repn's

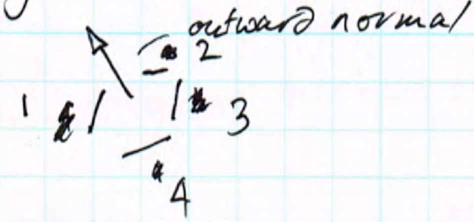
difficulty w/ CSG is its slow to render
raytrace)
to a boundary or B-rep.

ent each primitive with a mesh of
ns.

typically represented with winged edge solid
of
- faces (faces) w/ ptrs to relevant edges, verts
- faces (edges)
- faces (vertices)

entions

~~[illegible]~~ list edges in cw order going around a face




dge repn as

first vert last vert left face right face

next, prev moving along left n,p along right repn

least

rt . one incident edge.

ert all incident edges

repn

least

face one edge

face list of edges

-ne operations are straightforward

· rendering - throw faces into polygon renderer

· Some joins

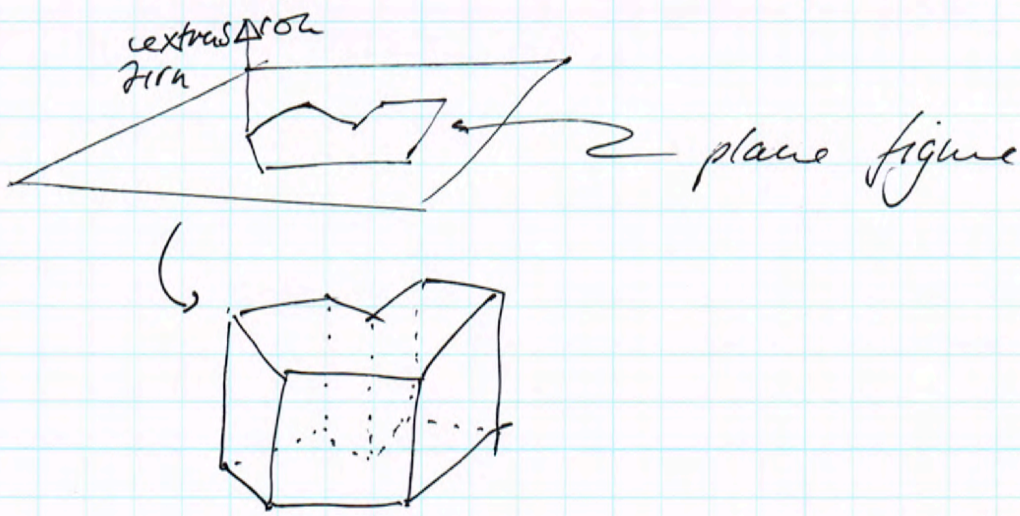
- eg. paste two objects together on shared face

cases: · faces are "the same"

· not ...

extrusion

· important operation to produce solids




· many objects are made like this.

ection is relatively easy
faces of $\cap$ are pieces of faces
of components.

convex components are particularly
easy
- only one connected component
- ~~only one~~ no more than 1
face of $\cap$ from any face
of component.
- verts are
(some of component verts) $\cup$

e (some (face(A) $\cap$ edge(B))) $\cup$
some (face(B) $\cap$ edge(A)))

- each of these sets is easy
to find.

- rest is pointer chasing (example)

~~secting WES is relatively straightforward~~

~~GHLY~~

~~· find edge-face ∩s, chase~~

---

pass from WES to general

roup of polygons
ometimes w/ combinatorial structure

· note tough to have much
if it isn't a solid.

HE not usually a solid

HE many computations can be tricky

E hard to spot core geometric properties

E · interpolation over meshes is easy

· ∴ normals are NOT piecewise const (or at least, not required to be)

WE MAKE ONE?

WES

elling system

h a set of sample points.

IG

meshes usually come from an assembly

f surface patches

hese are usually built w/

- splines
- subdivision surfs
- height maps (less often)

MAPS

mplest)

- have $(x_i\ y_i, z_i)$,

scattered data.

(e.g. image data)

interpolate or smooth, grid, resample

triangulcte $(x_i, y_i)$ use this to get mesh.

- Hard to avoid "bad" 3D triangles
- hard to sew together pieces
- resampling may bias.

ed Data interpolates, smoothers

have N pts $(x_i, y_i, z_i)$

'OT on grid

should like to build approximation

erpolate)

strategy:

hoose $\phi(x,y;x_i,y_i) = f\left((x-x_i)^2+(y-y_i)^2\right)$

(discuss choices later)

iterpolate is

~~next~~

$$\sum_j a_j \varphi(x,y;x_j,y_j)$$

$$z_i = \sum_i a_i \varphi(x_i,y_i;x_j y_j)$$

$$\underline{z} = \underline{M}\,\underline{a}$$

light conditions on $\varphi$, $M$ has full

(Micchelli)

sider some choices of $\varphi$.

$$; x_i, y_i) = f\left((x-x_i)^2 + (y-y_i)^2\right)$$

$$= f(d^2)$$

$$(d^2) = \frac{1}{d^2 + \varepsilon}$$

- not finite support
- $\varepsilon$ has important control properties

$$) = \max\left(1 - \left(\frac{d^2}{\sigma^2}\right), 0\right)$$

- finite support
- $\sigma$ has control properties

$$= -\log(d^2 + \varepsilon)$$

- not finite support
- rather odd far away from data
- minimizes a form of bending cost

$$\left( \nabla^4 f = 0 \right)$$

?

note each of these basis fn's has a
meter, which is essentially a scale
m.

hoose $(x_u, y_u)$ ← random subset of points
or random points
base points

$$Z_i - \sum_{j \in \text{basepoints}} a_j \, \phi(x_i, y_i; x_j, y_j) \Big\|^2$$

$$\Big\| \underline{z} - M_b \underline{a} \Big\|^2$$

$$M_b^T M_b a = M_b^T z \quad \text{— solve for } a$$

ing scale param: plot err vs scale
for pt set, choose
best

ber of base points:

- application logic
- MDL / AIC style reasoning

...at choices of basis, scale
...ffect linear algebra.

$\begin{pmatrix} ^2 \\ _2 & 0 \end{pmatrix}$ ← many zeros in $M_6$

← can often solve w/ iterative method

<u>precondition</u>

is often a good preconditioner.

...imates Laplacian on some triangulation of
...oints

point, pass to Shape from Shading

## form

iven shaded image of a surface,
ith domain $D$, viewed orthographi
lly, with KNOWN RADIOMETRIC
LIBRATION, known albedo, known
nse, RECOVER SURFACE GEOMETRY

971).

## Traditional Strategy:

source vector

odel $I(x,y) = \left(N(x,y) \cdot S\right) \cdot \rho(x,y)$

unit normal

image intensity,
in <u>radiometric units</u>
(hence calibration)

known albedo

assume WLOG, $\rho = 1$

$$N(x,y) = \frac{(-h_x, -h_y, 1)}{(1 + h_x^2 + h_y^2)^{1/2}}$$

ace $(x, y, h(x,y))$

PDE

$\overline{\phantom{x}}$ $+h_x^2 + h_y^2 + S_0 h_x + S_1 h_y - S_2 = 0$

an instance of an eikonal eqn

. No soln when $I^2 > S_0^2 + S_1^2 + S_2^2$

can be shown that existence of
olutions is a serious problem

nerally, Solving this PDE does not
yield approaches that
- make sense mathematically
- make sense practically
- yield good looking soln's

tric model is <u>WRONG</u>

correct for

- diffuse surfaces
- isolated patches
- distant sources

but these conditions don't apply.

radiometric model is, <u>at least</u>

$$\underline{(x)} = \underbrace{B_0(x)}_{\text{radiosity at } x \text{ due to source alone (eg, when patch at } x \text{ is isolated)}} + \int \underbrace{K(x,y)}_{\text{geometric, radiometric gain terms}} \underbrace{B(y)}_{\text{radiosity at } y} dy$$

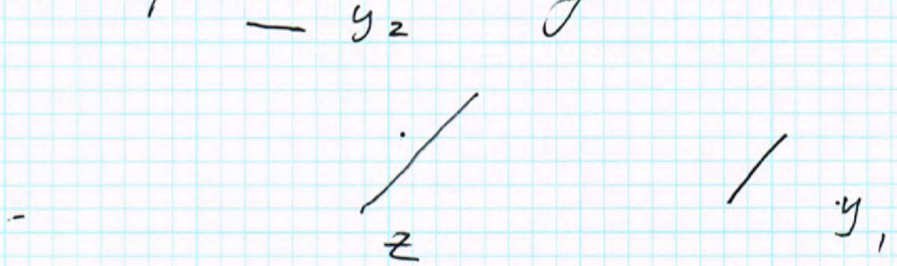
ct

brightness)

del is <u>wildly</u> unpromising

ll pairs of patches interact

her patches change interaction




$\to x$ light transfer occurs

$\to x$ doesn't, $z$ is in the way

a complicated fn of geometry

e are claims in literature that

can work ~~the~~ interreflns into shape

ence — I discount them.

[M]odify Shading model to

$$I(x,y) = G(N; S)$$

some fn of the unit normal

natural $G$

$$G(N;S) = \sum_i a_i \, S_i(N)$$

spherical harmonics

encode source properties

yields another PDE

. Still have existence problems

[atte]mpts to duck existence problems

[usin]g variational methods ~~fail~~ haven't [work]ed.

+ Malik

...imize $\left[ \text{Cost}(\text{Surface}, \text{albedo}, \text{Illum}) \right]$

...ect to

$$I - \rho G(N; a) = 0$$

...does not have existence problems,
I is badly mishandled.

...hat is Cost(Surface, albedo, Illum) ?

...t should it be)

...ues :

- illum field is "smooth"
  except at shadows

- albedo field is $>0$, $<1$,
  has few slow changes,
  has few distinct values

Surface is "smooth"

) - turns away from eye at outline

) - is biased toward front

 - ~~is~~ tends to be locally "flat"

). $n_x^2 + n_y^2 \geq$ thresh (at boundary)