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REU

WEEK 4 PRESENTATION



The problem

- How do we accurately detect ego-motion using optical flow?
- What can we do now that we know how the camera has moved?



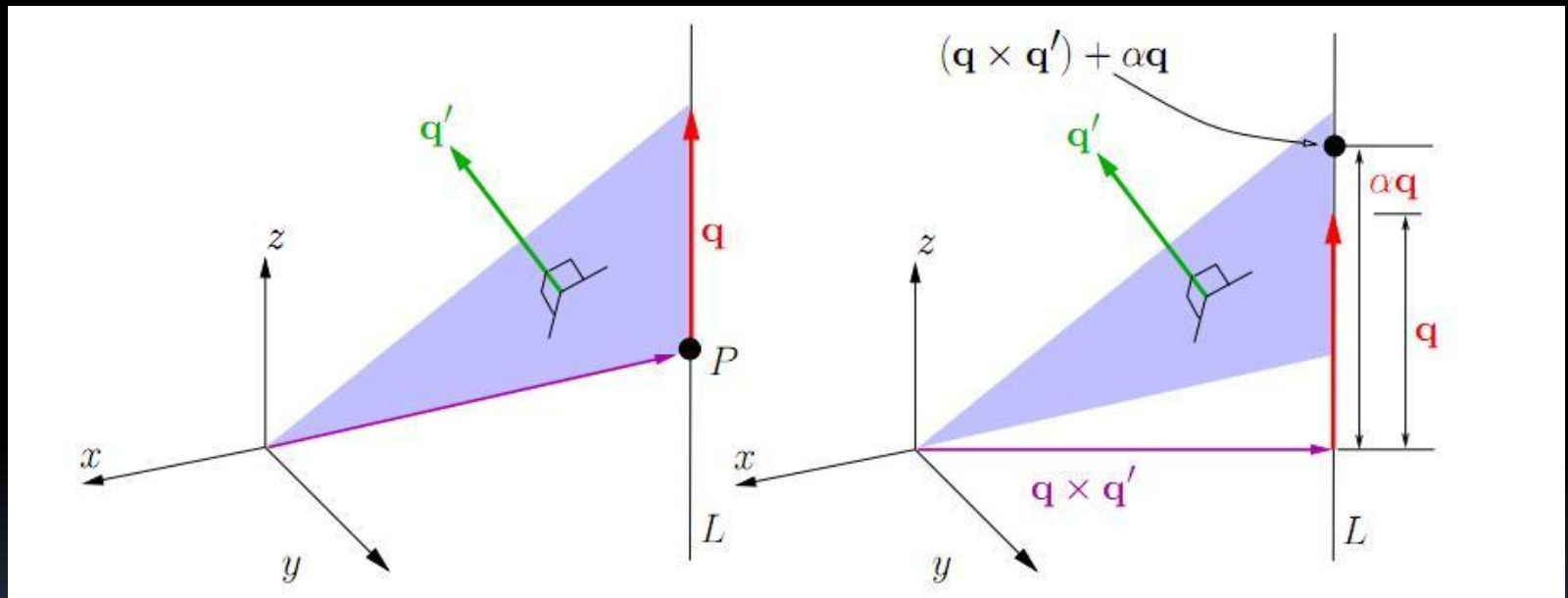
The literature

- Read the following papers:
- Using many cameras as one – Pless
- A linear approach to motion estimation using generalized camera models – Hartley et al

Plücker Vectors

- q is a vector in the direction of the line
- Then, $q' = q \times P$, for any point P on that line.
- The plücker vector for the line is (q, q')
- $(q \times q') + aq$

Plücker Vectors



From Jae-hak Kim

Generalized Epipolar Constraint

- Given two light rays, q and q' , the GEC is:

$$\mathbf{q}_2^\top \mathbf{R} \mathbf{q}'_1 + \mathbf{q}_2^\top [\mathbf{t}]_\times \mathbf{R} \mathbf{q}_1 + \mathbf{q}'_2{}^\top \mathbf{R} \mathbf{q}_1 = 0$$

- Or, rewrite it given $q = (\mathbf{x}, (\mathbf{v} \times \mathbf{x}))$

$$\mathbf{x}_i^\top \mathbf{E} \mathbf{x}'_i + \mathbf{x}_i^\top \mathbf{R} (\mathbf{v}'_i \times \mathbf{x}'_i) + (\mathbf{v}_i \times \mathbf{x}_i)^\top \mathbf{R} \mathbf{x}'_i = 0$$

GEC

- With our system, the following is true:
- $v = v'$
- $R_k * p = x$
- $R_k * p + R_k * p' = x'$
- R_k = rotation matrix of the k th camera
- P is the image point (in homogenous coordinates)
- P' is the optical flow at that point

Current Progress

- First algorithm in the Hartley paper
 - Complete
 - How do we know it's working?
- Second algorithm in the Hartley paper
 - Also complete
 - But... not semantically correct

The algorithms

$$\|A (\text{vec}(\mathbf{E})^\top, \text{vec}(\mathbf{R})^\top)^\top\| \text{ subject to } \|\mathbf{E}\| = 1$$

$$\sum_i |\mathbf{x}_i^\top [\hat{\mathbf{t}}]_\times \mathbf{R} \mathbf{x}'_i + \beta (\mathbf{x}_i^\top \mathbf{R} (\mathbf{v}'_i \times \mathbf{x}'_i) + (\mathbf{v}_i \times \mathbf{x}_i)^\top \mathbf{R} \mathbf{x}'_i)|^2$$



The future

- Suppose we have the rotation and translation
 - Now create a system to use that for gestures
 - Just about any wii-mote hack should be possible with the device
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