Optical Flow: Week 3

Jon Harter

University of Central Florida

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Project Outline

- Goal - Design a general purpose peripheral that uses optical flow to detect the user's motion.
- Restrictions - Device must work in realtime and require no external sensors or markups.

- Advisor - Dr. Lobo
- Associates - Prince Gupta, Phillip Napieralski

Prototype

Figure: Top down

Figure: Side view

- Target Design - Hand-held or wrist-fascened device

Related Works

Optical Flow Algorithm

- *Pyramidal Implementation of the Lucas Kanade Feature Tracker*
- `Jean-Yves Bouguet`

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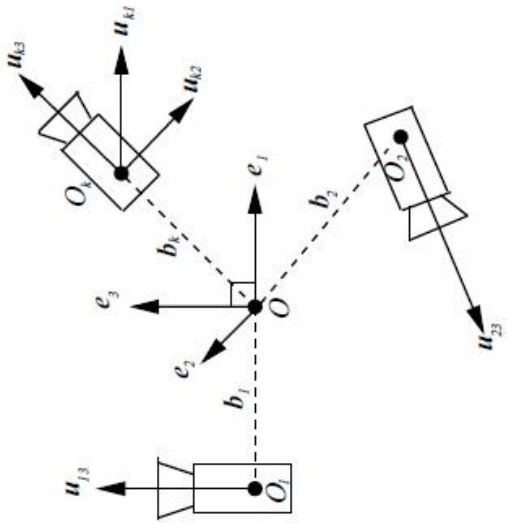
Rotation and Translation detection

- *Three-dimensional ego-motion estimation from motion fields observed with multiple cameras*
- `Yong-Sheng Chen, Lin-Gwo Liou, Yi-Ping Hung, Chiou-Shann Fuh`

Ego-motion Summary

Given

- Multiple Cameras
- Origin/orientation of each camera
- Optical flow values for each camera



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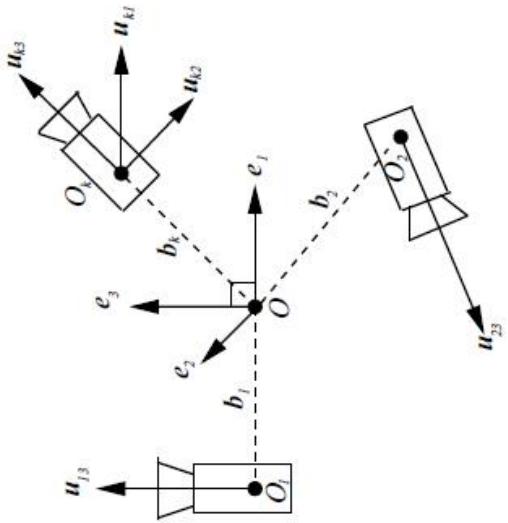

Minimize Equation to Determine $\hat{\omega}$ and solve for $\hat{\mathbf{t}}$

J_1: error function

$\mathbf{M}, \mathbf{c}, \mathbf{h}$: functions of ω_g

$\hat{\omega}$: optimal estimate of ω_g (rotation)

$\hat{\mathbf{t}}$: optimal estimate of $\mathbf{t}_g$ (translation)

$$J_1(\omega_g) = -\mathbf{c}_T\mathbf{M}^{-1}\mathbf{c} + \sum_{k=1}^{K}\sum_{i=1}^{N_k}(\mathbf{m}_{ki}^T\mathbf{h}_k)^2$$

Challenges

Optical Flow Problems

- Featureless environments
- Incompatible objects (large, uniform dark surfaces; redundant patterns)
- Distinguishing between translation and rotation
- Ego-motion works in theory, but must correctly minimize

Current Progress

Implementations[1]

- System to determine optical flow from cameras (Prince Gupta)
- Implemented ego-motion algorithm (Phillip Napieralski)
- Optical flow generater to construct test data from ego-motion equations

[1] Tasks completed by other members noted in parenthesis

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Recent Contributions

- Verified mathematics behind Ego-motion estimation
- Created single case test data sets for pure translation, pure rotation, and translation plus rotation
- Tested ego-motion algorithm with aforementioned data (Test failed)

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