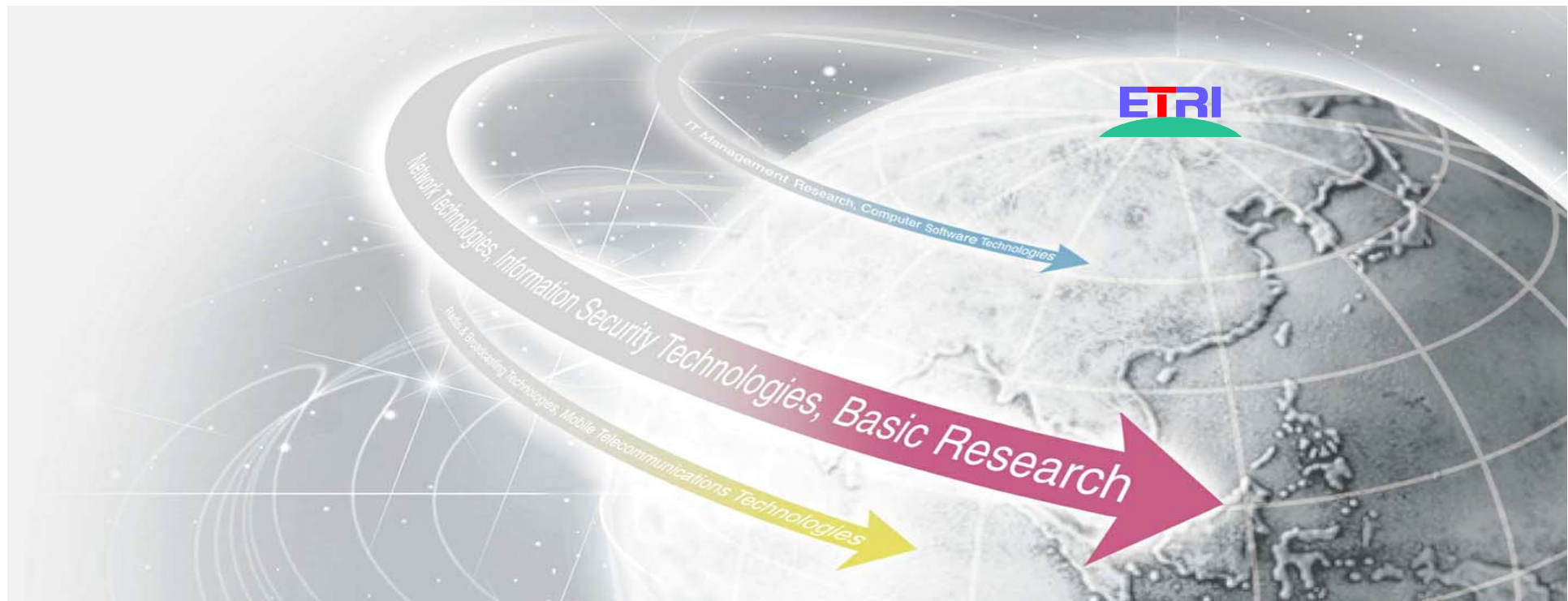


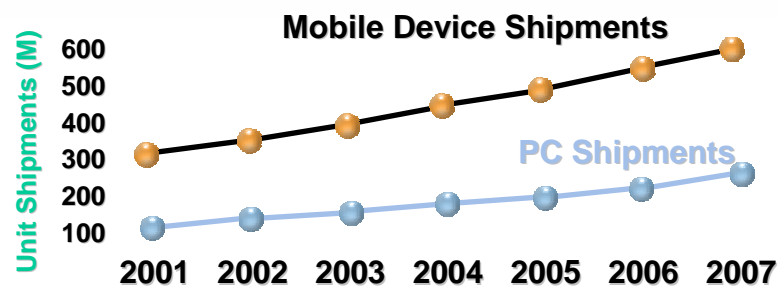
Smart GL



3DTV System Research Team
2004. . .

Daehee Kim

Development of Mobile Environments



Source: Gartner Dataquest (Dec. 2003)

Mobile Devices:

- 1 Increased amount of usages of Mobile Devices
- 1 Growth of Pocket PC Markets
- 1 Release of Smart Phone
(37+ OEMs, 50+ Communication Comp.s)
- 1 Horizontal/High Resolution Type of Screen



Mobile Application Programs:

- 1 Market of \$5,800,000,000 Billion (2006)
- 1 Increased Demands of Mobile Application Programs



Stronger Processors for Mobile Devices

■ Video Processors

- ◆ H.264
- ◆ Intel: PXA270, XScale
- ◆ SAMSUNG: S3C2440
- ◆ TI: OMAP, DM320, DM642, DM270
- ◆ ARM Core

■ Specified Processors for Graphics



Upcoming 3D Graphics on Mobile (1)



□ Current Status of Handsets for 3D Graphics

- ◆ Few Mobile Phones for 3D Graphics
- ◆ 3D Characters for Idle Time Screen
- ◆ SKY IM6400, LG Cyon SV9140, Samsung SPH—X9300
- ◆ Low Sales Performance
 - SKY 1M6400 – 150,000~200,000 EA

□ 177 Patents related to 3D Mobile Technology and Contents

- ◆ From 1999 to 2003
- ◆ 163 Patents from Domestic Companies (92%)
- ◆ 14 Patents from Foreign Companies

Upcoming 3D Graphics on Mobile (2)



- Release of 3D Mobile Game from 3rd Quarter in 2004
- Major Trend of Mobile Phone Markets in 2005
 - ◆ Graphic Accelerator Chip
 - ◆ SoC for Graphics
 - ◆ 3D S/W Engines
 - ◆ Breakthrough of Rater Depressed Wireless Internet Markets
 - ◆ Active Development of 3D Mobile Contents
 - ◆ Developing Implementation Technologies

Japanese Trends

■ 3D Consortium

- ◆ Starting in 2003 with Sanyo, Sony, NTT Data etc.
- ◆ Input/Output Devices for Stereoscopic Images
- ◆ Proliferation and Improvement of Distribution of 3D Contents
- ◆ Increasing Markets for 3D Contents

■ Sharp Co.

- ◆ Laptop Computer with Autostereoscopic Display (2003)
- ◆ Mobile Phone with Autostereoscopic Display (2004)
- ◆ Service Only for Stereoscopic Images

Standardization for 3D Graphics



□ Khronos Group

- ◆ OpenGL ES
- ◆ Lightweight API for *Advanced Embedded Graphics*
 - Using Well-Defined Subset Profiles of OpenGL
- ◆ Low-Level Applications Programming Interface (API)
 - Between S/W Applications and H/W or S/W Graphics Engines

□ JSR 184: Mobile 3D Graphics API for J2ME

- ◆ High-Level API for Java Mobile 3D Graphics
- ◆ To Help Developers Write 3D Programs
 - By Providing Features such as Scene Graphs

□ Mobile 3D Standardization Forum (Korea)

- ◆ Organized on April 24th 2004

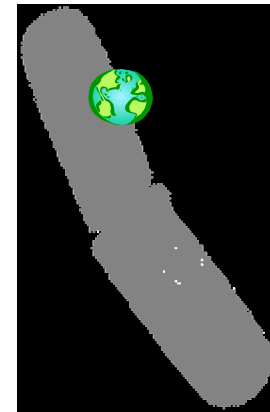
Smart GL



■ Stereoscopic Image Rendering S/W

- ◆ Implementation on Mobile Devices
- ◆ Handling of 3-D Objects

Small, but reliable and talented Graphic Library
Smart Graphic Library
Graphic Library as a result of Smart TV Project
(a Compound Word of Smart and GL)



Development Environments for PDA



H/W Connection: USB
S/W Connection: ActiveSync



- Stereoscopic Screen
(Lenticular Sheet, Parallax Barrier)
- Windows CE on PPC
- Windows CE on Handheld PC

- eMbedded Visual C/C++
- Windows 2000
- Emulator

Development Environments for Phone



- H/W Connection: RS-232C/Loader
- S/W Connection: Customized Program

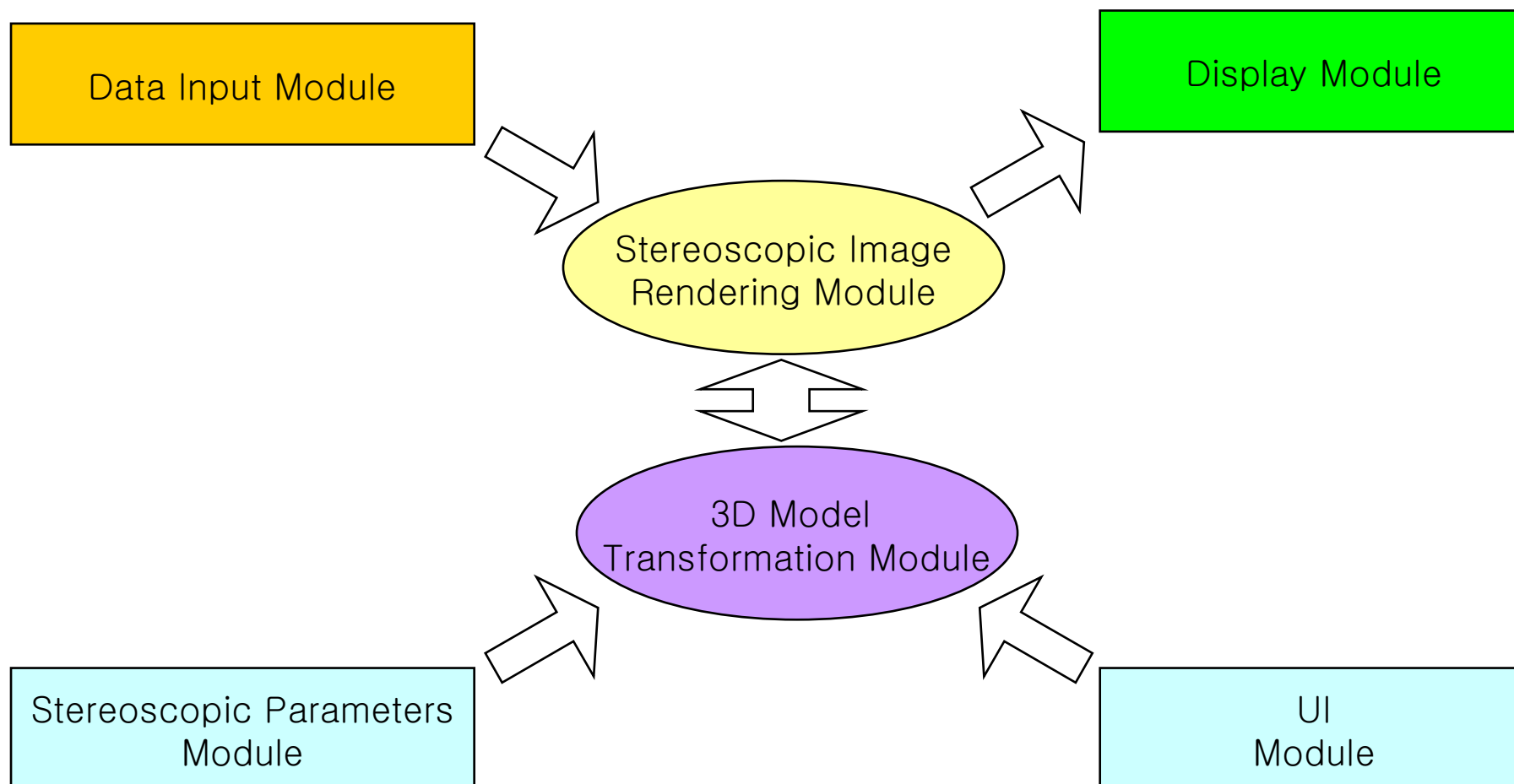


- Stereoscopic Screen
- Nucleus (Embedded O/S)

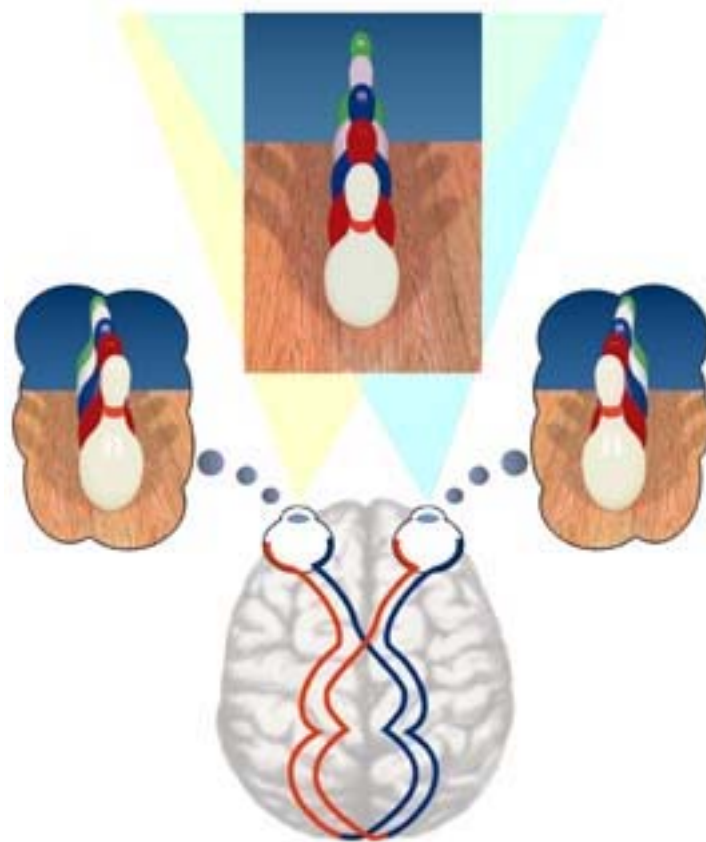


- Compiler supported by TI
- Windows 2000
- Emulator

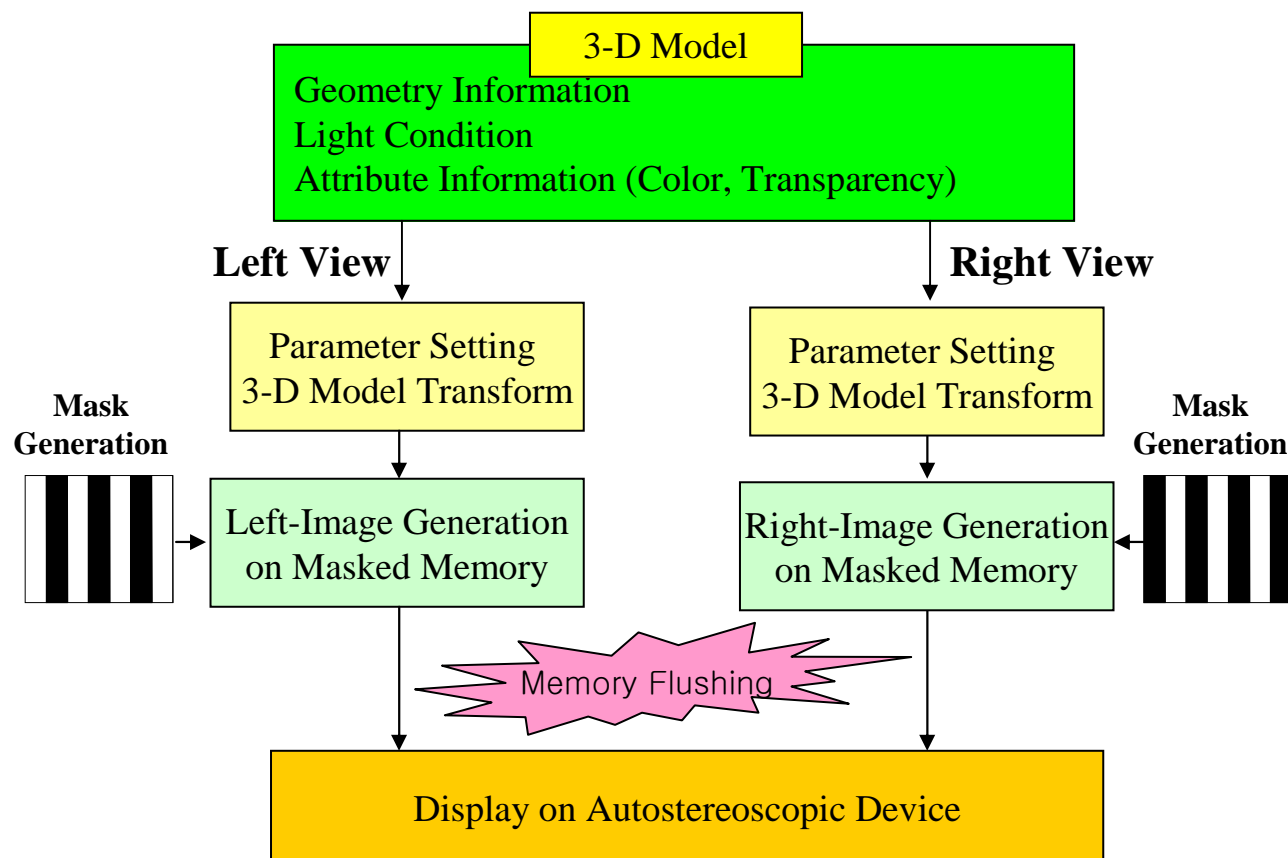
Overall System Diagram



Principle of Stereoscopy



Rendering Procedure



Implementation Issues

- Rendering S/W Implementation on Mobile Devices
 - ◆ Fixed Point Operation
 - ◆ Shift Operation instead of Multiplication
 - ◆ Look-Up Tables to Deal with Trigonometrical Functions

- Stereoscopic Image Display on Mobile Devices
 - ◆ Device-Oriented Display Routine for Fast Display

- User Interface for Handling 3-D Stereoscopic Objects
 - ◆ For Game Applications

Generation of Left/Right Image



- Rotate Entire Space
- Virtual Stereo Camera Effects



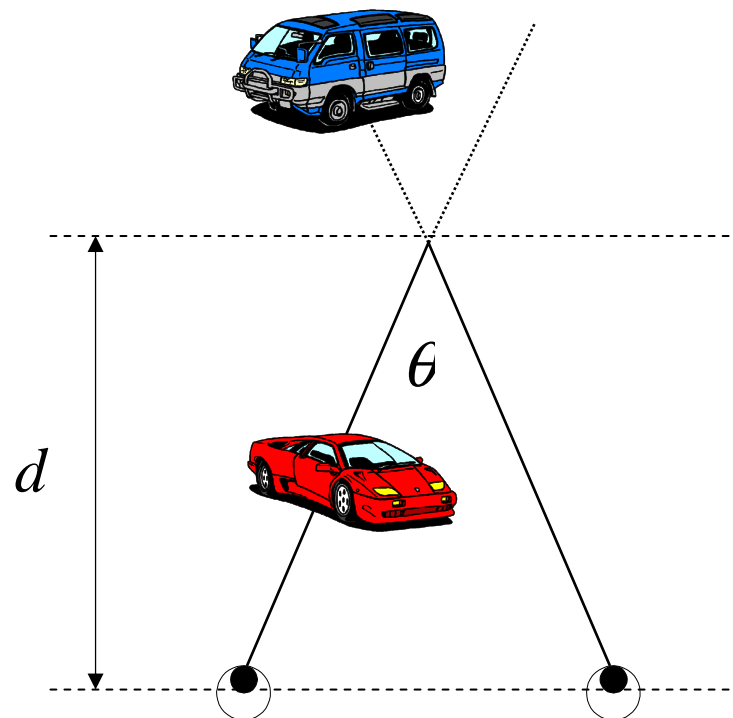
Left Image



Right Image

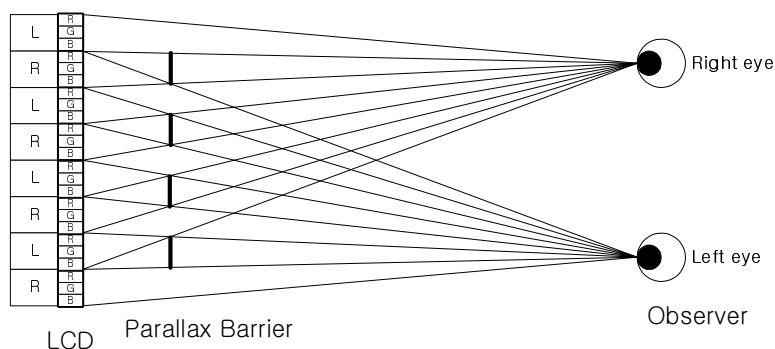
Parameters for Stereoscopy

- Convergence Angle θ
- Convergence Distance d
- Control Convergence Angle
- Control Convergence Distance

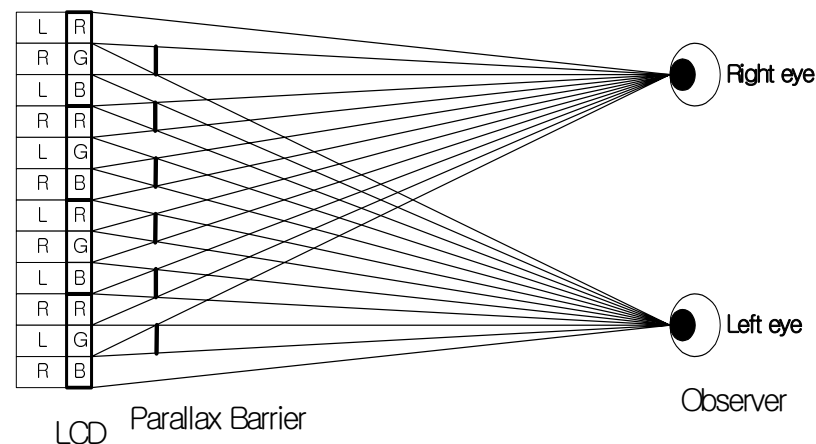


Parallax Barrier

- Devices for Stereoscopic Images
- Pixel-Based Parallax Barrier vs. SubPixel-Based Barrier

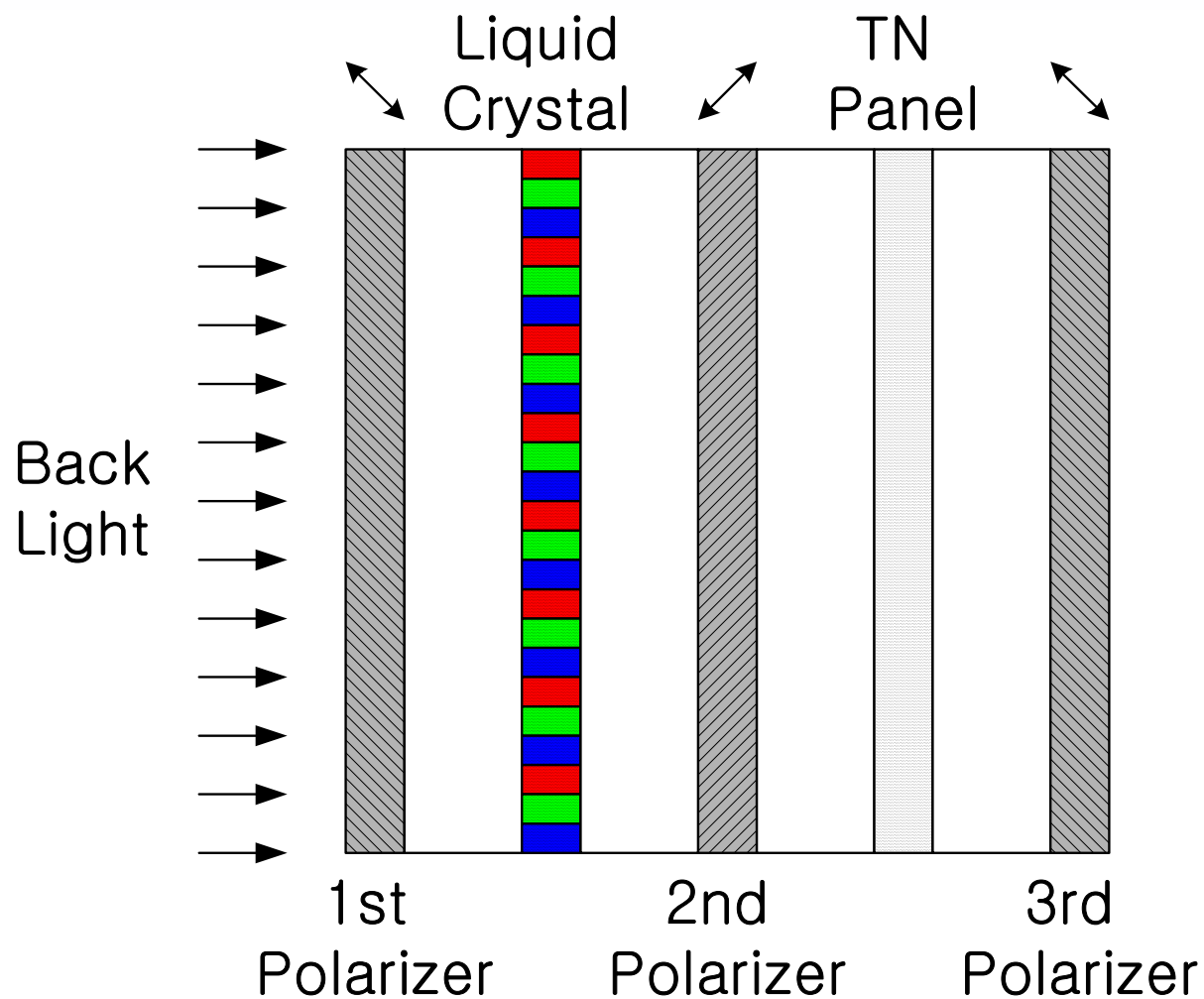


Pixel-Based

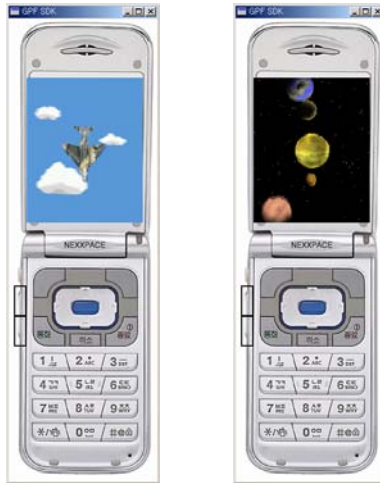


SubPixel-Based

Structure of Autostereoscopic Display Panel



Smart GL on Various Platforms



Simulation on Nucleus



Results on GPRS Phone



Results on PPC
with MIPS Processor



Results on Handheld PC
with XScale Processor