Environment For Three Dimensional Graphics User Interface Development

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Abstract

Graphics User Interface(GUI) serves as a link between the end user of an application and the application itself. Run time GUI is characterized by its look-and-feel and interaction style. Characteristics of a run time GUI system depends on the particular GUI building tool used and its underlying architecture. Current implementation of GUI are in two-dimensions(2D) and the trend is to extend GUI into three-dimensions(3D) in order to provide a natural interface for applications in 3D. It is expected that 3D specific GUI builder will become available when methodology for automating 3D GUI building process for a large class of 3D application is better understood. Until then, it is proposed that a 3D development and debugging environment should be available for building such interfaces for individual application as required. This paper describes the overall framework and some details that enables the building of 3D GUI.

Keycodes: D.1.7; D.2.5; I.3.2

Keywords: Visual Programming Language, Problem Analysis Diagram, Computer Aided Diagram, Visual Programming Environment, Graphics Kernal System, XLIB, Graphics User Interface

1. Introduction

Progress in the area of visual languages[1,2] for different applications have been reported and in turn motivated a visual programming environment(VPE)[3] that is specially architected to support the development and debugging of graphics applications.

The VPE can be considered as a lower CASE tool and is therefore suitable in developing applications[4] in which the software architecture is already specified. The VPE can also be applied to implement the Xlib part of the X Window System which is a network-transparent window based graphics system. As the Xt Intrinsic defines an architectural model for widget, GUI run time system such as Motif[5] can also be implemented by the VPE. It should be noted that although the Motif widget set is 3D in appearance, the contents of icon objects are not truly 3D. The need for rapid prototyping of GUI is reflected both in the area of research[6] and in the area of products[7]. However, existing User Interface methodology and tools can not adequately meet User Interface requirement of a 3D nature[8]. Until rapid prototyping for 3D GUI becomes mature, it is envisaged that complex 3D User Interface architecture will have to be derived through specification obtained by formal methods. The subsequent specification that yields the corresponding architecture can then be implemented in VPE and the appropriate use of functions in GKS-3D[9].

2. The VPE: the visual programming language(VPL)

The VPE is a visual programming environment that separates 'C' source code procedure into three parts. These three parts are the "Data Declaration and Initialization" part, the "Control of Flow using Problem Analysis Diagram(PAD)[10]" part and the "Executable Assignment Statements" part, respectively. A subset of the VPL syntax is presented as an extended BNF notation in Appendix 1.

The three parts in the VPL are illustrated in Figures 1, 2 and 3. Figure 1 and 2 illustrate how flow and execution are presented in VPL. It can also be deduced that, from Figures 1 and 2, icons can be inserted and deleted at will to alter the control flow and that there are certain viewing flexibility in the VPL system. Figure 3 is self explanatory by virtue of its contents for data declaration and initialization.

It is advantages to use VPL instead of representing a program procedure in terms of a piece of flat text when referred to the dimensional analysis proposed by Shu[11]. The visual extent[11] of VPL over a piece of 'C' source code increases the readability and maintainability of the target software. The VPL enforces programmer discipline by imposing structure at the program development stage.

3. The VPE: the debugger for graphics applications

Figures 4, 5, 6 and 7 are four snap shots during the debugging of a simple graphics application. The upper right window is the debugger and the lower left window is the debuggee. It should be noted that the two windows should really have been initiated to larger sizes to cover more of the display surface of the graphics workstation display monitor. The default 'trace' level during debugging is at icon trace level which means that a 'step' command advances execution by one icon. In Figure 5, the lines of code for 'graphics initialization for debuggee', 'clear graphics and text contents in debuggee', 'initialize locator input class with mouse as a physical input device', 'initialize x=y=0' has NOT yet been executed. These four statements will be executed if user types in either 'step<cr>' or simply '<cr>' from keyboard. The visual appearance of Figure 7 indicates that the 'locator position has been defined' and that 'the line positioned between x=y=0 and locator'. It should be noted that the code in Figure 6 would not have been executed if the cross-hair cursor position is not moved to the debuggee window. The sharing of input resources between debugger and debuggee and that the debuggee execution may either be suspended or runnable based on input context has also been reported[12].

Other debugging features include variable trace, execution until breakpoint, etc..

4. Similarity between GKS-2D functionality and Interactive Objects[13]

The Interactive Objects(IO) as proposed by Wood and Gray have three common attributes(visibility, selectability and movability). In the context of GKS-2D, the contents of an Object are OUTPUT PRIMITIVES and the Object itself is a NAMED SEGMENT containing all the output primitives. Visibility and selectability as defined in [13] can then be implemented by GKS-2D segment attribute such as invisible/visible, undetectable/detectable. The movability attribute can be implemented by SEGMENT transform in which translate-x and translate-y are the magnitudes to define distance moved. Additional settable segment attributes are highlighting and priority. Other SEGMENT manipulation capability through the use of segment transform include segment scaling and rotation.

5. An example of IO implementation using GKS-2D

Implementation of IO attributes by GKS-2D functionality is illustrated in Appendix 2. The implementation is in Fortran binding.

Appendix 2a defines the transformation number. All GKS segments(IO) are within this transformation number 10. In the context of GUI, it is useful to have a transformation number for IOs categorized under application and another number for IOs categorized under development tools, etc..

Appendix 2b illustrate how the fourth segment can be created.

Appendix 2c illustrates how a segment can be picked and then subsequently translated if required.

6. Conclusion

Infrastructure for developing 2D IO based on VPE and the suitable use of GKS-2D functions have been presented. Extension of VPE capability to cater for 3D graphics development and debugging requires no more than perspective and parallel projection[14] of 3D data. Such additional capability does not require structural change in the VPE and therefore modification to VPE is straight forward to catering for 3D IO development resulting in an enhanced VPE for 3D application development. The advantage of structural compatibility between 2D run time GUI system and 3D run time GUI system developed using the same methodology is obvious not be overlook in terms of compatibility and maintenance and well as programmer portability.

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Appendix I
A subset of the VPL syntax

The followings are the extended BNF representation for the meta-language of the visual language used on the PAD diagram.

<program>	::=	<declaration file><modules>
<modules>	::=	<module> <module><modules>
<module>	::=	<DDI file><PAD file>
<declaration file>	::=	<structure specifier list><declaration specifier list>
<structure specifier list>	::=	<structure specifier> <structure specifier><structure specifier list>
<structure specifier>	::=	struct <structure identifier>{<structure declaration>;
<structure identifier>	::=	<identifier>
<identifier>	::=	<letter> <identifier><digit> <identifier><letter> <identifier><sy mbol letter>
<letter>	::=	<upper-case letter> <lower-case letter>
<upper-case letter>	::=	A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
<lower-case letter>	::=	a b c d e f g h i j k l m n o p q r s t u v w x y z
<symbol letter>	::=	_ - \$
<digit>	::=	0 1 2 3 4 5 6 7 8 9
<structure declaration list>	::=	<structure declaration> <structure declaration><structure declaration list>
<PAD file>	::=

<icon tree>	::=	<empty>	

<structure declaration> ::= <type specifier><declaration>;

Appendix II

a)

- c all segments defined inside transformation number 10
- c TRANSFORMATION number 10
- c by setting window, setting viewport, select transformation number
 - CALL GSWN (10, 0.0, 10.0, 0.0, 10.0)
 - CALL GSVP (10, 0.0, 1.0, 0.0, 0.72)
 - CALL GSELNT (10)
- c set input priority for transform 10 greater than transform 0
 - CALL GSVPIP (10, 0, 0)
- c set workstation window and workstation viewport
 - CALL GSWKWN (IWKID, 0.0, 1.0, 0.0, 0.72)
 - CALL GSWKVP (IWKID, 0.0, 0.27, 0.0, 0.195)

(b)

- c now create segment for DUCK
 - CALL GCRSG(FOUR)
 - CALL GFA (NUMDUCK, DUCKX, DUCKY)
 - CALL GCLSG

c)

- c PICK any one of the six segments
- c default Prompt & Echo Type is Device Coordinate echo plus pick symbol
- c mouse, {none,ok}, segment, pickid
- 7700 CALL GRQPK (IWKID, IONE, ISTATUS, ISEGMENT, IPKID)
 - IF (ISTATUS .EQ. 0) GOTO 7700
- c TRANSLATE the segment that has been picked (selected)
- c Prompt & Echo Type 12 is World Coordinate digital value plus cross-hair
 - CALL GINLC(IWKID, 1, 10, XINITLC(ISEGMENT), YINITLC(ISEGMENT),
 - 12, 0.0, 0.1, 0.0, 0.1, 0, NULLSTR80)
 - CALL GSLCM (IWKID, 1, 1, 1)
- 7010 NORTRANS = 10
 - CALL GSMLC (IWKID, 1, NORTRANS, XLC, YLC)
 - IF (NORTRANS .NE. 10) GOTO 7010
 - DXLC = XLC - XINITLC(ISEGMENT)
 - DYLC = YLC - YINITLC(ISEGMENT)
 - TM(I,J) = ETM(ISEGMENT,I,J) [I=1,2; J=1,3]
 - CALL GACTM (TM, XINITLC(ISEGMENT), YINITLC(ISEGMENT),
 - DXLC, DYLC, 0.0, 1.0, 1.0, 0, TMO)
 - XINITLC(ISEGMENT) = XLC
 - YINITLC(ISEGMENT) = YLC
 - ETM(ISEGMENT,I,J) = TMO(I,J) [I=1,2; J=1,3]
 - IF (DXLC.NE.0.0 .OR. DYLC.NE.0.0)CALL GSSGT (ISEGMENT, TMO)
 - CALL GESC (100, 1, STR80)
 - IF (STR80(1:1) .EQ. '2' .OR. STR80(2:2) .EQ. '0') GOTO 7010
 - CALL GSLCM (IWKID, 1, 0, 1)
 - CALL GRSGWK (IWKID)

Appendix III

Figure 1. a Problem Analysis Diagram example

Figure 2. a shrunk Problem Analysis Diagram

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cprint
Constant :
PRWIDTH  132
PRHEIGHT 60
TAB_WIDTH 8
NULL     ((char *) 0)
Global :
alien    DQ#DECODE$TIME ();

Local :
int      seg, page, subpage, count, index, except$ptr;
int      width, height, S_continue;
FILE     *fin, *fout, *fopen ();
char     pr_date[9], pr_time[9];

Initial :
width = PRWIDTH
height = PRHEIGHT
S_continue = 0
file[20] = {":gp:"}

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Figure 3. a Data Declaration and Initialization example

Figure 4. Initializing Debugger and Debuggee

Figure 5. single stepping debugging

Figure 6. graphics application debugging

Figure 7. sharing of debugger/debuggee input resource