

MATLAB EXPO

基于云的MATLAB视觉检查系统

Yixin Chen



什么是自动视觉检查

Automated visual inspection is the evaluation of images or video, typically to detect failures and quality defects—often in manufacturing processes.

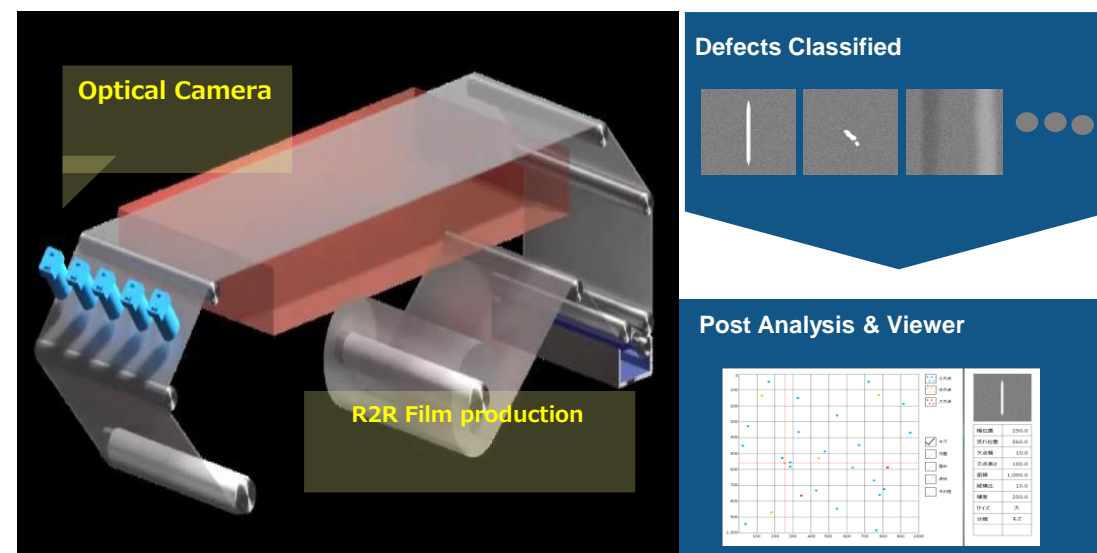
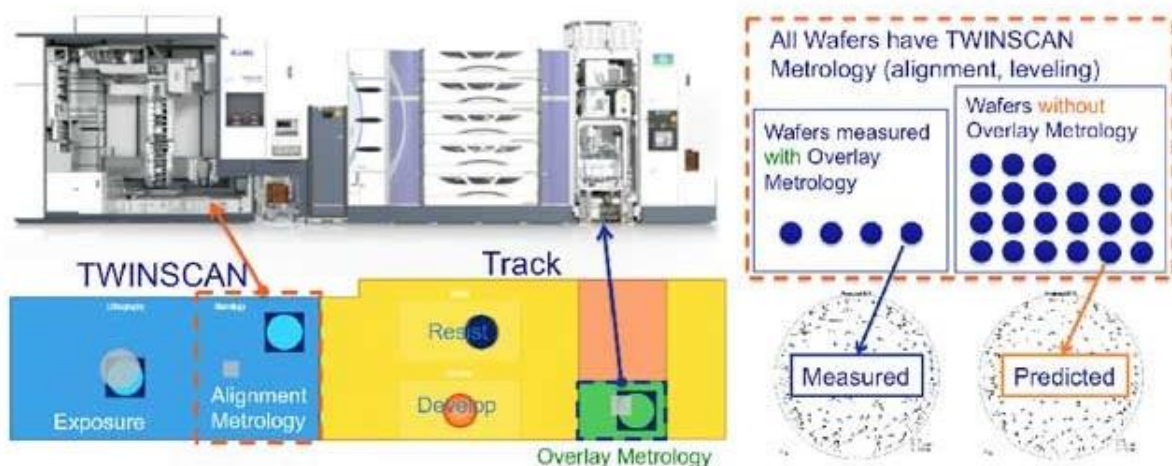
Automated Defect Detection

Machine Vision

Optical Inspection

Automated Inspection

MATLAB 自动视觉检查应用案例



Metrology Technology for Semiconductor Manufacturing



Film Production Inspection



基于云的视觉检查系统中的 MATLAB AI

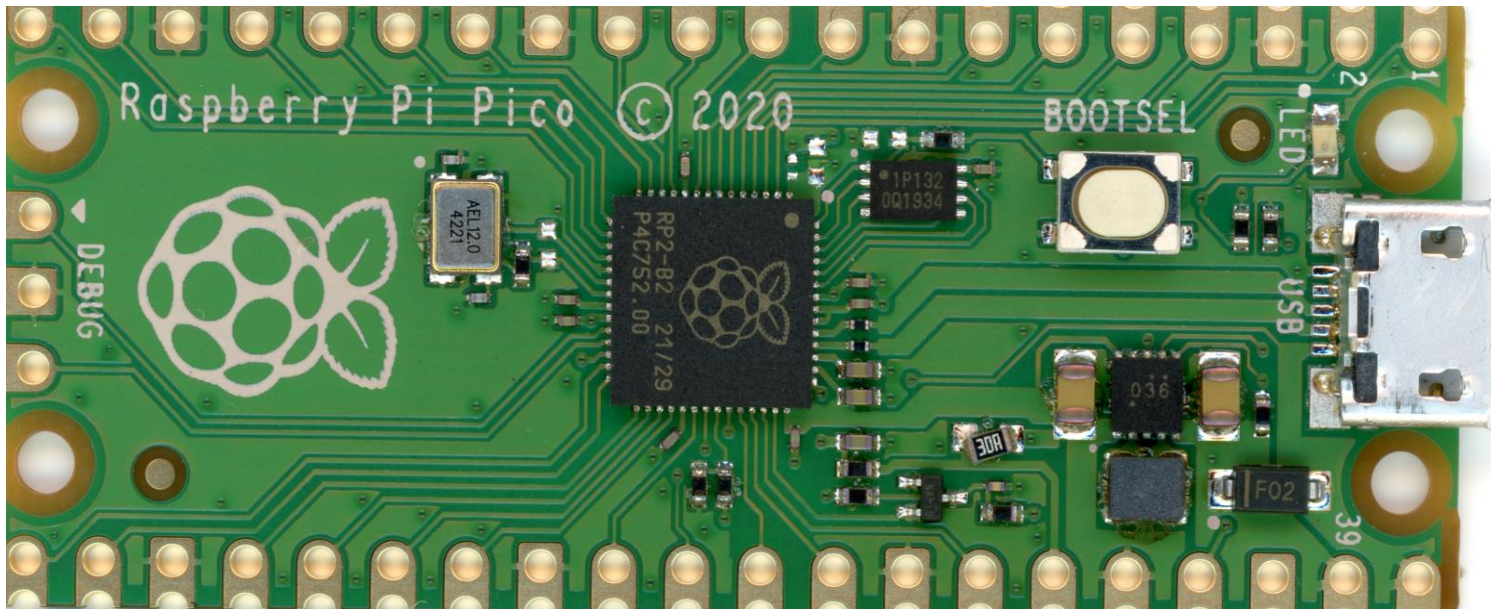
Requirements: A visual inspection system should:

- Be secure
- Run at-scale
- Be re-purposable for different applications

MATLAB's AI solution was operationalized on the cloud using:

- Microservices built to modern standards and best practices for scalability / security
- DevOps processes for agility in development and deployment of AI and vision algorithms

示例问题：检测和表征树莓派上的缺陷

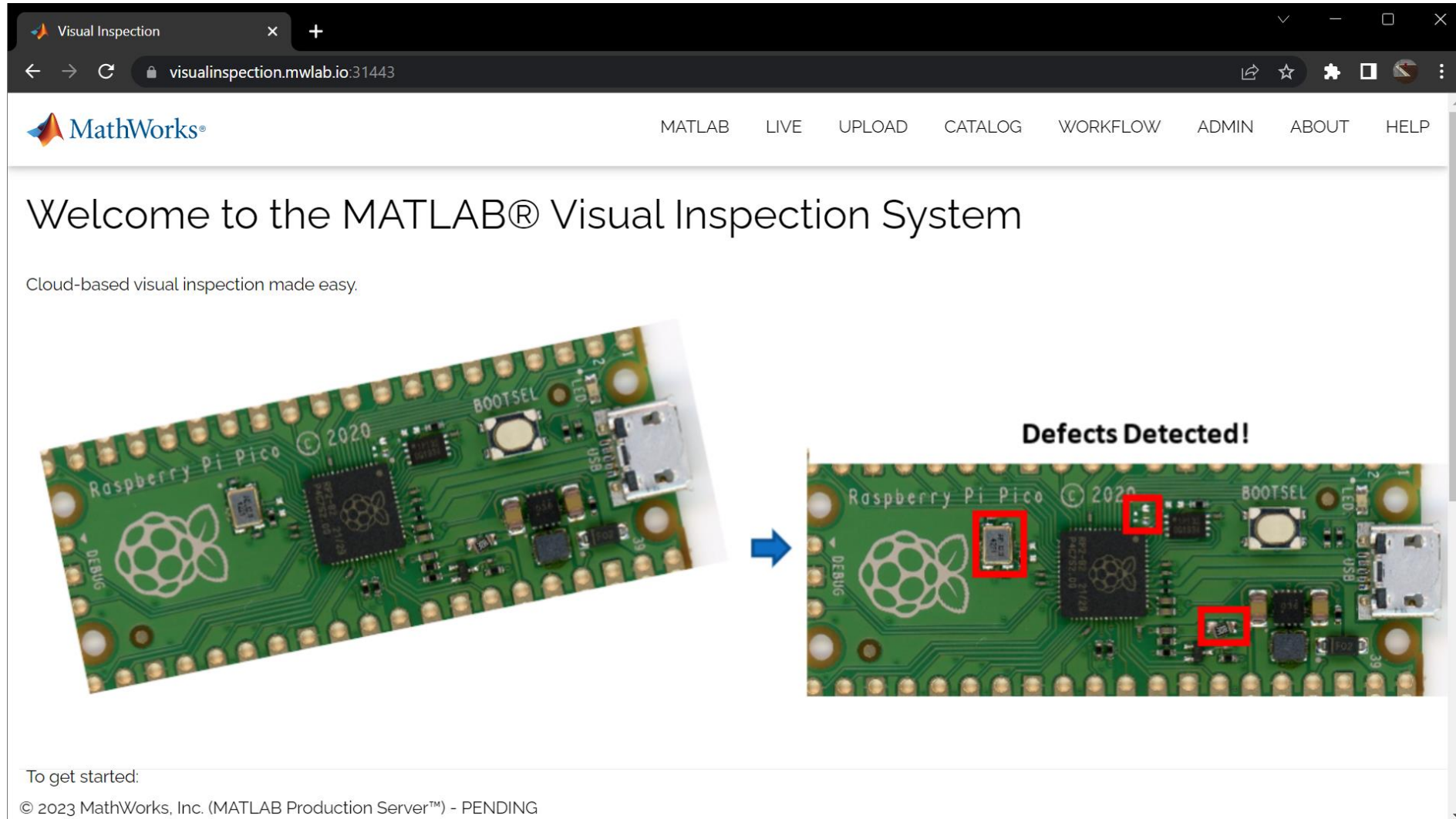


Potential defects* include:

- Misaligned components
- Bad assembly
- Damage
- Missing Solder
- Labeling mistakes
- Other?

**NOTE: Defects were artificially introduced for this demonstration.*

示例演示



The screenshot displays the MATLAB Visual Inspection System interface. The browser address bar shows the URL `visualinspection.mwlab.io:31443`. The page header includes the MathWorks logo and navigation links: MATLAB, LIVE, UPLOAD, CATALOG, WORKFLOW, ADMIN, ABOUT, and HELP. The main heading reads "Welcome to the MATLAB® Visual Inspection System" with the subtext "Cloud-based visual inspection made easy." Below this, two images of a Raspberry Pi Pico board are shown. The left image is the original board, and the right image, titled "Defects Detected!", shows the board with three red boxes highlighting detected defects: a missing component on the left, a component on the right, and a component at the bottom right. A blue arrow points from the original board to the detected board.

Visual Inspection

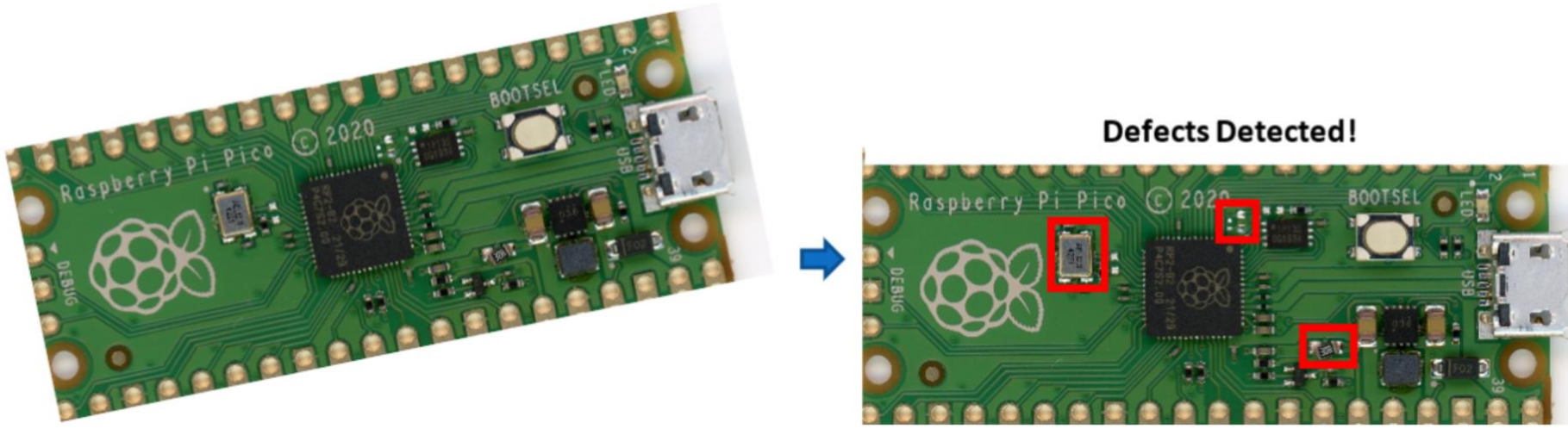
visualinspection.mwlab.io:31443

MathWorks®

MATLAB LIVE UPLOAD CATALOG WORKFLOW ADMIN ABOUT HELP

Welcome to the MATLAB® Visual Inspection System

Cloud-based visual inspection made easy.



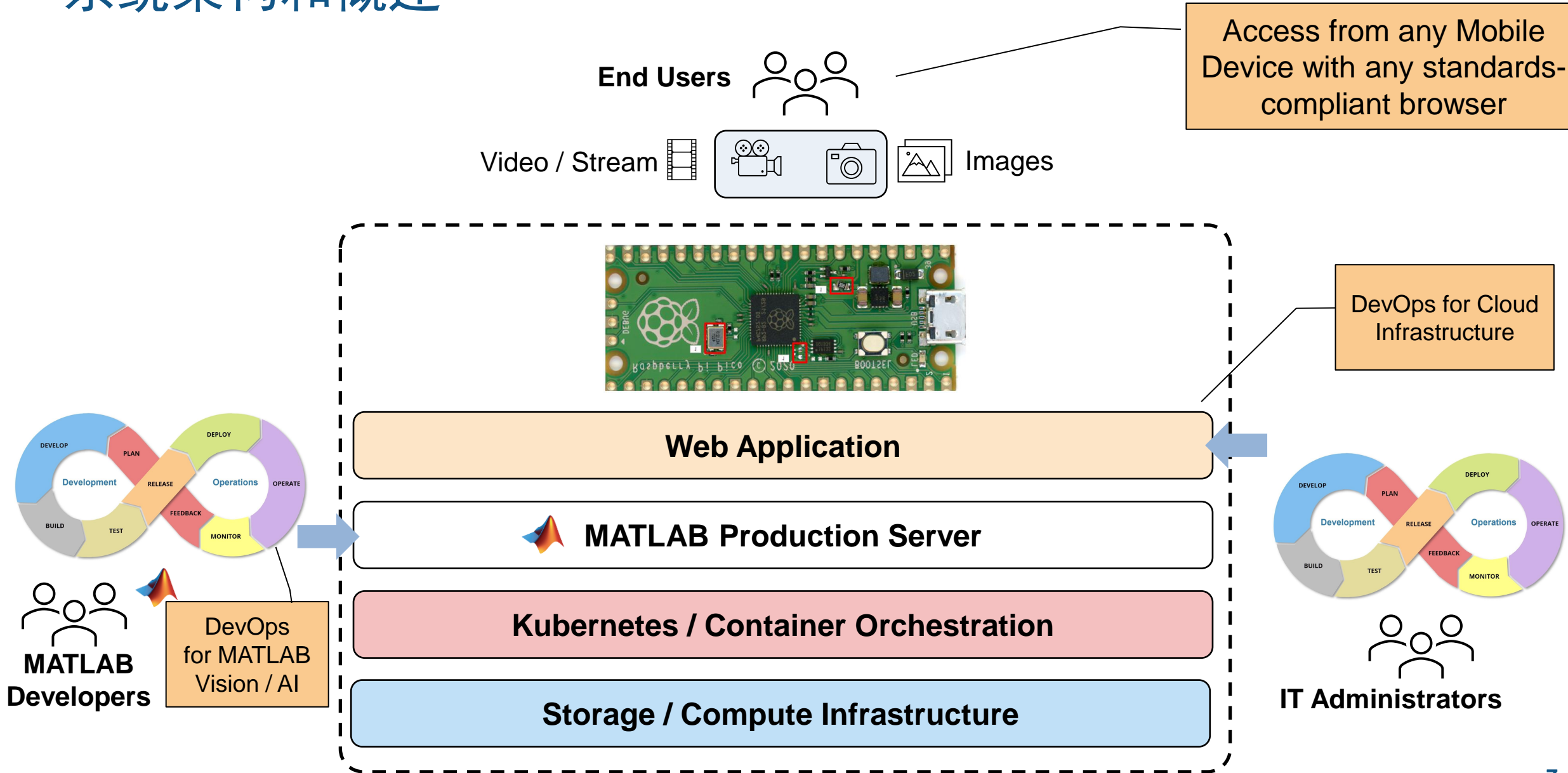
Defects Detected!

To get started:

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A Cloud-based MATLAB Visual Inspection System

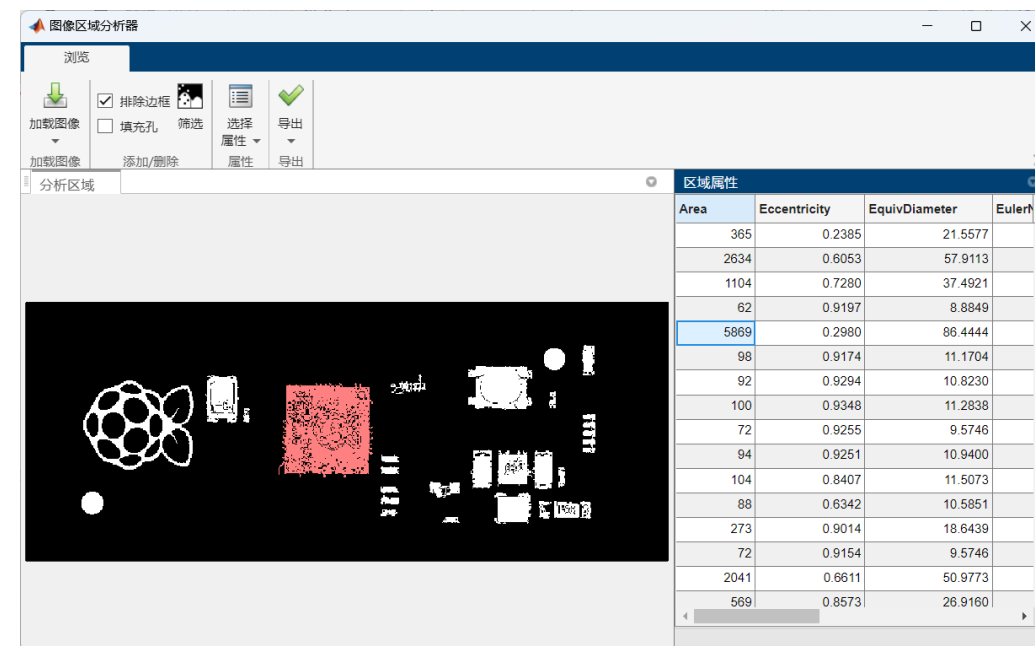
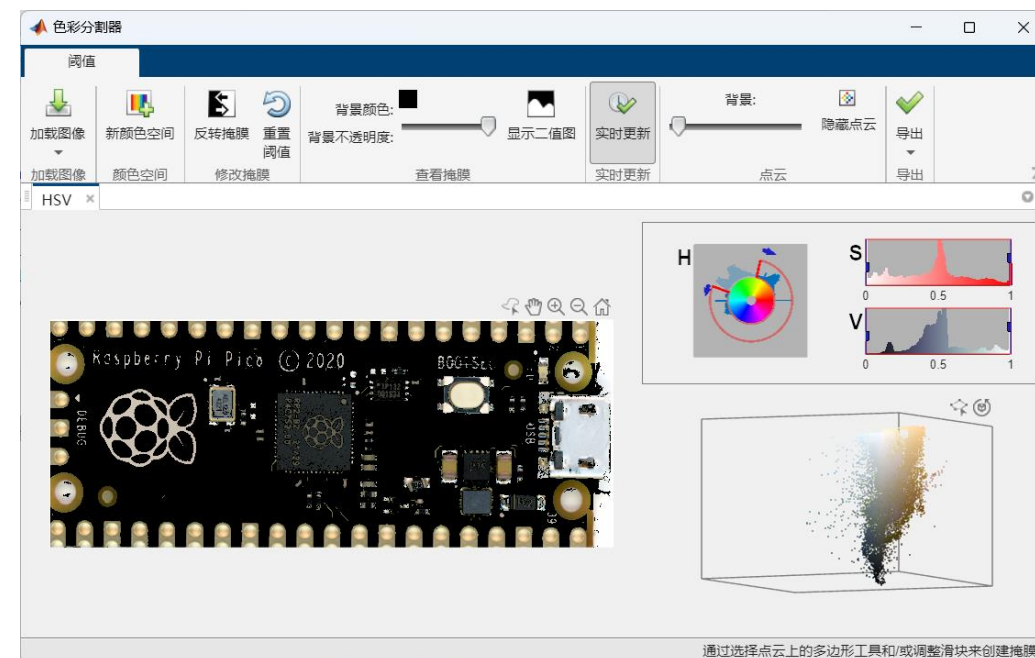
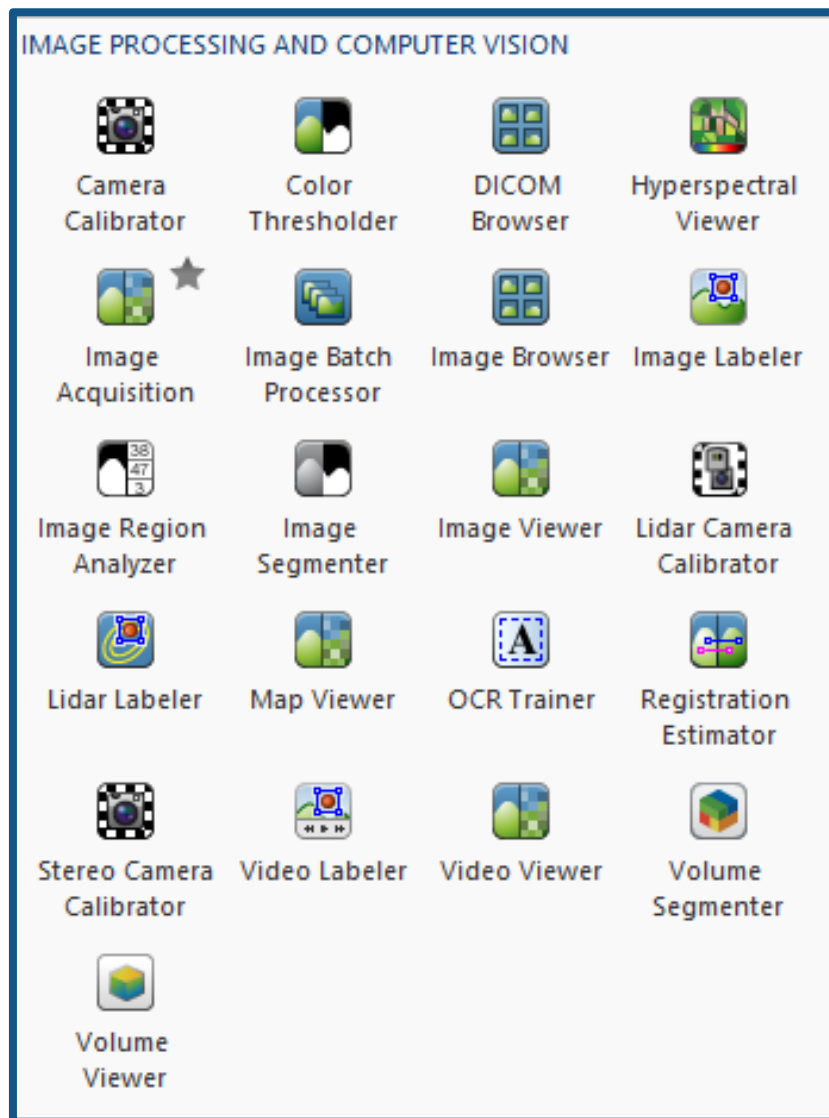
系统架构和概述



MATLAB 算法开发

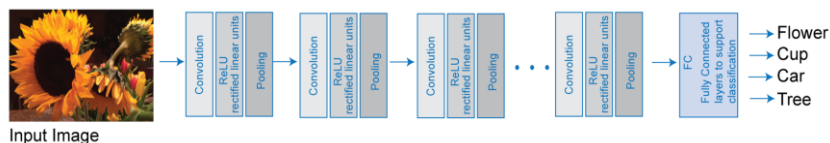
Image Processing Toolbox
Computer Vision Toolbox
Deep Learning Toolbox
Statistics and Machine Learning Toolbox
...

用于视觉检查的图像处理APP

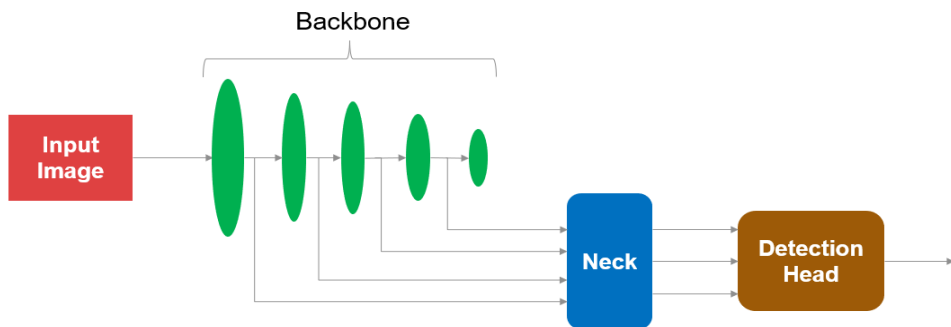


用于视觉检查的深度模型架构

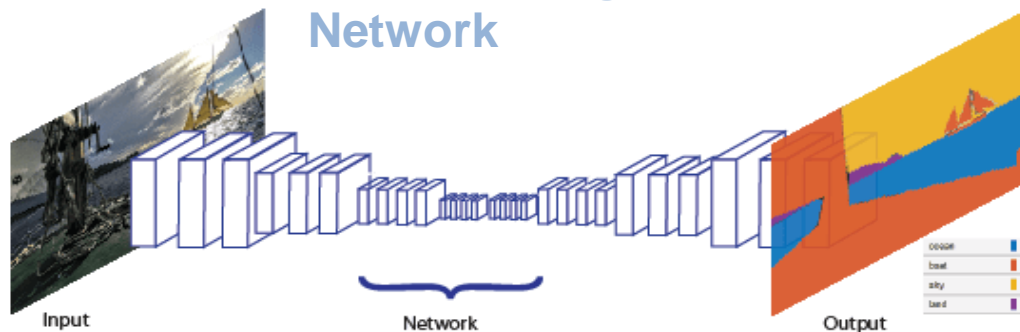
Convolutional Neural Networks



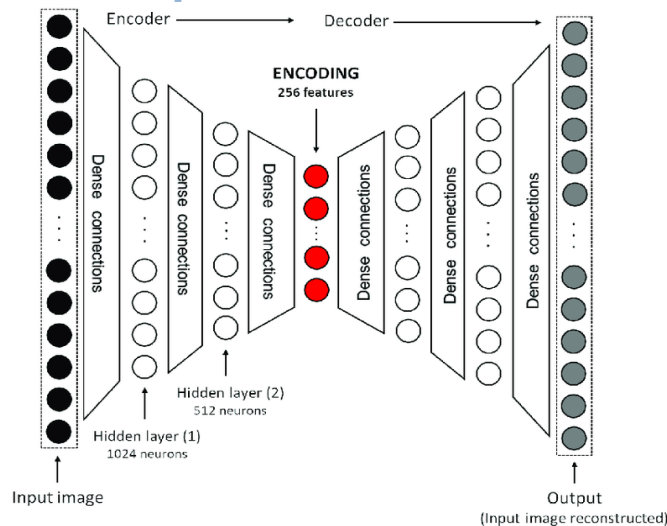
YOLO – Object Detector



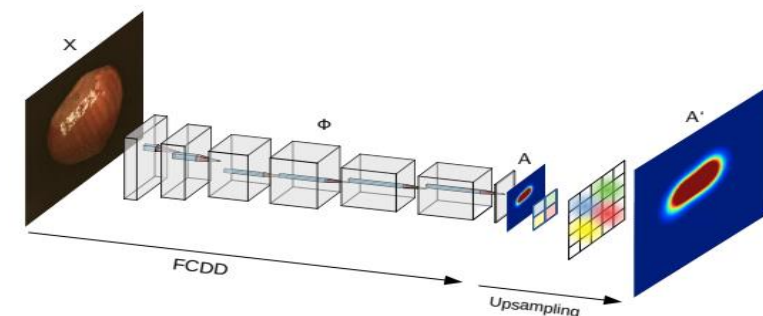
Semantic Segmentation Network



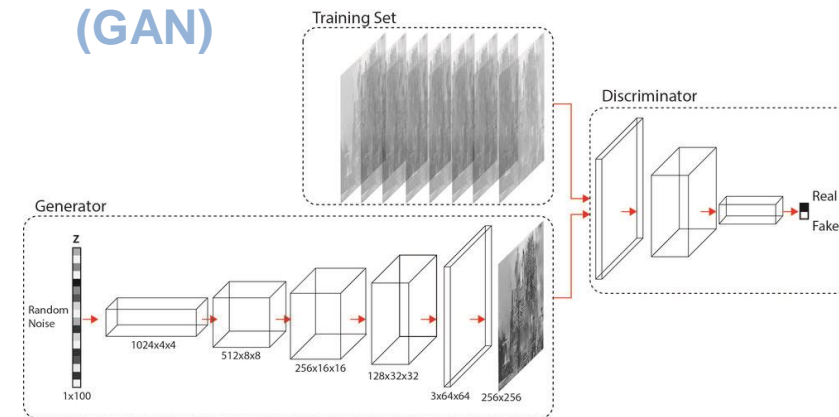
Deep Autoencoder



Fully Convolutional Data Description (FCDD) – Anomaly Detector



Generative Adversarial Network (GAN)



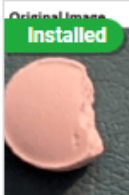
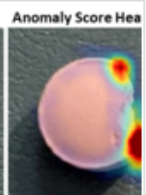
MATLAB 算法开发

Contribute | Manage Add-Ons

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Search for add-ons

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Computer Vision Toolbox Automated Visual Inspection Library

by MathWorks Computer Vision Toolbox Team STAFF

Identify anomalies or defects in images to assist and improve quality assurance processes.

▶ MathWorks Optional Feature

★★★★★ (0)

67 Downloads ⓘ

Updated 15 Mar 2023


Manage

Overview
Reviews (0)
Discussions (0)

The Computer Vision Toolbox™ Automated Visual Inspection Library offers functions that enable you to train, calibrate, and evaluate anomaly detection networks.

The library enables:

Training and evaluating state of the art anomaly detectors including [PatchCore](#), [FCDD](#), and [FastFlow](#). All detectors support standalone deployment with MATLAB Coder, GPU Coder, and MATLAB Compiler.



Calibration trained networks by setting the anomaly threshold for a given number of false positive and detection that are

Requires

- ✔ [Computer Vision Toolbox](#)
- ✔ [Image Processing Toolbox](#)

MATLAB Release Compatibility

Created with R2022b
Compatible with R2022b to R2023a

Platform Compatibility

Windows macOS Linux

Tags

[Add Tags](#)

computer vision

deep learning

image processing

MATLAB 算法开发

Documentation Examples Functions Blocks Apps

Automated Visual Inspection

R2023a

Automate quality assurance tasks using anomaly detection and classification techniques

Automated visual inspection (AVI) is a set of techniques used to determine whether an image represents a normal ("good") state or an anomalous ("defective") state. AVI assists and improves quality assurance processes commonly found in manufacturing settings. Modern visual inspection uses machine learning and deep learning techniques to produce useful results.

The specific technique you select to automate a visual inspection task depends on several factors. These factors include the amount of training data available for normal and anomalous samples, the number of anomaly classes to recognize, and the type of localization information required for understanding and monitoring predictions.

To perform automated visual inspection, download the Computer Vision Toolbox™ Automated **Visual Inspection Library** from the Add-On Explorer. For more information on downloading add-ons, see [Get and Manage Add-Ons](#). Some functionality also requires Deep Learning Toolbox™.

Functions

expand all

> Load Training Data

> Train Anomaly Detector

> Detect Anomalies Using Deep Learning

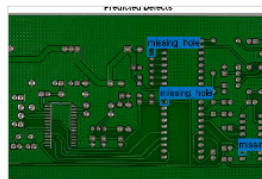
> Visualize and Evaluate Results

Topics

[Getting Started with Anomaly Detection Using Deep Learning](#)

Anomaly detection using deep learning is an increasingly popular approach to automating visual inspection tasks.

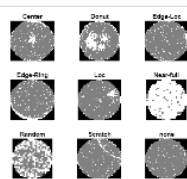
Featured Examples



Detect Defects on Printed Circuit Boards Using YOLO v4 Network

Detect, localize, and classify defects in printed circuit boards (PCBs) using a you only look once version 4 (YOLO v4) deep learning network.

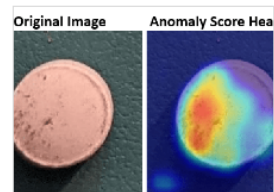
[Open Live Script](#)



Classify Defects on Wafer Maps Using Deep Learning

Classify manufacturing defects on wafer maps using a simple convolutional neural network (CNN).

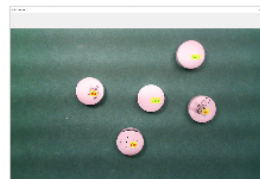
[Open Live Script](#)



Detect Image Anomalies Using Explainable FCDD Network

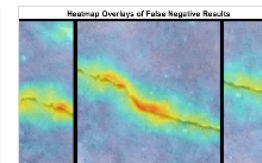
Use an anomaly detector to distinguish between normal pills and pills with anomalous chips or contamination.

[Open Live Script](#)



Detect Anomalies in Pills During Live Image Acquisition

Detect anomalies in pills during live image acquisition.



Detect Image Anomalies Using Pretrained ResNet-18 Feature Embeddings

Train a similarity-based anomaly detector using one-class learning of feature embeddings extracted from a pretrained ResNet-18

[Open Live Script](#)

MATLAB 算法开发

Documentation Examples **Functions** Blocks Apps

Automated Visual Inspection — Functions

Load Training Data

<code>groundTruth</code>	Ground truth label data
<code>sceneLabelTrainingData</code>	Create training data for scene classification from ground truth
<code>splitAnomalyData</code>	Split data into training, validation and testing sets for anomaly detection

Train Anomaly Detector

<code>trainFCDDAnomalyDetector</code>	Train fully convolutional data description (FCDD) anomaly detection network
<code>trainFastFlowAnomalyDetector</code>	Train FastFlow anomaly detection network
<code>trainPatchCoreAnomalyDetector</code>	Train PatchCore anomaly detection network
<code>anomalyThreshold</code>	Optimal anomaly threshold for set of anomaly scores and corresponding labels

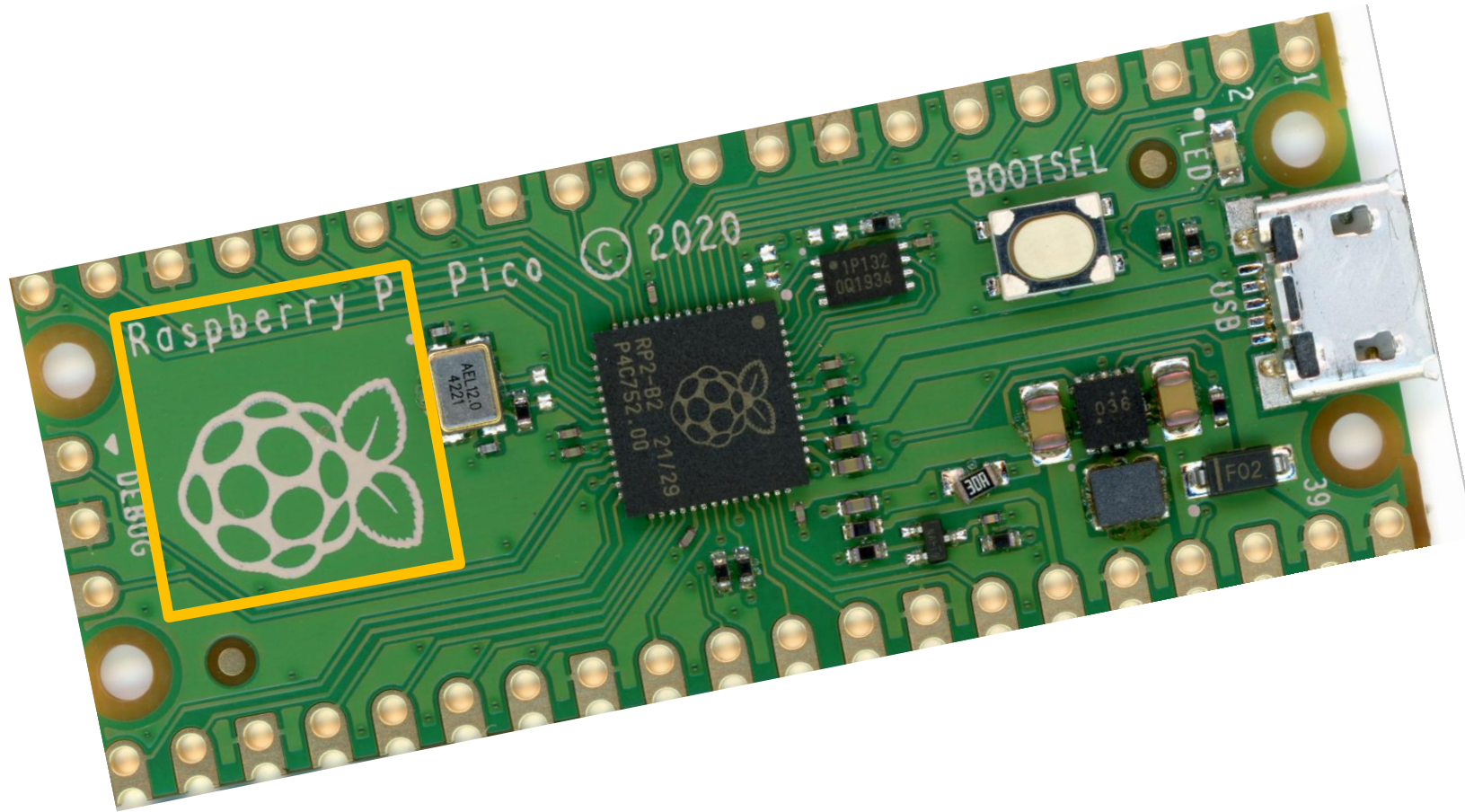
Detect Anomalies Using Deep Learning

<code>fcddAnomalyDetector</code>	Detect anomalies using fully convolutional data description (FCDD) network for anomaly detection
<code>fastFlowAnomalyDetector</code>	Detect anomalies using FastFlow network
<code>patchCoreAnomalyDetector</code>	Detect anomalies using PatchCore network
<code>classify</code>	Classify image as normal or anomalous
<code>predict</code>	Predict unnormalized anomaly scores

Visualize and Evaluate Results

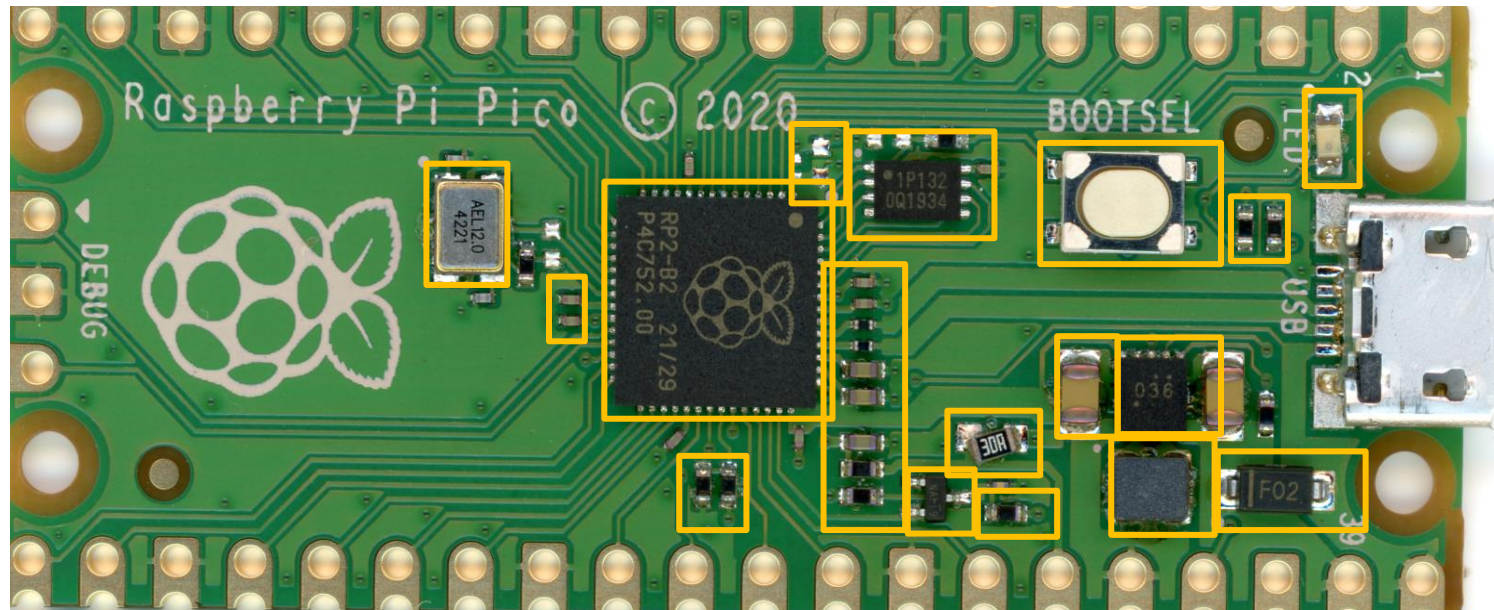
<code>anomalyMap</code>	Predict per-pixel anomaly score map
<code>anomalyMapOverlay</code>	Overlay heatmap on image using per-pixel anomaly scores
<code>viewAnomalyDetectionResults</code>	View anomaly detection results
<code>evaluateAnomalyDetection</code>	Evaluate anomaly detection results against ground truth
<code>anomalyDetectionMetrics</code>	Anomaly detection metrics

示例问题：检测和表征树莓派上的缺陷



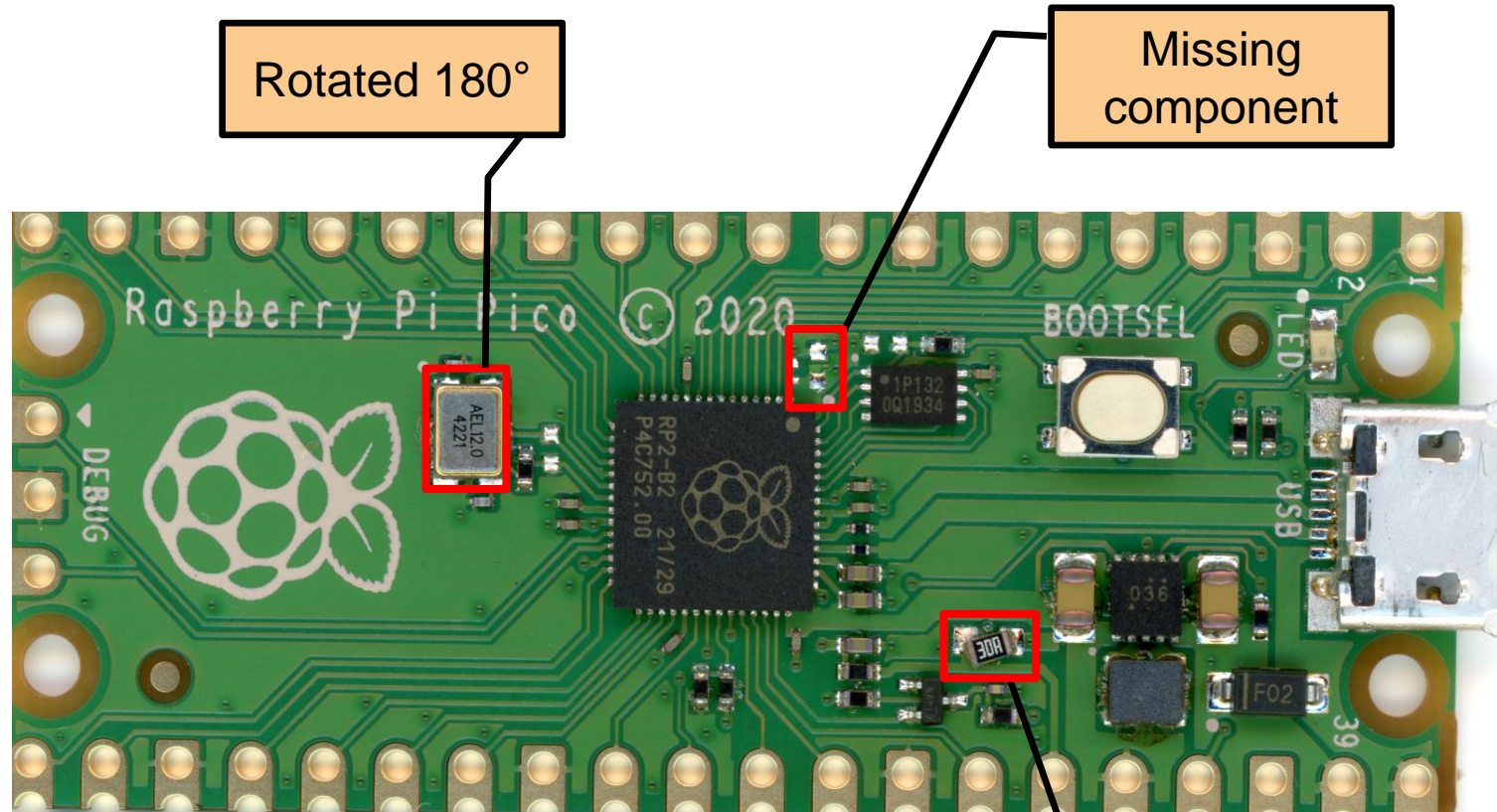
Template-based orientation and preprocessing...

示例问题：检测和表征树莓派上的缺陷



Component detection...

示例问题：检测和表征树莓派上的缺陷

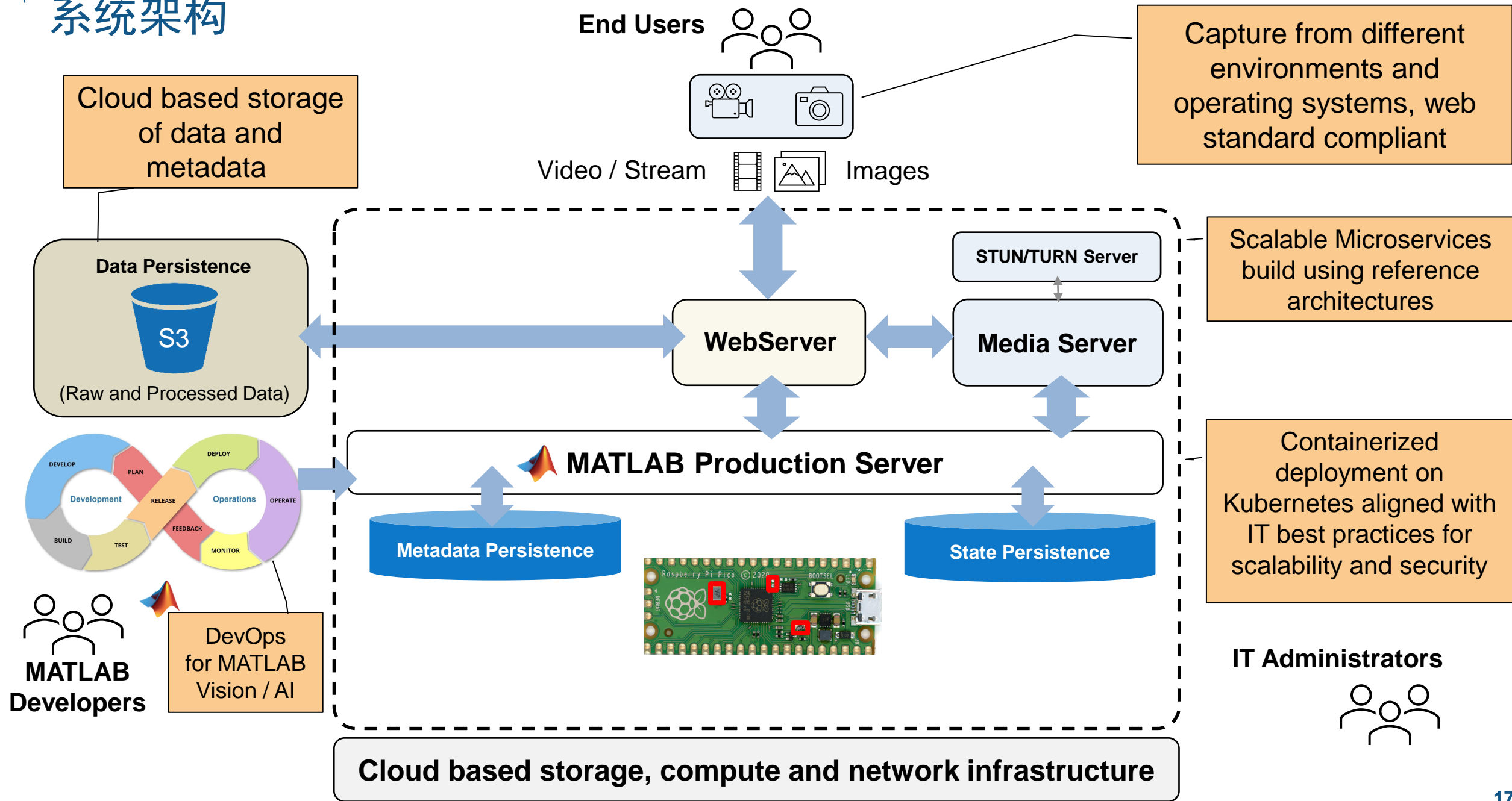


Defect detection and classification...

- QR-Code Triggering
- Live, Constrained Capture (iPhone, iPad)
- Automatic updating of ground truth and model
- Scalable, Cloud-Based Analysis and Reporting

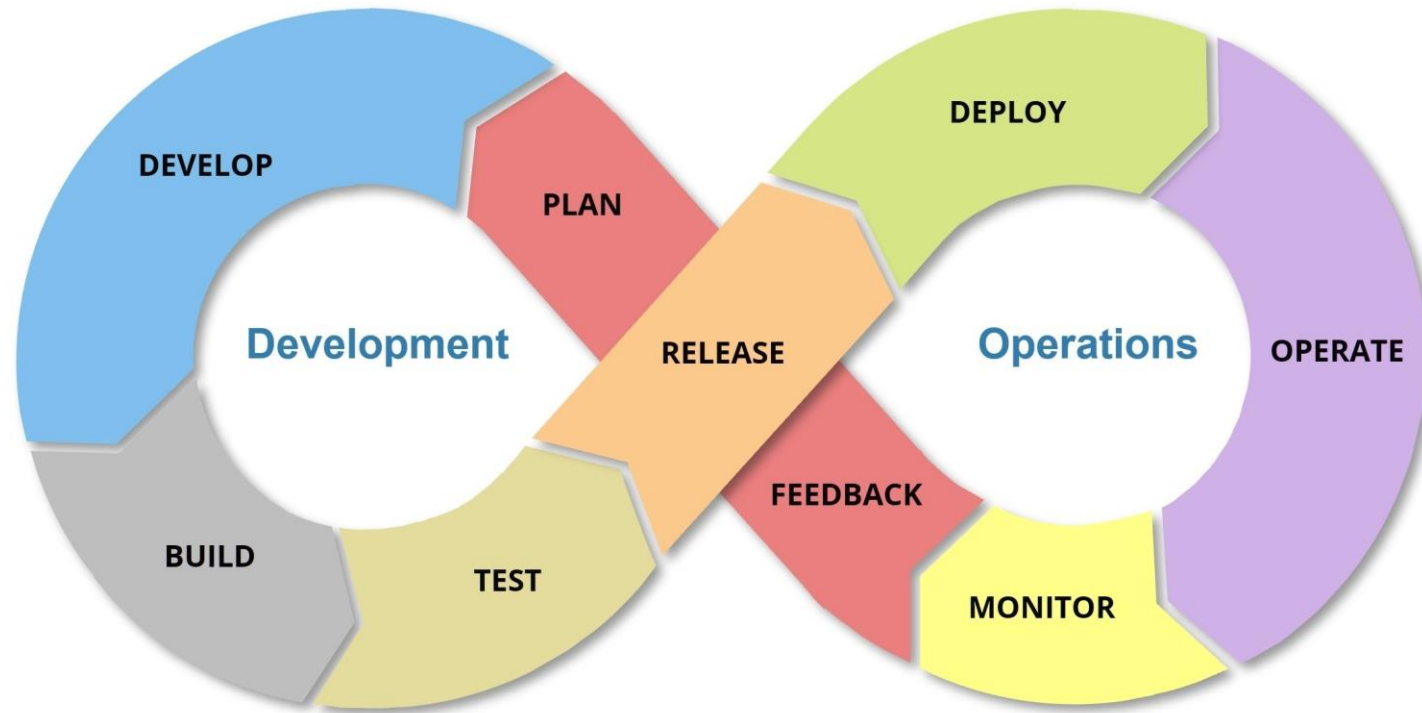


系统架构



使用 MATLAB 从原型到生产

- Modern DevOps based automated continuous deployment of MATLAB applications



MATLAB 部署和扩展

The screenshot displays the OpenShift Cluster Dashboard for a cluster named 'visual-inspection'. The interface includes a left-hand navigation menu with categories like Cluster, Workload, and Apps. The main content area is titled 'Cluster Dashboard' and provides an overview of the cluster's status, including provider (RKE1), Kubernetes version (v1.24.10), and creation time (3.2 days ago). Key metrics are shown in three cards: 202 Total Resources, 3 Nodes, and 25 Deployments. A 'Capacity' section features three progress bars for Pods (27.73% used), Cores (2.75% used), and Memory (5.92/31 GiB used). At the bottom, the status of Etcd, Scheduler, and Controller Manager is confirmed as 'OK'. On the right side, a vertical list of deployment cards is visible, each showing its age (e.g., 3.1 days) and a 'Scale' control set to 1. The 'Running' state is also indicated for one of the deployments.

要点和结论

- MathWorks products along with published reference architectures can be leveraged to build production-grade visual inspection systems for the cloud
- Secure, scalable and agile solutions for AI/Visual Inspection can be built to IT DevOps best practices
- Domain specific toolboxes and support packages are available for MATLAB users to go from prototype to production quickly

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Thank you



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