

Deep Learning Image Augmentation to Improve Performance of Automated Visual Inspection (AVI) Systems



BUSINESS PROBLEM

Deep learning has the potential to increase the flexibility and robustness of current automated visual inspection systems; however it requires a lot of training data to achieve optimal performance. In drug product manufacturing, the deliberate creation of defective units for training is complex and costly. A solution is hence needed to reduce the cost of training images for a deep learning visual inspection system

DATA SOURCES

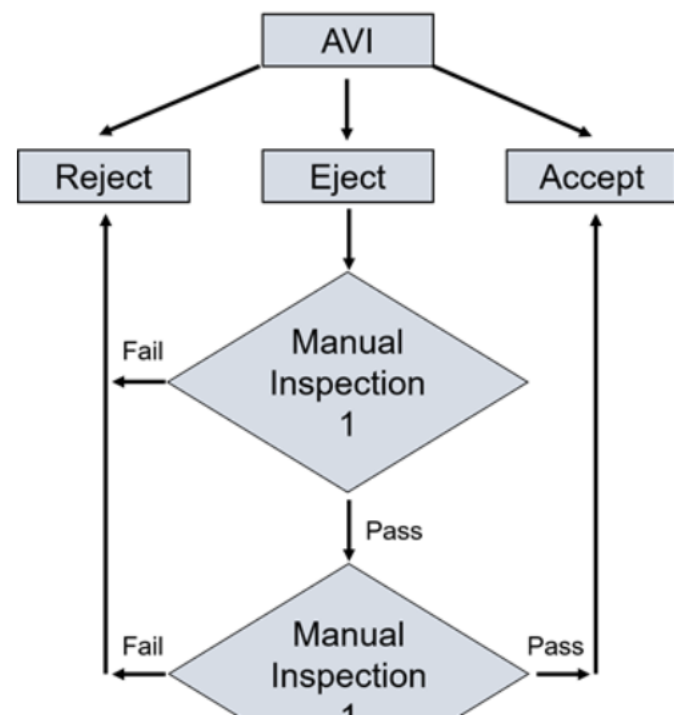
The images used for training the deep learning image generation tools were captured by a camera station in a tech development laboratory. The design is replicated from a station in a real manufacturing line.

Data Types and Format

Images of drug product units such as syringes and lyos.

APPROACH

A few deep learning tools are developed to generate synthetic images for training. These tools can generate a larger number of targeted images based on a smaller sample of training images.



IMPACT

Synthetic images increase the overall accuracy of visual inspection systems, which leads to smaller false reject and accept rates, and less manual reinspection. The tools also reduce characterization and setup time for new products as images are generated artificially.

DRIVERS

Flexibility and robustness of visual inspection systems are becoming increasingly important as more manufacturing lines require high mix low volume inspection capability due to industry trends like personalized medicine and increase in clinical manufacturing. While deep learning machine vision is a promising approach to achieve such flexibility, training images are still very expensive to source for high value pharmaceutical products.

BARRIERS

Due to Covid-19 and the remote working setup, I was unable to visit actual visual inspection lines to properly understand the challenges of current systems. Such visits would allow me to better adjust the deep learning tools to suit the comfort of the vision engineers.

ENABLERS

The strong collaboration culture at Amgen really helped the data-gathering process. The presence of team members in multiple manufacturing locations also helped illuminate any variations in processes across different sites.

ACTIONS



A large number of interviews were conducted to understand the current visual inspection systems and the envisioned future state. An extensive literature review was performed on data augmentation approaches. Based on this research, the final models were selected, implemented, and refined.

INNOVATION

The solution uses the state-of-the-art deep learning models to generate synthetic images for training defect classifiers in a visual inspection system. The solution is then evaluated not only based on accuracy of the defect classifier, but also on the classifier's ability to locate defects. This is measured using the latest visualization techniques.

IMPROVEMENT

The solution generated synthetic images that dramatically improved the accuracy of the defect classifiers in a visual inspection system.

BEST PRACTICES

To replicate the solution developed in this thesis, researchers should first understand the visual inspection process at their sites thoroughly.

OTHER APPLICATIONS

The image generation tools can also be used in machine vision applications other than pharmaceutical inspection