Application Note

On-line Surveillance Monitoring in Continuous and Batch Process Applications

Using parametric gating in the SKF Multilog Local Monitoring Unit (LMU), the Monitor Interface Module (MIM) and future SKF Reliability Systems surveillance instruments

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Background

Successful on-line surveillance based condition monitoring and evaluation relies on acquiring data at known, repeatable machine operating states and reporting detected abnormalities as quickly as possible. Most industrial machinery operates at reasonably steady states for extended periods. These machines are relatively easy to diagnose, as changes in their “condition indicating characteristics” can normally be attributed to changes in their physical, mechanical health. Identifying the operating state, beyond the simple verification that a machine is running or not, to control when data should be collected is usually not required. Unfortunately, not all industrial machinery can be expected to always be running at known, repeatable conditions.

The objective is not to alter or suspend production to put a machine into a known, repeatable state to make measurements; rather, it is to maintain production and make measurements when, in the cycle of normal operation, the machine is operating in an identifiable, repeatable state.

Fig. 1. Monitor interface module (MIM).

Two challenges – one solution

Among the most challenging types of machines to monitor and diagnose are those whose operating characteristics can vary based on the specific product produced, line speed or production capacity. Some of the best examples of these are found in continuous and batch process manufacturing operations typical of the Power Generation, Hydrocarbon Processing, Chemical and Pharmaceutical Manufacturing, Pulp and Paper, and Metal Producing industries. The technical challenge is for the on-line surveillance instrument to automatically determine when a machine is in the proper state for meaningful condition monitoring data to be acquired.

An additional challenge to successful on-line surveillance based condition monitoring and evaluation schemes is the pure volume of acquired data that needs evaluation. Clearly, the majority of acquired data does not typically indicate physical mechanical problems, and, often, databases become clogged with a huge volume of uninteresting data. Older surveillance systems had the capability to utilize a secondary set of measurement specifications that would only be acquired when a primary measurement went into an alarm state. As these older (and some current) instruments were essentially portable data collectors mounted on a wall, they could only run their primary or secondary “ROUTEs” on an either/or basis. The primary ROUTEs typically consisted of low resolution dynamic measurements, while the event ROUTEs were high resolution measurements. However, in all cases, the entire high resolution ROUTE was run when, perhaps, only a few measurements were required. This consumed valuable time at the instrument level and unnecessary space at the database level.

Fig. 2. Local monitoring unit (LMU).

The solution

The SKF Multilog Local Monitoring Unit (LMU) and Monitor Interface Module (MIM) have the most advanced parametric data acquisition control logic available in any surveillance based condition monitoring and evaluation instrumentation system. SKF is committed to perpetuate this capability in all future on-line surveillance instruments. Although data collection timing within LMUs is not synchronized with machine operating state, LMUs have the capability to determine operating state and locally control measurement data acquisition based on specific measurement results. This enables them to acquire only valid condition indicating data when the monitored machinery is verified by specific measurements to be in a known operating condition, or only those high resolution measurements necessary to diagnose the observed alarm.

The LMU and MIM each have eight binary digital inputs, eight speed indicating inputs and 32 input channels that can monitor either dynamic or static parameters. Any of these can be used to make measurements that first indicate the running or alarm state of the monitored machinery before selectively enabling the detailed condition indicating measurements.

The technique

Most measurement POINTs are independent of other measurements and acquired based on configuration parameters local to the POINT itself. Measurements that rely on the results of other measurements to determine whether they should be acquired are referred to as dependent or conditionally acquired measurements. Within an instrument, any measurement can be designated as dependent on any other measurement, and dependencies can cascade through multiple measurements. There are only two requirements to consider:

1. Dependent measurements can only be dependent on measurements on the same instrument. That is, acquiring a measurement on one LMU or MIM cannot be dependent on the measurement result from a different LMU or MIM.
2. The top of every dependency chain must be an independent measurement. If all measurements on an instrument are dependent, then no data will ever be acquired!

A dependent measurement can be set up to look at the result of any other measurement to determine if the machine is in the proper condition, or alarm state, for the measurement to be acquired. This relationship is established by entering a measurement in the **Control POINT** field in the dependent POINT's **POINT Properties Setup** tab. The POINT whose condition is evaluated is called the Control POINT, as its alarm state controls the acquisition of the dependent POINT. The control action is based on the Control POINT's alarm state. Simply put, if the Control POINT is in an alarm state, then the dependent measurement POINT's data will be acquired. If the Control POINT is not in alarm, then the dependent measurement POINT is bypassed and data is not acquired.

The most common use of this technique is to use low resolution or overall vibration measurements to determine if high resolution measurements are required. When the independent overall or low resolution spectrum measurement goes into an alarm state, a conditionally acquired measurement will automatically be acquired, thus giving the analyst high resolution data only when it is truly necessary to diagnose observed abnormalities.

The less common, but clearly the most powerful use of this technique is in determining the operating state of the monitored machinery. Mechanical condition indicating measurements can be tied directly to the operating state of the machine, as determined by specific measurements. Variable speed, variable load machinery provides the simplest example of the advantage of this capability. Consider the relatively simple example of a turbine driven feedwater pump. These machines are commonly used in a wide variety of manufacturing applications and often operate over a very large speed range, which span multiple "critical speeds" or resonances. Measurements can be set up to acquire only condition indicating data when the machine is operating within designated speed ranges, which avoids polluting trends with data acquired when the machine is running on or near one of several resonances, and compartmentalizing the data into segments below the first critical, between the first and second critical, and above the second critical. This is accomplished by creating three independent measurements of machine r/min and setting their alarms to identify when the machine is within the appropriate operating range.

SKF Reliability Systems on-line systems enable measurements to be assigned to any instrument channel, thus not restricting each channel to a set maximum number of measurements with finite alarms. The turbine driven feedwater pump scenario can be implemented so that the same speed channel can be used by multiple measurements. One speed measurement could be created with an "In Window" alarm set for 1 000 to 1 500 r/min, another set for 2 000 to 3 000 r/min, and the third set for 4 500 to 5 500 r/min.

Vibration measurement POINTs would be set up for each of these ranges, with their **Control POINT** fields specifying the appropriate speed range measurement. Using this technique automatically qualifies and compartmentalizes the dependent data into the appropriate area for meaningful trending and evaluation.

Although the example above uses r/min as the controlling parameter, any measurable parameter, including static or dynamic vibration, may be used. Often, machinery operating state is best determined by a process temperature, pressure, voltage or flow rate. The only requirement for an SKF Reliability Systems surveillance instrument to use any of these as a Control POINT parameter is the ability to connect to the appropriate sensor. In other words, if a parameter can be measured and alarmed on, it can be used as a Control POINT.

In addition to the traditional static and dynamic parameters, SKF Reliability Systems on-line surveillance instruments also have eight binary digital inputs that can be used as Control POINT measurements. Alarms are not used; rather the active state for each Logic POINT must be designated in the **POINT Properties Setup** tab. A dependent measurement using a Logic POINT as its Control POINT will be acquired if the Logic POINT is in its designated active state. The key to successfully setting up the logic control configuration is a thorough understanding of the relays available in the monitored machine's control system and how their states, opened or closed, represent the machine's operating mode at any point in time.

The binary inputs, identified on the LMU motherboard as BIN 1 through BIN 8 on terminal strip JP8, are all normally in a binary "high" state, as approximately 5 volts will be present across each input's terminal and ground. Using these inputs simply requires them to be connected to relays in the machinery control system and the knowledge of the control system relay states, which identify when the machine is in specific operating modes.

Conclusion

The LMU provides extremely flexible data acquisition control capabilities for use on batch and continuously operated machinery. Contact your local SKF Reliability Systems Service Engineer for assistance in implementing this powerful feature.

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