Abnormal Combustion Detection in a Compression Ignition Engine

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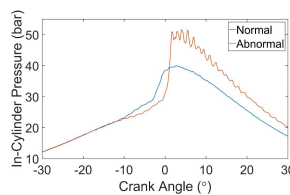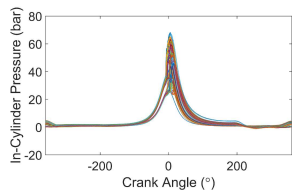burakc@stanford.edu, buyukalp@stanford.edu

Motivation

- ✓ Internal combustion engine failures severely affect the continuity of the operation.
- ✓ One of the main causes of these failures is abnormalities occurring during combustion process.
- ✓ Minimizing combustion abnormalities will help to minimize engine failures and to increase engine life.
- ✓ In this project, we work on a system that can help us for detection of abnormal combustion processes without using a knock sensor.
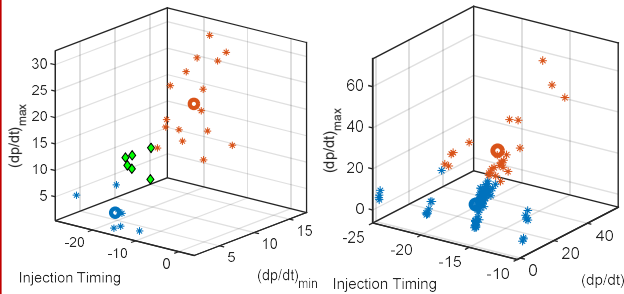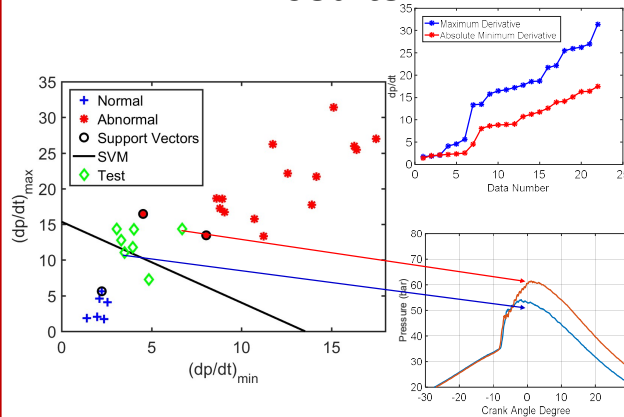
Data and Features

- ✓ Data from 135 cycles of combustion experiments
  - In-cylinder pressure
  - Injection starting time
  - Injection duration

- ✓ Features of an abnormal combustion:
  - Rapid increase in pressure trace
  - Rapid decrease in pressure trace
  - High ripples in pressure trace (engine ringing)

Method

- ✓ Using k-means clustering to label the data
- ✓ Support vector machines (SVM) to classify normal and abnormal combustion detection

Results

Discussions

- ✓ The data contain the injection timing, injection duration and pressure traces of Dimethyl-Ether(DME) combustion in a single cylinder compression ignition engine
- ✓ We have obtained the pressure gradients and selected a portion of the data and applied k-means as well as manually labeled the selected data.
- ✓ K-means clustering successfully worked to create a two groups (normal & abnormal). The comparison between the result of the k-means and manually labeling the data gave us ~100% success rate.
- ✓ After that we have applied SVM and superimposed our test data on the plot.
- ✓ Our method successfully predicted the characteristics of the test data as seen on the results section.
- ✓ The study shows that we can predict if engine is going to undergo an undesired cycle

Future Work

We can improve our system by using additional features such as second gradients of pressure trace inlet air temperature to the engine, et cetera.

We can try to detect abnormal combustions before their occurrences.

Acknowledgment