Performance Monitoring for Mineral Processing

The chemical and metallurgical process industries face stiff challenges in the form of increasing energy costs, increasingly stringent environmental regulations, and global competition. Although advanced control is widely recognized as essential to meeting these challenges, implementation is hindered by more complex, larger-scale circuit configurations, the tendency toward plantwide integration, and in some cases an increased lack of trained personnel. In these environments, where process operations are highly automated, algorithms to detect and classify abnormal trends in process measurements are critically important. Advanced algorithms and measurement control systems have been designed and implemented for process performance monitoring and operational performance management, yielding substantial benefits in operating installations.

Monitoring and Control with Computer Vision

Most of the developments were based on the application of computer vision systems in areas where no devices were previously in place to measure key variables in reaction systems:

- Customized computer vision algorithms are used to estimate the proportion of fines in coal feed systems accurately enough to allow online control (Figure 1). Excessive fines in the feed may adversely affect gas flow through the reactor burden, leading to substantial losses associated with suboptimal operation. Previous methods for online analysis of particulate feeds were either nonexistent or based on inefficient automated sieve samples taken from belts.
- Multivariate feature extraction from platinum froth images could be used as a basis for system identification and advanced control of froth flotation systems. With the aid of advanced process models, these features can be used to reliably estimate prevailing process conditions, which is not otherwise feasible (Figure 2).

Figure 1: An image from a computer vision system on a coal conveyor is automatically processed to estimate the proportion of fines in the coal.

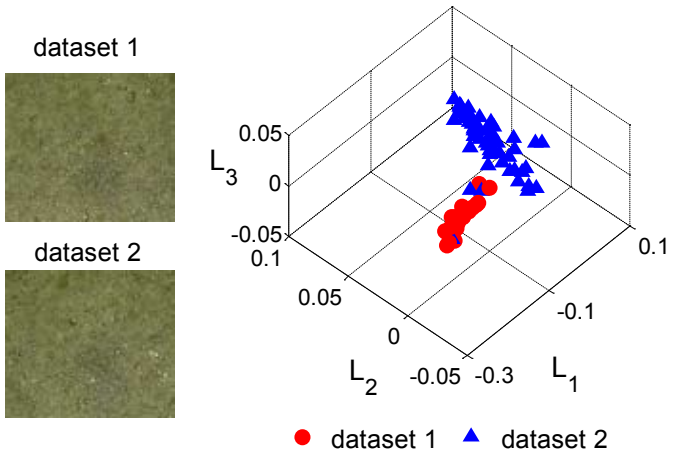

Figure 2: Change in process conditions is detected by an online computer vision system by projection of froth image features to a control chart.

These techniques have been developed by the Anglo Platinum Centre for Process Monitoring and their associates at the University of Stellenbosch in South Africa to enable their industrial partners to realize the competitive advantages afforded by advanced control and monitoring systems.

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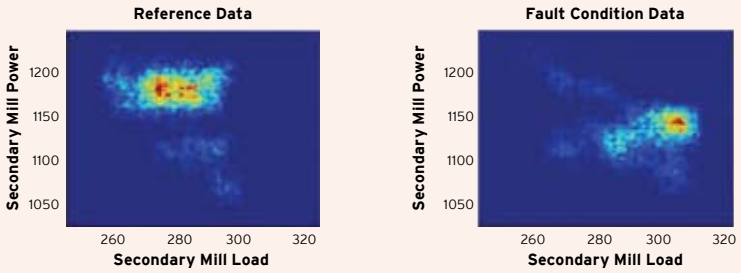
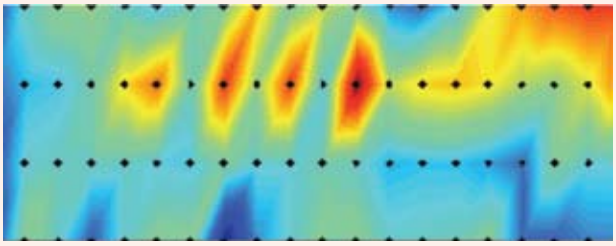
Advanced process monitoring technology can expedite safe operation closer to production limits, eliminate major process upsets, and reduce minor, often unreported, abnormal situations. Capacity increases of 3-8% have been estimated for a range of process industries with monitoring and related technologies (www.asmconsortium.net); this amounts to $200—500 million per year for the South African platinum industry alone.



Monitoring of an autogenous mill on an industrial concentrator plant



Prognostic monitoring of wall temperatures for a metallurgical furnace

Process Fault Detection and Identification

The Centre and its associates have developed state-of-the-art algorithms (Figure 3) for process fault diagnosis that are currently used plantwide by one of the premier mineral processing companies in South Africa. The following benefits have resulted from use of the algorithms:

- The turnaround time associated with attending to plant faults has been reduced from several weeks or even months to less than three days.
- The frequency of large events leading to process circuit and equipment downtime—and associated losses in revenue—has been substantially reduced.
- Plant alarms and the cost of alarm management have been reduced considerably.
- The development of large-scale process monitoring systems has enabled early detection of thermal runaway in metallurgical furnaces.
- The detection and identification of different operational states in autogenous and semi-autogenous mills can at times be realized with an accuracy of up to 80%—providing a basis for better control and potentially large reductions in energy usage by mineral processing plants.

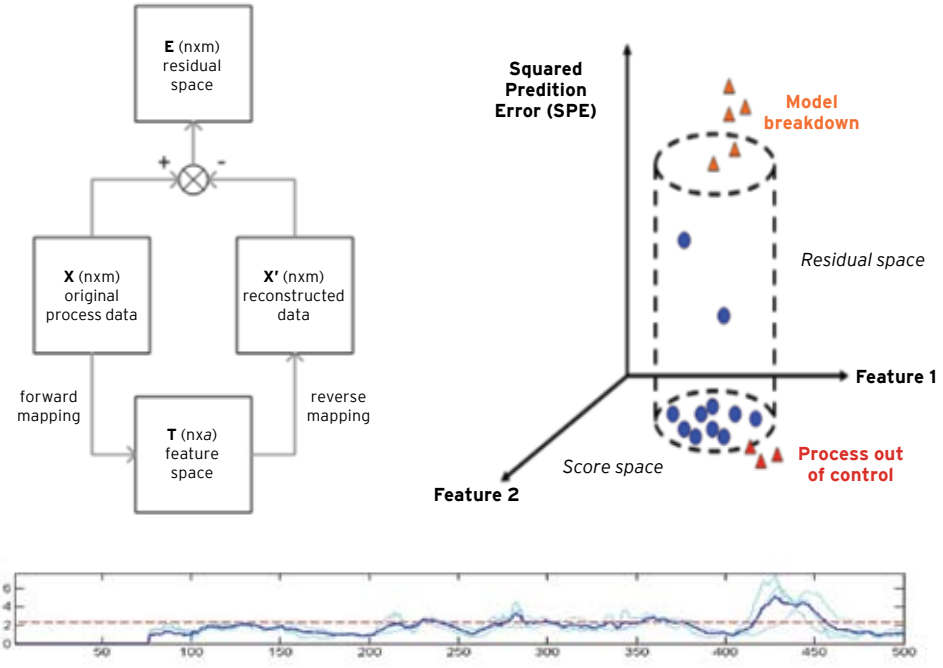


Figure 3: Monitoring the model prediction error in an appropriately constructed feature space enables advance warning of process upsets.

For further information: The Anglo Platinum Centre for Process Monitoring, www.sun.ac.za/cpm