Modeling Sensor Data For Knowledge Discovery And Explainable Decision-Making In Fruit Storage

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Introduction

The project focuses on utilizing advanced sensors and machine learning to enhance real-time data management in fruit cold storage facilities, aiming to maintain fruit quality and minimize waste.

Objectives

- Implement sensors network for real-time storage monitoring
- Develop predictive models for environmental condition forecasting
- Create a Digital Twin for end-user management and simulation
- Apply Explainable AI techniques for clarity in AI-driven decisions

Data Collection

Smart sensors deployed for real-time monitoring in fruit storage.

Fig. 1 – Respiration Measuring Sphere RMS88 and Wetness Sensor deployed for real-time monitoring

Predictive Modelling

To what degree can AI and machine learning models predict key fruit quality variables based on real-time sensor data?

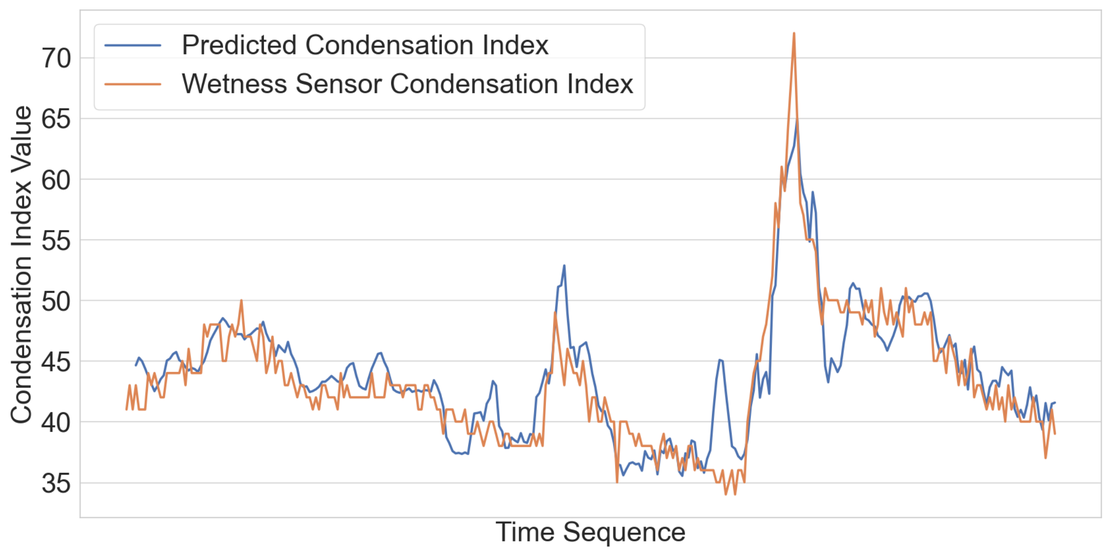

Fig. 2 – Prediction of Apple Condensation Index

Explainable AI and Decision Support

In what ways can we increase transparency and enhance the understanding of complex data-driven decision processes for end-users?

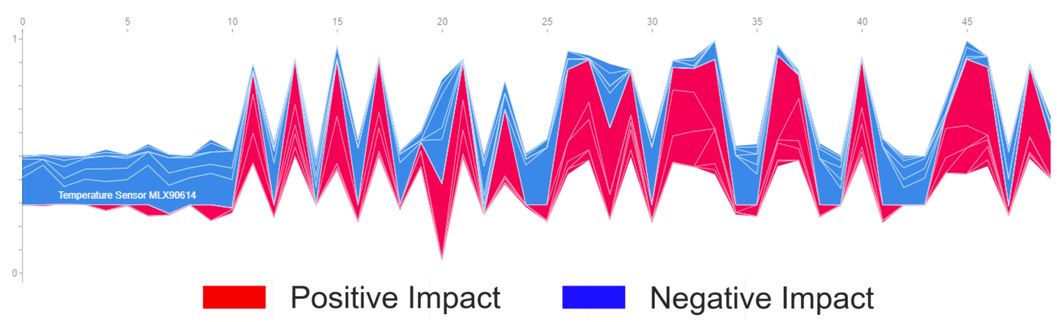

Fig. 3 – Additive force SHAP visuallisation

Anomaly Detection

How can self-supervised learning be utilized to identify anomalies and prevent potential issues in fruit cold storage?

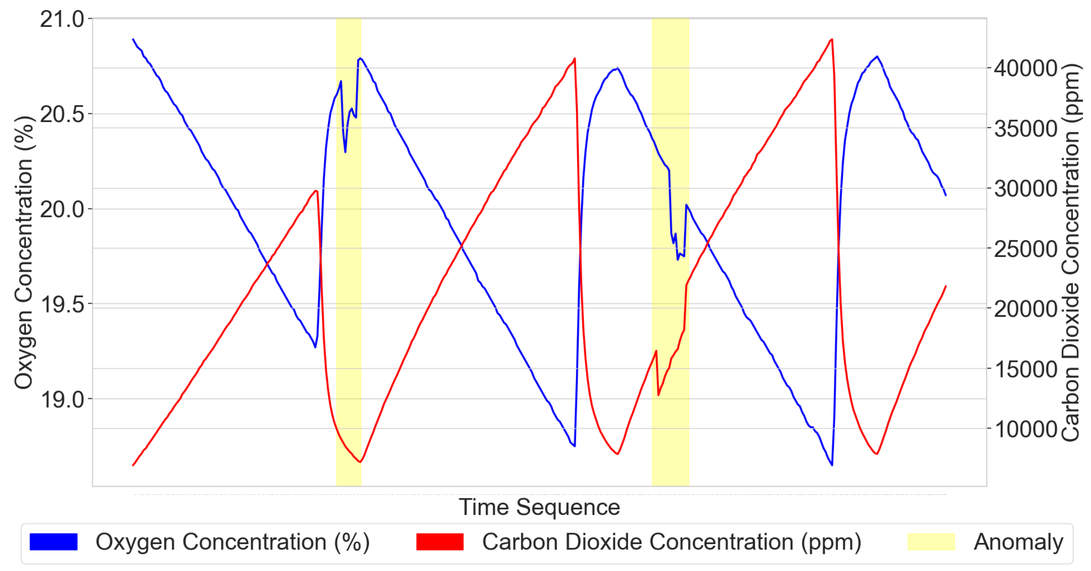

Fig. 4 – Detected Oxygen and Carbon Dioxide Anomalies in Apple Storage

Digital Twin

How can real-time sensor data and predictive models be combined into a comprehensive integrated system?

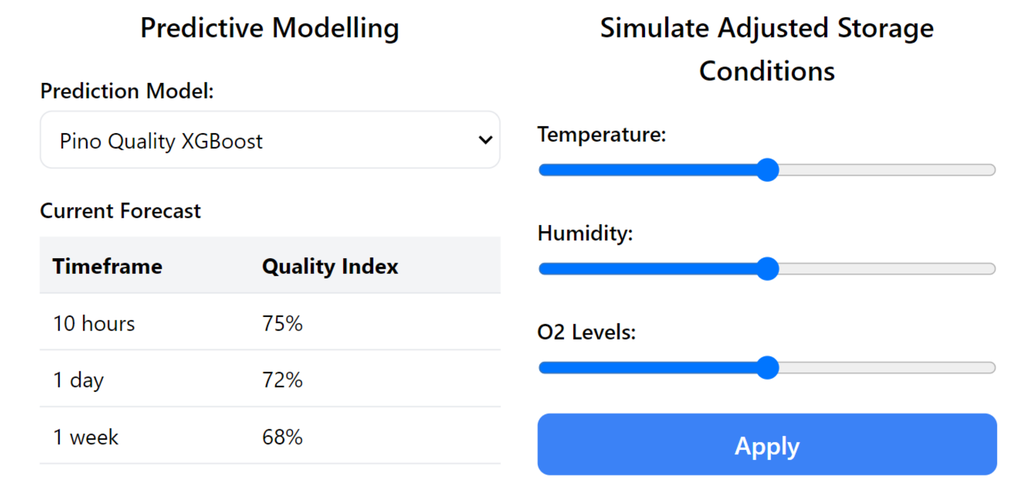

Fig. 5 – Digital Twin Prediction Interface

Conclusion

The project aligns current AI advances with the necessity to innovate cold storage practices. Developed models and the comprehensive Digital Twin can assist in managing storage environments, ensuring high-quality fruit and reducing food waste, while allowing end-users to understand and interact with complex AI systems.

Acknowledgment

This research was supported by the Lower Saxony Ministry of Science and Culture (MWK), funded through the zukunft.niedersachsen program of the Volkswagen Foundation

References

1. Keshri N, Truppel I, Herppich WB, Geyer M, Weltzien C, Mahajan PV (2019) Development of sensor system for real-time measurement of respiration rate of fresh produce. Computers and Electronics in Agriculture, 157: 322-328
2. Höhne, M. M.-C., Raut, S., Sturm, B., Atzmüller, M. (2023) Explainable AI Methods for Multimodal Data in the Circular Bioeconomy. 2023 Circular Bioeconomy Systems (CBS) Day, ASABE Annual International Meeting (AIM) Omaha, Nebraska (9th – 12th July 2023).