

Description of Additional Supplementary Files

Supplementary Movie 1: LodeSTAR successfully detects objects of various shapes, orientations and noise.

Supplementary Movie 2: Mouse hematopoietic stem cells are detected by LodeSTAR as they divide. The score map used for detection is also shown.

Supplementary Movie 3: Human hepatocarcinoma-derived cells are detected by LodeSTAR. The score map used for detection is also shown.

Supplementary Movie 4: Pancreatic stem cells are detected by LodeSTAR as they divide. The score map used for detection is also shown.

Supplementary Movie 5: *Noctiluca scintillans* are detected by LodeSTAR. LodeSTAR detects the optically dense area near the ventral groove where the nucleus is located. The score map used for detection is also shown.

Supplementary Movie 6: *Noctiluca scintillans* are detected by LodeSTAR. LodeSTAR detects the plankton as a whole. The score map used for detection is also shown.

Supplementary Movie 7: Polystyrene particles under flow are detected by LodeSTAR in 3D.

Supplementary Movie 8: SH-SY5Y cells with polystyrene particles inside and around the cell. LodeSTAR detects both the polystyrene (orange markers) and intracellular particles (blue markers).