Dense Point Trajectories By GPU-Accelerated Large Displacement Optical Flow

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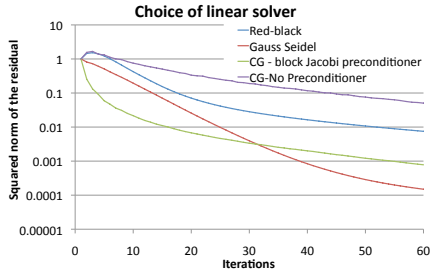
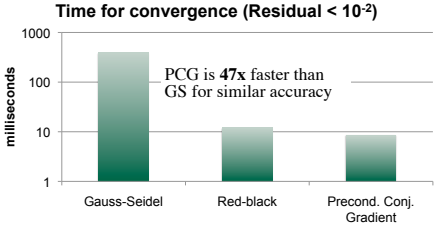
Video Point tracking

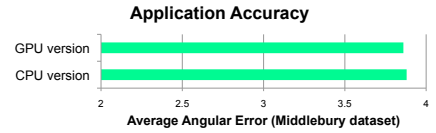
- With the amount of video material, e.g. on YouTube, increasing rapidly, there is growing interest in video analysis tools.
- Motion analysis is a pre-requisite for video applications such as semantic video analysis, intelligent video editing, video summarization etc.
- All these applications require the ability to track long range motion.
- Such analysis requires tracking points densely over many frames accurately. Optical flow provides the means to achieve this.
- Optical Flow involves computing the motion vectors ("flow field") between the consecutive frames of a video.
- Optical flow computation solves a non-linear optimization (energy minimization) problem.
- We use the *Large Displacement Optical Flow (LDOF)* algorithm, which is crucial for point tracking in real world videos.
- Our CUDA-implementation of the LDOF algorithm provides a 78x runtime improvement over an auto-vectorized single-threaded implementation, enabling its use in a highly accurate point tracker.

Algorithmic Exploration

- The linear solver is a significant component of the overall application.
- Detailed algorithmic exploration is necessary to pick the right solvers for serial and parallel platforms.







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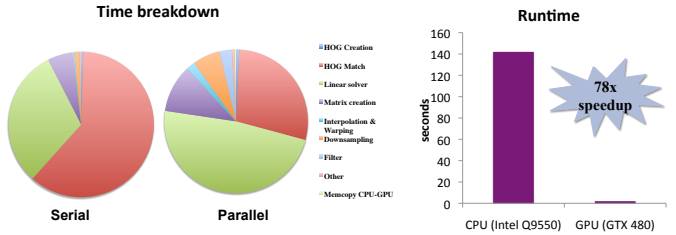
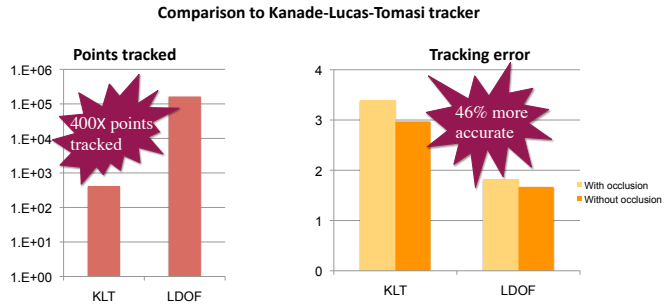
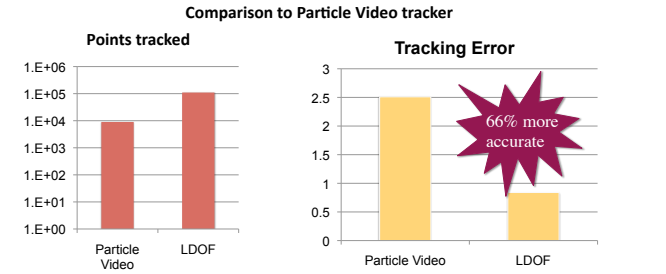
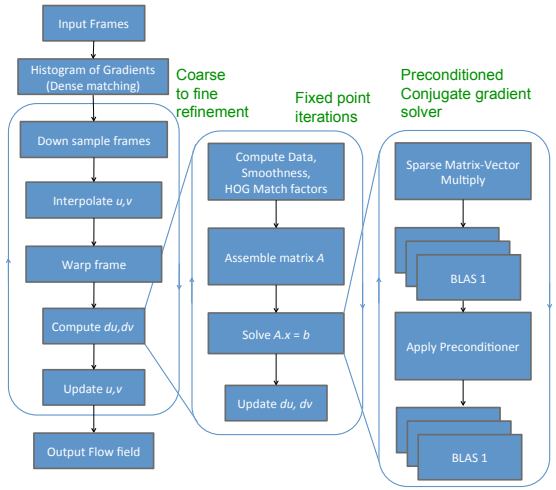
Results





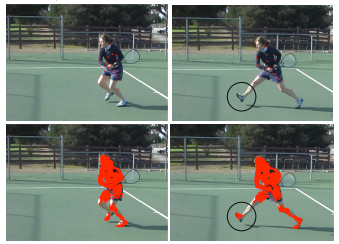


LDOF Application Architecture



Conclusion

- Point tracker based on LDOF outperforms other trackers
  - **46%** better than Kanade-Lucas-Tomasi (KLT) tracker and tracks up to **3 orders** of magnitude more points
  - **66%** more accurate than the Particle Video tracker while handling large displacements and tracking an order of magnitude more points
- Runtime for computing LDOF on a pair of 640x480 frames is only 1.8 seconds (comparable to other GPU-based optical flow algorithms)



KLT tracker cannot track the foot

LDOF tracker tracks large displacements

• For more detailed information, please refer to the following paper:
Narayanan Sundaram, Thomas Brox, Kurt Keutzer, "Dense Point Trajectories by GPU-accelerated Large Displacement Optical Flow", European Conference on Computer Vision, Greece, September 2010.