3D Wireframe Modelling

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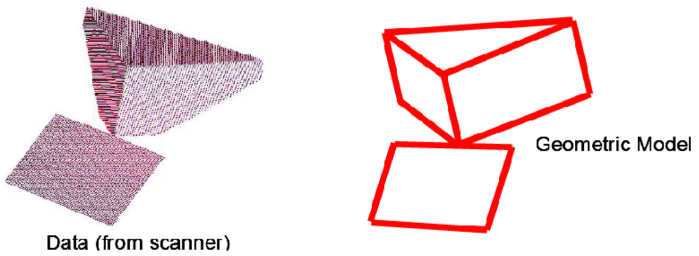
3D Geometric Modelling

Goal: model 3D objects for recognition



Recognition requires some sort of model
Easier matching if data and model use same representations

3D Coordinate Systems

Like 2D systems: for modelling and object pose

Need rotation and translation specification
Translation easy - 3D vector $\vec{t} = (t_x, t_y, t_z)'$

Rotation needs 3 values. Many different coding systems.

Altogether, 6 degrees of freedom = 6 position parameters.

Typical Rotation Specification

Arbitrary angle order, so specify rotation as:

$$\mathrm{R} = \mathrm{R}_x(\theta_x)\mathrm{R}_y(\theta_y)\mathrm{R}_z(\theta_z)$$

Where

$$\mathrm{R}_x(\theta_x) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & cos(\theta_x) & -sin(\theta_x) \\ 0 & sin(\theta_x) & cos(\theta_x) \end{bmatrix}$$

$$\mathrm{R}_y(\theta_y) = \begin{bmatrix} cos(\theta_y) & 0 & sin(\theta_y) \\ 0 & 1 & 0 \\ -sin(\theta_y) & 0 & cos(\theta_y) \end{bmatrix}$$

$$R_z(\theta_z) = \begin{bmatrix} cos(\theta_z) & -sin(\theta_z) & 0 \\ sin(\theta_z) & cos(\theta_z) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Rotation parameters are: $\{\theta_x, \theta_y, \theta_z\}$
Here, we used a right-hand coordinate system. A positive rotation is defined as clockwise when you look along the rotation axis starting from the origin.

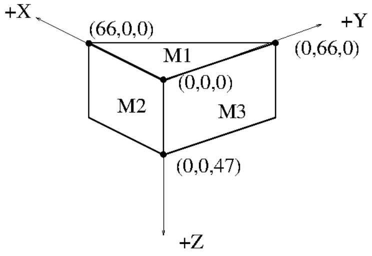
Other systems possible: yaw/pitch/roll, azimuth/elevation/twist

Different parameter values, but always the same rotation, when encoded in matrix R

Object position/translation: vector in R^3.

3D Shape Modelling

Similar to 2D Modelling
Needs 3D coordinate system + 3D shape primitives



Our primitives: polyhedra, defined by polygonal patches, defined by lists of edges

Wireframe modelling

Representation Scheme

Model: set of polygons (object faces)

Polygons: set of edges (polyhedron edges)

Edge: 2 points in R^3 (edge endpoints)

Wedge Model

```
planenorm(1,:) = [0,0,-1];       % tri face 1 surf normal
facelines(1) = 3;                % # of boundary lines
model(1,1,:) = [0,0,0,66,0,0];   % Edge 1
model(1,2,:) = [0,0,0,0,66,0];   % edge 2
model(1,3,:) = [0,66,0,66,0,0];  % edge 3
planenorm(2,:) = [0, -1, 0];     % rect face 2 surf normal
facelines(2) = 4;
model(2,1,:) = [0,0,0,0,0,47];
model(2,2,:) = [0,0,0,66,0,0];
model(2,3,:) = [66,0,0,66,0,47];
model(2,4,:) = [0,0,47,66,0,47];
planenorm(3,:) = [-1, 0, 0];     % rect face 3 surf normal
facelines(3) = 4;
model(3,1,:) = [0,0,0,0,0,47];
...
```

What We Have Learned

- A simple 3D shape modelling scheme
- A review of 3D coordinate systems