Review: Prediction for Manufacturing Factors in a Steel Plate Rolling Smart Factory Using Data Clustering-Based Machine Learning

Link

CSE424: Pattern Recognition
Section: 2

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This paper focuses on improving the prediction of key manufacturing factors in steel plate rolling mills, specifically roll force and plate thickness. It presents the use of data clustering-based machine learning, which combines clustering and supervised learning models to enhance the precision of predictions. The goal is to optimize the steel plate production process by predicting in-process thickness and roll force, ultimately improving product quality while reducing sensor costs.

1.1 Motivation

The objective for this research is to improve the prediction accuracy of key manufacturing factors, such as roll force and plate thickness, in steel plate rolling mills using machine learning, thereby enhancing product quality and reducing the cost of expensive sensors in smart factory operations.

1.2 Contribution

The paper introduces data clustering based machine learning to predict manufacturing factors in a steel plate rolling mill. It is shown that Clustering based technique improves prediction accuracy for roll force and plate thickness over other models.

1.3 Methodology

Four ML regression models are used to make predictions for the roll force and plate thickness; Random Forest, Gradient Boosting, Gaussian Process and Conditional Linear Gaussian. For DC-ML, real world manufacturing data was collected from sensors, and clustering algorithms such as Gaussian Mixture, Birch, Mini Batch K-Means, etc. was used to group the data. Data was acquired through factory data stored in the factory's main computer.

Model's performance was evaluated using cross-validation and testing based on real data to determine the best cluster-algorithm combination.

1.4 Conclusion

The DC-ML model achieved higher accuracy than the traditional machine learning, with an R^2 score of 0.8828 for roll force and nearly perfect precision for plate thickness prediction. The study demonstrates that DC-ML significantly improves prediction accuracy in steel plate rolling, enabling high-quality production while reducing sensor and operational costs. The approach is well-suited for smart manufacturing environments and can be applied to other industrial processes.

Limitations

2.1 The performance of DC-ML depends on selecting appropriate number of clusters, too many clusters can reduce model quality.
2.2 Missing data can significantly impact performance.
2.3 The process is still not full optimal, and needs further research to automate the optimal number of clusters.

Synthesis

3.1 We can further refine this method by developing algorithms or methods to automatically determine the optimal number of clusters to improve DC-ML performance without manual tuning.

3.2 It is possible to extend the DC-ML approach for real-time prediction and decision-making in industrial environments, ensuring low latency and high reliability in smart factories.