Low-cost virtual reality visualization for SMEs

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• 1996-2001: Master student of Manufacturing Technology at Department of Production, AAU.
  
  Title of master project:
  
  *Virtual processing of multi-stage forming using Linux clustering.*

• 2001-2004: Ph.D. student at Department of Production, AAU.
  
  Title of Ph.D. Project:
  
  *Industrialization of virtual processing.*
Agenda

• Background
• Importance, motivation and scope
• Low-cost VRV system
  – Passive stereo projection
  – Hardware
  – Software
  – Example
• Current results
• Future work and perspectives
Background

- Beowulf clustering
  - Components
    - Standard PC hardware
    - Standard network hardware
    - Open Source software
      - Linux
      - MPI – LAM / MPICH
  - Advantages
    - Inexpensive compared to commercial systems
    - Good scaling properties
  - Application
    - LS-DYNA3D MPP FE simulation
Background

• LS-DYNA3D MPP
  – Advantages of MPP version
    • Faster processing of models
    • Possible to use less expensive computer systems (Beowulf clusters)
  – Parallel processing technique
  – Communication technique
Background

- LS-DYNA3D MPP multi-stage forming simulation
  - 7 stages in all
    - Deep drawing operations
    - Sharp press operations
  - **Goal:** To investigate if variations in certain input, output and process parameters can be simulated in *LS-DYNA3D.*
Research in the use of VRV within for example the automotive industry has shown:

- Better visualization of 3D information
  - Scale
  - 3D effect
- Enhanced communication
  - Between technical and non-technical staff
- Accelerated decision making
- Shorter time for production
- Reduced costs
Currently VRV technology is inaccessible to SMEs due to high cost of commercial systems

- Advances in PC hardware
- Advances in Open Source software
- Research in alternative low-cost VRV systems

- Gain understanding of low-cost VRV systems
- Gain understanding of possible application areas of VRV within virtual processing
Scope and objectives

To investigate and show how VRV coupled with virtual processing can be employed within manufacturing tasks in SMEs

- Build a low-cost VRV system
- Program a low-cost VRV application
  - Input data
    - LS-DYNA3D finite element simulation
      - LS-POST – VRML2 data
    - CAD
  - Study of practical cases
Low-cost VRV system

• Low-cost
  - Mass produced hardware components (e.g. PC)
  - Open Source software (e.g. Linux)

• Single screen passive stereo using front projection
Passive stereo projection system

- LCD projectors
- Polarization filters
- Screen material
- Polarized glasses
- PC
  - Graphics card
- Software
  - Linux
  - OpenSG
  - VR Juggler

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System hardware

Pictures from the initial setup
System software

Software base components

• Red Hat Linux - http://www.redhat.com
  – GNU GCC compiler
  – XFree86 and GLUT
  – nVidia graphics driver

• Why?
  – Platform fits VRV well and it's a popular choice
  – Good programming environment
  – Free, flexible and stable
Project started in 2000 at SIGGRAPH
Beta version out in 2001, now at ver. 1.2 in 2003
C++ APIs for writing graphics applications
Real-time rendering system
Scene graph metaphor
Platform independent (Unix/Linux + Windows)
For more information: http://www.opensg.org
System software, VR Juggler

- Project started in 1998 at VRAC
- Now at version 1.0.7 and 2.0 Alpha in 2003
- C++ APIs for writing VR interfaces like display surfaces, tracking, navigation, graphics engines and more
- Supports OpenSG graphics engine among others
- Platform independent (Unix/Linux + Windows)
- For more information: http://www.vrjuggler.org
OpenSG example

First state

Last state

Left eye

Right eye

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Current results

• The system works! - both hardware and software
• Cost of building the current system: 9,500 EUR.
• The system is quite easy to set up
• Possible to join LS-DYNA3D and CAD output
• OpenSG
  – Documentation is getting better
  – Good tutorial examples
  – Good mailing list
Future work and perspectives

- Currently looking into practical applications
- Adding VR device to system and use VR Juggler together with OpenSG
- Clustering, both OpenSG and VR Juggler support it
- Easy expandable to panorama and cave like system
- Make VRV technology accessible to SMEs
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