Motivation

- Online learning and detection based trackers are not suitable for tasks requiring fast and high precision tracking.
- Progress in registration based tracking has become fragmented.
- A principled way to relate these by decomposing the tracking task into three modules: Search Method (SM), Appearance Model (AM) and State Space Model (SSM).

Registration based Tracking

\[ p_t = \arg \max \left\{ f(I_0(x_0), I_t(w(x_0, p_s), p_t)) \mid p_s, p_t \right\} \]

\[ x_0 \]

\[ I_0 \]

\[ I_t \]

\[ w(x_0, p_s) \]

Decomposition

State Space Model

\[ f_{SSM}(x, p_0, p_s) \]

Search Method

\[ f_{SM}(x, p_0) \]

Appearance Model

Contributions

- Provide a unifying formulation for registration based tracking.
- Adapt a popular image quality measure called Structural Similarity for high DOF tracking.
  - simpler but faster version called SPSS
- Evaluate models comprehensively by comparing against 8 AMs using 11 SMs and 7 SSMs.
- Experiments are done using 4 large datasets with over 100K frames.
- Provide an open source tracking framework called MTF.
  - efficient C++ implementation
  - experimental platform
- 14 SMs, 16 AMs and 10 SSMs currently implemented.

Evaluation

Alignment error (Full Pose)

\[ F_{ALL} = \frac{1}{N} \sum_{i=1}^{N} \left| C_{gt}(\theta_i) - C_{pred}(\theta_i) \right| \]

Area overlap used in VOT does not capture rotations.

Results

ALS with NCC

\[ \text{MIL: 7.975} \]

\[ \text{TLD: 6.686} \]

\[ \text{CMT: 9.076} \]

\[ \text{NN: 9.135} \]

\[ \text{ICLK: 9.820} \]

\[ \text{FCLK: 10.458} \]

ALS with RCLK

\[ \text{RSCV: 12.637} \]

\[ \text{SCV: 11.574} \]

\[ \text{CCRE: 9.961} \]

\[ \text{MI: 11.992} \]

\[ \text{ZNCC: 12.367} \]

\[ \text{NCC: 12.736} \]

\[ \text{SPSS: 11.163} \]

\[ \text{SSIM: 12.444} \]

\[ \text{NN: 9.172} \]

\[ \text{ESM: 12.515} \]

\[ \text{ICLK: 11.392} \]

\[ \text{FCLK: 12.736} \]

\[ \text{NNIC: 12.915} \]

\[ \text{PFFC: 14.239} \]

\[ \text{LMS: 13.207} \]

\[ \text{LMES: 14.869} \]

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Speed in FPS