



ARDI LLM Insight

LLM-Powered Asset Analysis

Overview

Abstract

This document introduces ARDIs LLM Insight addon and covers some of the cases where it might be used.

Assumed Knowledge

None.

Who to Talk To?

For more information please contact Optrix.

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Introduction

What is LLM Insight?

LLM Insight is designed to help customers safely bring some of the power of Large Language Models (such as Chat GPT, Grok etc.) into the day-to-day operations of their automated process systems.

While these sorts of AI models are **not** suitable for large scale control or optimisation tasks at this point in time, they can be very useful when used for what they are intended for – helping humans and computers communicate.

The addon allows users to ask simple, pre-formatted questions about a range of topics around asset health and behaviour, including...

- Human-readable summaries of the current asset state,
- Discussions and summaries of recent history,
- Lists of unusual events,
- Suggestions of alerts and alert setpoints,
- Suggestions of performance KPIs and additional sensing

Why Would I Need It?

While a full chat-style interface to your data can be useful, they can be daunting for users for several reasons...

Knowing where to start: When you can ask *anything*, people often find themselves paralysed, not knowing what they should or can ask for. Pre-built prompts give users direct suggestions for how they might want to interact.

Knowing what is reliable: LLMs are prone to *hallucinations*, where they respond with random or made-up information that has been picked up from sources other than your own data. Pre-built prompts can be engineered to help avoid these issues.

Knowing how to phrase requests: Not all users are great writers, and LLMs can be very sensitive to the words you use to phrase your request – adding a single word can dramatically change your output. Pre-made prompts give you consistent, tested phrasing that can be tailored to the specific needs of a model (ie. ChatGPT 4, Gemini, Grok etc.).

Understanding the process: Using chat, users have to describe the specific piece of equipment they are talking about. This might be difficult for them to do in an unfamiliar site. LLM Insight instead allows users to interact with ARDI to find the asset visually, making it easy for users to narrow down items of interest.

Fundamentally, LLM Insight guides users to *easily access* LLM-powered queries that are *useful* and *reliable*.

Example Prompts

Current Status

This query asks the LLM to summarise the *current status* of an asset.

This feeds the raw information about the asset and its current values to the LLM, which then returns a simple report summarising what it's doing **now**.

As part of the summary, you'll often see comparisons between points (such as commentary when there's a difference between *target* and *actual* values), as well as comparisons to what the LLM believes would be normal, comfortable or safe in the situation.

It will also point out bad data or irregularities, such as the speed being high when the voltage is zero.

Recent Status

In this case, we provide *history* of the asset and ask the LLM to review the data over time.

The summary provided by the LLM will often discuss minimum and maximum values and comment on fluctuations during the day.

In some cases, it will also suggest *root causes* for correlations between data points, such as power usage being reduced because the machine has been out-of-service.

Note – the LLM models are only sent relatively coarse information, so will be unable to detect very small, sudden movements in data unless you specifically configure the system for this use-case.

See an example in the **Recent Status** section on page 5.

Suggested Alerts

This option suggests how the existing points of data on the asset could be used to create alerts, such as control, data quality and anomaly alarms.

These suggestions don't just include a description of what you'd be looking for, but also include the *actual logic that can be used to detect the issue*. This can be used to create calculations, models or scripts.

Additional Data

The LLM does a good job of identifying blind-spots in your sensor network, suggesting where additional I/O might be useful – such as adding vibration and temperature sensors to moving machinery, feedback on valves etc.

It can also help identify opportunities to use your existing data to build virtual sensors and performance KPIs. See an example in the **Additional Data & KPIs** section on page 7.

Sample Responses

Recent Status

This example shows the results when using LLM Insight on Apartment 402 in our *Building Management* demo site.

Analytics and Commentary on Apartment 402

Overview: Apartment 402 is equipped with various monitoring and control systems that track water usage, gas usage, temperature settings, power consumption, and safety statuses. The historical data provided spans a 24-hour period, offering insights into the operational efficiency and safety of the apartment.

Key Metrics:

1. Water Usage:

- The water usage fluctuates between approximately 2.8 to 18.5 kL/hour throughout the day.
- The peak usage of 18.5 kL/hour occurred around 13:24, which may indicate increased activity or usage of water-intensive appliances during that time.
- The average water usage appears to be around 3-4 kL/hour during non-peak hours, suggesting a baseline consumption level.

1. Gas Usage:

- Gas usage remains relatively low, mostly around 0.4 to 6.0 MJ/hour, with occasional spikes up to 9.4 MJ/hour.
- The consistent low gas usage suggests that heating or cooking appliances are not heavily utilized, which could be a point of efficiency or indicate a preference for electric appliances.

1. Temperature Control:

- The AC setpoint temperature is consistently maintained at 24°C, which is within the acceptable range (17-26°C).
- The air temperature remains stable around 24°C, indicating effective temperature regulation by the AC system.

1. Power Usage:

- Power consumption shows significant variability, with usage peaking at 3135.88 KWh during high-demand periods (around 20:44).
- The average power usage during the day appears to hover around 1500-2000 KWh, indicating potential high energy consumption during peak hours.

- The spikes in power usage may correlate with the operation of multiple appliances or systems simultaneously.

1. **Fire and Occupancy Status:**

- The fire status remains at '1' (OK) throughout the data period, indicating no fire incidents were detected.
- The occupancy status fluctuates, with periods of being '1' (Occupied) and '0' (Vacant), suggesting that the apartment is not continuously occupied.

1. **Air Flow and Temperature:**

- The air flow from the AHU (Air Handling Unit) is monitored, with values indicating effective air circulation.
- The air temperature readings are consistent with the setpoint, suggesting that the HVAC system is functioning properly.

Commentary:

- **Efficiency Considerations:**
 - The water and gas usage metrics suggest that Apartment 402 is operating efficiently, particularly with low gas consumption. However, the significant spikes in power usage warrant further investigation to identify the causes and explore opportunities for energy savings.
 - The consistent maintenance of the AC setpoint indicates effective climate control, which is crucial for occupant comfort.
- **Safety Monitoring:**
 - The absence of fire incidents and the consistent 'OK' status for fire safety is reassuring. Regular maintenance of the smoke detector and fire safety systems should continue to ensure ongoing safety.
- **Occupancy Patterns:**
 - The fluctuation in occupancy status may indicate varying usage patterns, which could be leveraged for optimizing energy consumption. For example, if the apartment is often vacant, energy-saving measures could be implemented during those times.
- **Recommendations:**
 - **Energy Audit:** Conduct an energy audit to identify high-consumption appliances and explore energy-efficient alternatives.
 - **Water Management:** Investigate the peak water usage times to understand if there are opportunities for conservation or efficiency improvements.

In conclusion, Apartment 402 demonstrates effective operational metrics, but there are opportunities for further efficiency improvements, particularly in energy management and water usage. Regular monitoring and analysis of these metrics will help maintain optimal performance and safety.

Additional Data & KPIs

This example shows the results when using LLM Insight on a 'roller' on a product line conveyor that contains a number of moving parts.

To enhance the monitoring and diagnostics of the 'Bridle #2 Roller 2' (BR02-2), consider adding the following sensors, measurements, and key performance indicators (KPIs):

Additional Sensors and Measurements:

Temperature Sensors:

- **Bearing Temperature:** Monitor the temperature of the roller bearings to detect overheating, which can indicate lubrication issues or excessive load.
- **Motor Temperature:** Measure the temperature of the motor driving the roller to prevent overheating and ensure optimal performance.

Vibration Sensors:

- **Vibration Analysis:** Install vibration sensors to detect imbalances or misalignments in the roller system, which can lead to premature wear or failure.

Tension Sensors:

- **Tension - Setpoint:** Measure the tension setpoint to ensure that the system is operating within the desired parameters.
- **Tension - Feedback:** Additional feedback sensors to confirm the actual tension being applied versus the target tension.

Speed Sensors:

- **Speed - Differential:** Measure the speed difference between BR02-2 and adjacent rollers (e.g., BR02-1 and BR03-1) to ensure synchronization and prevent slippage.

Current Sensors:

- **Phase Current Monitoring:** Monitor the individual phase currents of the motor to identify imbalances that could indicate issues with the motor or load.

Voltage Sensors:

- **Phase Voltage Monitoring:** Measure the voltage across each phase of the motor to detect issues with power supply or motor performance.

Load Cells:

- **Load Measurement:** Install load cells to measure the actual load on the roller, which can help in understanding the operational conditions and performance.

Humidity Sensors:

- **Environmental Monitoring:** Measure humidity levels in the area to assess the potential impact on material properties and system performance.

Key Performance Indicators (KPIs):**Tension Control Efficiency:**

- Calculate the ratio of actual tension to target tension over time to assess how effectively the system maintains desired tension levels.

Energy Consumption:

- Monitor the energy consumption of the roller system to identify trends and potential inefficiencies.

Operational Time vs. Downtime:

- Track the operational time of BR02-2 versus downtime due to maintenance or failures to assess reliability.

Mean Time Between Failures (MTBF):

- Calculate the average time between failures of the roller system to evaluate reliability and performance.

Mean Time to Repair (MTTR):

- Measure the average time taken to repair the roller system when failures occur, which can help in assessing maintenance efficiency.

Vibration Levels:

- Monitor vibration levels and set thresholds to trigger alerts for maintenance when vibrations exceed acceptable limits.

Temperature Trends:

- Track temperature trends over time to identify potential overheating issues before they lead to failures.

Speed Consistency:

- Measure the consistency of actual speed against target speed to ensure that the roller is operating as intended.

By integrating these additional sensors and KPIs, you can gain a more comprehensive understanding of the operational status and performance of 'Bridle #2 Roller 2', leading to improved diagnostics and maintenance strategies.