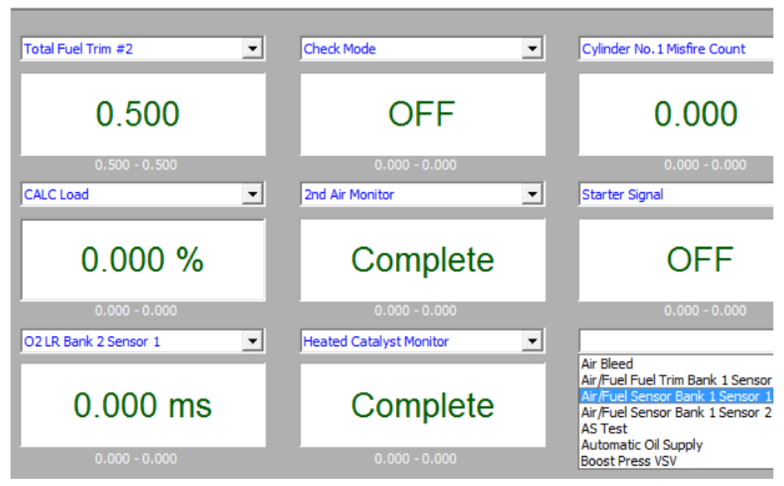
AI-AIDED EXPANDER MACHINE PARAMETER OPTIMIZATION

TE AMT

- The Automation Manufacturing Technology (AMT) team aims to automate parameter adjustments for a medical manufacturing machine using a closed-loop system, with assistance from a machine learning model.
- The project automates parameter adjustments for a medical manufacturing machine using a closed-loop system and a machine learning model.
- The current method for machine tuning in our process generates approximately 20% scrap material, primarily due to the initial setup required to achieve the correct Outer and Inner diameters within needed specification.

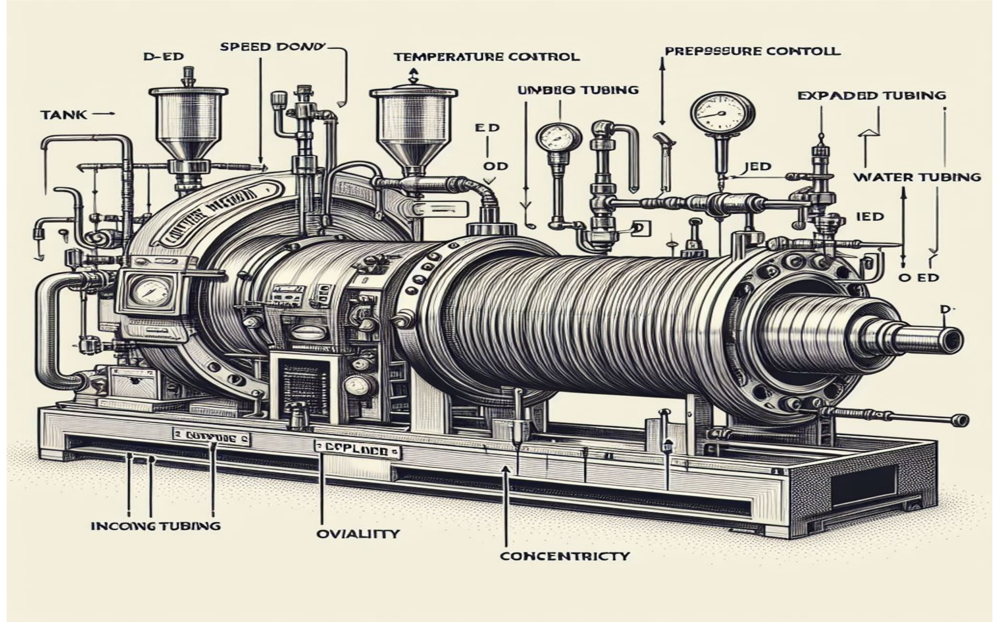
Expander Line Machine

- The expander line is a complex machine with a dozen parameters. i.e Air Pressure, Outer Diameter, Water Pressure, etc.
- Operators rely on their experience & intuition to setup and run the machine parameters.
- Using ML model that can predict setup parameters will save hours and additional costs.
- Adding a process control algorithm will also help monitor product quality which required human oversight.



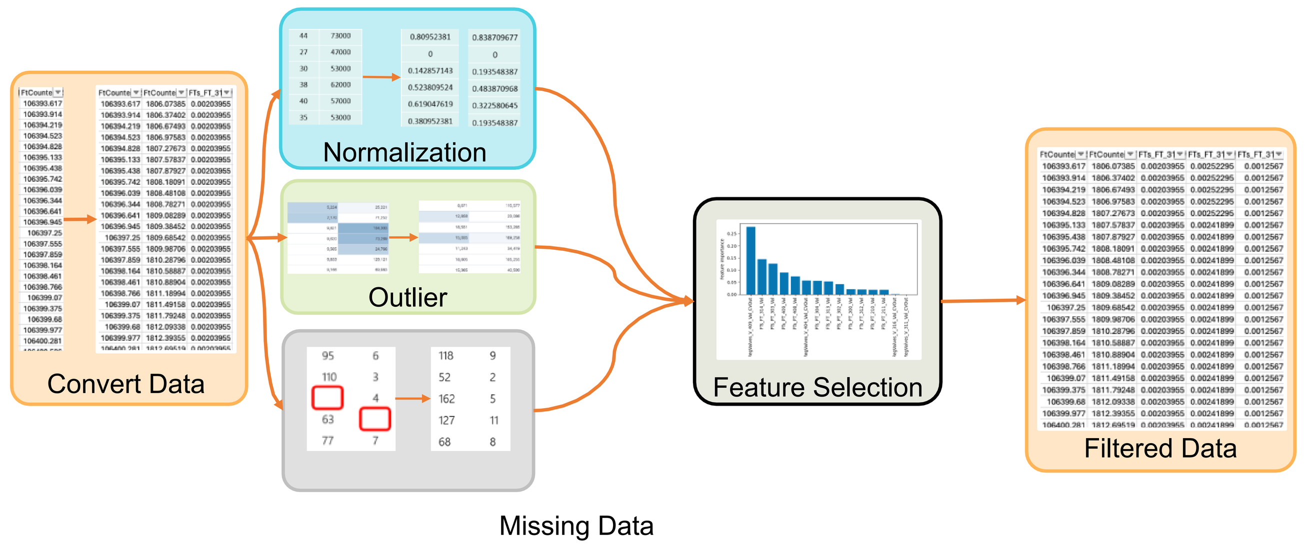
Emulator Features

Tubing enters the expander machine, where temperature and pressure are regulated to ensure uniform expansion. The machine adjusts speed and monitors dimensions to meet quality standards. After processing, the tubing is ready for further use.



Machine Learning Approach

- Preprocess data by eliminating redundant entries and conducting exploratory analysis on essential parameters.
- Create an AI model with a baseline accuracy of at least 70%, capable of iterative accuracy enhancement.
- Validate the model using the Cpk metric, ensuring it meets a threshold of 1.3. Integrate real-time prediction deployment into a website for dynamic user interaction.

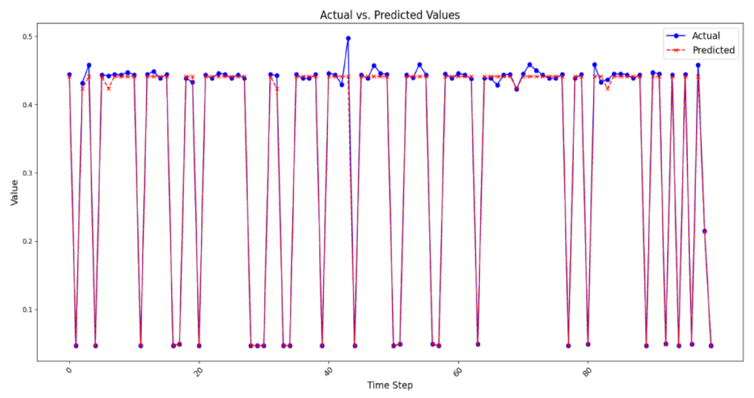


Models Prediction

The low MSE and MAE indicate precise predictions. The high R-squared shows the model explains much of the data's variance. This makes the model effective for predictive and analytical tasks in complex data environments.

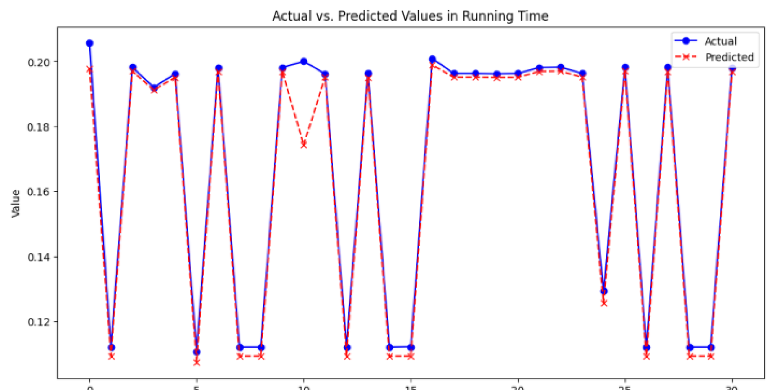
Decision Tree

MSE: 0.00053
MAE: 0.00655
R^2: 0.97



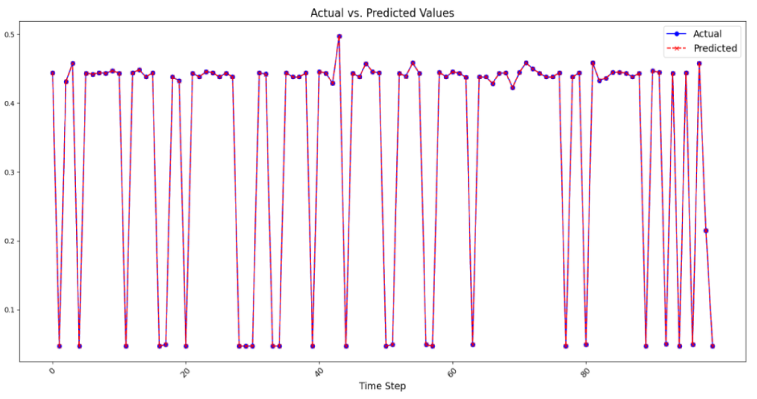
RNN(LSTM)

MSE: 4.89e-05
MAE: 0.00266
R^2: 0.9677



Random Forest

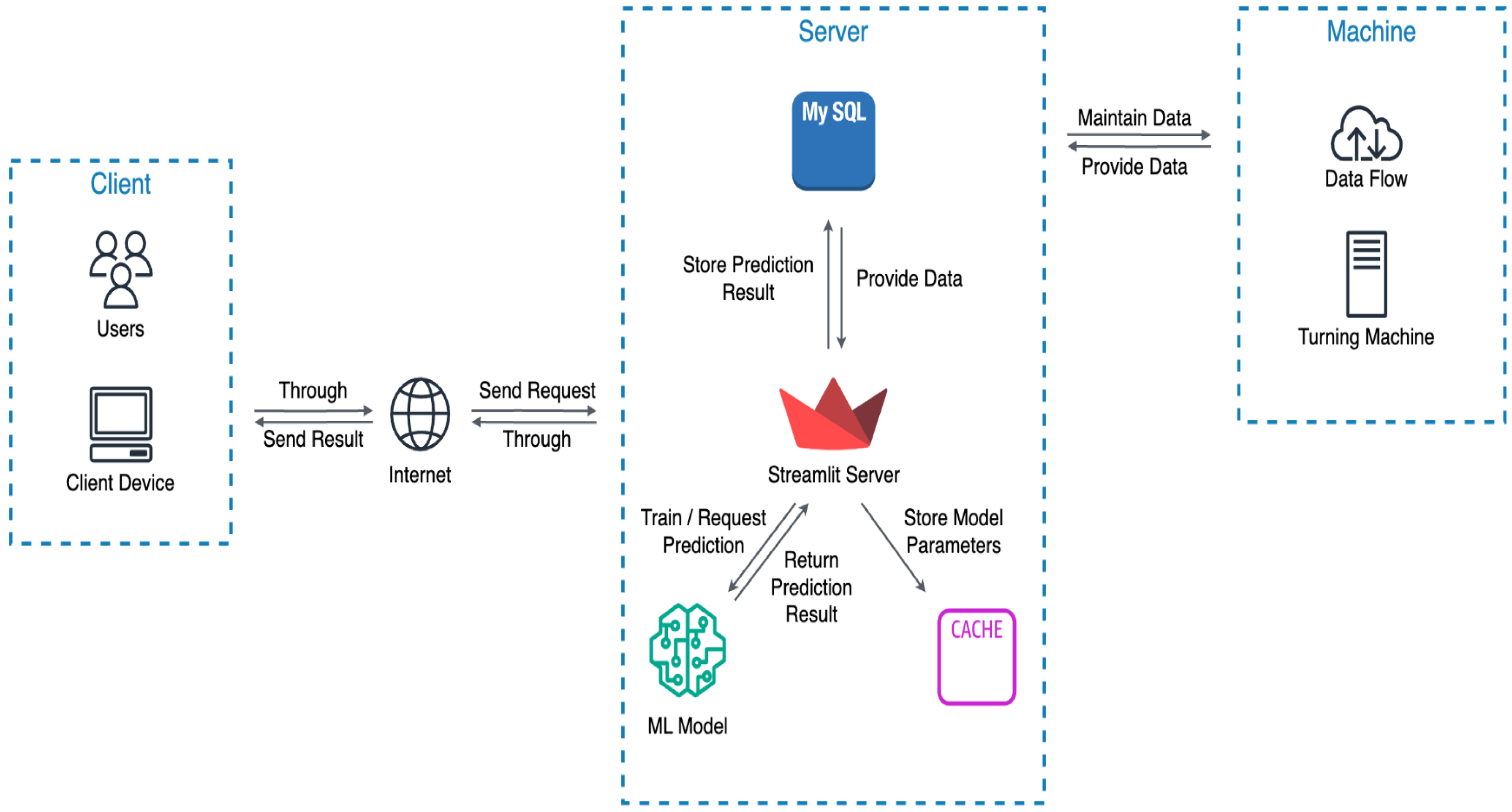
MSE: 7.3e-05
MAE: 0.0006
R^2: 0.98



Website Deployment

Methodology
Use Streamlit, a Python library, to connect backend ML processing with frontend presentation. This allows users to interact with ML models directly through a web browser. Data for ML models is stored in MySQL for efficient storage and retrieval.

Features
- Model Selection
- Real Time Predicted Results
- Calculates CPK, a statistical measure that evaluates how well a process meets predefined specifications.



Future Work, References, and Acknowledgments

- Expand data collection to ensure comprehensive coverage and representation.
- Use advanced preprocessing techniques and feature scaling to improve dataset quality.
- Explore ensemble methods and deep learning for greater accuracy and stronger model robustness.
- Evaluate model performance with statistical methods under varied conditions.
- Enhance the website UI to improve user comprehension and interaction.

References

[1] Scikit-learn. (2020). "Scikit-learn: Machine Learning in Python." Retrieved from https://scikit-learn.org/stable/index.html
[2] Streamlit. (2020). "Streamlit: The fastest way to build custom ML tools." Retrieved from https://www.streamlit.io/

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