A Low-Cost, High-Speed, and Robust Bin Picking System for Factory Automation Enabled by a Non-stop, Multi-View, and Active Vision Scheme

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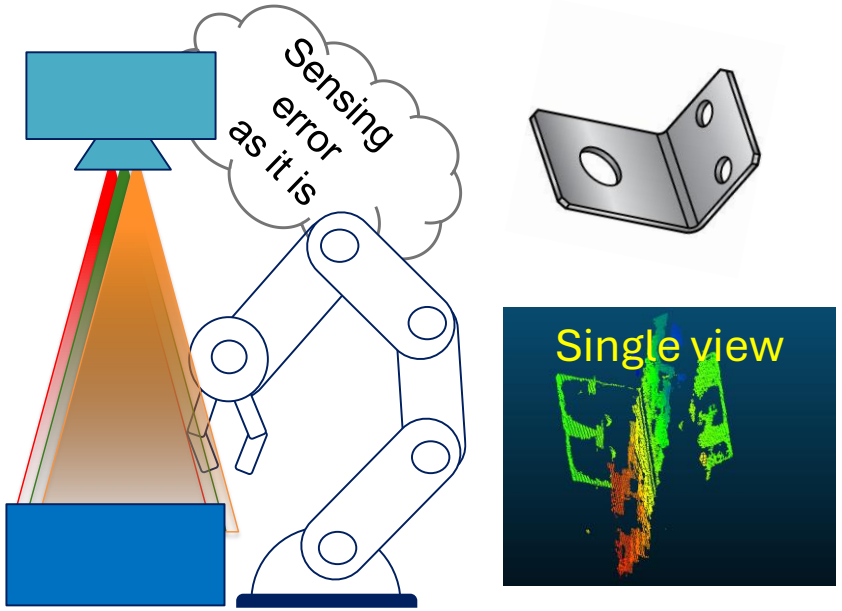
Background: challenges of bin picking in factory automation

- Metallic object with a shiny surface
  - Sparse and noisy 3D data
- Textureless
  - Recognition on 3D data is preferred
- Vision controllers without GPUs
  - Unsuitable for AI-based approach on RGB images

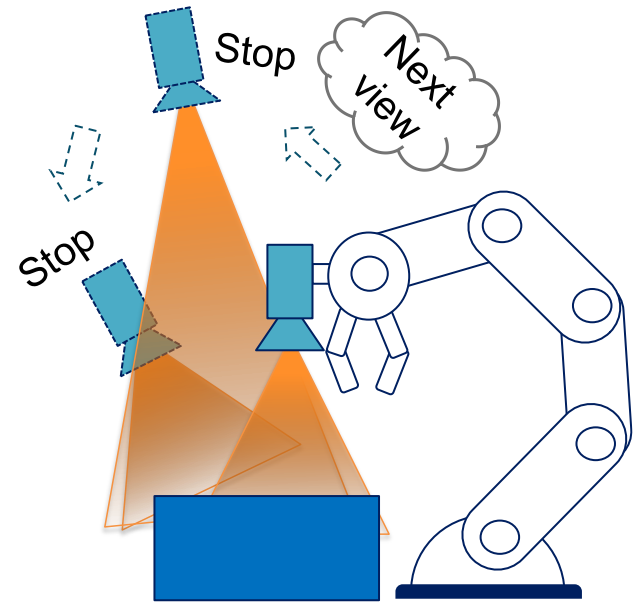
Bottom image is from BOP challenge 2023, R6D workshop at ICCV 2023

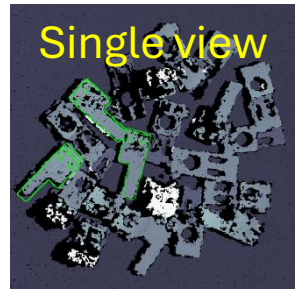
Background: multi-view “Sensor on hand” systems are getting popularity

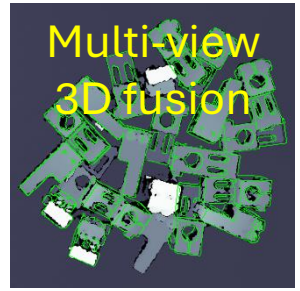
-Robust (optimization from different views), Low cost (one-shot 3D sensor)



Fixed on top
Multi-shot 3D sensor
Single view





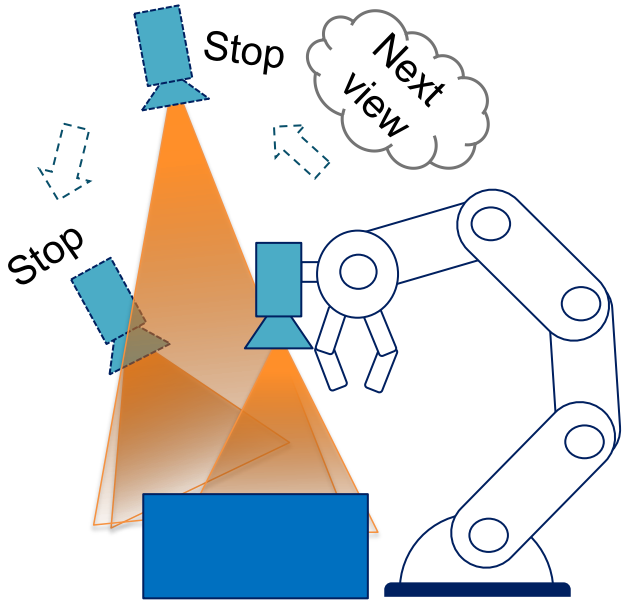


Sensor on hand (Conventional)
One-shot 3D sensor
Multiple views (multiple stops)

Challenge: conventional multi-view “sensor on hand” systems are slow

-Not acceptable in factory automation

Sensing time cost in takt time		
Robot Fusion [12]	***More Fusion [14]***	***MV6D, ROBI-related [16], [6-8]***
≈6.0 s	≈8.0 s	Not applicable



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One-shot 3D sensor
Multiple views (multiple stops)

Contribution: a high-speed, multi-view, active vision bin picking

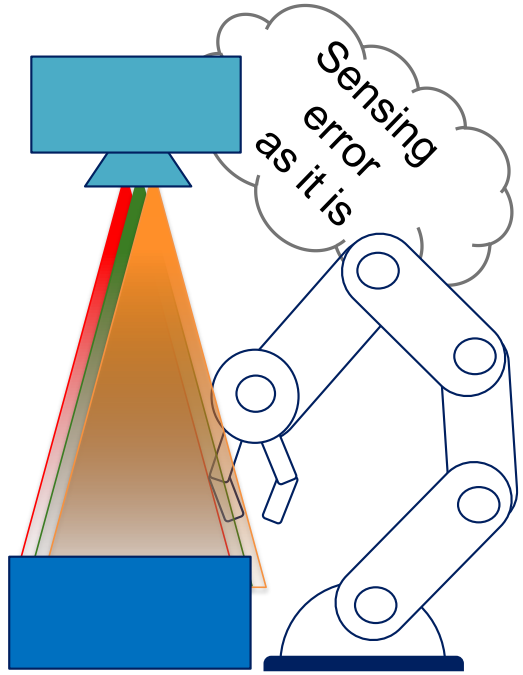
-Cater to time-critical applications in factory automation

Sensing time cost in takt time			
Robot Fusion [12]	***More Fusion [14]***	***MV6D, ROBI-related [16], [6-8]***	***Ours***
≈6.0 s	≈8.0 s	Not applicable	0.635 s

Ours ≈ 90%

Our approach: typical systems v.s. ours

-Reorganized task orders / Parallelled vision and motion / Active vision



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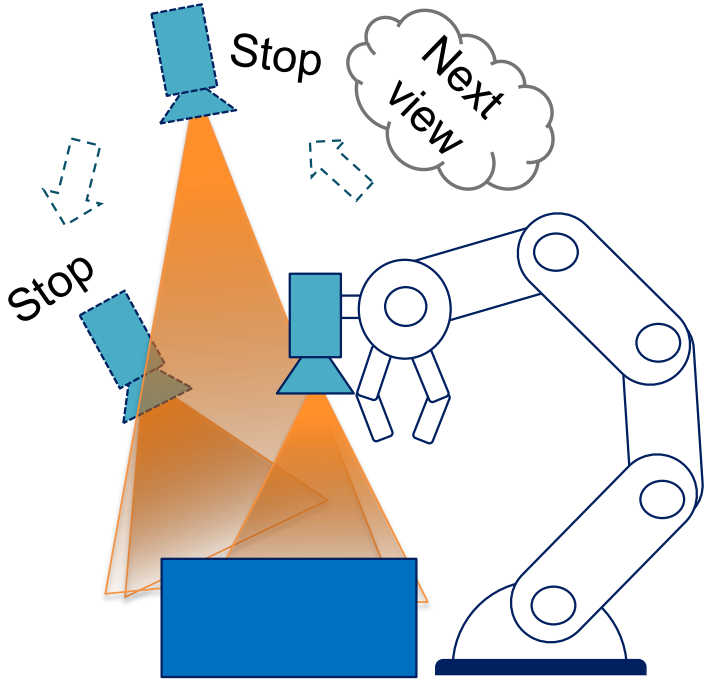
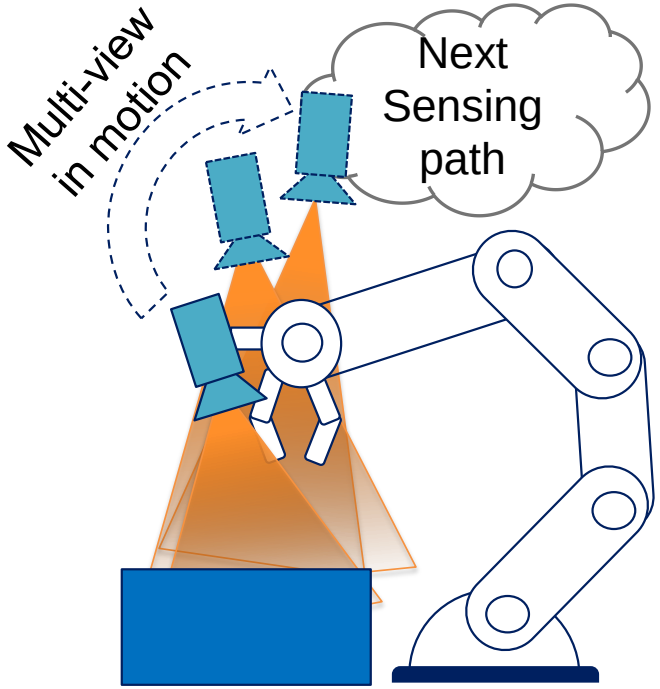
Single view



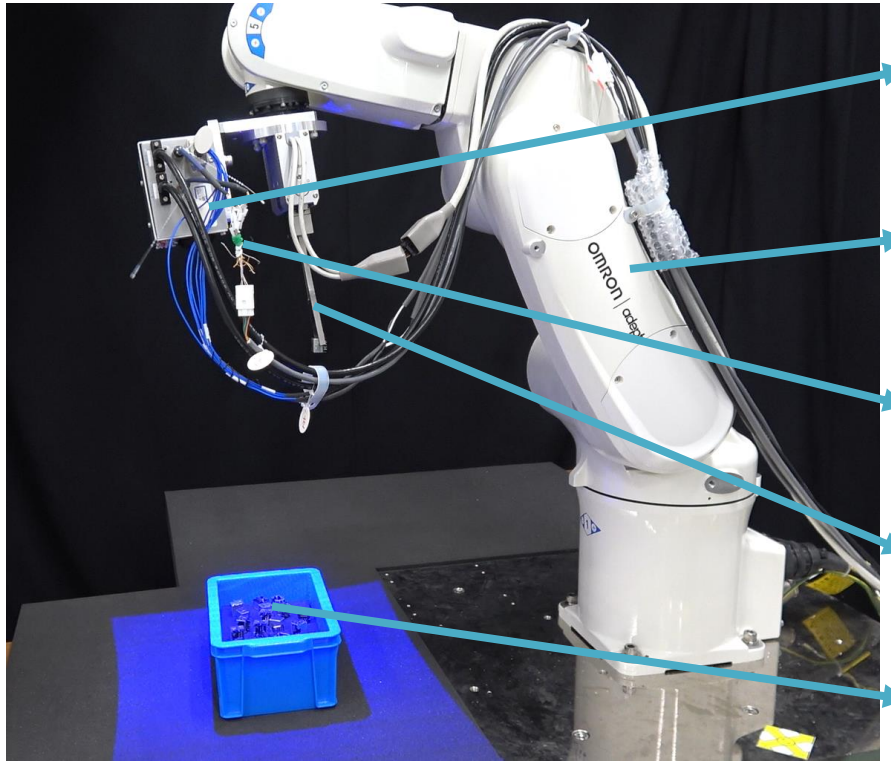
Sensor on hand (Conventional)
One-shot 3D sensor
Multiple views (multiple stops)



Sensor on hand (Ours)
One-shot 3D sensor
Multiple views (in motion)

Hardware and Picking test

-Picking complete rate > 97.75%



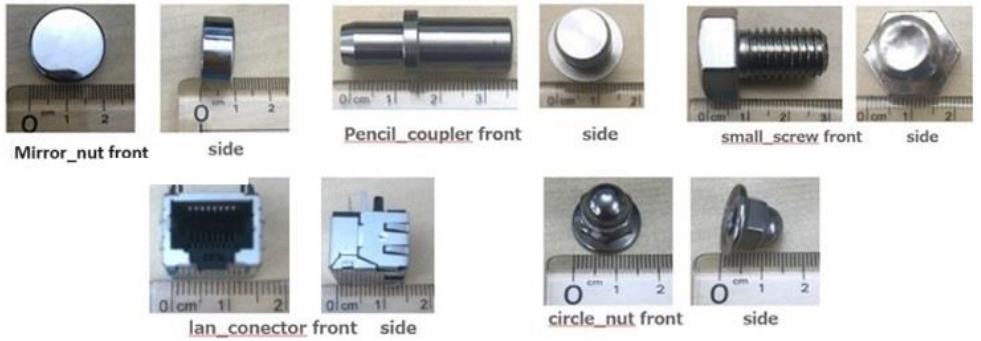
One-shot active stereo camera

OMRON Adept robot arm S650

Camera trigger

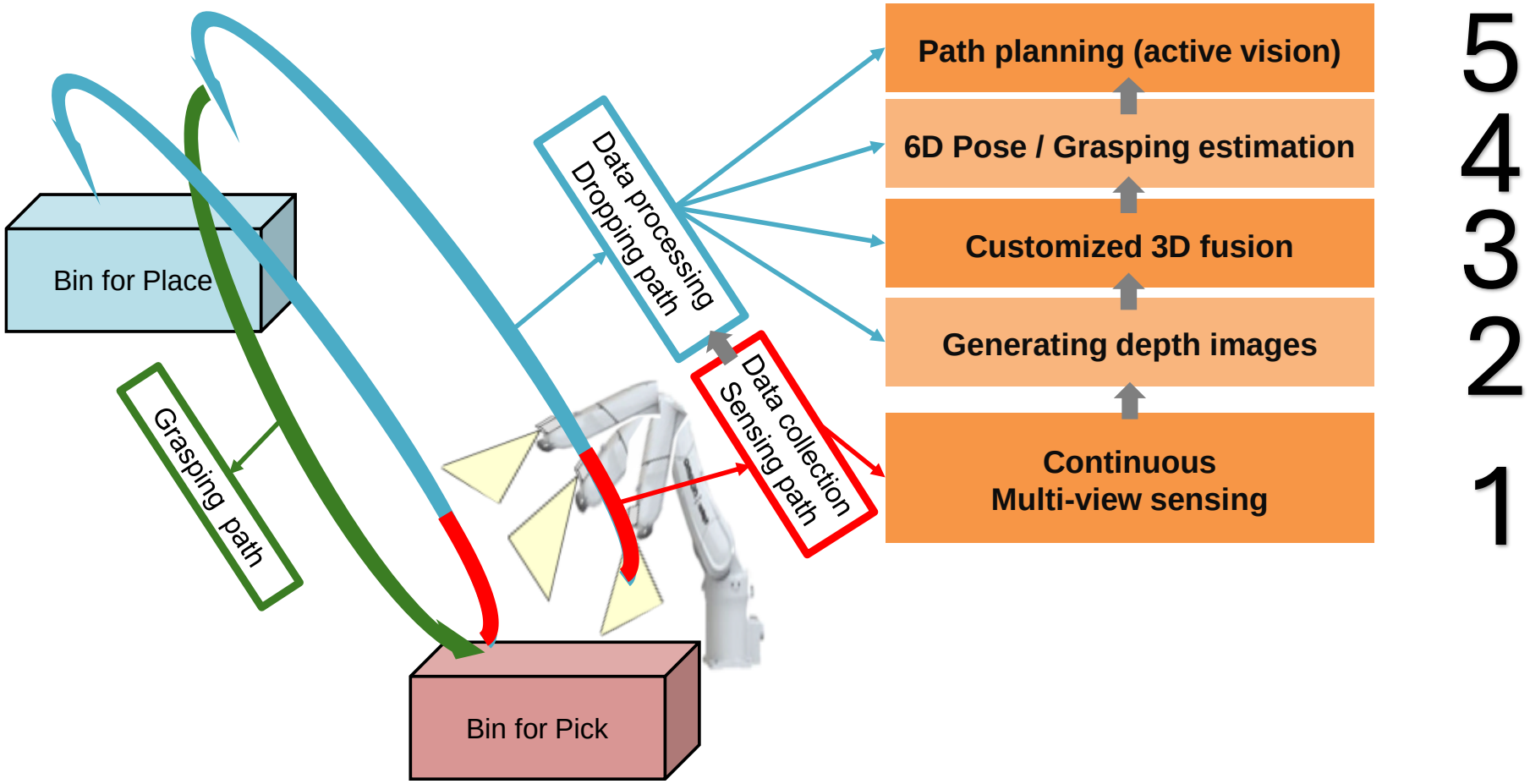
Gripper

Randomly piled Shiny Objects



Our approach: more details in workflow

-Two phases (Data collection/Sensing path, Data processing/Dropping path)



The real experiment video is also available at https://www.youtube.com/watch?v=mWCG1OzMO3g