2011 INTRODUCTION TO GRAPHICS NOTES

ADDITIONAL NOTES AND EXERCISES

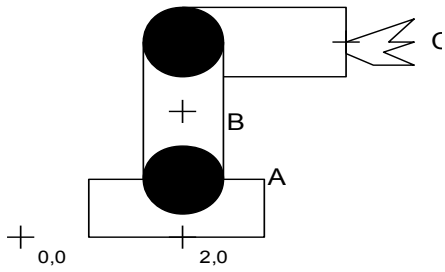
JAN KAUTZ

DEPARTMENT OF COMPUTER SCIENCE, UNIVERSITY COLLEGE LONDON

LECTURE 7: SCENEGRAPHS

RENDERING TRAVERSE

Lets look at an explicit example of a rendering traverse for the robot arm.



In this case, the Base is translated by 2,0 relative to world coordinates. So the matrix B is

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 0 & 1 \end{pmatrix}$$

The point A on the base, is the point (1.5,0) in local coordinates. So its position in world coordinates is (3.5,0).
The point B is on the upper arm of the robot. Its position in local coordinates is (0.5,0) (note where the centre of the upper arm is). To get the position in WC we use the matrix USB

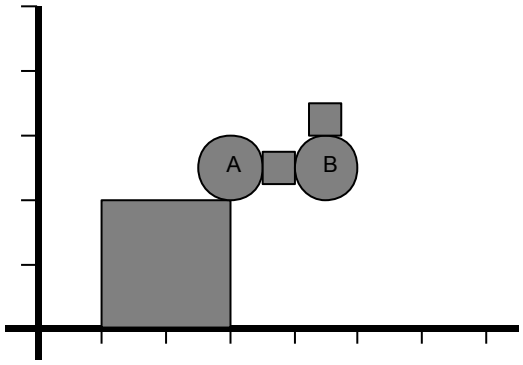
$$\begin{pmatrix} 0.5 & 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 3 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 2.5 & 4 & 1 \end{pmatrix}$$

The point C is on the hand of the robot. Its position in local coordinates is (0,1) (note where the centre of the hand is and also that in local coordinates the fingers point upwards, but the hand has been rotated by a matrix above it in the scene graph). To get the position in WC we use the matrix HFEUSB. Note that the matrix L is a translation then a rotation.

$$\begin{pmatrix} 0 & 1 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 2 & 1 \end{pmatrix}\left(\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 2 & 1 \end{pmatrix}\begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}\right)\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 3 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 3 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 1 \end{pmatrix}\begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 6 & 7 & 1 \end{pmatrix} = \begin{pmatrix} 7 & 7 & 1 \end{pmatrix}$$

EXERCISES

1. Describe a scene graph with transformations for the following scene. Assume that the only drawing primitive are a unit square and a unit circle:



Where have you placed local co-ordinates for each part the diagram? Why did you do this? What would you change if the Circle A had to pivot around the top-right of the biggest square?

2. Describe the following figures as a CAG: the first using only circles at the leaves, the second using only squares and triangles, the third using squares and circles and the fourth using only half-circles.