Feature Tracking

Discussion

Questions

- What can be tracked?
  - Brightness changes → Need temporal **contrast**
    (DVS has a contrast sensitivity of ~ 15%)
  - What causes brightness changes?
    - Blinking lights (LEDs) - seldom considered.
    - **Moving edges**, found in textures, silhouettes, etc.
      Regions with low contrast or texture are challenging to track.
  - What's the scenario?
    - Static or moving camera?
    - How many objects are there in the scene?
    - How big are the objects on the image plane?
  - How to express what we want to track in terms of events?
    - Need a "template" or "representation" (**Detection**)

Questions

- How to track?
  - Can we track with just one event?
  - Better if multiple events (or additional knowledge) to build a **representation** to track.
  - Exploiting high temporal resolution and spatial vicinity: (nearest neighbor) **data association**.
  - How to handle **nuisances**, such as perspective distortion, noise, etc.?
    - We would like the tracker to have some "**invariance**" and "**robustness**".
  - Tracking may be posed as a **registration** problem
    - and solved via ICP, gradient descent, etc.

Tracking Methods

- Blob / Cluster tracking
  - A filter updates the parameters of the “blob” distribution
  - Example: vehicles or people modeled as “blobs”
- Shape tracking (evolving point shapes on image plane 2D)
  - Simple shapes (squares, triangles, stars)
  - More complex shapes
- Tracking posed as a registration problem
  - What is registration?
    - Matching events to a model
    - What is being optimized?
    - What type of distortions can be handled?
  - Iterative Closest Point (ICP)
  - Point set registration by gradient descent
  - Extension of the KLT tracker to events: EKLT

More Questions

- How are **outliers** handled by ICP?
- How to handle events due to **occlusions** or disocclusions?
- Is **polarity** used in the different methods?
  - Typically not. Only in EKLT (in the event generation model).
  - Example: an Off event may be caused by a dark-to-bright (DL) edge moving right or by a bright-to-dark (LD) edge moving left, thus polarity can be confusing; need to be able to **disambiguate**.
- Classical computer vision:
  - What is Canny edge detection?
  - What are Harris corners?
  - What are the colors in the plot? (Tedaldi et al. EBCCSP 2016)

Evolution Analysis

- We can identify several **axes of progression** (evolution):
  - Increasing **complexity of shapes** to be tracked: from hand-crafted to natural shapes, obtained from the data itself.
  - **Techniques** used:
    - **Data association**: from hard to soft (explicit or implicit).
    - **Registration / alignment methods**: from point-based methods (shapes represented as 2D point sets) to grid-based ones (shapes represented by histograms of events, to account for edge strength, using lattice-based implicit data association and reutilizing registration techniques from images): more **accurate and longer tracks** but higher **computational cost**.

- Improve this progression by reading **Section 4.1** of Event-based Vision: A Survey, TPAMI 2020