Supersampling:

Goal

Supersampling (basic)

$N \times N$ array of sub-pixel

Simple bit can still cause aliasing.
Stochastic Supersampling

Choose $N^2 = M$

many subpixel locations

Pixel on screen

More noise
But less aliasing

Texture Map
Jittered Stochastic Subsampling

\[ N = 3 \]

- Screen pixel
- 3² subpixels

Pick a random location inside each subpixel.

Not much aliasing
Less noise.
**Cube map** (Environment Mapping)

Typically, six images of the entire surrounding are submerge.

```
Ceiling
Left
Front
Right
Back
Floor
```

Texture map with 6 subimage positions, the texture are indexed by directions (3 vector).

Open GL supports including mipmapping.

GL SL usual texture map:
- uniform sampler 2D the TexMap;
  texture (the TexMap, tex Coord);
- Vec 2

**Cube Map**:
- uniform sampler Cube the Cube Map;
  texture (the CubeMap, tex Direction);
  Vec 3
Bump mapping

New normals - used in Phong lighting calculation.

Normals for the perturbed surface

Surface

Normals

\( \vec{n}(u,v) \) normals

\( \vec{p}^*(u,v) \) normals

\( \vec{p}^*(u,v) = \vec{p}(u,v) + \Delta(u,v)\vec{n}(u,v) \)

A texture map holds the values of \( \Delta(u,v) \)

Surface is "displaced" by some function \( \Delta(u,v) \)
Color:

2 theories:

Trichromatic theory

Palmer Young 1777 / 1801

We see color in 3 components: Red, Green, Blue.

Physiological basis:

Humans have 3 kinds of retinal cells: cones and rods (see in low light, don't see color).

Opponent Theory

Hering 1878

We see colors in contrasts:

- Dark versus light
- Yellow versus blue
- Red versus green

Physiology:

There are 3 "channel" neurons to your brain.
In Practice

Additive Colors  $R$, $G$, $B$

CRTs, monitors.  (Black - add color)

Subtractive Colors  Cyan (C), Magenta (M), Yellow (Y)

$CMY$

$= \text{Start with white + subtract color.}$

Nominally  $C = 1 - R$
$M = 1 - G$
$Y = 1 - B$

Printers $CMYK$

Ink, Paint ...

Professional Colors $CMYK$

black

violet

orange

green
HSL - less physical - intended to be more intuitive.

G is max.
R, B are min.

G

R, B = (0.1, 0.0)
< (1/4, 1/4, 1/4)

Cyan 180°

Red 0°

Yellow 60°

Magenta 300°

G

B

G = R = Max
B = R = Min

Color Wheel

RGB Value

Red to Max
Green, Blue Min

Eg. RGB = (1.0, 0.0)
= (3/4, 1/4, 1/4)

Saturate - How much it's pure color instead of white

Luminance - Brightness

Hue - color "value"
\[
R = G = \max \quad H = 60
\]

\[
R = \max \quad B = \min
\]

\[
H = 30 \quad G = \frac{R + B}{2}
\]

\[
R = \max \quad H = 0
\]

\[
G = B = \min
\]

\[
R = \max
\]

\[
B = \min
\]

\[
G = \lvert \text{eval}(\min, \max, \frac{1}{3}) \rvert
\]