

Robotics and Automation (Fanuc, iRVision and AMR)



BAJAJ

**THE WORLD'S
FAVOURITE
INDIAN**

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***Date of Joining – 1st October
(Robotics and Automation Dept)***

Manager – Bhupendra Verma Sir

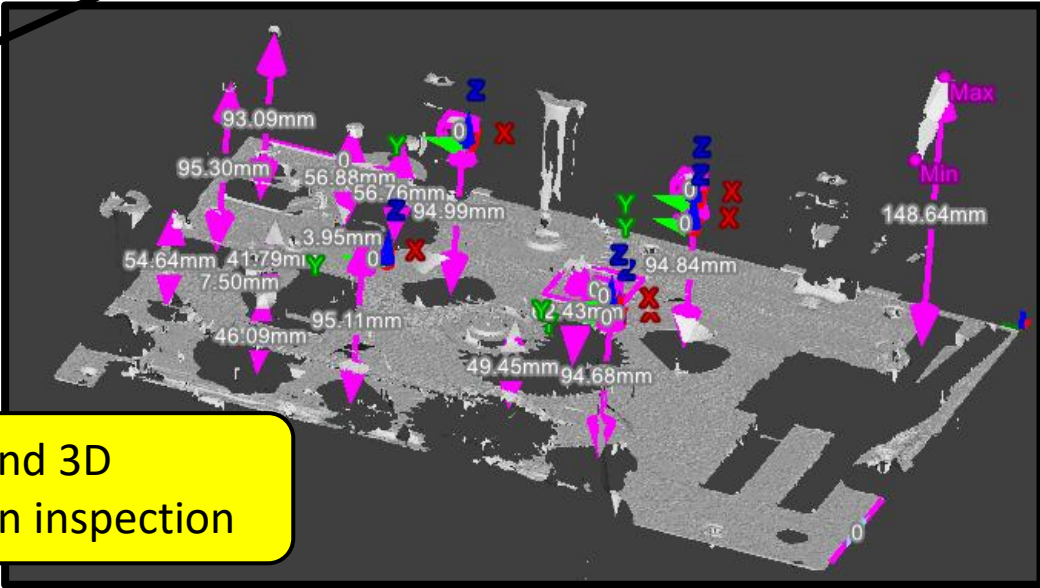
December 19, 2023



SG4 Assembly line

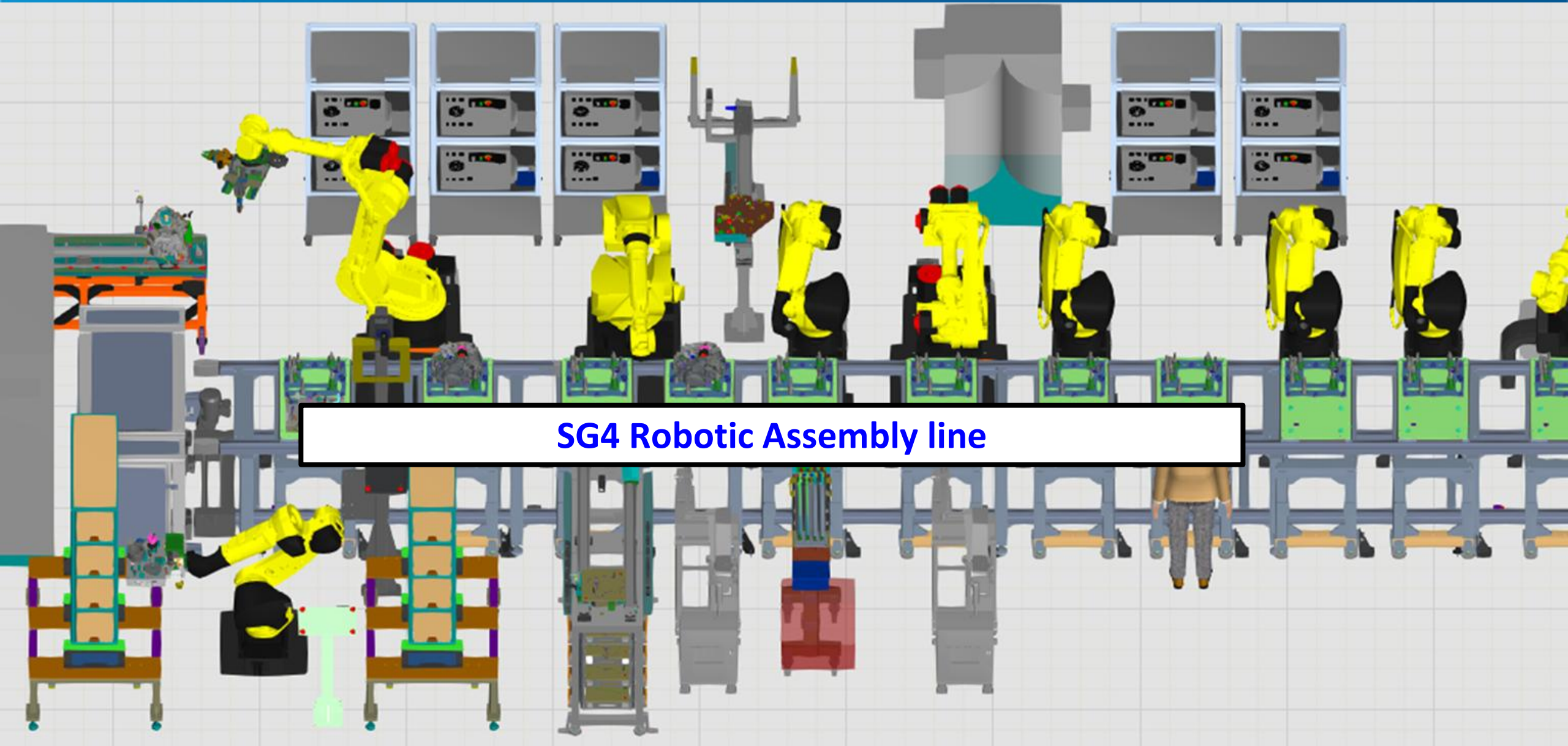


Latent Mobile
Robot / AMR



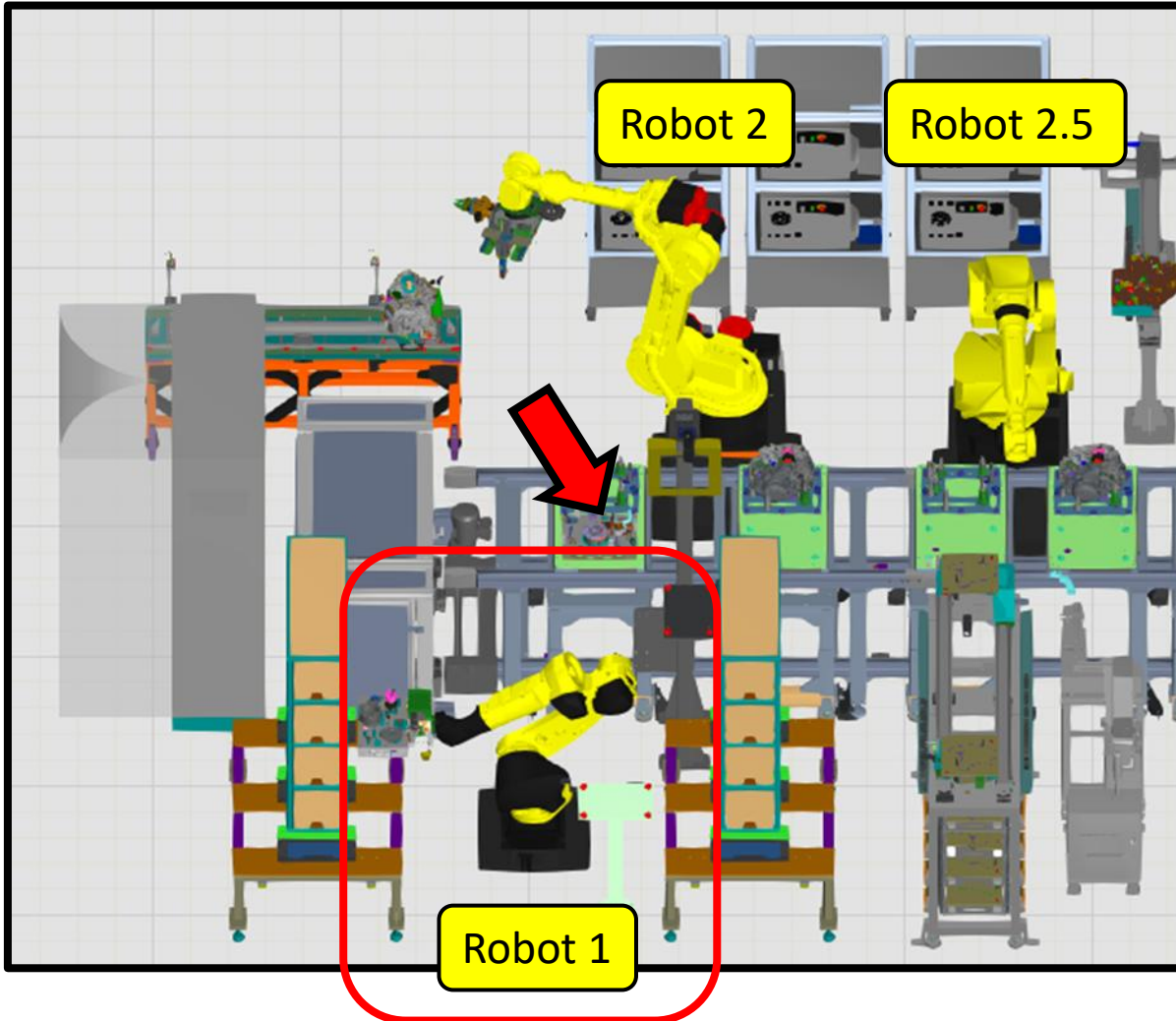
iRVision 2D and 3D
camera kit-bin inspection

Projects



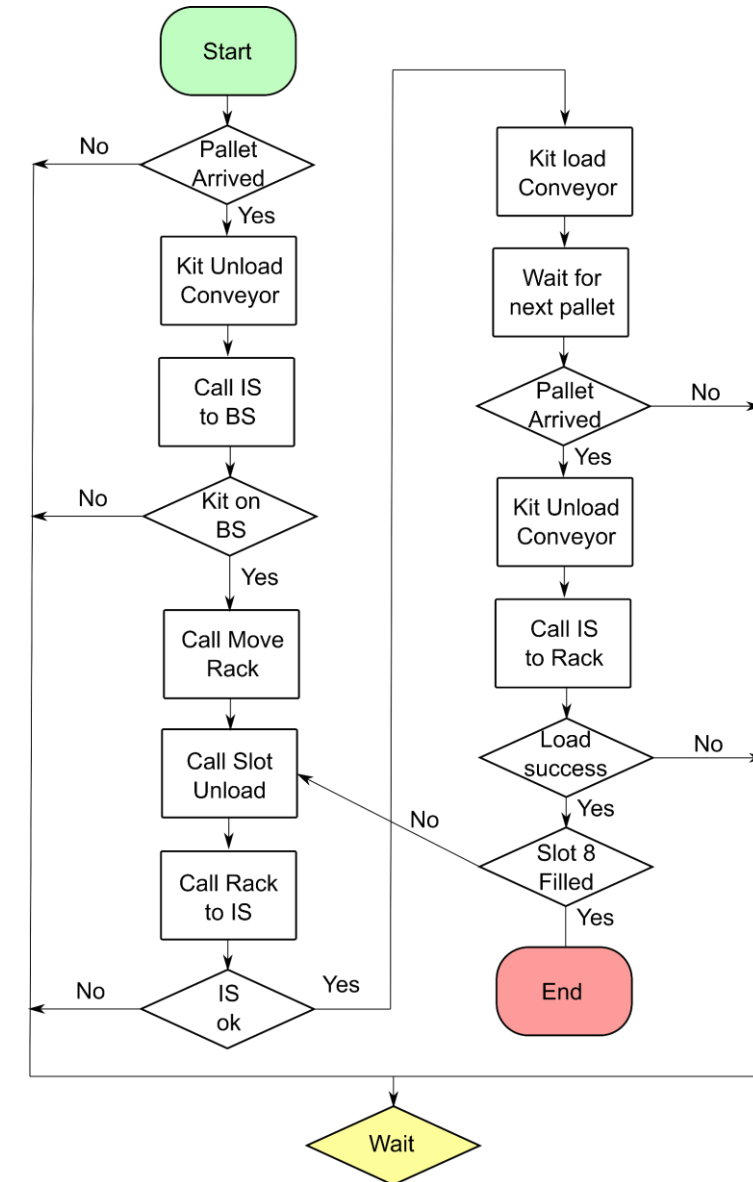
SG4 Robotic Assembly line

Layout and Stages



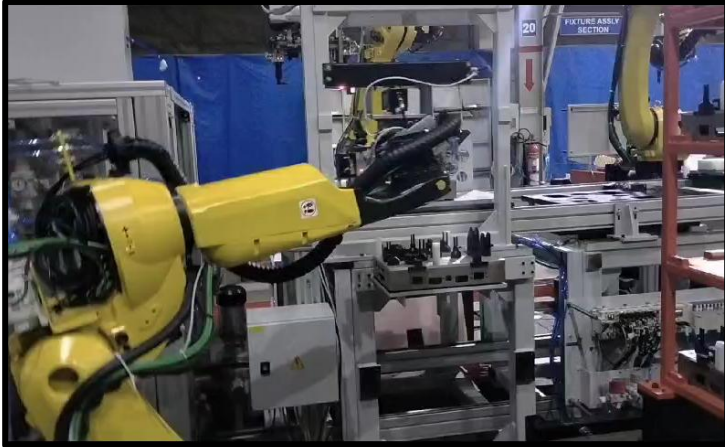
Robot 1:

- Pick from Conveyor and load to buffer
- Pick from Rack and load to Inspection
- From Inspection and load to Conveyor
- Pick from Conveyor and load to Rack
- Repeat



Vision Robot - Picking and placing of kit-bin basic function

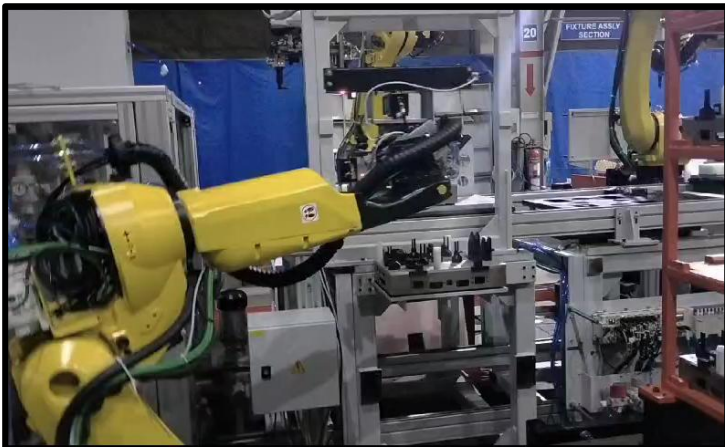
Picking from Conveyor - Taking to the IS - Loading to the BS



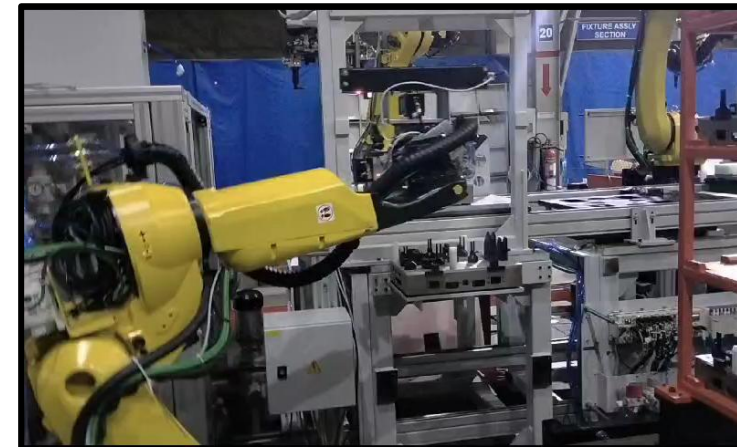
Picking from the Rack- Taking to the Home - Loading the IS



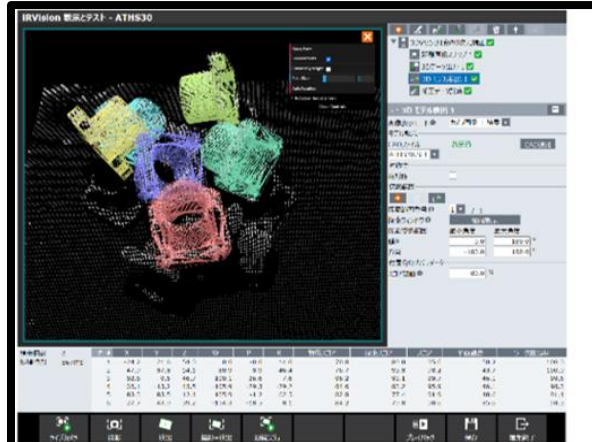
Picking from the BS - Taking to the rack - Loading the rack



From the IS - Loading the Conveyor



Use of CAD Data for Efficient picking

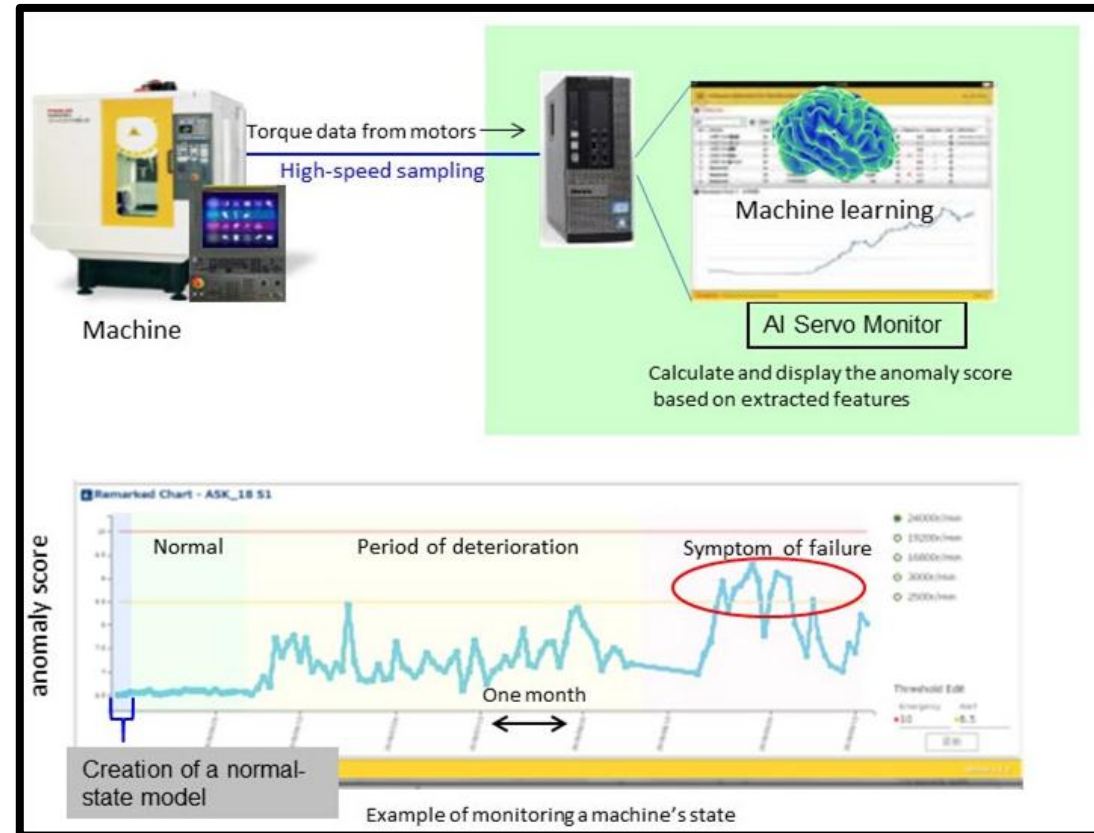


Screen of the 3D Model Detection Function

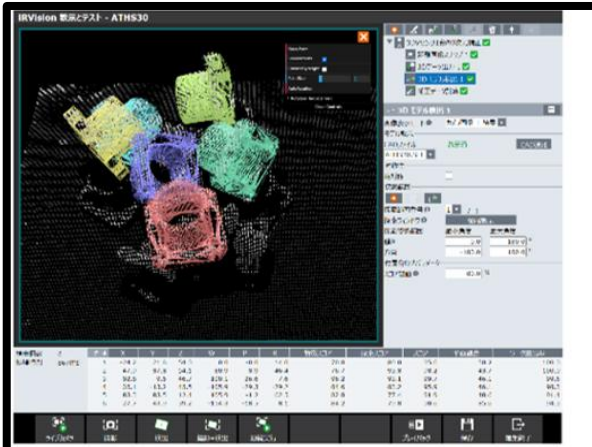


Bin-picking of parts

AI Monitoring of Data



Loading of the Kit-bins



Screen of the 3D Model Detection Function



Bin-picking of parts

FANUC has developed the 3D Model Detection Function, which easily captures the characteristics of a part from its 3D CAD data and uses vision to detect the part. It can be applied to a system in which a robot picks up one of many parts placed randomly in a returnable container, by using a 3D vision sensor.

- The part detection processing is performed by [PANEL iH Pro](#).
 - a. Improved the detection capability
 - b. Reduced the detection time
 - c. Made it easier for FANUC to provide lifetime maintenance.

- Our Aim:
 - a. To enable autonomous loading of part into kit-bins
 - b. For proper picking of part from kit-bin even if its misaligned
 - c. To autonomously correct disorders in rejection kit-bins

https://www.fanuc.co.jp/en/product/new_product/2021/202107_irvision3dmodel.html

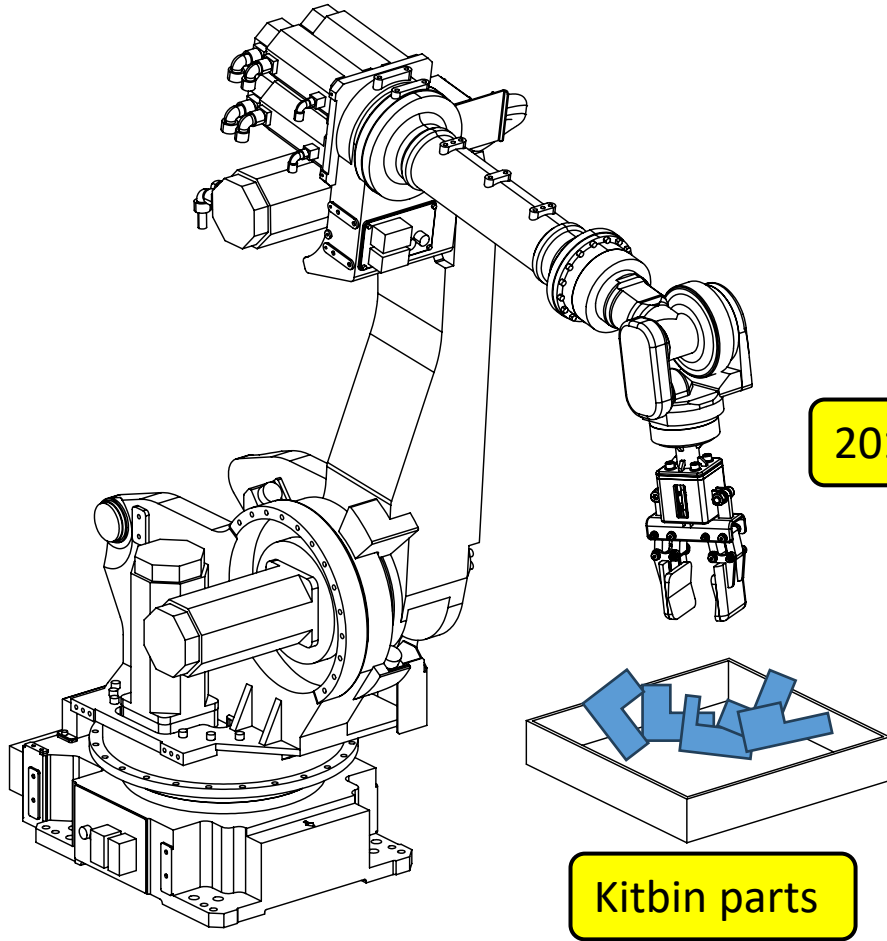
July 2021

Industry 4.0 Solutions – What other companies are doing

Fanuc loading of the Kit-bins

2014

Mitsubishi Electric



2019

Euclid Labs

Euclid Labs
3D Vision and Robotics

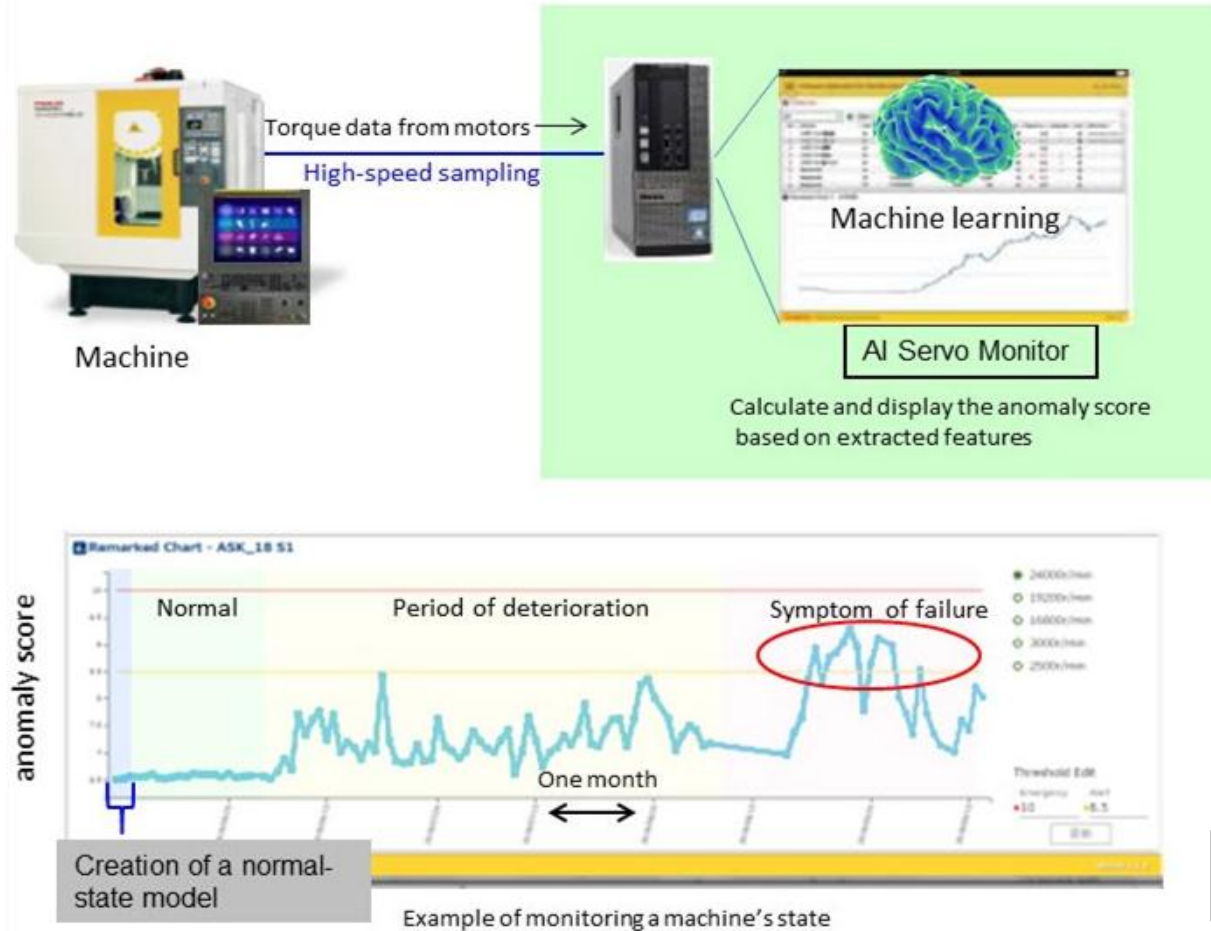
Important Question to ask

Do we really need – A kit-bin rack?

Do we really need – A robot to load kit-
bins in the rack? Can't each robot pick their parts from a bin
with parts in random orientation? Can't we make it fully autonomous?



Fanuc AI to prevent failure



Problems that can occur:

- Mechanical breakdown caused by sudden malfunction of the spindle axes or feed axes of a machine tool

Solution:

- Train a model using torque data from motors as input while the machine is operating normally.
- The trained model has extracted features of the torque data and can represent its normal state.
- During the machine's actual operation, AI Servo Monitor takes the torque data as input and compares it with the normal state to calculate and display the anomaly score.

<https://www.fanuc.co.jp/en/profile/pr/newsrelease/2018/notice20180529.html> April 2018

<https://www.fanuc.co.jp/en/profile/pr/newsrelease/2019/notice20190411.html> April 2019

Autonomous Ground Vehicle a.k.a. AMR

Simultaneous Localization and Mapping (SLAM) is a technology that allows autonomous vehicles to:

- Create a map and
- Locate themselves on that map simultaneously

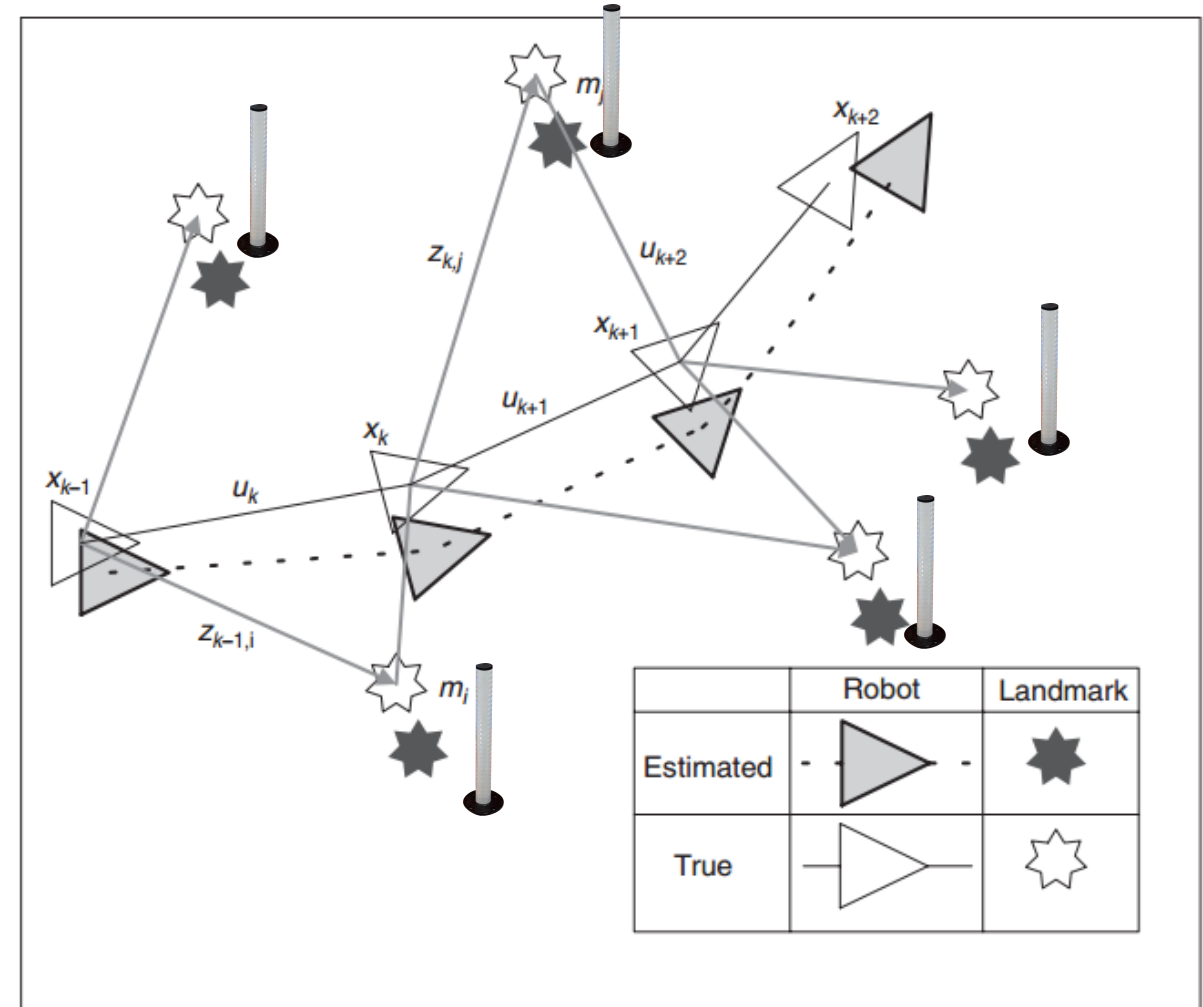
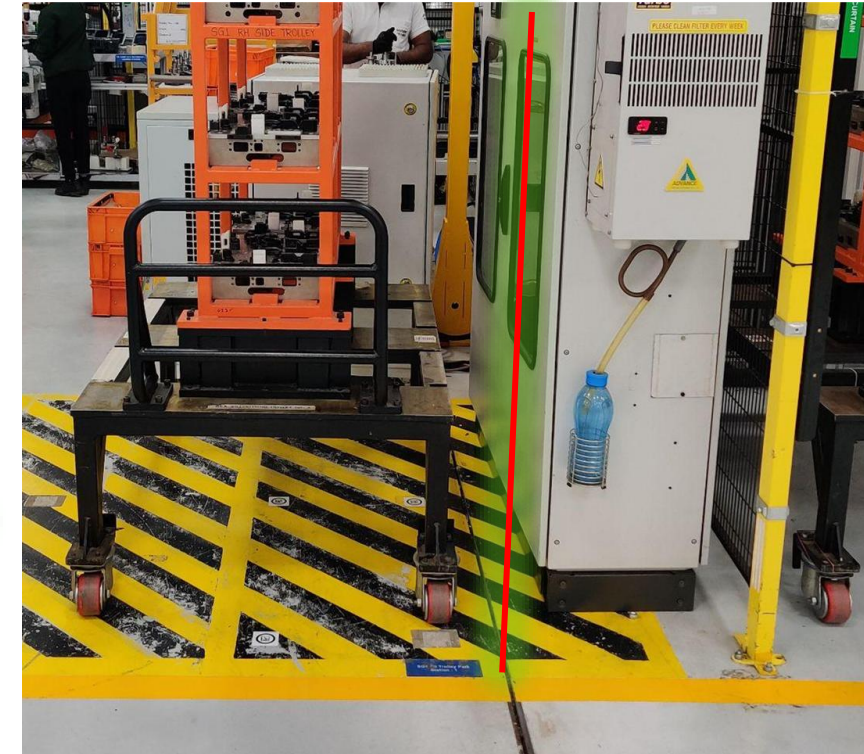


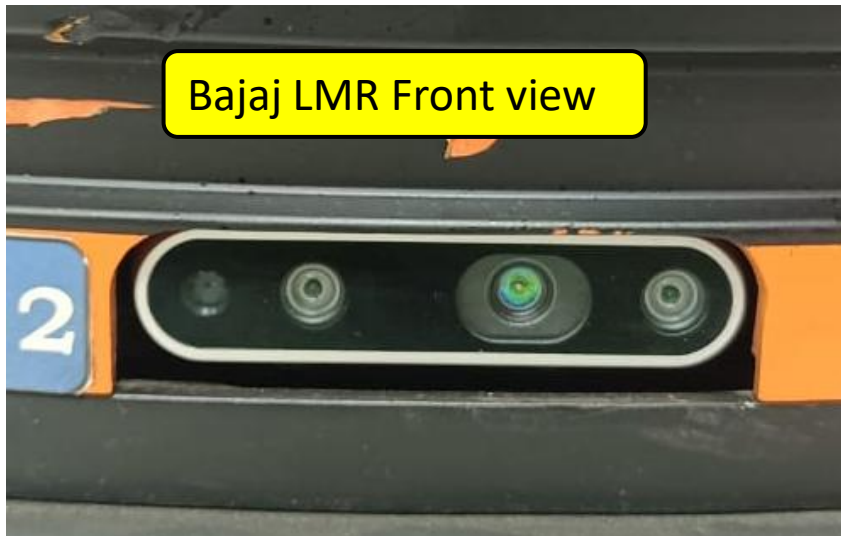
Figure 1. The essential SLAM problem. A simultaneous estimate of both robot and landmark locations is required. The true locations are never known or measured directly. Observations are made between true robot and landmark locations.

- Problems faced during AMR operation.
 - Reflector location issues
 - Environment change issues

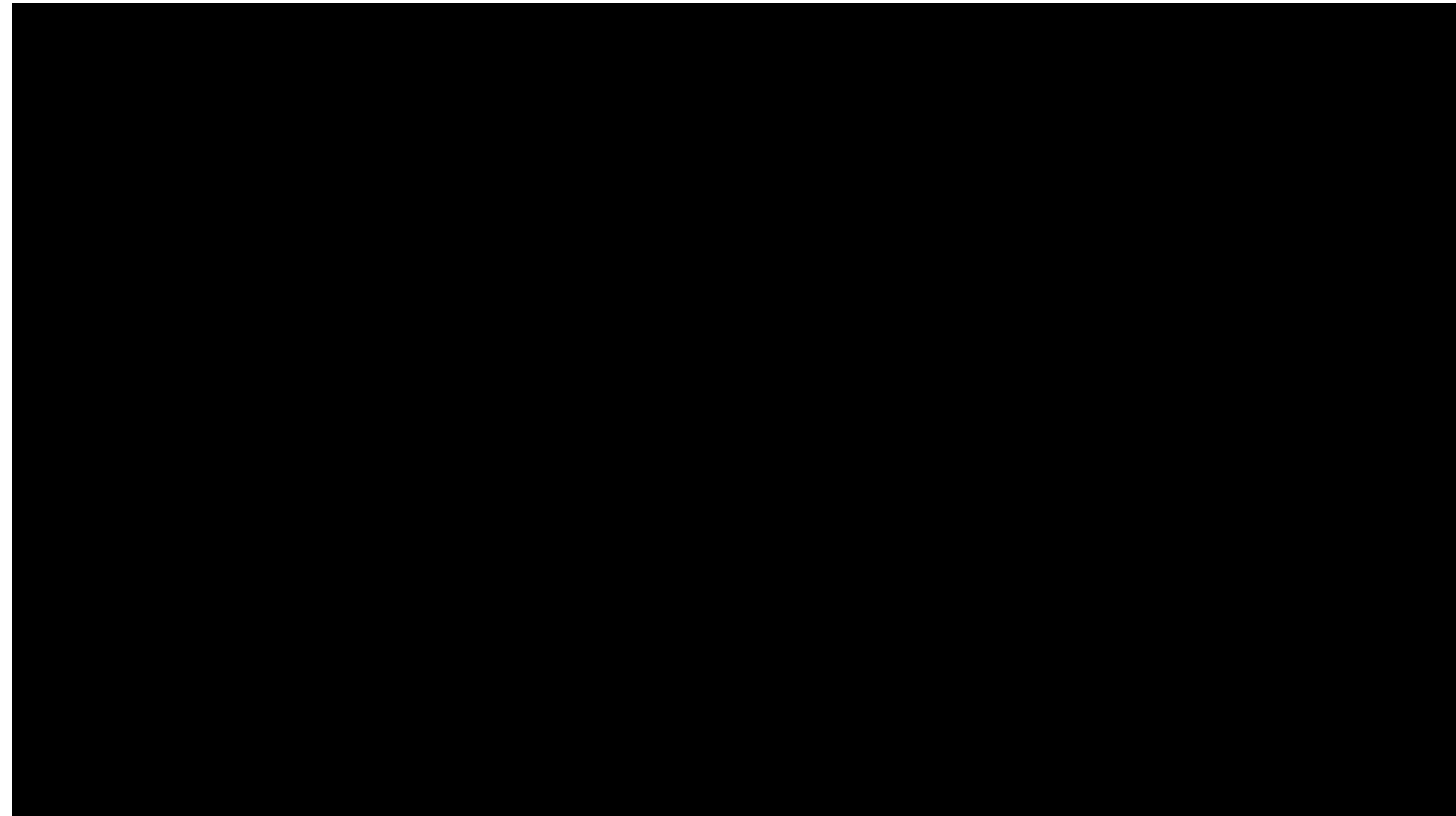
Solution:

- Introduction of 3D SLAM to avoid use of Reflectors.
- First finalize the Environment and then start AMR mapping process.





Utilizing Depth camera already installed in the AMR for 3D SLAM purposes

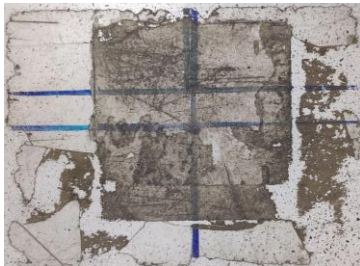


Accelerometer m/sec^2

Gyroscope rad/sec

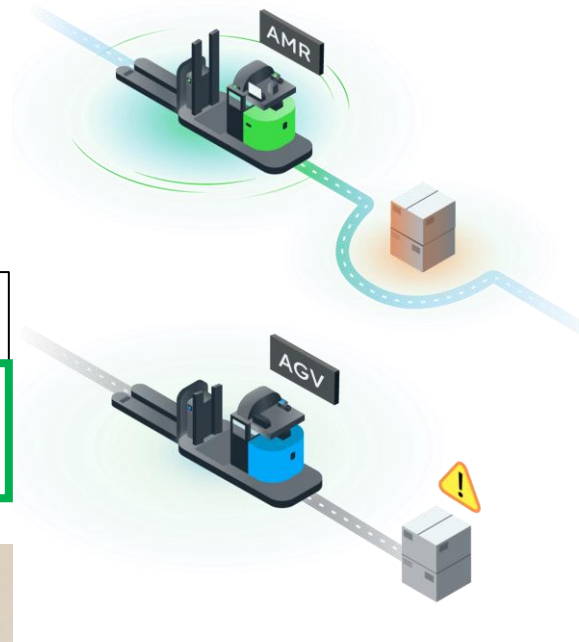
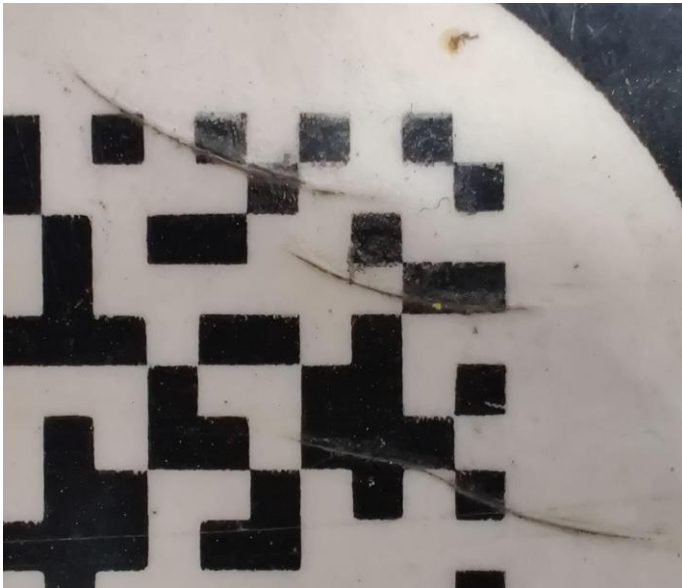


- Problems faced during AMR operation.
 - QR vulnerability
 - No option for path planning (Dumb AMR)



Solution:

- Make QR code on steel plates – laser etched



Path planning requires a map of the environment along with start and goal states as input.

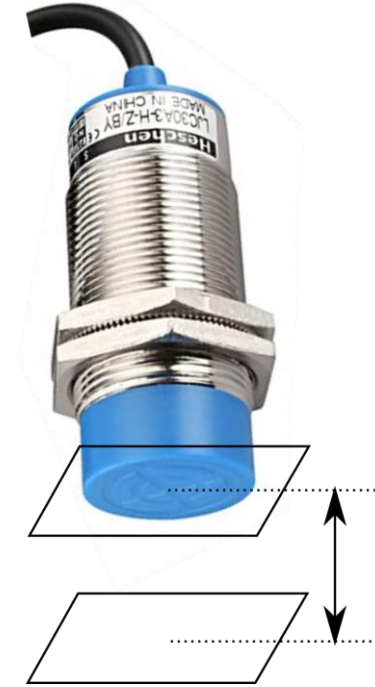


Solution:

Utilysing LMR's **Dynamic Obstacle By-passing capability!!**

- But it's not possible currently in Bajaj KTM engine line as the other paths are very close to each other.
- Exploring the possibility.

- Problems faced during AMR operation.
 - Rack wheel issue
 - Proximity issue

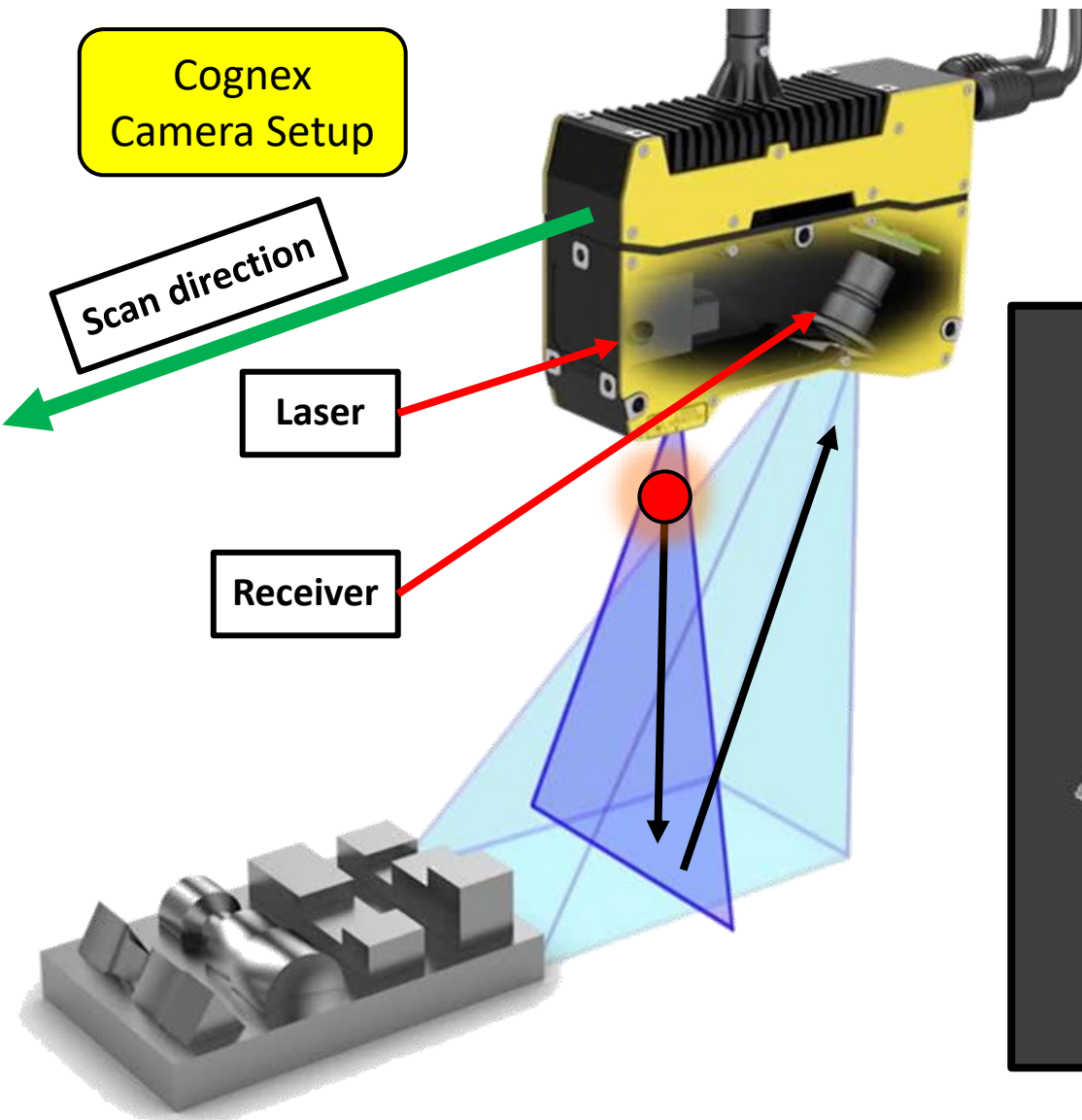


Solution:

- Will go away once the full line is running in Auto cycle
- Have to insure the clamps be present permanently

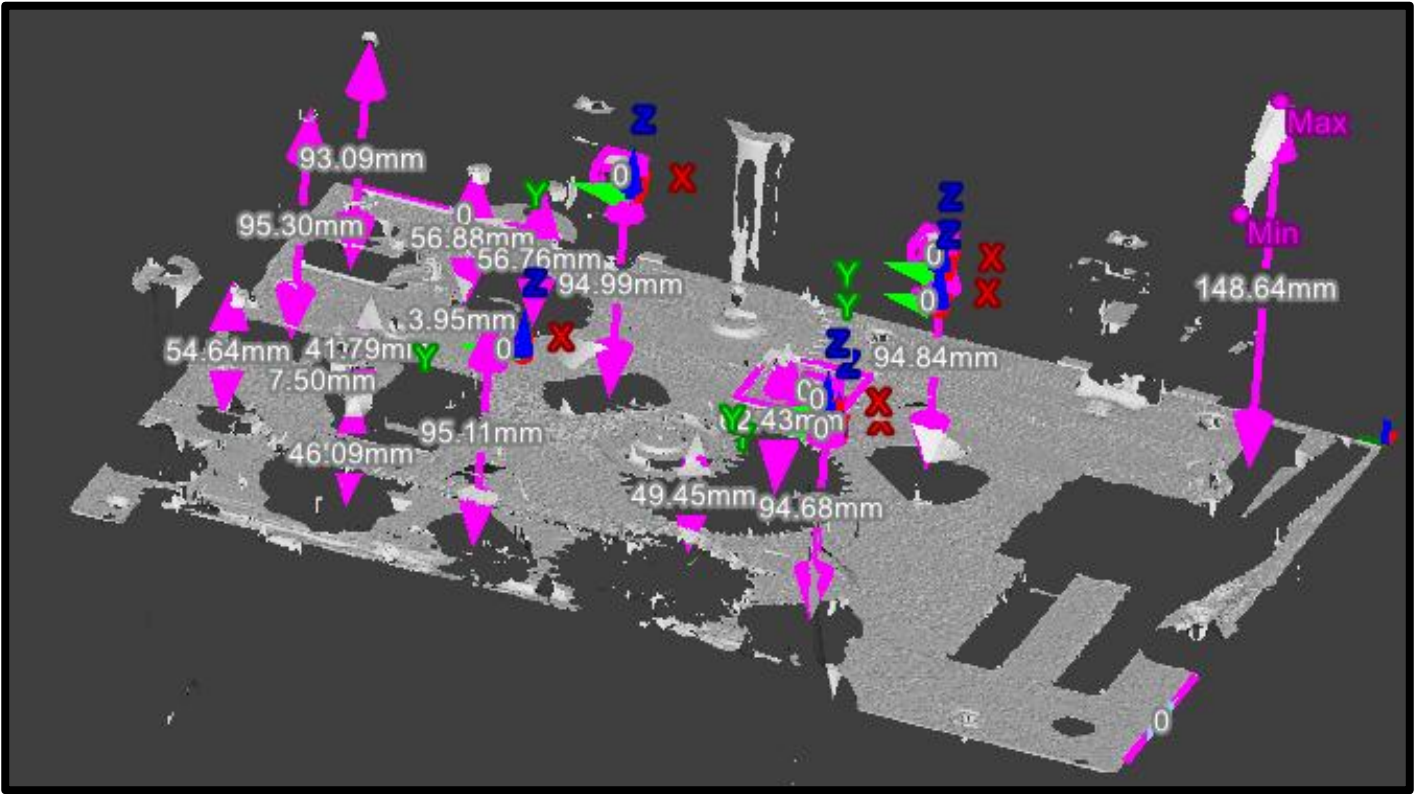
Solution:

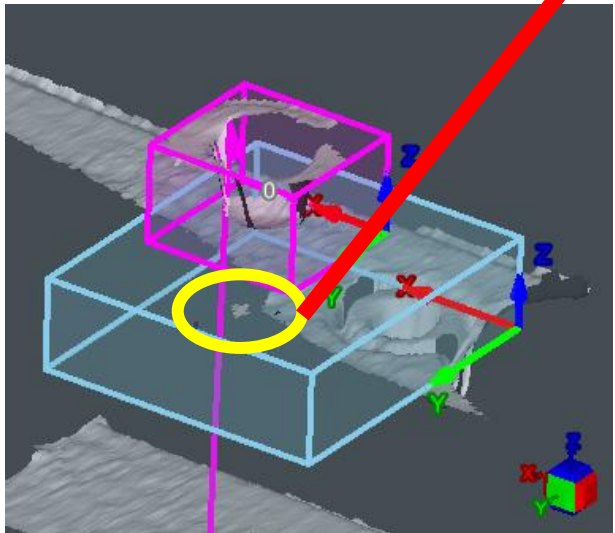
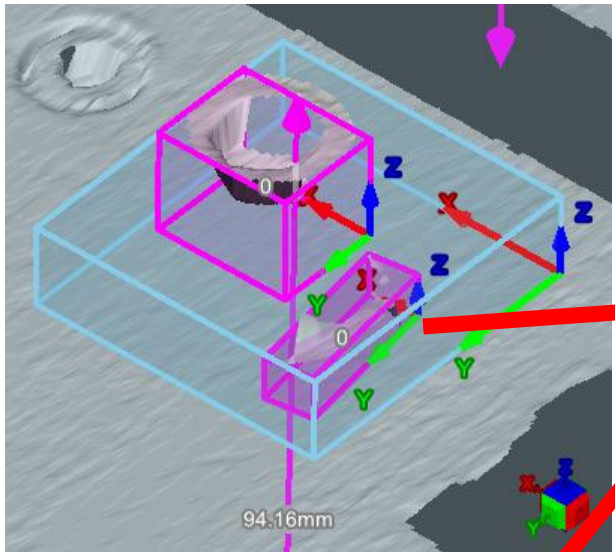
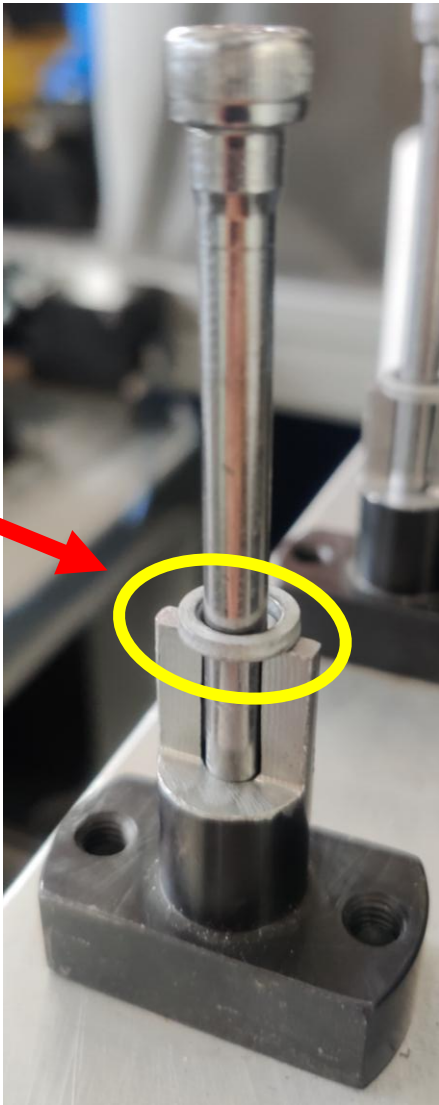
- Increase the Proximity sensor sensing limit
- Design proper fixtures for the sensor



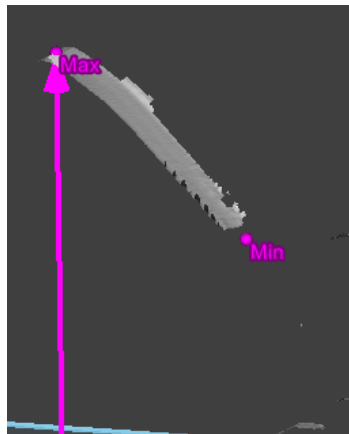
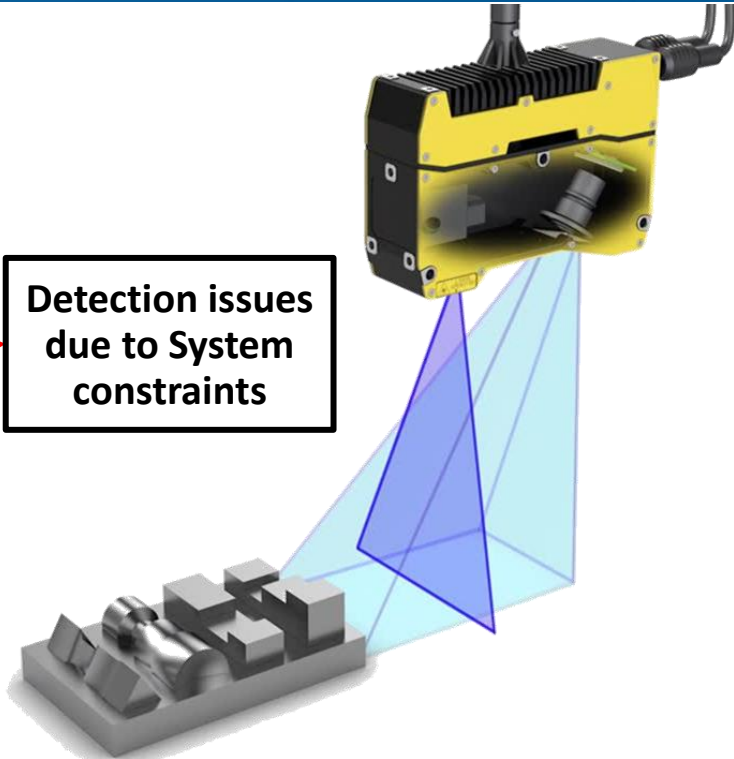
3D Point cloud data

Points received at various heights





Detection issues due to System constraints



Learnings

- **Fanuc Robot Programming**
 - Teaching
 - Force control
 - Handshaking
 - I/O Working
- **Vision system 2D and 3D**
- **PLC**
 - 2 Day Mitsubishi training completed
- **Autonomous mobile robot**
 - Path and Map making
 - SLAM
- Working of PLC + MES + Fanuc all together

Already implemented

- **SG4 Vision Robot 1**
 - Calibration
 - Snapping
 - Loading and unloading
 - Rack
 - Conveyor
 - Buffer
 - Full cycle program
 - Cycle time (**36s start**)
- **AMR Integration**
 - SG1
 - SG2

Goals

- Introduce **Industry 4.0** solutions for Bajaj Auto

- Utilise current available resources and incorporating AI as much as possible

- Plan complete automation – No human interference for SG4 - **Chain insertion SG4 ***

Extra learning to implement at Bajaj

- AI courses *
- Industry 4.0 certification *

Thank You!

* in progress