Project Title: DETECTION OF PIPELINE INSPECTION GAUGE (PIG) IN A STEEL PIPE

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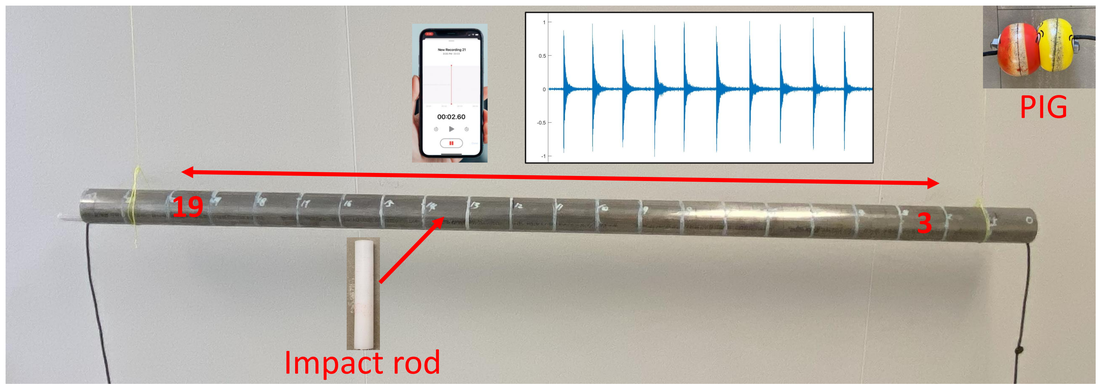
Problem Statement

- The Focus of this project is to classify the locations associated with PIG and no-PIG in a steel pipe. The challenge of this project is to be able to detect the specific location in the pipe where there is PIG.
- This research would have an impact in detecting the presence and location of sand/mud/water deposit, PIGs in a pipeline, and pipeline leakage.

Brief Literature Review

- Percussion based-detection of deposits and leakage along the inside of a pipeline using CNN has major application prospects since this method could help early detection of different issues to the pipeline, saving cost, time and preventing serious problems such as pollution to the environment, accidents. [1],[2]

Experimental Setup and Collection of Data



- 2 cases of interest: PIG and NO-PIG.
- PIG was moved from location 3 to 19.
- Each time the PIG was moved, data was collected for locations from 3 to 19 and saved as separate audio file for each location. 10 hits for non-PIG and 20 hits for PIG locations. 256 audio files for training model.
- Separate dataset was obtained for testing model. Each time the PIG was moved, locations from 3 to 19 were tapped once and saved as 1 audio files. 16 audio files for testing model.

Method(s)

Multi-hit signals were divided into single-hit signals

Data augmentation on PIG's single-hit signals

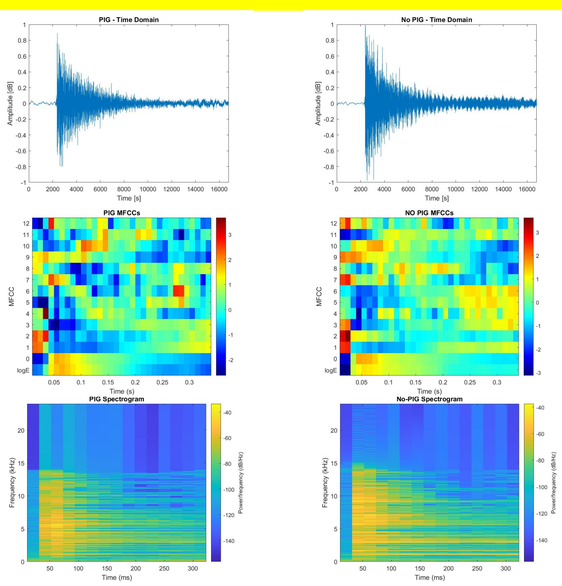
MFCCs

Generating spectrograms via STFT

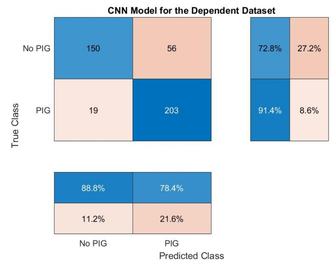
SVM

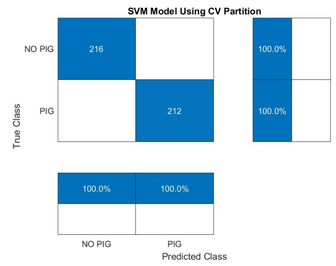
CNN

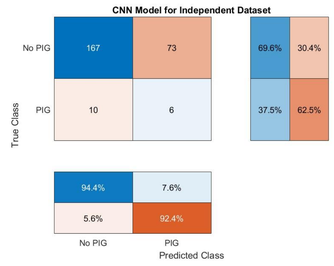
- Validate models using 10% of training data
- Test models using independent data

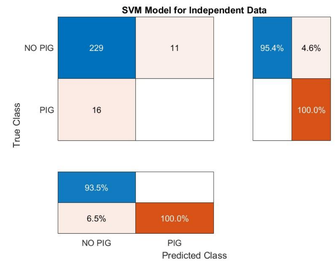


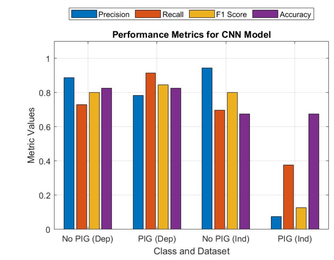
Results, Analysis and Discussion

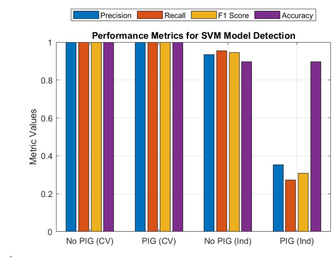












- CNN model:
  - More balanced performance and better consistency across dataset
  - Performance for "PIG" in the independent dataset is lower. Similar to SVM's.
- SVM model:
  - High consistency in dependent data
  - Performance drop in independent data
  - High overall accuracy which is misleading

Conclusion

- Challenges: data quality, time constraint, technical issues with Matlab
- Both models can be improved by:
  - Increase quality and quantity of raw data
  - Enhance feature extraction and selection
  - Optimizing and tuning different parameters for CNN and SVM
  - Implement better resampling techniques
  - Have more classes instead of just two

Acknowledgements

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References (brief)

1. Longguang Peng, et.al.," One-dimensional residual convolutional neural network and percussion-based method for pipeline leakage and water deposit detection", Process Safety and Environmental Protection, Volume 177, 2023, Pages 1142-1153, ISSN 0957-5820, (https://www.sciencedirect.com/science/article/pii/S095758202300664X)
2. Yang, D, et.al.," Percussion-Based Pipeline Ponding Detection Using a Convolutional Neural Network." Appl.Sci. 2022, 12, 2127. https://doi.org/10.3390/app12042127