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Lecture notes, computer graphics (F07) (Foley 7, SPHIGS)

SPHIGS concepts and overview
Will describe SPHIGS/SRGP:

Hand-out about SRGP/SPHIGS
But use the textbook (chapters 6,7) as well.

SRGP - SPHIGS contrasted:

SRGP - immediate mode, pixel manipulation 2D screen coordinate system.
SPHIGS - retained mode (CSS), 3D floating point, 3D viewing pipeline.
database of structures. (user can edit, it is SPHIGS' job to make sure that the screen shows what's in the database).

Master/instance (Sketchpad)

Structure: a sequence of elements: primitives, attributes. transf. matrices, substructures
Traversal: computation of a new view of the model, should be rapid

Is the CSS necessary or sufficient: not nec: the application can do the work
not suff: still need an application model
retained mode does not pay off if data is changed.
# of elements to edit should be small compared to the total # of elements.

1/ Open a SPHIGS workstation
2/ Creating a description of the model: (primitives, attributes -> structures, CSS)
3/ Link the model to the description (post)
4/ Tell the workstation to display the model (update)

Software structure:
include file: sphigs.h.
Defines all constants, data types & functions.

Naming conventions:
Functions begin SPH_

Important datatypes:
point: double [3]
matrix: double[4][4]

Note: different from book (which is Pascalish)

System states (7.3.1, SPHIGS 1)
Init/exit:
SPHIGS is always in exactly one of: 1) disabled, 2) enabled with no open structure,
3) enabled with an open structure.
SPH_begin(width, height, planecount, shadecount) - opens a window
SPH_end(void) - closes the window

Screen regeneration:
```
SPH_setImplicitRegenerationMode( int mode )  /* SUPPRESSED / ALLOWED */
SPH_regenerateScreen( void );
SPH_setDoubleBufferingFlag( int new_value );  /* 0 / 1 */
```

The structure database (SPHIGS 2.2)
SPH_openStructure(int) like open a file
SPH_closeStructure(); like close a file

SPH_setElementPointer(int)
SPH_offsetElementPointer(int)
SPH_moveElementPointerToLabel(int)
SPH_inquireElementPointer(void)

SPH_label(int)

SPH_deleteElement(void)
SPH_deleteElementsInRange(int, int)
SPH_deleteElementsBetweenLabels(int,int)

SPH_copyStructure();

Primitives and their attributes (7.3.2, SPHIGS 5.1-5.5)
Fewer than SRGP (different packages for different needs):
SPH_polyLine(int count, point *points)
SPH_polyMarker(int count, point *points)
SPH_fillArea(int count, point *points)
SPH_text(point, char *)
SPH_polyhedron(int vertexcount, int facetcount, point *vertices, vertexIndices *facets);
describe! facets must be convex
there's no check that fillarea, facets in polyhedrons are planar
One set of attributes per primitive: linestyle, linewidth, color
interiorcolor, edgecolor, edgestyle, edgeflag, width
text font, text color (SRGP_loadFont(int, char *name))

Modelling (7.4, SPHIGS 3.3)
Creation of objects in their own local coord. system & transforming them to the WC.
position/scale/rotate
SPH_set*Modeling*Transformation(); ASSIGN/PRECONCATENATE/POSTCONCAT
If several are composed at traversal time: slow:
use SPH_composeMatrix(mat1, mat2, resultmat) to move to specification time

Note: SPH_scale/ SPH_composeMatrix is *not* defined as in book.

House()
SPH_setModelling()
House()
SPH_setModelling()

Structures House, Window, Chimney, Door:
And if the House consists of windows, doors, each can be defined in its local system. In House you can select a local trans matrix for each window. The 2 local transformations are automatically concatenated.

Viewing transformation (7.3.4, SPHIGS 3.2)
Once the model is assembled we want to look at it.
Structures are shown by SPH_postRoot(int structureID, int viewIndex) (diff from PHIGS)

Viewing volume:
(0,0,0) unit cube - by default from positive Z

View table:
0: default
SPH_evaluateViewOrientationMatrix()
SPH_evaluateViewMappingMatrix()
SPH_setViewRepresentation()

Structures & Traversal (7.3.3, SPHIGS 2.1)

Traversal when the application changes the database (or SPH_regenerateScreen):
1/ an entry in the view table is changed
2/ a structure is closed
3/ a structure is deleted
4/ a structure is posted/unposted

A structure must be linked to the workstation:
SPH_postRoot(strucID, viewindex);
SPH_unpostRoot(strucID, viewindex);
SPH_UnpostAllRoots();

Colour & Shading (SPHIGS 4, 5.6)
only indirect: SPH_loadCommonColor
colour names in '/usr/lib/X11/rgb.txt' (/opt/SUNWxt/v2.0/rgb.txt')
3rd parameter to SPH_begin & hardware determines

Rendering modes: WIREFRAME_RAW, WIREFRAME, FLAT, LIT_FLAT,
GOURAUD
SPH_setRenderingMode(int view, int mode)

RAW_WIREFRAME: no hidden surface/clipping.
WIREFRAME (default): clipping/hidden surface but only edges
LIT_FLAT: surfaces as filled polygons.

SPH_setViewRenderAlgorithm(int view, int algorithm) RENDER_PAINTERS/BSP

Name sets, filters, and input (2.2, 7.10, SPHIGS 6-7)
SPH_addToNameSet(int) - local to current (and children)
SPH_addToInvisFilter(name) - filter (a set of names) controls visibility.
SPH_removeFromInvisFilter(name)

Input mode: as SRGP

View index number also used for priority.

Pick correlation:
An object rather than a position
SPH_setPickIdentifier
In PHIGS there is also a pick filter

Differences PHIGS/SPHIGS:
1/ Bundled attributes in PHIGS:
previous - only individual attribute settings.

Separate bundle tables on each workstation line/int/edge/text/marker
cf. colour index
Aspect source flags: PASF_BUNDLED PASF_INDIV (def. unknown)

predefined bundles exist

pset_line/int/edge/text/marker_ind( )
pset_line/int/edge/text.marker_rep(_plus) - workstation specific

2/ text in SPHIGS is always horizontal.

text vs. annotation text (displayed in the plane of the screen)

3/ Colour
colour type (RGB, HLS,etc.) and value
pset_line/int/edge/text/marker_colr
indirect: (colour index) PINDIRECT pset_line/int/edge/text/marker_colr_ind

pset_colr_rep() -> set an index

(functions with a ws identitifer or error ind. does not create structure elements, others to

4/ Hidden surfaces, etc.
Ensure that only unobscured portions of primitives are drawn
Performed as the primitive is drawn *after* transformation

pset_hlhsr_mode (ws, mode)
PHIGS_HLHSR_MODE_NONE/ZBUFF/PAINTERS/SCANLINE
pset_hlhsr_mode(mode); structure elem

Examples:

house.cc, colhouse.cc (/home/grafik/

Exercise (hints, potential problems):

Purpose: learn about transformations (modelling, viewing)

- Don't spend a lot of time constructing a beautiful car (cars are so small they are barely visible)
- Colour index 1 reserved!
- Angle in degrees!
- SPH_setMaxStructureID(MY_MAX_STRUCTURE_ID); // about 300 needed !!!
- There's a difference between { (0,0,0), (4,5,6), (4,5,6) } and { {0,0,0}, {4,5,6}, {4,5,6} }
- Fill areas and polyhedron faces must be convex!