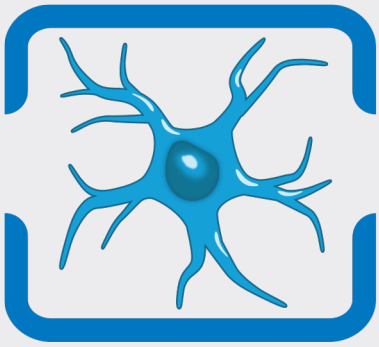
ASTROCYTE

Code-free AI Training Tool for Machine Vision Solutions

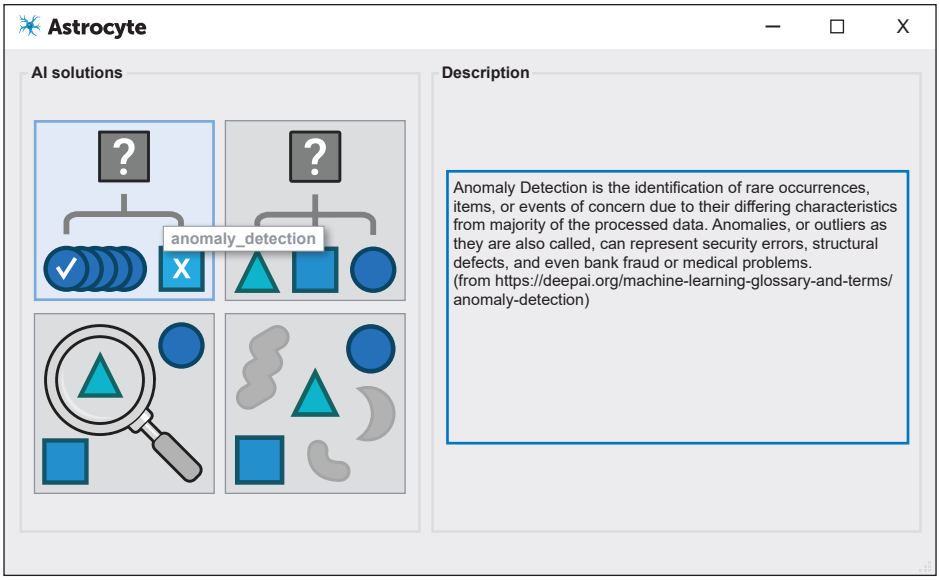


KEY FEATURES

- Graphical User Interface for rapid machine vision application development.
- Automatic tuning of training hyperparameters for maximum ease-of-use for non-experts in AI.
- Automatic generation of annotations via pre-trained models or semi-supervised training.
- Continual Learning (aka Lifelong Learning) in classification for further learning at runtime.
- Object detection at an angle (also known as rotated bounding boxes)
- Location of small defects in high-resolution images via tiling mechanism.
- Training on multiple GPUs to reduce training time.
- Masking of regions to exclude from inspection via ROI markers of multiple shapes.
- Highly accelerated inference engine for optimal runtime speed on either GPU or CPU.
- Easy integration with Sapera Processing and Sherlock vision software for runtime inference.

Overview

Teledyne DALSA Astrocyte™ is a code-free AI training tool to quickly deploy AI models for machine vision solutions. Astrocyte empowers users to harness their own images of products, samples, and defects to train neural networks to perform a variety of tasks such as anomaly detection, classification, object detection and segmentation. With its highly flexible graphical user interface, Astrocyte allows visualizing and interpreting models for performance/accuracy as well as exporting these models to files that are ready for runtime in Teledyne DALSA Sapera™ Processing and Sherlock™ vision software platforms.

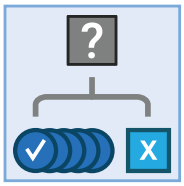
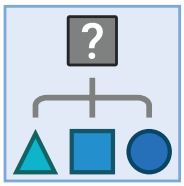


BENEFITS

- Train AI models quickly (within a few minutes with good data).
- Save time labelling images with automatically generated annotations.
- Decrease training effort with automatic tuning of hyperparameters.
- Assess AI models via visual tools (such as heatmaps, loss function curves, confusion matrix).
- Preserve full image data privacy by training and deploying AI models on local PC.
- Acquire live video from Teledyne and third-party cameras directly into Astrocyte.
- Run inference at a high frame rate with speed-optimized inference engine.

DEEP LEARNING ARCHITECTURES

Astrocyte supports the following deep learning architectures.

MODULE	DESCRIPTION
ANOMALY DETECTION 	Anomaly detection is a binary classifier (good/bad) trained on "good" images only. It is used in defect inspection where simply finding defects is sufficient (no need to classify defects). It is also useful on imbalanced datasets where many "good" images and a few "bad" images are available. It does not require manual graphical annotations, making it very practical on large datasets.
CLASSIFICATION 	Classification is a generic classifier for identifying the class of an image. It is used in applications where multiple class identification is required. For example, it can be used to identify several classes of defects in industrial inspection. It can also train in the field using continual learning.
OBJECT DETECTION 	Object detection is an all-in-one localizer and classifier. It finds the location and the orientation of an object in an image and classifies the object. Orientation of objects is important. For example, it can be used to provide the location and class of defects in industrial inspection.
SEGMENTATION 	A pixel-wise classifier, segmentation associates each image pixel with a class. Connected pixels of the same class create identifiable regions in the image. Segmentation is used in applications where the size and/or shape of objects are required. For example, it can be used to provide location, class, and shape of defects in industrial inspection.

Astrocyte Graphical User Interface

CREATING DATASET

Generating image samples

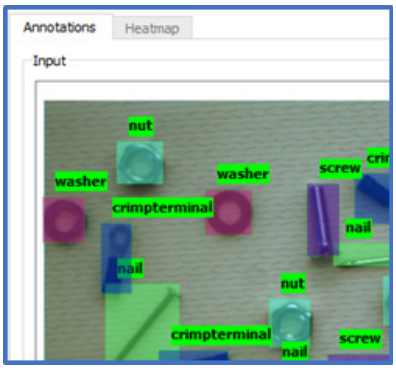
- Connect to a camera (Teledyne or 3rd party) or a frame-grabber to acquire live video
- Save images while acquiring live video stream (manually from click or automatic)

Importing image samples

- File selection based on folder layout, prefix/suffix and regular expressions.
- Image file formats: PNG, JPG, BMP, GIF and TIFF.
- Image pixel formats: Monochrome 8-16 bits, RGB 24 and 32-bits.
- Automatic (random) or manual distribution of images into training and validation datasets.
- Adjustable image size via resizing or cropping for optimal memory usage.
- Creation of a mask via visual editing tools to mark portions of the image to be excluded.

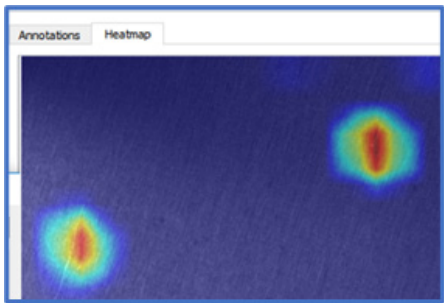
Creating/importing annotations (ground truth)

- Manually create annotations with built-in visual editing tools: rectangle, circle, polygon, brush, ...
- Automatically create annotations using pre-built models.
- Automatically create annotations using Semi-Supervised Object Detection (SSOD) applied to a partially annotated dataset.
- Import annotations from user-defined text files with customizable parsing scheme.
- Import annotations from common database formats such as Pascal VOC, MS COCO and KITTI.



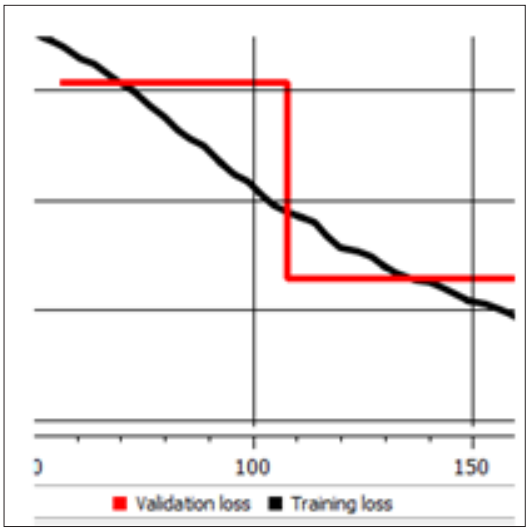
Visualizing/editing/handling dataset

- Image display and zoom.
- Annotation display as overlay graphics on image.
- Annotation selection, deletion and editing.
- Manual editing of annotations on - individual samples.
- Merging of two datasets.
- Exporting dataset to file.



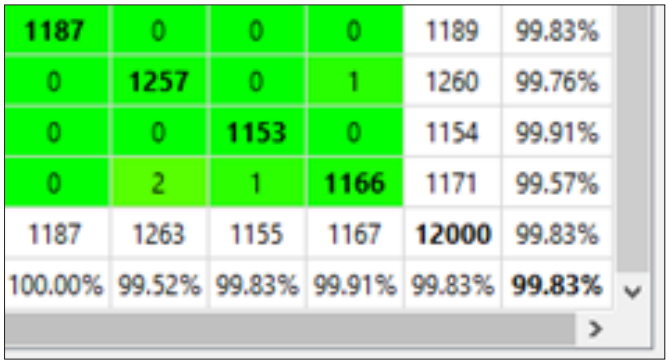
TRAINING MODEL

- Training on system GPU. See minimum requirements below.
- Selection of device (multiple selection available)
- Choice of deep learning models for optimal accuracy.
- Selection of preprocessing level: native, scaling or tiling.
- Support of rectangular input images (preserving aspect ratio)
- Automatic or manual setting of hyperparameters.
- Access to hyperparameters such as learning rate, number of epochs, batch size, etc., for customization of training execution.
- Hyperparameters pre-set with default values commonly used.
- Image augmentation available for artificially increasing the number of training samples via transformations such as rotation, warping, lighting, zoom, etc.
- Training session control: save while training and cancel if needed.
- Progress bar with training duration estimation.
- Graph display of progress including accuracy and training loss at each iteration (epoch).



VALIDATING MODEL

- Statistics on model training.
- Metrics on model performance: accuracy, recall, mean average precision (mAP), intersection over union (IoU).
- Model testing interface to perform validation of the model on either training, validation, entire, or user-defined dataset with possibility of reshuffling samples.
- Display of confusion matrix (graph showing intersection between prediction and ground truth). Interactive selection of individual images.
- Display of heatmaps for visualization of hot regions in classification.



RUNNING INTERFERENCE

- Run inference on sample images for testing validity and speed inside Astrocyte.
- Select which GPU/CPU to run inference on.
- Adjust inference parameters like thresholds and options

EXPORTING MODEL

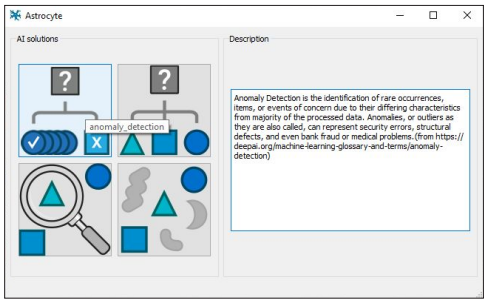
- Proprietary model format compatible with Sapera Processing and Sherlock.
- Model contains all information required for performing inference: model architecture, trained weights, metadata such as image size and format.
- Multiple model management. Models stored in Astrocyte internal storage.
- Model can be imported into user application via Sapera Processing or Sherlock.

Integration with Sapera Processing and Sherlock

- Both Sapera Processing and Sherlock include an inference tool for each supported model type.
- Model files are imported into the inference tool and ready for execution on live video stream.
- The inference tool can be coupled with other image processing tools such as blob analysis, pattern matching, barcode reading, etc.
- To be used in conjunction with Sapera LT or Spinnaker for acquiring images from Teledyne DALSA cameras and frame-grabbers.
- Examples available with source code.

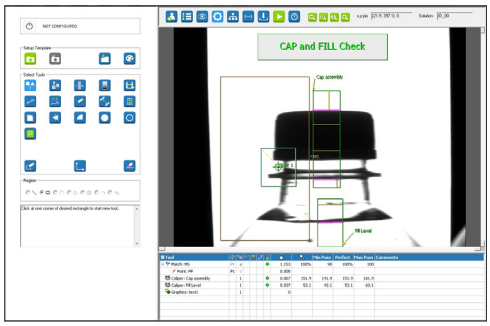
As

Astrocyte



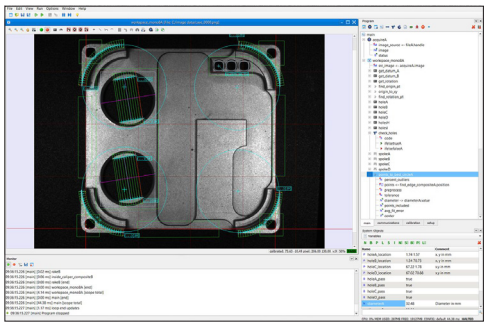
SP

Sapera Processing



Sh

Sherlock



Licensing

Astrocyte Licensing

- Requires either **Sapera AI SDK** or **Sherlock AI SDK** to operate.
- If no license is present Astrocyte will run in evaluation mode for 60 days.

Sapera Processing Licensing

- AI inference in Sapera Processing is enabled by the **Sapera Group 4 Runtime** license.
- If no license is present Sapera Processing will run in evaluation mode for 60 days.

Sherlock Licensing

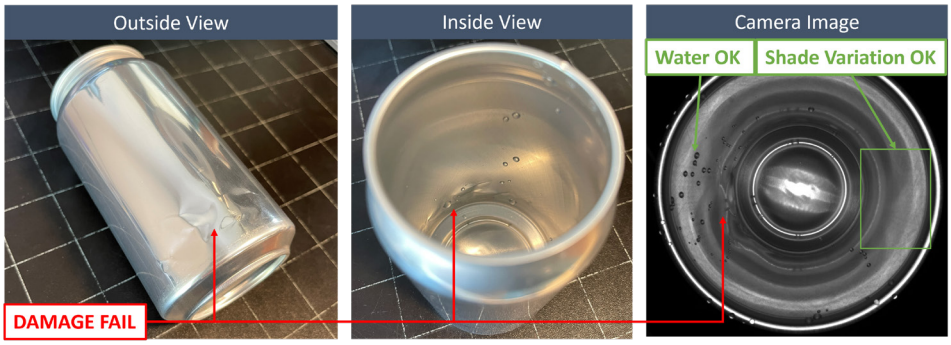
- AI inference in Sherlock is enabled by the **Sherlock AI Runtime** license.
- If no license is present Sherlock will operate with no video acquisition.

System Requirements

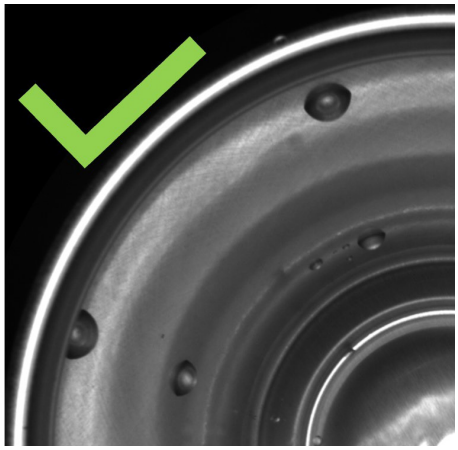
- Microsoft® Windows® 10 or 11 (64-bit)
- Intel® Processor supporting EM64T technology
- Minimum 16GB of RAM (32 GB recommended)
- An NVIDIA® GPU
  - With minimum 8GB of RAM
  - With minimum Compute Capability 5.2 (equivalent to GTX 900 series)
  - With graphics driver version 516.31 or later
  - **Recommendations:**
    - **Good:** RTX 3070/4070 or any other card with 8GB RAM
    - **Very good:** RTX 3080/4080 or any other card with 12GB RAM
    - **Best:** RTX 3090/4090 or any other card with 24GB RAM

Application: Beverage Industry Container Inspection

Sherlock and Astrocyte make it easy to implement an AI Classification algorithm with just a basic machine vision background and without any coding. A vision system was created to inspect aluminum cans for dents and damage on the production line just prior to filling. Traditional vision tools failed to accurately detect damage due to variable presence of water droplets and surface finish variations. Dents and damage are visible on the inner surface of a can, but natural surface variations and variable water droplets added noise to the image, adding a level of difficulty to the inspection.



Dents and damage are visible on the inner surface, but natural surface variations and variable water droplets added noise to the image, adding a level of difficulty to the inspection



Production-ready system accurately categorized cans as normal or damaged when they were wet or dry. The model proved to be very robust in difficult conditions and could maintain accuracy even with small changes in camera position, focus, and lighting.

Using AI allowed customer to quickly solve a vision challenge that would have been otherwise impossible using traditional vision tools.

Traditional Machine Vision Tools

- ✕ Confuse water droplets and surface damage
- ✕ Can't handle shade and perspective changes
- ✕ Miss subtle surface damage

AI Classification Algorithm

- ✓ Ignores water droplets
- ✓ Is robust to variations in surface finish and perspective
- ✓ Can detect a full range of defects

KEY METRICS

- Demonstrated 99.77% accuracy on validation image set
- Model trained using 100 samples and 1200 images
- Resnet18 architecture
- 512 x 512 image size
- 10-12ms inference time on Nvidia RTX A1000 4GB GPU
- Factory integration to PLC using Modbus

Confusion matrix showing performance on independent validation image set

	damage	normal	actual	recall
damage	533	0	533	100.00%
normal	2	349	351	99.43%
predicted	535	349	884	99.72%
precision	99.63%	100.00%	99.81%	99.77%

FOR MORE INFORMATION CONTACT:

AMERICAS Boston, USA | +1 978-670-2000 | TDI_sales.americas@teledynedalsa.com
EUROPE Krailling, Germany | +49 89-89-54-57-3-80 | TDI_sales.europe@teledynedalsa.com
ASIA PACIFIC Tokyo, Japan | +81 3-5960-6353 | TDI_sales.asia@teledynedalsa.com
Shanghai, China | +86 21-3368-0027 | TDI_sales.asia@teledynedalsa.com

Revision Number:
Revision Date: 2023 12 01