Parallelism changes the possible

- Highly parallel processors bring new possibilities.
- Through the use of tailored algorithms and careful implementation, we achieve new capabilities in the field of Computer Vision.
- We have successfully transitioned from achieving speedups of existing algorithms to advancing the state of the art through the use of massive parallelism.

OPL Patterns Used

- Dense and Sparse Linear Algebra
- Geometric Decomposition
- Data parallelism
- Task parallelism
- SIMD

Video Point tracking

- Long range motion analysis in video requires us to track 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.

LDOF Application Architecture

Input Frames

Histogram of Gradients (Dense matching)

Down sample frames

Interpolate u,v

Warp frame

Compute du, dv

Update u,v

Output Flow field

Coarse to fine refinement

Fixed point iterations

Preconditioned Conjugate gradient solver

Sparse Matrix-Vector Multiply

Preconditioned Conjugate gradient solver

BLAS 1

BLAS 1

BLAS 1

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 Sand-Teller tracker while handling large displacements**

Results

**Choice of linear solver**

- Red-black
- Gauss-Seidel
- CG - block Jacobi preconditioner
- CG-No Preconditioner

**Points tracked**

- **400X** points tracked

**Tracking Error**

- **45%** more accurate

**Runtime**

- **70x** speedup

**Accuracy**

- Based on the MIT dataset (Liu et al, CVPR 2008)
- **Based on particle trajectories from http://rvs.csail.mit.edu/pv/data/pv/ (Sand and Teller, IJCV 2008)**

* Based on the MIT dataset
** Based on particle trajectories from http://rvs.csail.mit.edu/pv/data/pv/ (Sand and Teller, IJCV 2008)