AI in Manufacturing

SURF Updated Abstract

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COMPLETE ABSTRACT

The implementation of Internet of Things (IoT) and Artificial Intelligence (AI) techniques in manufacturing has become increasingly significant for improving yield and reducing expenses. Edge computing holds great potential to monitor machine productivity and predict performance anomalies in real-time. With most manufacturing equipment being electrically powered, the consumption pattern of electrical current can be an indicator of the state and condition of equipment. However, conventional IoT and AI solutions that rely primarily on cloud computing encounter issues with bandwidth, latency, economic, reliability, and privacy (BLERP). In this project, edge data analytics were utilized to convert current consumption signals into operation and condition information for modern manufacturing equipment. Three current transformers using the IO-Link protocol were deployed on a plasma etching machine for creating semiconductors. The monitoring model consists of three steps: 1) operation state, 2) operation type (recipe), and 3) anomaly detection. Pattern matching of time-series data and Machine Learning (ML) algorithms were developed and implemented on an edge computer. Electrical usage was calculated from the monitoring system. The collected data and operation history indicates a periodic pattern in the idle state due to subcomponent operation. Additionally, when the machine operates a recipe, the data indicates an increase in electrical current magnitude that aligned with operation start times. The study demonstrates the application of edge data analytics for monitoring the operation of manufacturing equipment through electrical current consumption. The implementation of edge computing of electrical current analysis provides real-time insights into equipment's operational state, type of operation, and potential anomalies.

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LABELED ABSTRACT

Motivation: The implementation of Internet of Things (IoT) and Artificial Intelligence (AI) techniques in manufacturing has become increasingly significant for improving yield and reducing expenses. Edge computing holds great potential to monitor machine productivity and predict performance anomalies in real-time.

Problem: With most manufacturing equipment being electrically powered, the consumption pattern of electrical current can be an indicator of the state and condition of equipment. However, conventional IoT and AI solutions that rely primarily on cloud computing encounter issues with bandwidth, latency, economic, reliability, and privacy (BLERP).

Methods: In this project, edge data analytics were utilized to convert current consumption signals into operation and condition information for modern manufacturing equipment. Three current transformers using the IO-Link protocol were deployed on a plasma etching machine for creating semiconductors. The monitoring model consists of three steps: 1) operation state, 2) operation type (recipe), and 3) anomaly detection. Pattern matching of time-series data and Machine Learning (ML) algorithms were developed and implemented on an edge computer. Electrical usage was calculated from the monitoring system.

Results: The collected data and operation history indicates a periodic pattern in the idle state due to subcomponent operation. Additionally, when the machine operates a recipe, the data indicates an increase in electrical current magnitude that aligned with operation start times.

Conclusion: The study demonstrates the application of edge data analytics for monitoring the operation of manufacturing equipment through electrical current consumption. The implementation of edge computing of electrical current analysis provides real-time insights into equipment's operational state, type of operation, and potential anomalies.