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Cse AIML 'B'

COMPUTER VISION
ASSIGNMENT

EXPLOITING SPARSITY:

Large Bundle adjustment problems, such as those involving reconstructing 3D scenes from thousands of Internet photographs.

Fortunately, Structure from motion is a bipartite problem in structure and motion.

Each feature point x_{ij} in a given image depends on one 3D point position p_i and one 3D camera pose (R_j, c_j).

If the values for all the points are known or fixed, the equations for all cameras become independent, vice versa.

If we order the structure variables before the motion variables in the Hessian Matrix. A.

When such a system is solved using sparse cholesky factorization. the fill in occurs in the smaller motion Hessian A_{cc}

The reduced motion Hessian is computed using the schur complement

$$A'_{cc} = A_{cc} - A_{pc}^{T} A_{pp}^{-1} A_{pc}$$

where A_{pp} is the point (structure) Hessian.

A_{pc} is the point - camera Hessian.

A_{cc} and A'_{cc} are the motion Hessians before and after the point-variable elimination. A'_{cc} has a non-zero entry between two cameras if they see any 3D point in common.

The Advantage of such norms is that globally optimal solutions can be efficiently computed. using second-order cone programming (SOCP).

The Disadvantage is that L_∞ norms are particularly sensitive to outliers and so must be combined with good outlier rejection techniques before they can be used.

CYLINDRICAL AND SPHERICAL COORDINATES

An alternative to using homographies or 3D Motion to align images is to first warp the images into cylindrical coordinates and then use a pure translational model to align them.

Unfortunately, this only works, if the images are all taken with a level camera or with known tilt angle.

Rotation Matrix $R = I$

optical axis is aligned with z axis and y axis is aligned vertically.

The 3D Ray corresponding to an (x, y) pixel is therefore (x, y, f)

Project this image onto a cylindrical surface of unit radius. by angle θ, height h, Coordinates corresponding to (θ, h) given by

$$(\sin\theta, h, \cos\theta) \propto (x, y, f)$$

Mapped Coordinates:

$$x' = s\theta = s\tan^{-1}\frac{x}{f}$$

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$$y' = sh = s\frac{y}{\sqrt{x^2+f^2}}$$

s is an arbitrary scaling factor

$s = f$

$$x = f\tan\theta = f\tan\frac{x'}{s}$$

$$y = h\sqrt{x^2+f^2} = \frac{y'}{s} f\sqrt{1+\tan^2\frac{x'}{s}}$$

$$f\frac{y'}{s}\sec\frac{x'}{s}$$

Sphere is parameterized by two angles (θ, ϕ)

$(\sin\theta\cos\phi, \sin\phi, \cos\theta\cos\phi) \propto (x, y, f)$

$$x' = s\theta = s\tan^{-1}\frac{x}{f}$$

$$y' = s\phi = s\tan^{-1}\frac{y}{\sqrt{x^2+f^2}}$$

while the inverse is given.

$$x = f \tan\theta = f \tan\frac{x'}{s}$$

$$y = f \tan\frac{y'}{s} \sec\frac{x'}{s}$$

Polar mapping $(\cos\theta \sin\phi, \sin\theta \sin\phi, \cos\phi)$

$= s(x, y, z)$

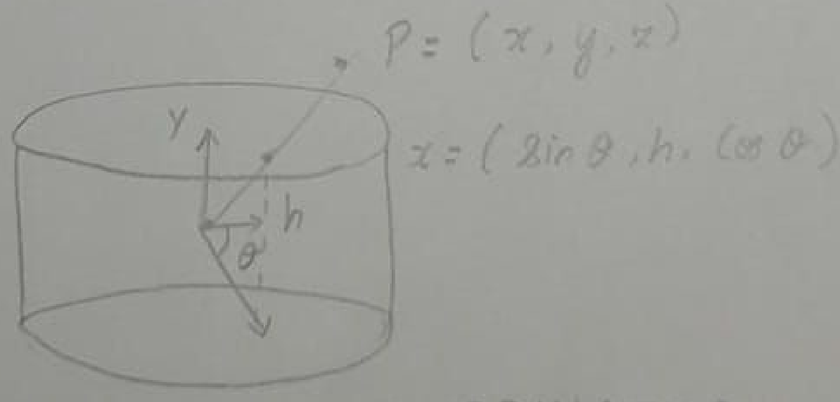
Mapping equation, $x' = s\phi\cos\theta = s\frac{x}{r}\tan^{-1}\frac{r}{z}$

$$y' = s\phi\sin\theta = s\frac{y}{r}\tan^{-1}\frac{r}{z}$$

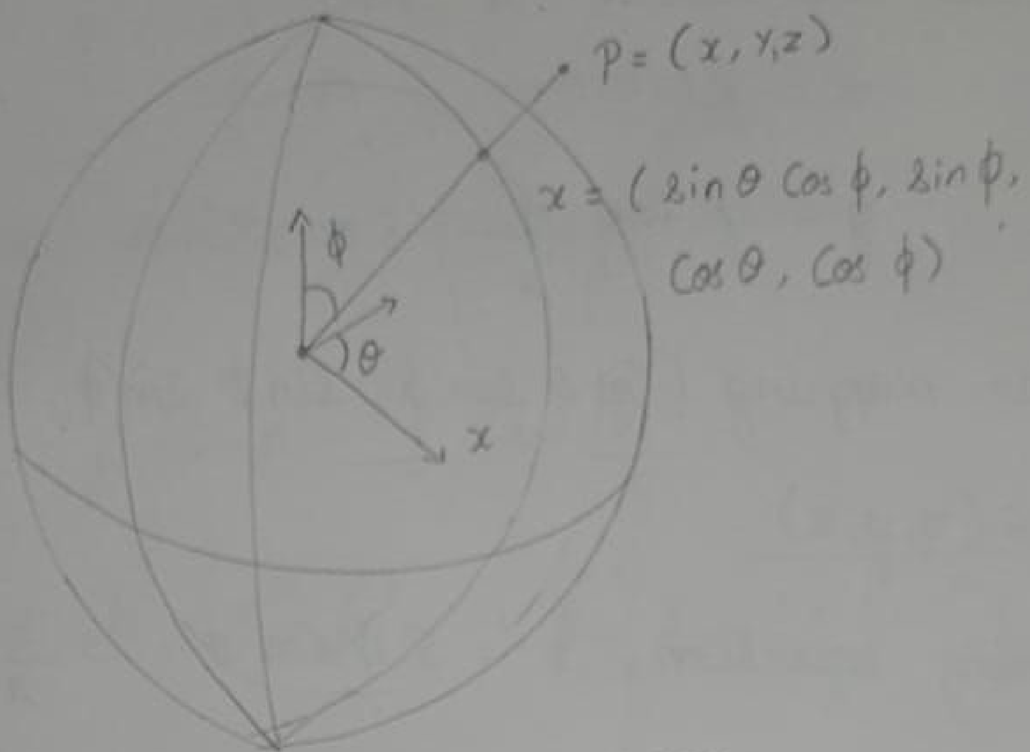
where $r = \sqrt{x^2+y^2} \Rightarrow$ radial distance

in (x, y)

$$x' \simeq sx/z$$



CYLINDRICAL COORDINATES



(b) SPHERICAL COORDINATES

Projection from 3D to (a) cylindrical and (b) spherical coordinates