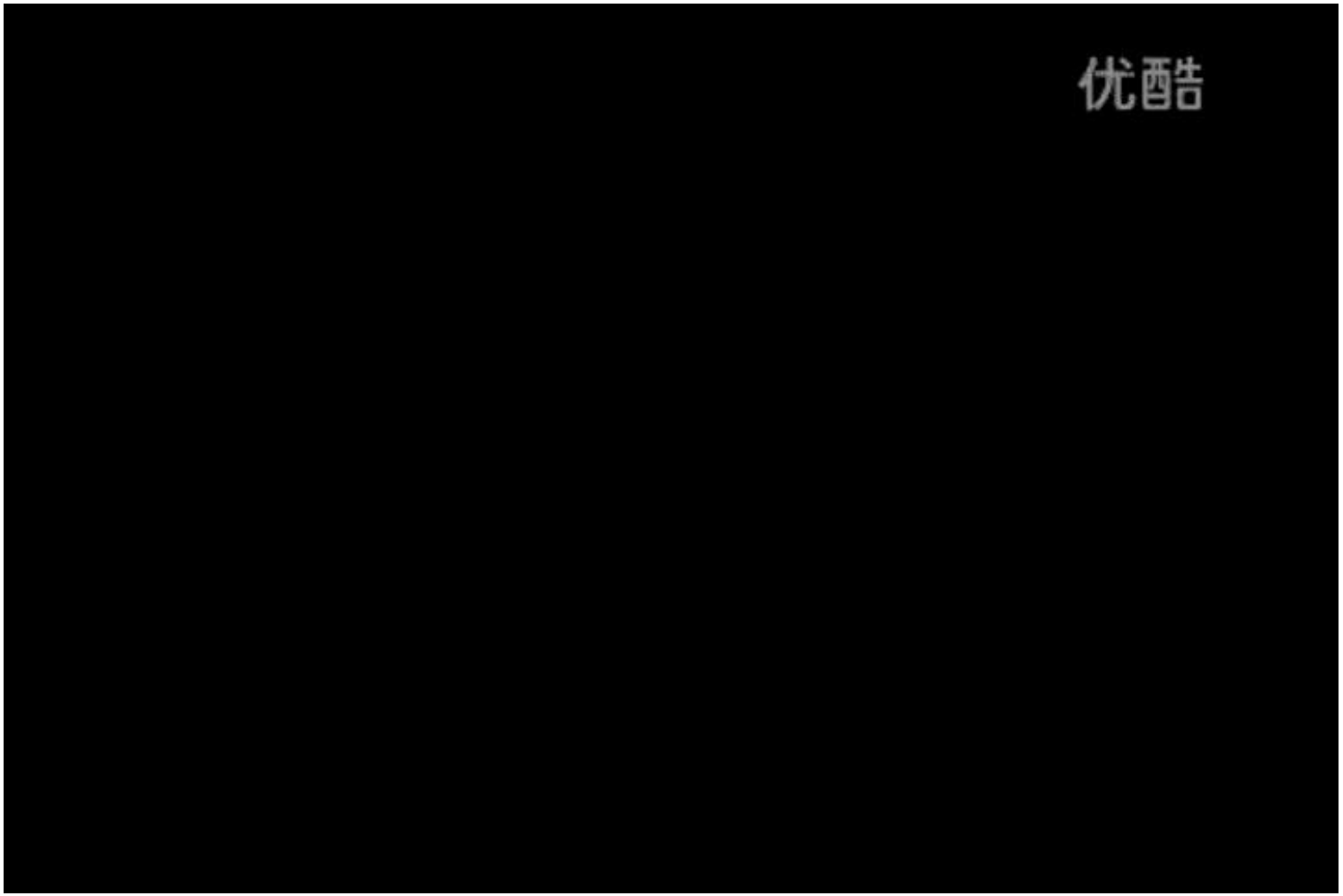

奇幻 因相信而真實
少年PI的奇幻漂流
LIFE of PI
11.21(三) 見證不凡


PACIFIC RIM
ON JULY 12 GO BIG OR GO EXTINCT
IMAX 3D

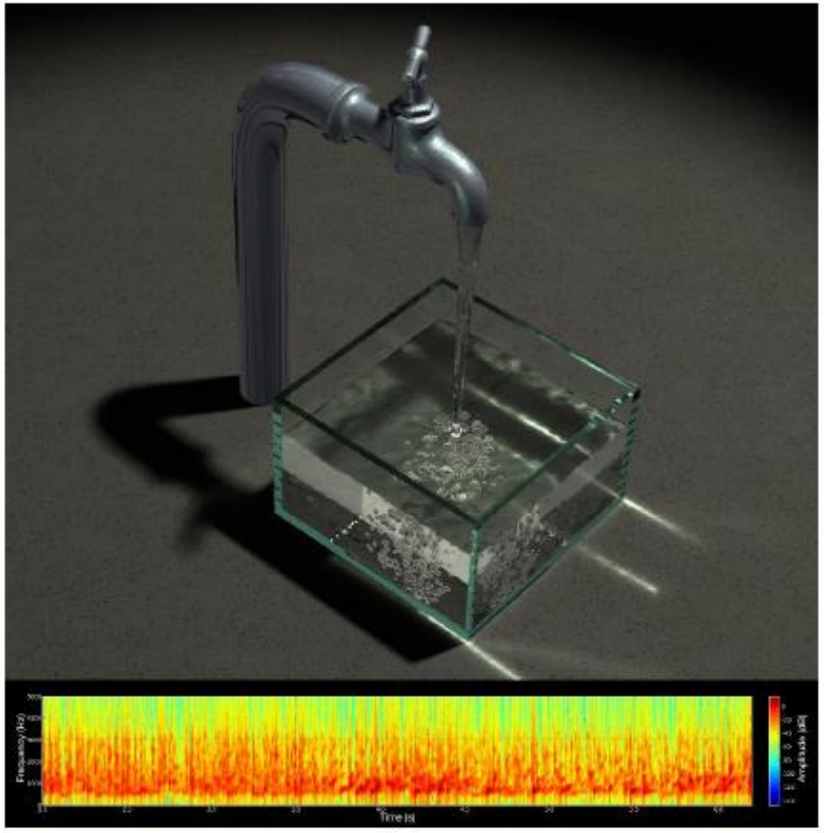
# Visual Effects: Life of Pi



# Visual Effects: The Adventures of Tintin



# Simulation

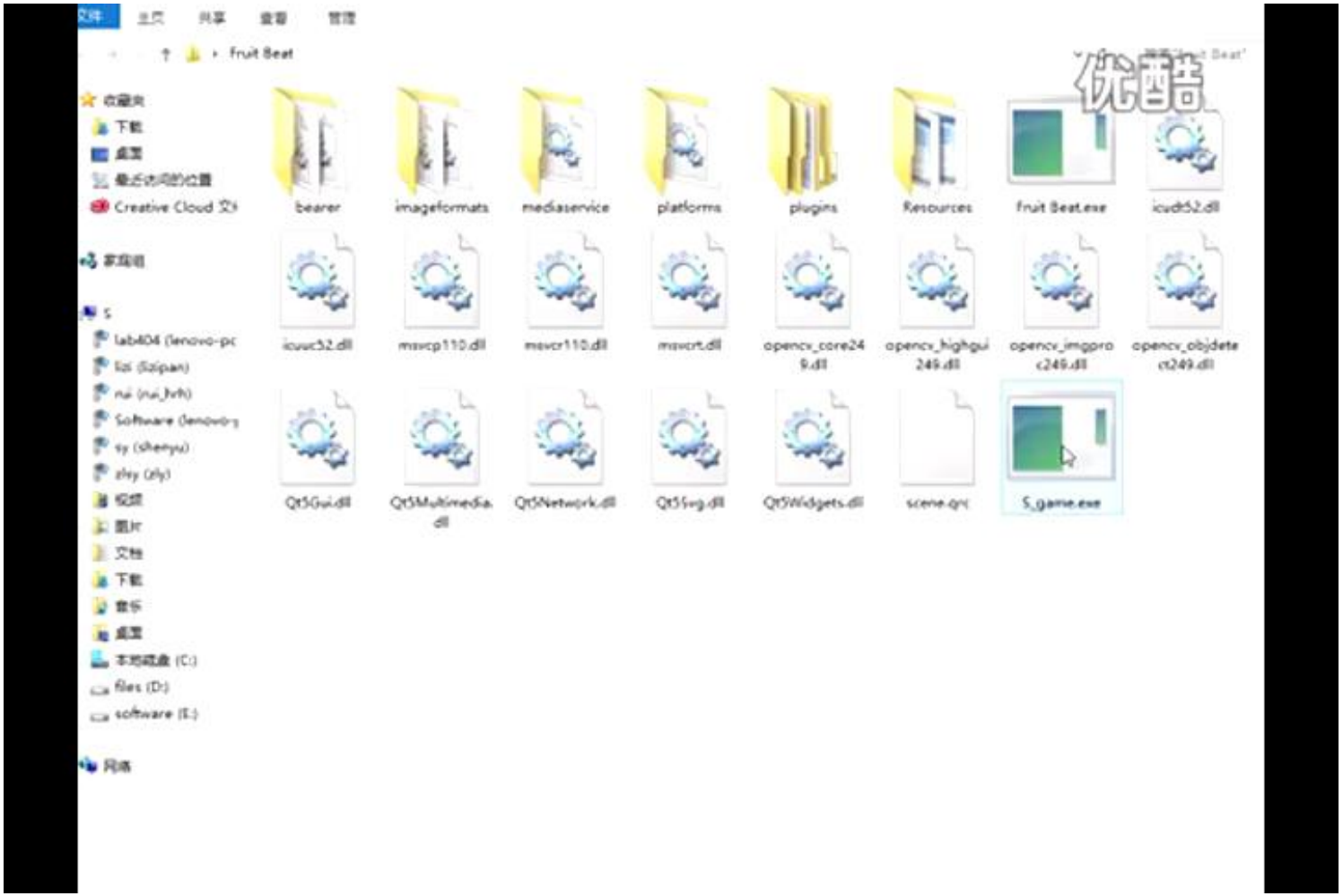


# User Interface

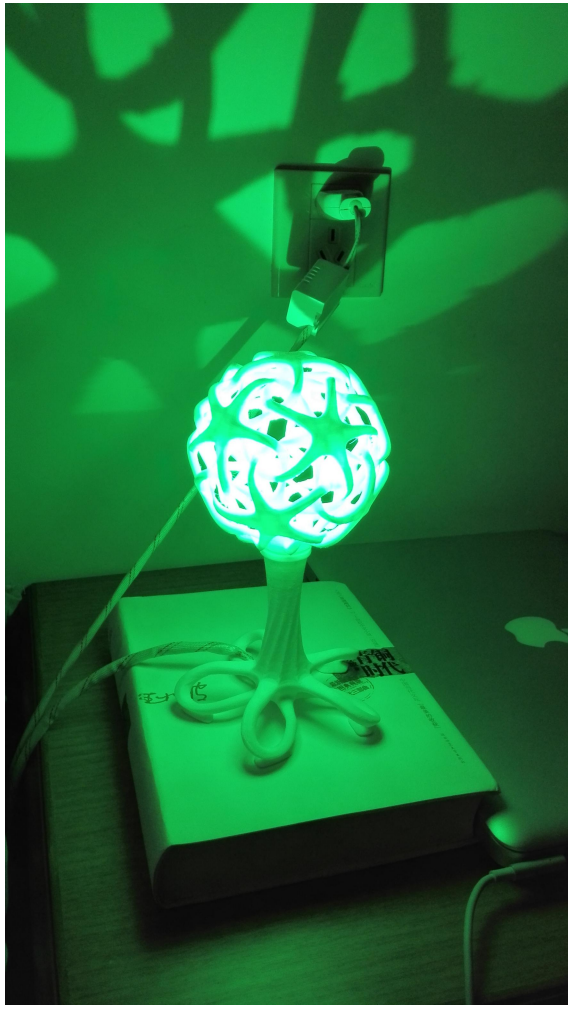

# User Interface

- Kinect

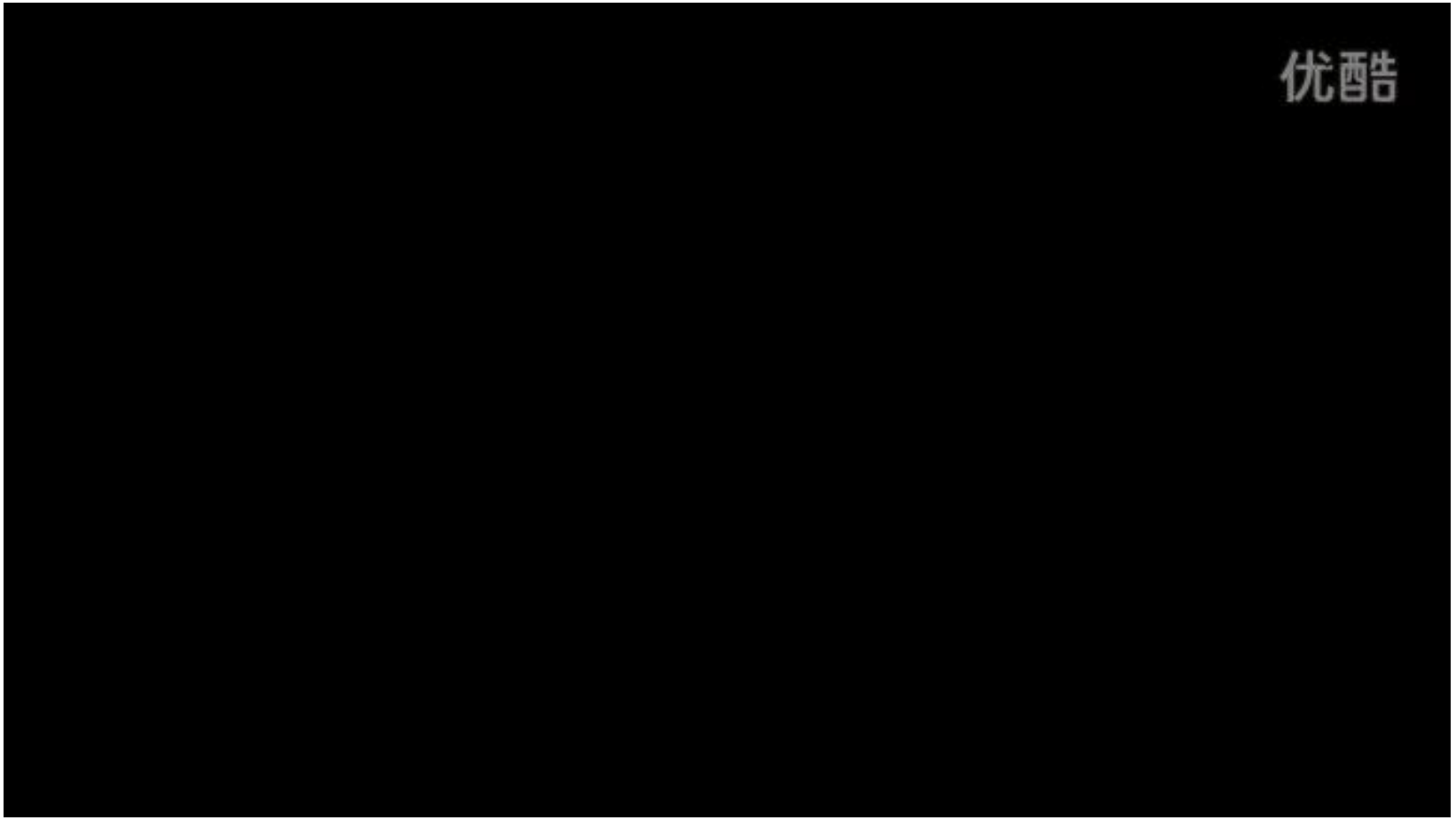
# Fruit Cut


Fruit Beat
bearer
imageformats
mediaservice
platforms
plugins
Resources
fruit Beat.exe
icudt52.dll
icuuc52.dll
msvcp110.dll
msvcr110.dll
msvcrt.dll
opencv_core249.dll
opencv_highgui249.dll
opencv_imgproc249.dll
opencv_objdetect249.dll
Qt5Gui.dll
Qt5Multimedia.dll
Qt5Network.dll
Qt5Svg.dll
Qt5Widgets.dll
scene.qrc
S_game.exe

# 3D Printing



# 3D Printing



# CG / CV / AI

- CG: Generate an Image
- CV: Parse an Image
- AI: The tools of CG/CV