Digital Twins model for pumps using water circulation system

Team 71

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Problem Statement

The challenge lies in reducing the risk of economic losses and minimizing the downtime of failures in a process because of pump failures, using digital twin technology.

Constraints

- **Accurate Data** on the system's failure modes
- **Fast data transmission**

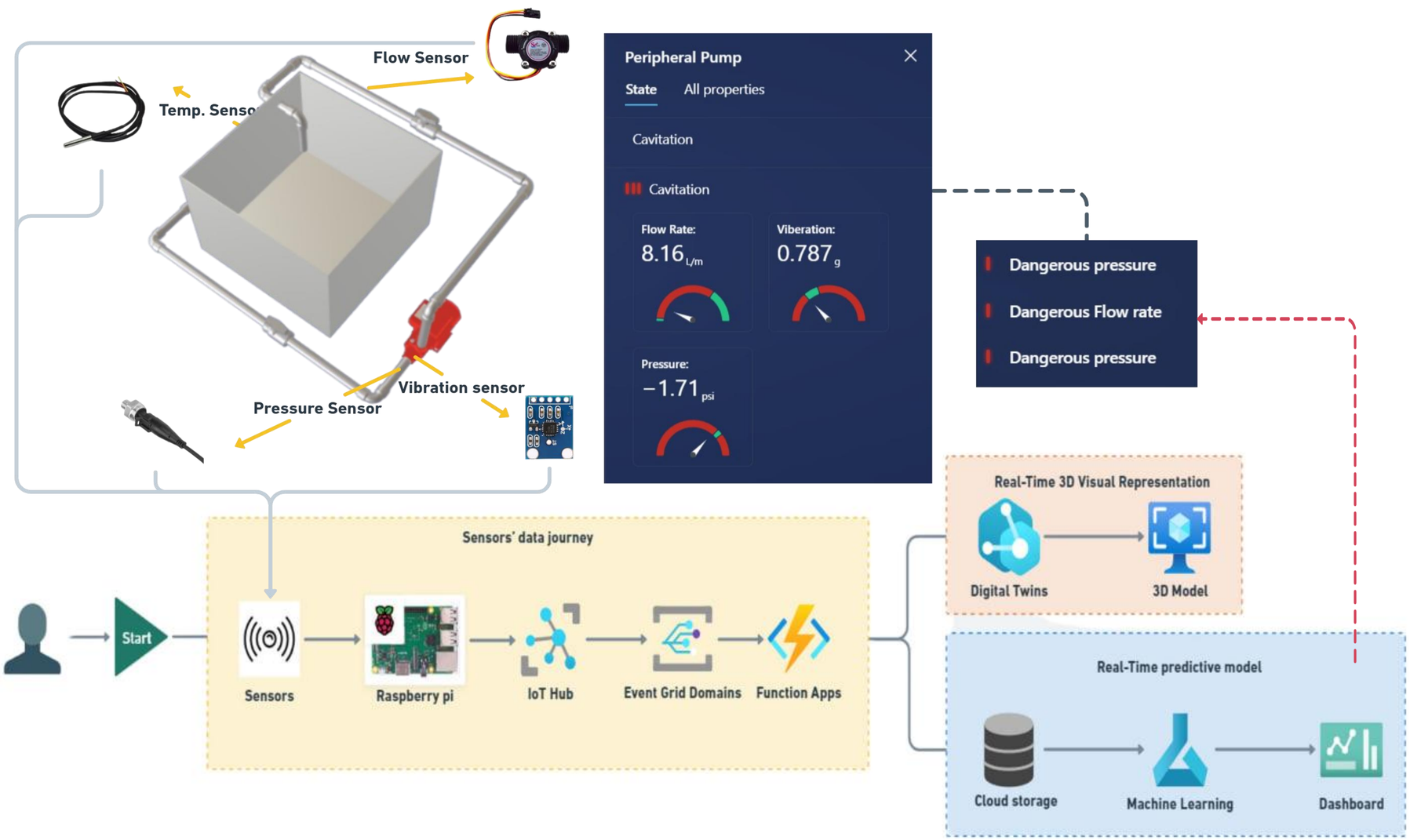
- **Min 90% accuracy**
- **Accurate representation** of physical entity

- **Sensors compatibility** with process type

Target Specifications

Specification	Target
Update Latency	< 30 Seconds
Prediction Accuracy	~ 90%
Integration Complexity Level	Medium
Dashboard Customization	Easy UI
System Uptime	99.8%
Data Handling Capacity	60TB
Maintenance Prediction Lead time	72 hour
Scalability	High

Product Design and Process



Results Validation

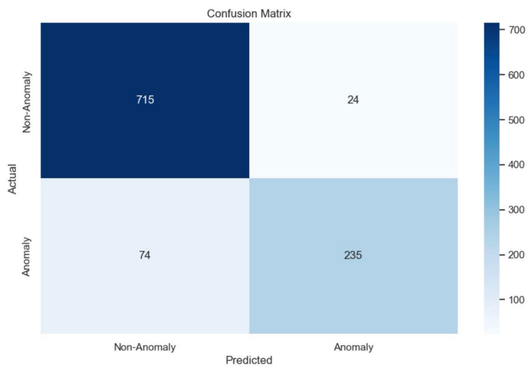


Figure 1: the confusion matrix of the predictive model

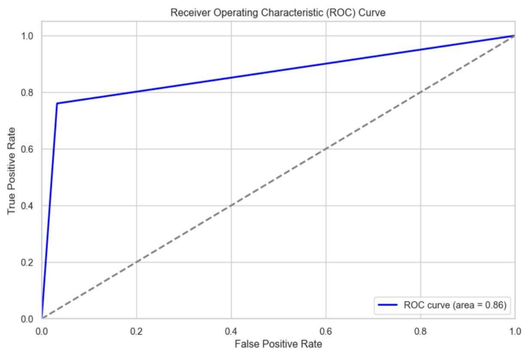


Figure 2: receiver operating characteristic curve

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Classification Report:
              precision    recall  f1-score   support

           0       0.91      0.97      0.94       739
           1       0.91      0.76      0.83       309

    accuracy                           0.91      1048
   macro avg       0.91      0.86      0.88      1048
weighted avg       0.91      0.91      0.90      1048


ROC-AUC Score: 0.8640207400011386
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Figure 3: classification report including precision, recall, and f1-scores for the prediction model

Conclusion

This project seeks to establish a digital-twin system that replicates a physical process's operational behavior and conditions, providing detection, prediction, and real-time 3D simulation of processes, to reduce the downtime of processes due to pump failures. By enabling proactive maintenance and optimization of the system's reliability and efficiency, using Microsoft Azure software and Machine Learning models. This project combines advanced technologies to create a sophisticated system that enhances operational efficiency and reliability through predictive maintenance and real-time analytics. Implementing a digital twin supported by machine learning and cloud infrastructure represents a significant step towards intelligent, data-driven industrial management.