

CS 569 – Mobile & Ubiquitous Graphics

Lecture 01: Introduction

Instructor:

Asst. Prof. Dr. Tolga Çapın
tcapin@bilkent.edu.tr

Office: EA431

Office Hours: Thursday 10:40-12:30
 or by appointment

Lecture Topics

- Administrivia
- Course Overview

What is this course about?

- Current techniques in mobile and ubiquitous graphics
 - Fundamental research problems in mobile and ubiquitous graphics
 - Mobile graphical interaction techniques
- Programmer-oriented view
- Not focusing on:
 - Design issues
 - Production issues, gaming, etc.

Administrivia

- Textbook:
 - Pulli et al., *Mobile 3D Graphics, with OpenGL ES and M3G*, Morgan Kaufmann, 2008.
 - Möller et al. *Real-Time Rendering*, AK Peters, (Second Edition, 2002) or (Third Edition, 2008).
- Additional journal and conference articles will be provided in class.
 - Research paper reviews: core part of the course.

Administrivia

- Grading

□ Course Project	40%
□ Programming Assignments (x 3-4)	30%
□ Research paper review / presentation	20%
□ Participation	10%

Administrivia – Reading / Programming Assignments

- There will be **3-4 programming** assignments
 - Implementation of a technique described in class
 - C/C++/OpenGL ES and Java/M3G
 - **On a mobile device with a GPU and/or OpenGL ES 1.1 (you must have one!!!)**
- There will be almost **weekly reading** assignments
 - Either: One chapter of Mobile Graphics Book
 - Or: reviewing of an assigned recent research paper
 - **Evaluation and discussion in class**
 - For each paper, a short **QUIZ**, followed by class discussion
 - Each person will present ~ 3 papers in class

OpenGL ES

- Is for everyone!
 - Example:
 - PS3 uses it
 - iPhone uses it
- Many mobile phones use it today:



PlayStation III



iPhone



NOKIA N95
PowerVR MBX with VSP



Sony Ericsson P990
OpenGL ES 1.1 through PowerVR MBX Lite



Samsung P810
GeForce 5200



Sony Ericsson W900
GeForce 4800

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Administrivia – Course Project

- Largest contribution will be a 10-week **course project** (40%).
 - Either design of an original solution
 - Or novel categorization (evaluation, implementation) of recent research
- Includes:
 - Selecting a topic
 - Submitting a proposal
 - Doing the implementation work
 - Writing a research paper
 - Presenting the implementation results in class
 - Creating a video based on the project

Administrivia – Course Project

- Freedom to choose the project topic
 - Rendering, animation, user interaction, augmented reality
- But must be specific to mobile
 - e.g. Address how memory bandwidth was reduced
 - e.g. Consider device limitations (e.g. physical size)
 - e.g. Consider context of use

Administrivia – Course Project

- Possible topics:
 - Mobile graphics architectures
 - Mobile graphics rendering and optimization techniques
 - Mobile user interfaces, interaction design and techniques, user-centered studies
 - Camera-based or sensor-based user interaction
 - Streaming mobile multimedia
 - Mobile media management
 - Intelligent, aware, proactive, and attentive environments, perception and modeling of the environment
- **Project ideas will be presented on Friday, Oct 17**
 - **Discuss proposed topics with me earlier than that**

Administrivia

- Course homepage:
 - <http://www.cs.bilkent.edu.tr/~tcapin/courses/cs569>
- Contains:
 - Lecture notes and slides
 - Assignments
 - Links to papers for further information

Administrivia

- Any Questions?

What is this course about?

- Mobile Graphics
- Mobile User Interaction

Mobile Graphics Used For

- Games
- Maps
- User Interfaces
- Mobile Web
- Multimedia
- Augmented Reality
- ...

Course overview

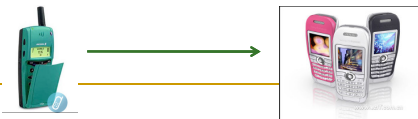
- **Mobile graphics architectures**
- **Mobile graphics rendering and optimization techniques**
- **Mobile user interfaces, interaction design and techniques, user-centered studies**
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- Mobile media management
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Course overview

- We will review the low-level techniques for graphics rendering and user interfaces
 - Culling
 - Rasterization
 - Interpolation
 - Texture compression
 - ...

Why mobile graphics?

- Phone is not just a phone!
 - Calendar, camera, messages, images, animations, games, surfing, email, sounds+music, radio, tv, addresses, notes etc.
- BIG market: ~1.13 billion mobile phones/year (2007)
 - Only games on mobiles: 160 M USD in 2006 (est.)
- The visual is a strong differentiating factor
- The displays have changed dramatically lately



Displays

- Used to be one-bit graphics @ ~50x80 pixels
- Today 16-18 bits is common
 - 24 bits is probably not far away
- Resolution:
 - Today ~208x176 – 640x320
 - QVGA (320x240) is the norm...
 - Nokia series 90 is 640x320
 - Nokia N95 is 320x240
 - Sony Ericsson P990, M600i, K800i: 240x320
 - Apple Iphone is 320x480
- We'll get 1024x768 in the future...
 - But VGA resolution (640x400) first



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Displays in the near future?

- Real 3D displays are around the corner
 - Big breakthrough might be mobiles
 - Simple principle:

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Some examples where 3D graphics key technology

Maps:

User interfaces (simpler, smoother, more intuitive)

Simple stuff: screen savers

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Slide copyright by Kari Pulli, Nokia

Mobile graphics applications SIGGRAPH2005

3D Menu
3D Games
3D Animation
3D Messaging
Location services
Advertising

More applications...

Data mining/visualization?

E-commerce

Gaming, game development

More?
You decide!

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Mobile 3D in 2005 SIGGRAPH2005

- PSP
- Gaming phones with 3D gfx HW

My note: estimated 300-400 million mobile phones with graphics hardware (OpenGL ES) by 2009

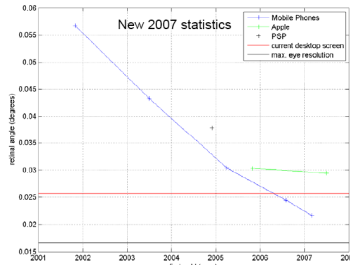
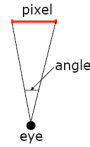
Why is it hard with 3D graphics on mobile devices?

- Small amount of memory
- Limited instruction set
- Low clock frequency
 - 100-200 MHz ARM9
 - 400-600 MHz ARM11
- Small area on the chip for CG
- Must be cheap and physically small
- Powered by batteries!
 - A memory access is one of the most expensive operations
 - Battery growth: 9% per year
 - Performance growth: 40% per year

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Small display, but very close to eyes

- Our measurements [in 2003]:
 - Average eye-to-pixel angle is 1-4 times larger for mobile than for a laptop/desktop



Still, about the same requirements as for desktop (where resolution might increase as well)

So, we need about the same image quality as for desktop graphics

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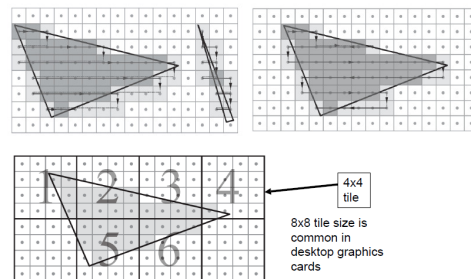
Major Problems

- Computational power
- Power supply
- Physical display size
- Input modalities

Solutions : Rendering

- Rendering optimization
- Edge functions
- Interpolation
- Culling algorithms
- Stereo rendering speed-up
- Power-aware algorithms

Solutions : Rendering

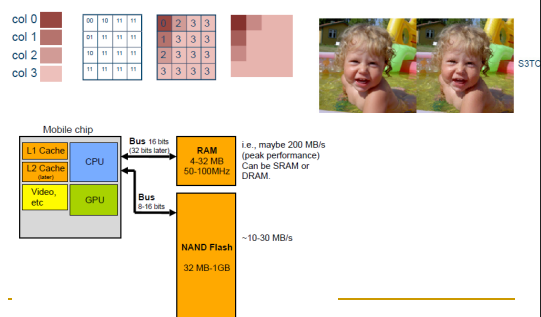


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Solutions: Graphics HW

- Texture compression
- Buffer compression
- Culling

Solutions: Graphics HW

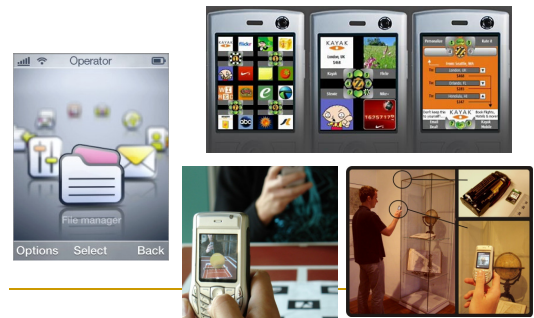


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Solutions: Interaction & visualization

- Direct manipulation
- 3D User Interfaces
- Sensors

Solutions: Interaction & visualization



Topics – First Half of Semester

- Introduction, state of art
- Real-time rendering pipeline
- Mobile APIs – OpenGL ES 1.0/1.1, M3G
- Rasterization on mobile device, antialiasing
- Texture and buffer compression
- OpenGL ES 2.0

Topics – Second Half of Semester

- Mobile User Interfaces
- 3D Displays and Rendering
- 3D Visualization
- 3D UIs
- Sensor-Based / Camera-Based Interaction
- Graphics Streaming
- Augmented Reality

Lecture Summary

- Overview of current techniques in mobile and ubiquitous graphics
- Fundamental research problems in mobile and ubiquitous graphics
- Graphically rich interaction techniques

Readings for Next Week

- Pulli, *Mobile Graphics*, Chapter 1. (required)
- Class discussion and Quiz on Chapter 1 next Wednesday!

Assignment for Next Time

Assignment 0: due Wednesday, September 24th

Send me an email (tcapin@cs.bilkent.edu.tr) with your answers to the following questions:

- Your name
- The degree you are pursuing (M.S., Ph.D...)
- Your planned thesis area, or if you know, expected thesis topic
- The mobile device you will use: **IT MUST HAVE A GPU and at least OpenGL ES 1.1 support!!!**
- Your expectations for this course

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