MicroVec Light Field PIV

3D3C velocities in a single camera

Microvec has developed a new light field volumetric PIV (LF-PIV) system. Microvec LF-PIV can resolve 3D velocity fields through MART based reconstruction and 3D cross correlation. This new system can provide an interesting alternative and affordable substitute to a Tomographic PIV. It is based on only one compact camera, and can be used to calculate 3D3C velocity in applications and environments with space constraint.

In-house light field camera was developed according to plenoptic imaging where a customised micro-lens array (MLA) is precisely positioned one focal length away from the CCD of a 29 megapixel camera (See Figure 1 and 2). The MLA consists of $458 \times 301$ hexagonal lens unit, which maximises the pixel usage when compared to square lens unit. Light field image of tracer particle article can be simulated via linear Gaussian optics.

LF-PIV system pre-determines the location of a particle through inverse dense ray tracing (DRT) and reconstructs the voxel value using multiplicative algebraic reconstruction technique (MART).

DRT-MART technique implemented in Microvec LF-PIV achieves higher reconstruction resolution at much better computational efficiency than the MART method. To speed up the calculations even more, the system supports GPU and its parallel processing.
Case 1: Low Speed Jet

The experiment was conducted in air with a slow jet. Measurement Volume: $39.4 \times 26.2 \times 10.7 \text{ mm}$ and $2200 \times 1466 \times 130$ voxels.

Case 2: Air Jet

Tracer particle: $1 \mu m$ olive oil, ReD: 45000, Measurement Volume: $27.3 \times 34.2 \times 12 \text{ mm}$ DRT-MART Iteration: 40, Multi-grid Cross Correlation: Initial Volume: $120 \times 120 \times 64$, Final Volume: $60 \times 60 \times 32$, Overlap: 75%

Pictures courtesy of Dr. Shengxian Shi, Shanghai Jiaotong University