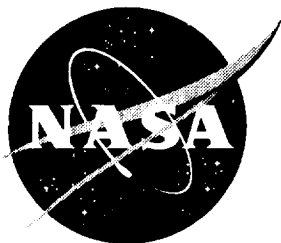


005034

NASA Technical Memorandum 110294



User's Guide for Flight Simulation Data Visualization Workstation

Joseph A. Kaplan and Ronnie Chen
Langley Research Center
Hampton, Virginia

Patrick S. Kenney, Christopher M. Koval, and Brian K. Hutchinson
UNISYS Corporation
Hampton, Virginia

November 1996

National Aeronautics and
Space Administration
Langley Research Center
Hampton, Virginia 23681-0001

Abstract

Today's modern flight simulation research produces vast amounts of time sensitive data. The meaning of this data can be difficult to assess while in its raw format. Therefore, a method of breaking the data down and presenting it to the user in a graphical format is necessary. Simulation Graphics (SimGraph) is intended as a data visualization software package that will incorporate simulation data into a variety of animated graphical displays for easy interpretation by the simulation researcher. This document is intended as an end user's guide.

Table of Contents

1.0 - Introduction	1
2.0 - User Interface	2
Connection Established	2
Replay	6
Graphic Objects	9
Strip Chart	9
Mode Indicator	10
GL 3D View	11
X Window System 3D View	12
Heads-Up Display	13
Out of the Cockpit View	14
3.0 - Conclusions	15
References	16

Table of Figures

Figure 1 - Communication Selection Window	2
Figure 2 - Main Option Window	3
Figure 3 - Save Data Window	3
Figure 4 - Open Graphic Objects Window	3
Figure 5 - HUD Selection Window	4
Figure 6 - Strip Chart Selection Window	4
Figure 7 - Close Graphic Objects Window	5
Figure 8 - User Configuration Window	5
Figure 9 - Replay File Selection Window	6
Figure 10 - Replay Control Window	7
Figure 11 - Open Graphic Object Box	7
Figure 12 - Close Graphic Object Box	8
Figure 13 - Strip Chart Graphic Object	9
Figure 14 - Mode Indicator Graphic Object	10
Figure 15 - SGI GL 3D View Graphic Object	11
Figure 16 - X Window System 3D View Graphic Object	12
Figure 17 - Control Strip for X Window System 3D View	12
Figure 18 - Heads-Up Display Graphic Object	13
Figure 19 - Out of the Cockpit View Graphic Object	14

1.0 - Introduction

Simulation Graphics (SimGraph) is intended as a data visualization tool for researchers who use the Flight Simulation Facilities of NASA Langley Research Center. The SimGraph program is designed to allow the researchers to view their data from the flight simulation environment using several different types of displays, including Heads-Up Displays (HUDs), 3D views, out of the cockpit views, strip charts, and mode indicators. SimGraph is written in object-oriented C++ to allow for additional graphical displays to be added. SimGraph executes using a variety of communication options, including Internet Domain Sockets, UNIX Domain Sockets, and the Advanced Real-Time Simulation System (ARTSS)¹. SimGraph is designed to be platform independent. It is configured to allow researchers to use it for simulations running in either real-time or batch mode on their choice of workstations.

2.0 - User Interface

The Graphical User Interface for SimGraph is easy to use. The first window that is presented to the user is the Communication Selection Window (Figure 1). This window allows the user to select the method of communication between SimGraph and the simulation program. When the user selects a method, the window disappears.

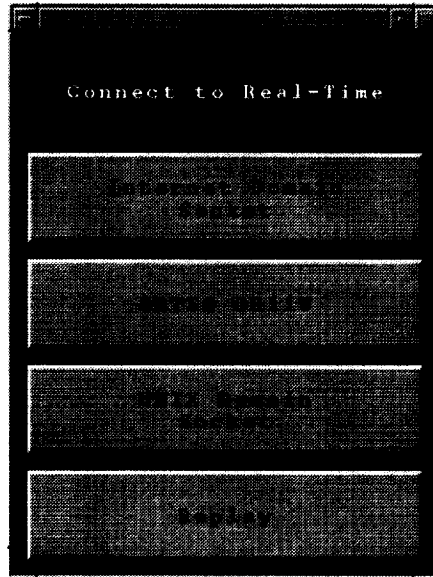


Figure 1 - Communication Selection Window

Connection Established

If the user selects Internet Domain Socket, ARTSS DR11W, or UNIX Domain Socket from the Communication Selection Window, the Main Option Window in Figure 2 will be shown. This window allows the user to save data, open Graphic Objects, close Graphic Objects, load (or save) User Configurations, and quit the program. This window stays on the screen for the duration of the SimGraph program.

The Save Data Button allows the user to access the Save Data Window (Figure 3). This window enabling the user to begin saving data to a file. The user is prompted for a filename and all data received after this point is saved to the specified file. It is recommended that the user append the suffix, ".data", to the filename. If the user is already saving data, then the user may cancel the saving of data by selecting the button labeled "Don't Save Data."

The Open Graphic Objects Button, if selected, presents the user with the Open Graphic Objects Window (Figure 4). The Open Graphic Objects Window is the only method for the user to select Graphic Objects to be presented to them. This window will change depending upon what Graphic Objects are available to the user.

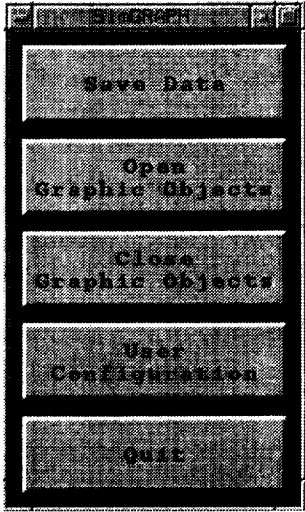


Figure 2 - Main Option Window

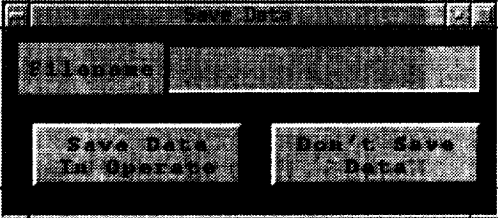


Figure 3 - Save Data Window

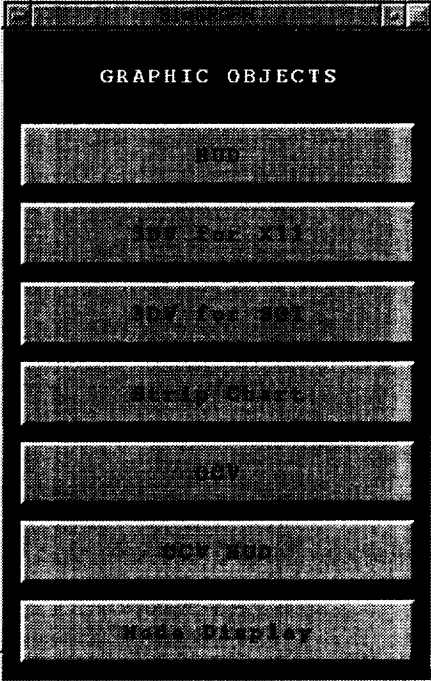


Figure 4 - Open Graphic Objects Window

Depending upon which Graphic Object is selected from the Open Graphic Objects Window, different actions occur. If a Graphic Object is selected that depends upon the number of vehicles in the simulation, a window similar to the HUD Selection Window (Figure 5) is presented to the user. In the case of Figure 5, the simulation has two vehicles in it. If there were four vehicles in the simulation, the HUD Selection Window would present the user with four Buttons, HUDs for vehicles one through four. If the Graphic Object does not show an individual vehicle status but instead presents information about the entire simulation, such as the Mode Display, then pressing the button on the Open Graphic Objects Window would cause that Graphic Object to be created. The only Graphic Object at the present time that does not follow these two examples is the Strip Chart Graphic Object. The names and number of the Strip Charts are sent over from the simulation program. Selecting the Strip Chart Button causes SimGraph to present the user with the Strip Chart Selection Window (Figure 6). The window that the user selects from (i.e., the HUD Selection Window or the Open Graphic Objects Window) disappears after a button is pressed.

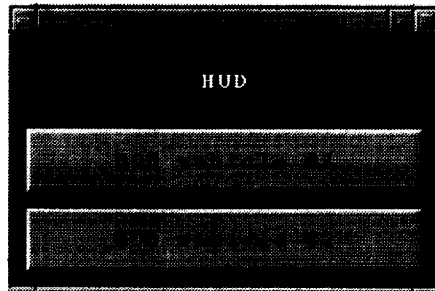


Figure 5 - HUD Selection Window

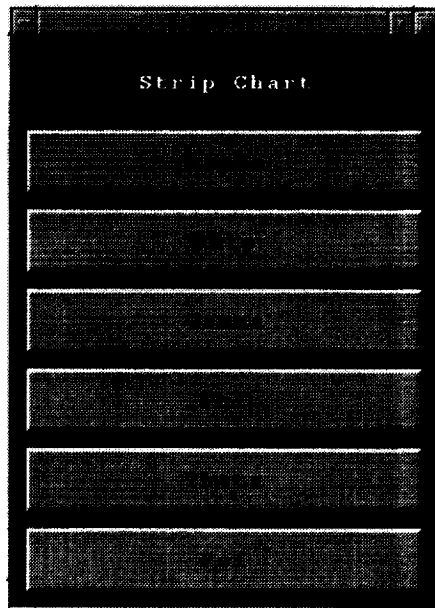


Figure 6 - Strip Chart Selection Window

The Close Graphic Objects Button on the Main Option Window (Figure 2) allows the user to access the Close Graphic Objects Window (Figure 7). The window presents the user with a list of the Graphic Objects that are currently open. The user can select one of the Graphic Objects and then select the Close Object Button. The Graphic Object will be removed from the screen. When the user has finished closing Graphic Objects, selecting the Done Button will close the Close Graphic Objects Window.

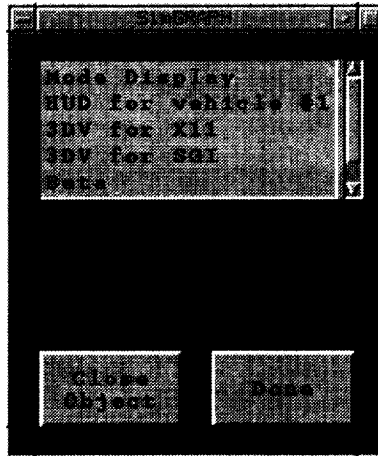


Figure 7 - Close Graphic Objects Window

Selection of the User Configuration option from the Main Option Window (Figure 2) causes the User Configuration Window (Figure 8) to be presented to the user. This window allows the user to save and load configuration files. These configuration files consist of the Graphic Objects that are open and their position on the screen. When a configuration file is opened, all of the currently opened Graphic Objects are closed. The Graphic Objects in the configuration file are then opened and positioned on the screen.

By convention, the suffix of “.config” is added to name of the configuration. There is the possibility that a configuration file will refuse to be opened if the current number of vehicles or strip charts does not equal the number in the configuration file. This is done to prevent SimGraph from requesting data from vehicles that do not exist.

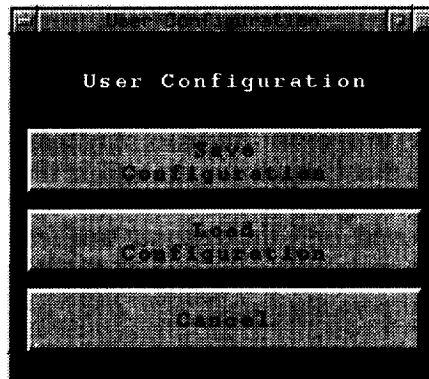


Figure 8 - User Configuration Window

Replay

The **Replay Button** on the **Communication Selection Window** (Figure 1) allows the user to examine data from a previous SimGraph session. The data may be viewed either forward or backward at various speeds. All the information for the displays is loaded from a data file instead of being transmitted from the simulation program.

If the user selects the **Replay Button** from the **Communication Selection Window** (Figure 1), the **Replay File Selection Window** will be displayed (Figure 9). The user may now select a data file to open. After the user selects a data file the program replaces the normal menu system with the **Replay Control Window** (Figure 10).

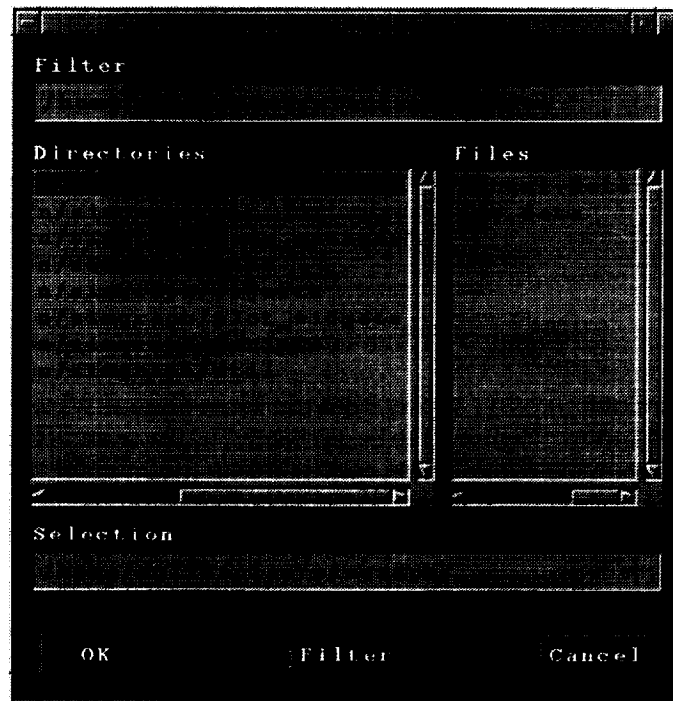


Figure 9 - Replay File Selection Window

If the user would like to open **Graphic Objects** to be viewed during the replay, the **Open Button** on the **Replay Control Window** must be selected. Activating the **Open** push-button causes the **Open Graphic Object Box** (Figure 11) to appear. The user may then select a **Graphic Object** and press the **Open Object Button** to have that **Graphic Object** appear on the screen. Only those **Graphic Objects** being viewed during the original session will be available to the user during replay. If an object is created and then destroyed, only the data that was sent from the real-time program for that period of time between creation and destruction will be available to the user during replay.

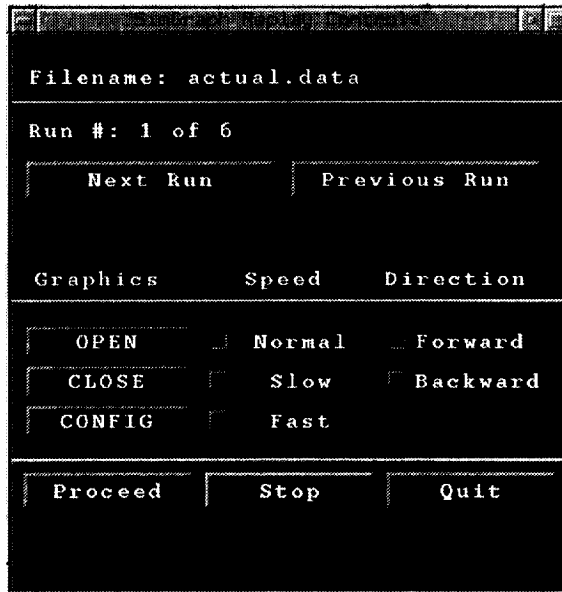


Figure 10 - Replay Control Window

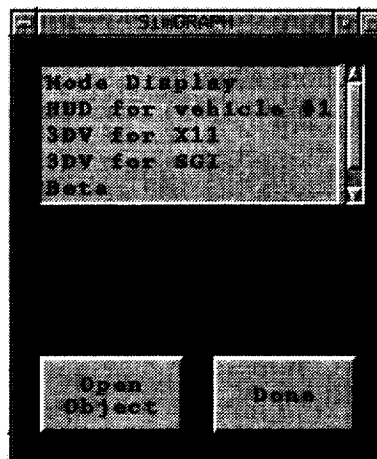


Figure 11 - Open Graphic Object Box

If the user would like to close a Graphic Object that is currently open during the replay session, the Close Button on the Replay Control Window must be selected. Activating the Close Button causes the Close Graphic Object Box (Figure 12) to appear. The Graphic Objects that are currently open will be shown in the scrollable list area. The user may select one of the objects and press the Close Object push-button to remove the Graphic Object from the screen.

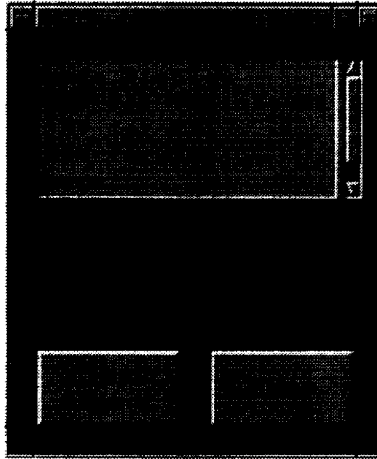


Figure 12 - Close Graphic Object Box

If the Config Button (Figure 10) is selected, the User Configuration Window (Figure 8) will be displayed. The remaining buttons on the Replay Control Window dictate how the data is to be replayed. If Slow is selected, the data will update approximately twice a second. If Normal is selected, the data will update approximately ten times a second. If Fast is selected, the data will update approximately twenty times a second. The next panel of buttons is used to indicate replay direction. Forward and Backward allow the user to move through the data in the selected directions. The bottom panel of buttons allow the user to begin playing data (Proceed), halt the playing of data (Stop), and exit SimGraph (Quit). The currently selected option will be highlighted in red.

Graphic Objects

Strip Chart

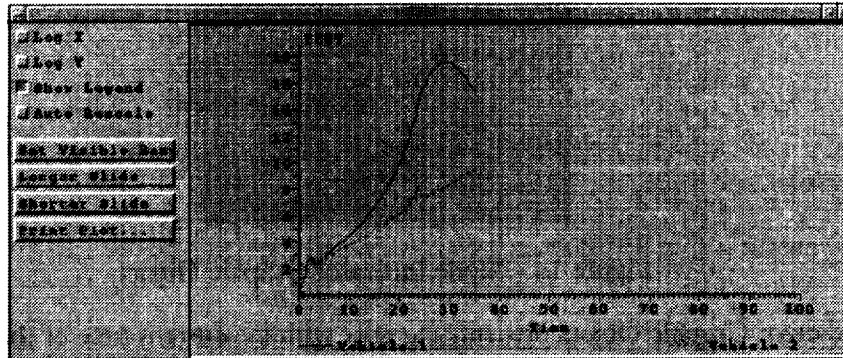


Figure 13 - Strip Chart Graphic Object

The Strip Chart Graphic Object was designed to plot data from the simulation program. This Graphic Object will plot data on its drawing area, updating that plot whenever new data arrives. The Strip Chart object is also capable of displaying multiple plots of data on the same drawing area. Each plot can be drawn with a distinctive line pattern to differentiate the separate plots. The main widget used for this Strip Chart Graphic Object was provided by Fermi National Laboratory.

The Log X and Log Y buttons allow the user to change the scale on the axis from linear to log based. The Show Legend Button will hide or reveal the legend at the bottom of the plot. The Auto Rescale Button changes the scaling function for the plot. If it is on (i.e., depressed), then the plot will show all of the data points. If it is off, then only the last 100 elements will be shown. It is recommended that this only be toggled during Reset and that this feature remain on during replay.

The Set Visible Range Button allows the user to look at whatever range and domain of the data that is desired. The Longer and Shorter Slide buttons are only applicable if the Auto Scale Button is off. The plot will only show the last 100 elements unless these buttons are selected. The Longer Slide Button increases the number of elements by ten while the Shorter Slide button decreases the number by ten. The Print Plot Button makes a Postscript file of the plot.

Mode Indicator



Figure 14 - Mode Indicator Graphic Object

The Mode Indicator Graphic Object presents the user with the current time of the simulation run, the mode of the simulation, and the number of vehicles currently in the simulation. The mode the simulation is in is indicated by a red box. In Figure 14, the simulation is in Operate.

GL 3D View

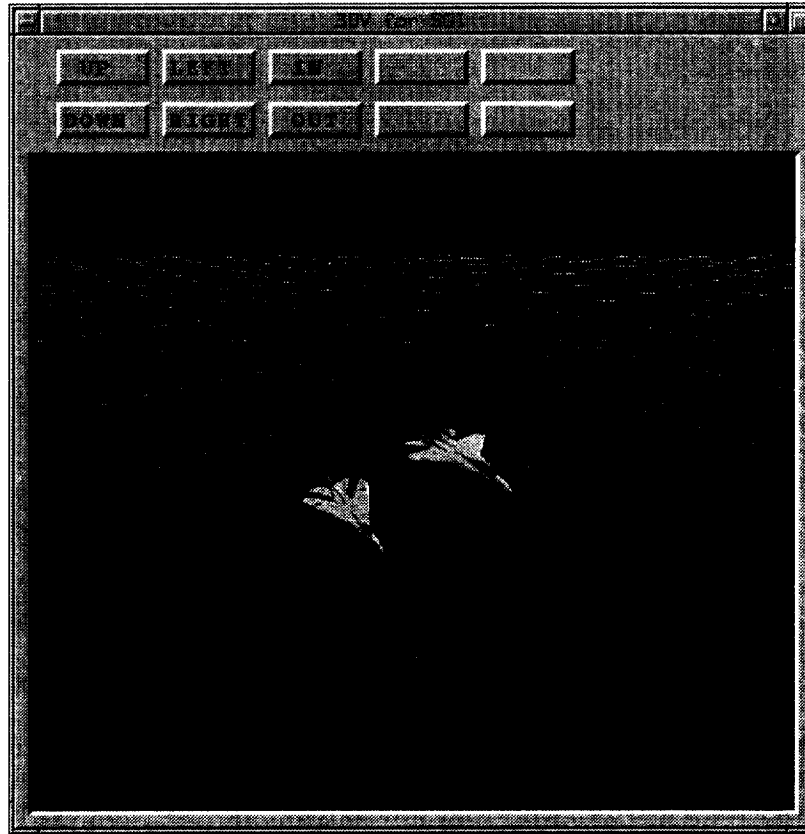


Figure 15 - SGI GL 3D View Graphic Object

The SGI GL 3D View Graphic Object plots the position of the simulated aircraft in the correct orientation and then allows the user to move the viewpoint that looks at these aircraft in space. GL is a Graphics Language that works only on Silicon Graphics, Incorporated, computers³. By moving the viewpoint, the user can gain new insight into what is actually occurring inside the simulation. The software for this display was originally taken from the VISION software package².

X Window System 3D View

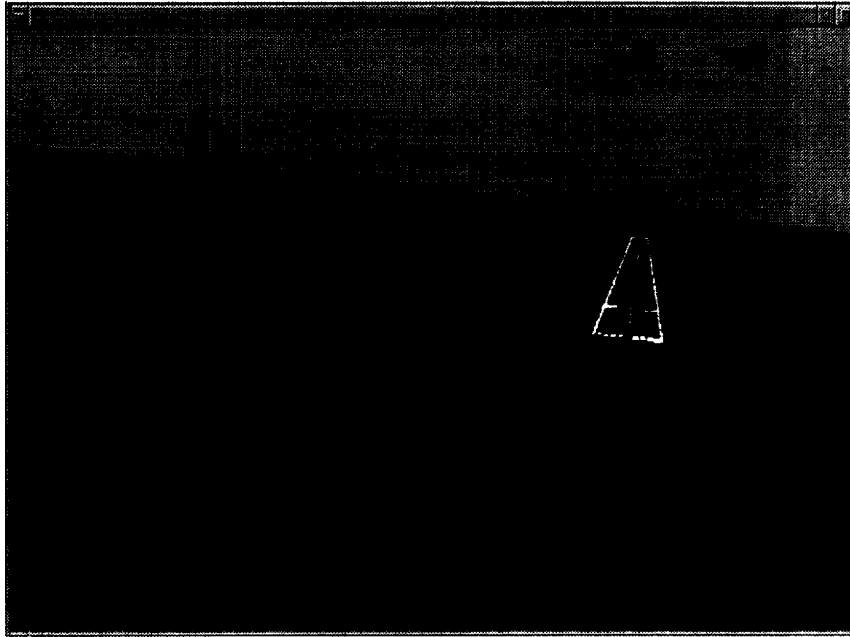


Figure 16 - X Window System 3D View Graphic Object

The X Window System 3D View Graphic Object was designed as an alternative for the SGI GL 3D View Graphic Object. The 3D View Graphic Object plots the position of the simulated aircraft in the correct orientation and then allows the user to move the viewpoint that looks at these aircraft in space. By moving the viewpoint, the user can gain new insight into what is actually occurring inside the simulation. The Vlib graphics library was used in this Graphic Object⁵.

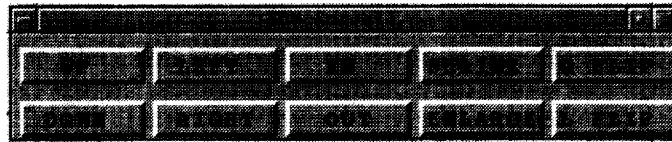


Figure 17 - Control Strip for X Window System 3D View

Most of the buttons for the Control Strip (Figure 17) are self-explanatory. The Shrink Button brings the aircraft closer together while the Expand Button does the opposite. The G Flip Button toggles a Grid off and on. The Grid is very computationally expensive and is turned off by default. The L Flip Button toggles off and on lines that are plotted from the aircraft to the ground.

Heads-Up Display

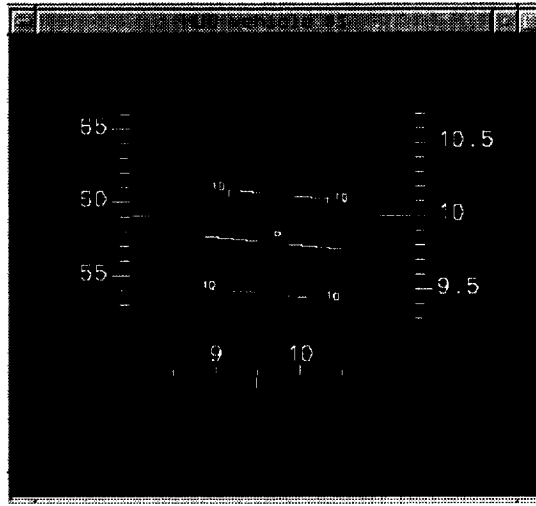


Figure 18 - Heads-Up Display Graphic Object

The Heads-Up Display (HUD) Graphic Object displays a representative view of the pilot's HUD. HUDs typically give information about the current state of the vehicle, such as heading, pitch, roll, altitude, and velocity. Additional information, such as weapon status, fuel state, and rates of closure to other aircraft, is sometimes included and can easily be added to the HUD Graphic Object. The Vlib graphics library was used in this Graphic Object⁵.

Out of the Cockpit View

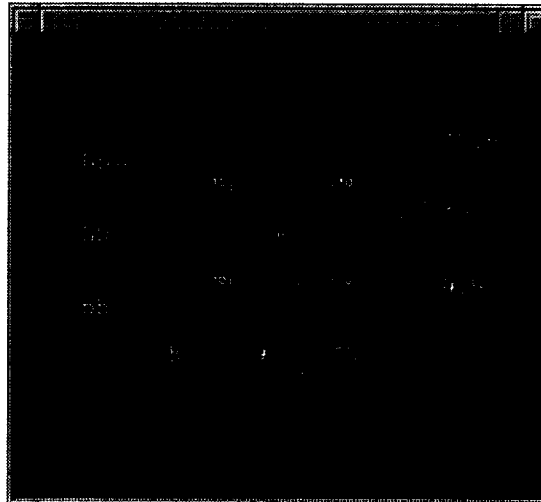


Figure 19 - Out of the Cockpit View Graphic Object

The Out of the Cockpit View (OCV) Graphic Object gives the user a representative view of what the pilot is seeing. The OCV Graphic Object plots the locations of the simulated vehicles and positions the eyepoint at one of these locations. The resulting view is then shown. Two separate OCV Graphic Objects are available. The Graphic Object shown in Figure 19 is the OCV-HUD Graphic Object. This object has this name because a Heads-Up Display is superimposed upon the Out of the Cockpit View. An additional OCV Graphic Object is available without the HUD and it is referred to as the OCV Graphic Object. The Vlib graphics library was used in this Graphic Object⁵.

3.0 - Conclusions

The increasing complexity of modern flight simulation has created the need for tools to aid in the visualization of the tremendous amount of data that is produced. SimGraph was created not only to simplify data interpretation but also to allow the users to adapt it to suit the requirements of their research. The modular design of the program allows the user to pick and choose from a library of graphical displays that will meet the needs of the research being conducted. This document should provide sufficient help to the user in understanding how to interact with the system.

References

1. Cleveland, Jeff I., II; Sudik, Steven J.; Grove, Randall D.: "High Performance Flight Simulation as NASA Langley", AIAA 92-4179, in AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, South Carolina, August 24-26, 1992, Technical Papers, Pages 313-319.
2. Dare, A., Burley, J.: "Pilot/Vehicle Display Development From Simulation To Flight", AIAA 92-4174. AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, South Carolina, August 24-26, 1992.
3. O'Reilly, Tim; Nye, Adrian: X Toolkit Intrinsic Programming Manual, Motif Edition, Volume 4, November 1992.
4. OpenGL Architecture Review Board: OpenGL Programming Guide The Official Guide to Learning OpenGL, Release 1. Reading, Massachusetts, 1993.
5. Riley Rainey, ACM Version 4.3 The Aerial Combat Simulation for X11, February, 1994.



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE November 1996	3. REPORT TYPE AND DATES COVERED Technical Memorandum	
4. TITLE AND SUBTITLE User's Guide for Flight Simulation Data Visualization Workstation			5. FUNDING NUMBERS	
6. AUTHOR(S) Joseph A. Kaplan, Ronnie Chen, Patrick S. Kenney, Christopher M. Koval, and Brian K. Hutchinson				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) NASA Langley Research Center Hampton, VA 23681-0001			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Aeronautics and Space Administration Washington, DC 20546-0001			10. SPONSORING / MONITORING AGENCY REPORT NUMBER NASA TM-110294	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Unclassified-Unlimited Subject Category 61			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Today's modern flight simulation research produces vast amounts of time sensitive data. The meaning of this data can be difficult to assess while in its raw format. Therefore, a method of breaking the data down and presenting it to the user in a graphical format is necessary. Simulation Graphics (SimGraph) is intended as a data visualization software package that will incorporate simulation data into a variety of animated graphical displays for easy interpretation by the simulation researcher. This document is intended as an end user's guide.				
14. SUBJECT TERMS Heads-Up Display, Out of the Cockpit View			15. NUMBER OF PAGES 19	
			16. PRICE CODE A03	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT	