N91-10895

Visualization of Fluid Dynamics at NASA Ames

Val Watson
NASA Ames Research Center

The hardware and software currently used for visualization of fluid dynamics at NASA Ames is described. The software includes programs to create scenes (for example particle traces representing the flow over an aircraft), programs to interactively view the scenes, and programs to control the creation of video tapes and 16mm movies. The hardware includes high performance graphics workstations, a high speed network, digital video equipment, and film recorders.

With the current workstations, a scientist can interactively view flow over simplified objects, such as the flow over a circular cylinder. For complex objects, such as an aircraft, the workstation creates each picture too slowly to gain a sense of the dynamics of the flow. Therefore, each picture is stored frame by frame on a video tape or 16mm film and then the video or movie is played back at normal speed to illustrate the flow dynamics.

The upgrade in workstations planned for this year is expected to permit moderately complex pictures (pictures that can be represented by 10,000 polygons or less) to be created at a rate of 10 frames per second --- fast enough to gain a sense of the flow dynamics. Therefore, these workstations should permit interactive viewing of the flow over complete aircraft rather than just simple objects. Upgrades planned this year for software should provide a more effective interface for controlling the interactive viewing.

A comparison of the upgrades planned this year with an ideal simulation and visualization environment shows that there is still potential for major improvements in both software and hardware. The greatest potential for improving the environment is the development of software to extract and illustrate the essence of very complex phenomena.

Results presented by other scientists during this conference clearly demonstrate the effectiveness of the current visualization tools for assisting in the understanding of complex simulations, but it is also clear that we are a long way from utilizing visualization tools to their full extent.

Outline

NASA's current visualization tools

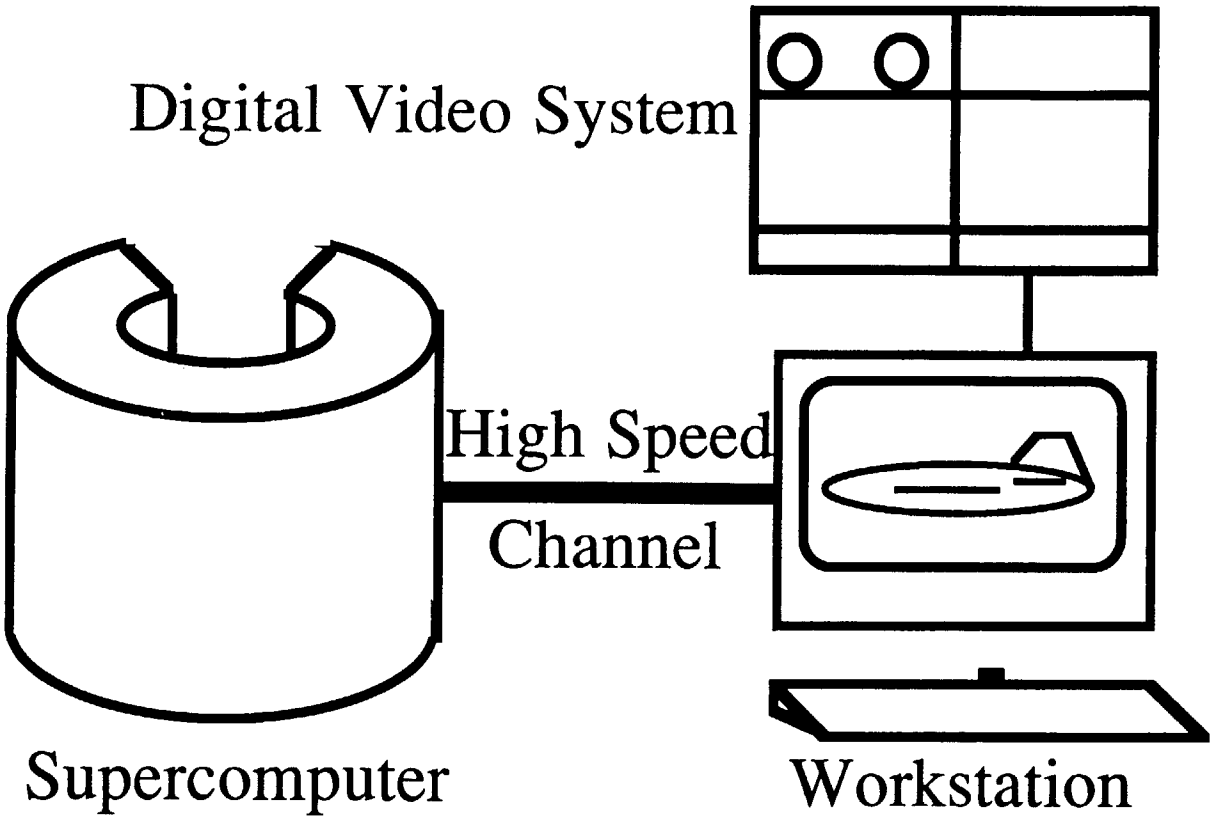
Capabilities with the current tools

Upgrades planned for this year

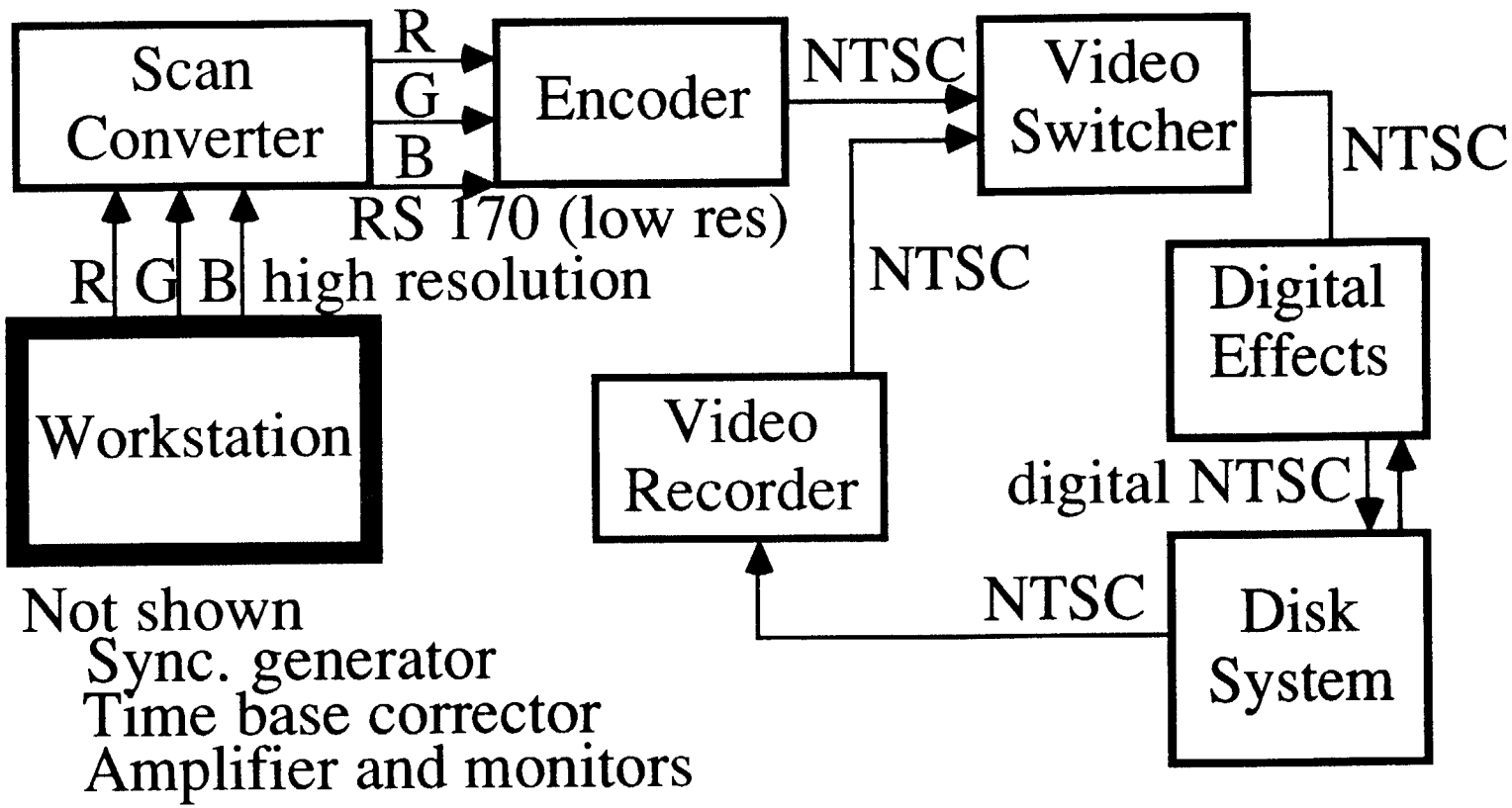
Potential for further improvements

Conclusions

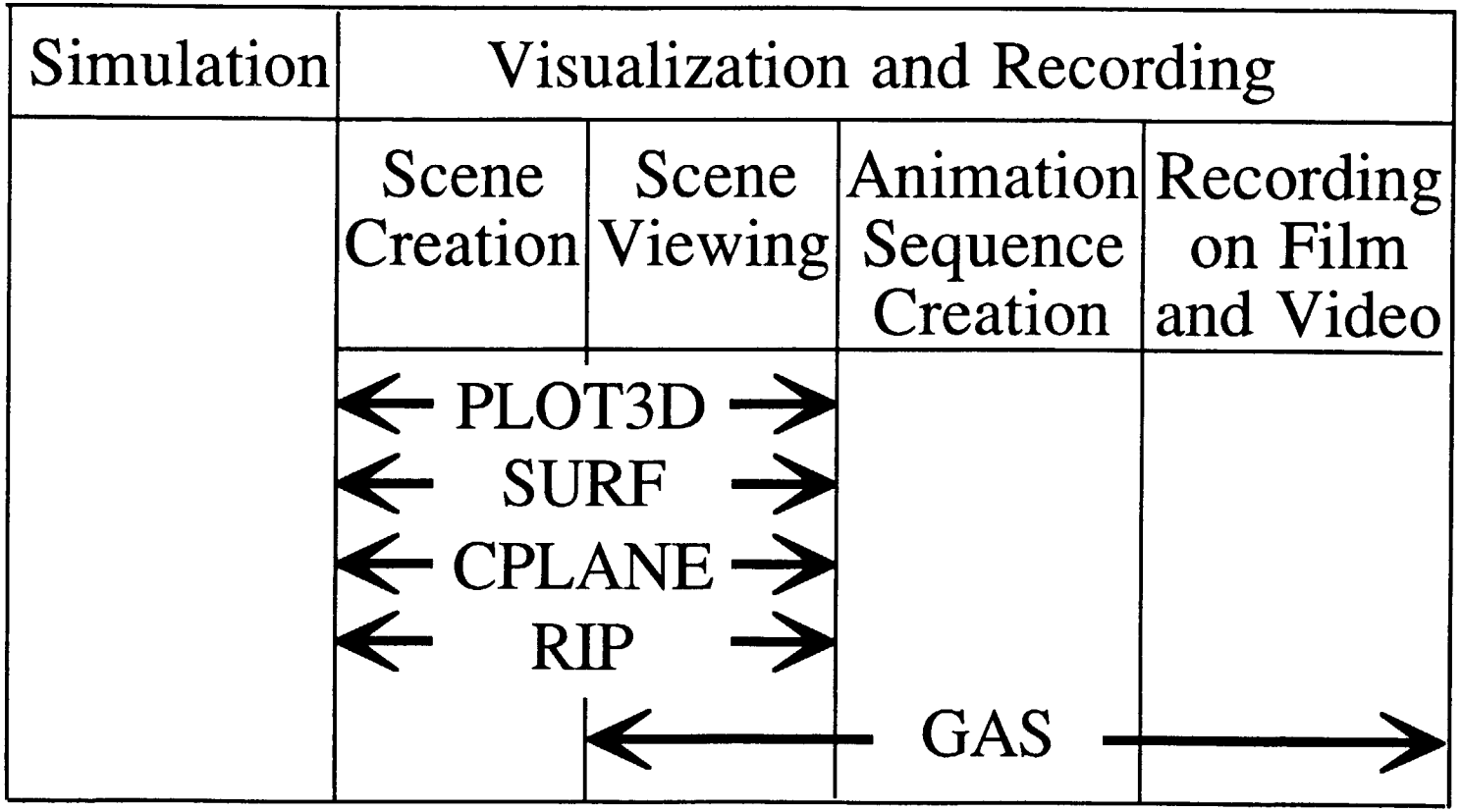
Visualization Hardware



Video Recording System



Software


Simulation
Visualization and Recording
Scene Creation
Scene Viewing
Animation Sequence Creation
Recording on Film and Video
PLOT3D
SURF
CPLANE
RIP
GAS

Current Capabilites in Visualization

Interactive viewing with workstations

- Dynamic illustration of wire frame objects
- Dynamic illustration of simple solid objects
- Static illustration of complex solid objects

Playback viewing with video or film

- Dynamic illustration of complex solid objects

Upgrades in Workstations Planned this Year

Basic Workstation features

Central processor	from 2600 to 2000 Dhrystones
Arith processor	from 0.1 to 6.0 MFLOPS
Primary memory	from 4 to 32 MBytes
Secondary mem.	from 474 to 1000 MBytes

Graphics Features

3D coord. transf.	from 80K to 800K coord./sec
Solids rendering	from 0.5K to 100K polygons/sec

(= 10,000 polygons at 10 frames/sec)

Upgrades in Software Planned this Year

Combination of old modules into a single program

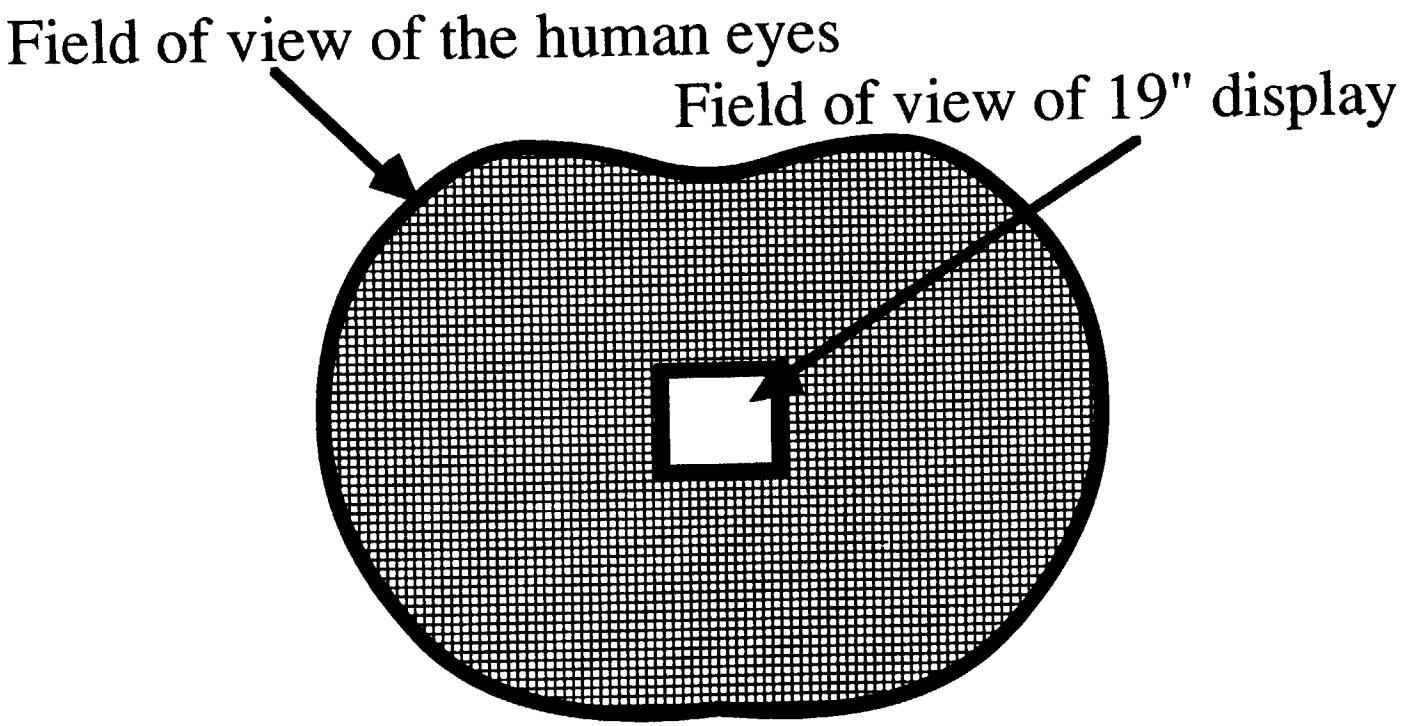
Changes to take advantage of new workstations

Changes to make visualization more interactive

Comparison of Current Capabilities with "Ideal" for Vision

Feature	Current	"Ideal"
spatial res.	1 minute of arc	of the same order
color res.	16 million colors	of the same order
freq. resp.	(scene dependent)	15 frames/sec
field of view	1/5 steradian	5 steradians

Comparison of the Ideal vs Current Field of View



Comparison of Current Capabilities with "Ideal" for Interactive Control

Current

mouse and keyboard

"Ideal"

6-degree of freedom control
voice recognition

Potential for Improvements in Software

Tools for extraction of critical features

Tools for highlighting critical features and suppressing less important features

CONCLUSIONS

The NAS decision to invest in visualization tools has been justified by improved analysis capabilities

The most effective use of vis. tools is the *routine* interactive viewing of solutions *and techniques*

Current workstations permit interactive viewing of the flows over simple shapes

Workstations to be procurred should permit interactive viewing of flows over complex shapes

CONCLUSIONS (continued)

A new generation of software is being developed
- to take advantage of new workstation capabilties
- to make the visual analysis more interactive

The most critical task is overcoming visual clutter
- developing techniques to extract the "essence"
- developing techniques to illustrate the "essence"

We are a long way from utilizing our present visualization tools completely

For Further Information

NAS procurement for the new workstations

Rosemary Buchanan
Mail Stop 258-6
NASA Ames Research Center
Moffett field, CA 94035
(415) 694-4610

Scientific visualization materials

Stanford report on automated feature extraction
1988 CFD Highlights video
Stereo slides

Pat Mumford Elson
Mail Stop 258-2
NASA Ames Reseach Center
Moffett Field, CA 94035
(415) 694-4463