ROBSEN

Case Study #1

Consider the following classification task and the robotics system:

There are three different types of metal parts. The parts are moving on a conveyor belt as shown in Fig.1. A vision-based robotics system will pick and put the parts in related boxes.

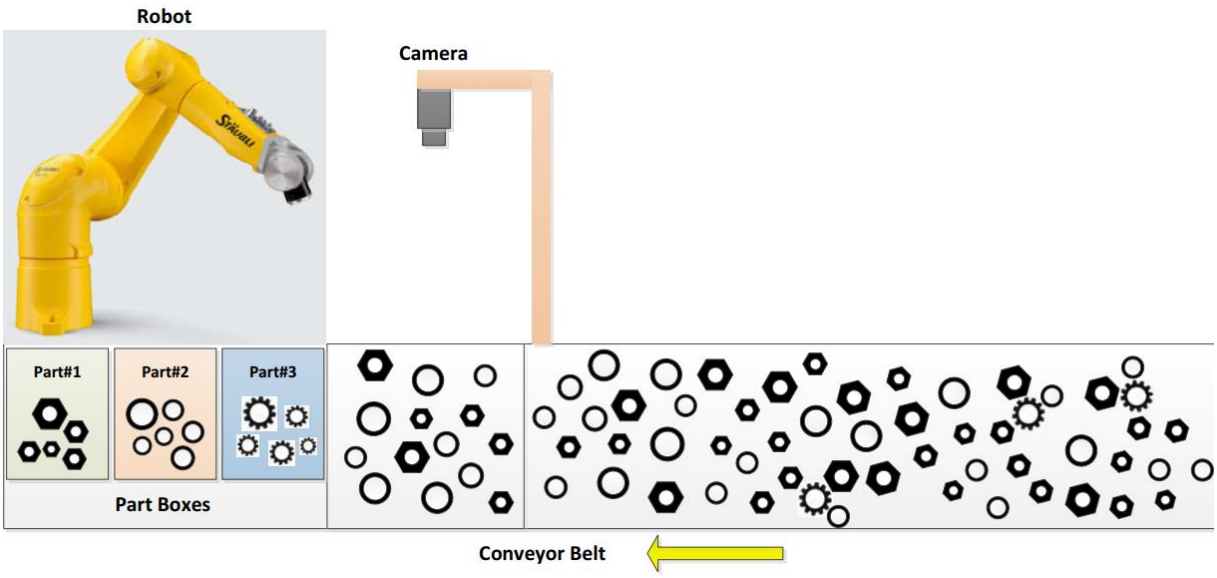

Figure 1) Industrial Robotics System

In this case study, you will develop a program to classify different metal parts using a simple neural network model.

Here is an example of scene image, the object indexes and their related data.

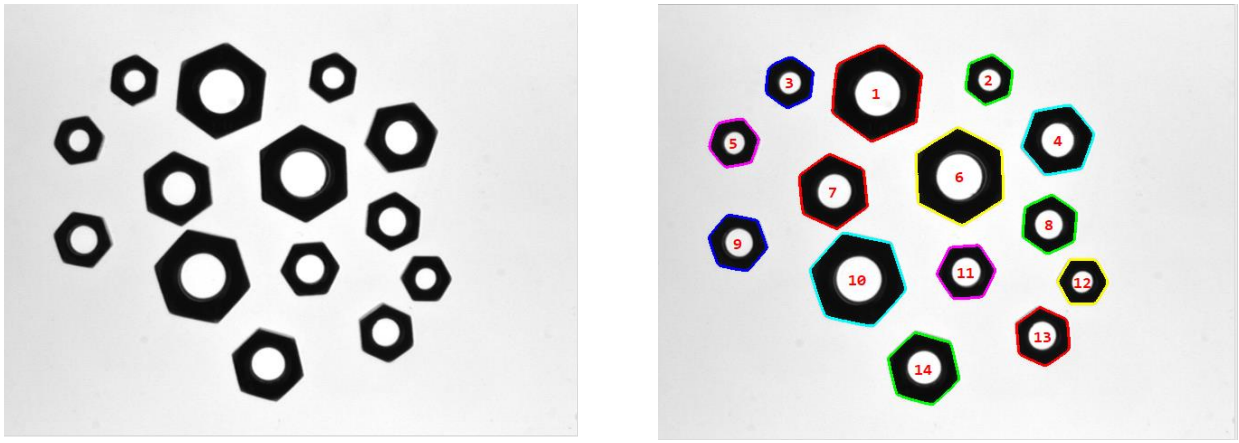

Figure 2) a) Input Image b) Object Index Numbers

Object ID	Circularity	Roundness	M1	M2	M3	M4	Class No
1	0.846786	0.958419	0.00641377	-1.05255e-016	-8.84061e-010	4.67224e-011	1
2	0.866845	0.959604	0.00640027	-4.23036e-015	-5.25395e-009	2.70499e-010	1
3	0.874629	0.960965	0.00639082	-2.79165e-016	-1.48806e-009	7.86532e-011	1
4	0.861045	0.956838	0.00641619	-7.66969e-016	-2.27632e-009	1.18553e-010	1
5	0.866993	0.962957	0.00638919	-1.54058e-015	-3.19635e-009	1.65133e-010	1
6	0.853356	0.957954	0.00641492	-5.00037e-017	-5.74781e-010	2.97408e-011	1
7	0.849957	0.956491	0.00641682	-2.49639e-016	-1.29704e-009	6.7237e-011	1
8	0.877531	0.959258	0.00640434	-1.2755e-017	-2.87913e-010	1.48114e-011	1
9	0.869556	0.960289	0.00640382	-1.95587e-015	-3.57299e-009	1.84034e-010	1
10	0.860482	0.959669	0.00641081	-3.10903e-017	-5.16564e-010	2.80134e-011	1
11	0.875212	0.957473	0.00640808	-7.68419e-016	-2.25571e-009	1.16567e-010	1
12	0.872388	0.958121	0.00640225	-1.81663e-015	-3.4889e-009	1.8036e-010	1
13	0.854047	0.957306	0.00640806	-1.64082e-016	-1.11895e-009	6.09304e-011	1
14	0.862528	0.958754	0.00640891	-1.14596e-018	-1.25996e-010	7.63953e-012	1

Table 1) Object features: Circularity, Roundness and Image Moments

Dataset: In directory "case_study1_data/Train", you will find training data to train your model: input image, object indexes and feature data. In directory "case_study1_data/Test", you will find data to classify objects and test your model.

Features:

- Circularity**:** the similarity of a region with a circle. (0<=Circularity<=1)
- Roundness: the measure of how closely the shape of an object approaches that of a mathematically perfect circle. This feature is used to examine the distance between the contour and the center of the area.
- Image Moments: geometric moments of regions that are invariant under translation and general linear transformations. (M1, M2, M3, M4: moment of 2nd order.)

Tasks:

1. Write a detailed technical report to describe your neural network model (structure of your own model: number of input neurons, hidden layers, output neurons etc.), activation functions/optimization methods you will use, the results for test data using graphs and the comments about the results (success rate, etc.).
2. Build and implement your neural network from scratch in Python. *(Note: Do not use any deep learning libraries such as Keras, TensorFlow, PyTorch etc. Please, write your development details: python version, dependencies, library versions etc.)*

Case Study #2

In this case study, you are asked to implement an application to estimate the approximate cycle time of robot movements to be able to use in simulation studies.

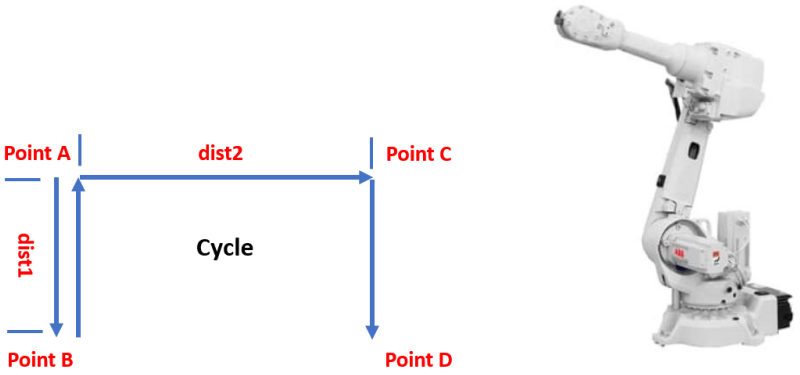

Figure3) a) Trajectory b) ABB IRB 2600 Robot

dist2	dist1	Acc	Mass	Cycle Time
500	100	10	1	1,575
500	100	20	1	1,576
500	100	30	1	1,352
500	100	40	1	1,22
500	100	50	1	1,113

Table 2) Trajectory features: dist1, dist2, Acc and Mass

Dataset: In directory "case_study2_data", you will find data to train and to test your model. We collected data changing parameters(features) for each different trajectory. You should decide how to split dataset.

Features:

- dist1**:** Vertical movement value in mm.
- dist2**:** Horizontal movement value in mm.
- Acc: Acceleration/Deceleration rate value. (0<= Acc<=100, Max Acc: 100)
- Mass: mass value of grasped object by robot in kg.

Note: Cycle time is total elapsed time in seconds.

Tasks:

1. Write a detailed technical report to describe your method (which method you have used?) and give your results (success rate, etc.).
2. Develop a machine learning application to predict cycle time of ABB IRB-2600 robot movements on a defined trajectory. Implement your method in Python. *(Note: You can use machine learning/deep learning libraries such as Scikit-learn, Keras, TensorFlow, PyTorch etc. Please, write your development details: python version, dependencies, library versions etc.)*