Data Analysis in Advance Automobile Manufacturing

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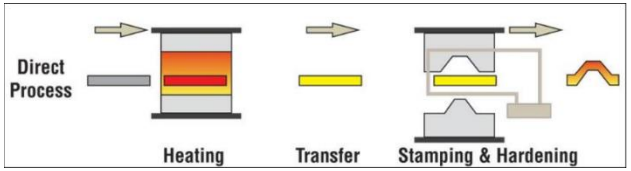
Abstract

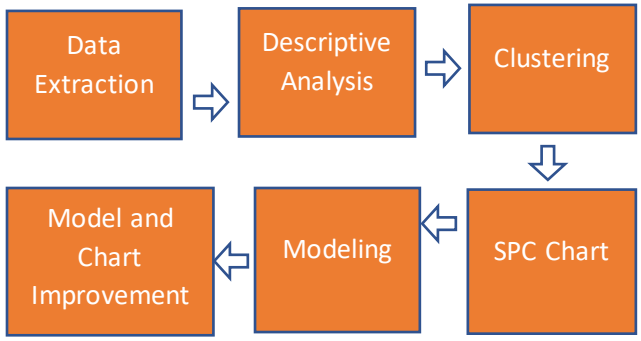
- As machine starts to replace human role in manufacturing plants, it has improve workers' working condition. Besides, the crutial part is to control the outcome product from the machine. Our purpose is to get the most meaningful insight from the pictures of the product.

Background

- The process is hot stamping process in automotive manufacturing. We are interested in how the heat affected zone of the part.
- Procedure: Part were alligned, heated then stamped in order to be a finished good that were inspected by camera right after stamping.



Procedure



Prelimary Analysis

- From images, extract essential features that might be helpful for modeling and making control chart. The features are: Max, Mean, Area, Pictures Size, Time Interval, Space between and Length.
- Using Area parts are clustered into 5 subgroup:

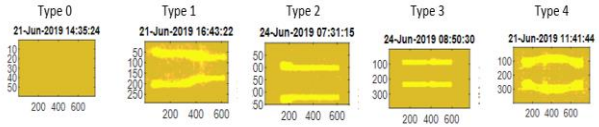


Figure 1: Example of each subgroup

Then each subgroups, normality test and plot is performed. As the result, Type 1 is the part that is most manufactured, with normal distribution on Area so it is the main focus on this research.

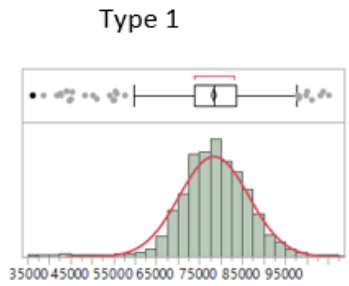


Figure 2: Type 1 Normality Plot

Statistical Process Control (SPC)

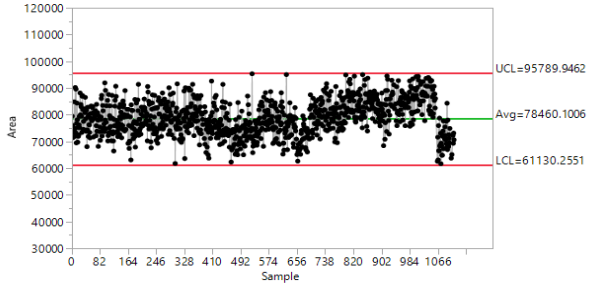


Figure 3: SPC Chart of Type 1

- By creating the SPC Chart based on the Area of the parts, I was able to lable the part that shows sign of defects. And parts which out of the control range are consider defect and should be take into further diagnostic.

Modeling

- Apply Multivariate Gaussian distribution, we have a anomaly detection model to predict defects parts.

$$p(x,\mu,\Sigma) = \frac{1}{\sqrt{(2\pi)^k|\Sigma|}} e^{\left[-\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)\right]}$$

- Predicting the probability of a part that being defect based on others features x_i. Generate a threshold (ε) at which $p(x,\mu,\Sigma) < \varepsilon$ will raise a flag as anomaly.

Result

- Final model give accuracy of 0.9411 on the test set with Precision=0.074 and Sensitivity=1.0. The model able to classify 100% of defect but there are some cases which a part is not defect and being misclassify.

Future Improvement

- On the SPC chart at the end there is a drop and all the data below the average control line.
- Apply Convolutional Neural Network to process on the images and get a better result on predicting defect.