Real-time energy audit reduces power consumption

October 23 2013

Engineers could reduce overall energy consumption by using new software that monitors the energy usage of individual machines on a factory floor. Credit: Stockbyte/Thinkstock

Governments are pressuring industries to reduce energy consumption for both environmental and economic reasons. Optimizing factory processes and improving equipment can lower energy usage but this not only takes time and money, it also requires a vast amount of background operational knowledge.

Now, Oon Peen Gan and co-workers at A*STAR's Singapore Institute of Manufacturing Technology, together with researchers at the National University of Singapore and The University of Texas, United States, have developed an approach to track the daily energy usage of individual

machines. Their approach monitors the operational state of a machine in real time.

"Our proposed idea improves energy efficiency through better sequence control of machines and operations," notes Gan. "It can be as simple as switching off a light when not in use."

To test their idea, Gan and his team identified the operational state of two individual industrial molding machines, based on their energy consumption. The researchers placed sensors inside the machines and fed the data from the sensors into a mathematical model called a finite-state machine (FSM), which is commonly used for analyzing manufacturing processes. Since a machine in the 'start-up' state has a different energy output to one in full production, the FSM could be used to produce power-consumption profiles of the machines.

The researchers then used a unique two-stage framework to help them analyze and classify the data. "During the first stage we cleaned the raw energy signals using a digital filter to produce a much smoother dataset with less noise," explains Gan. "Secondly, we trained a pattern-recognition algorithm, or neural network, to classify the data into separate events. Each event represents a machine operation state."

Using the model, Gan and co-workers determined the exact operational state of each molding machine in real time. Because the researchers could easily find abnormal energy patterns in the model output, the software tool may prove very useful for engineers looking for machine faults across the factory floor.

With the trained neural network in place, a software user can classify any machine's operational state from its energy output without needing to know the machine type. Theoretically, the model could be used to monitor many different types of machines in any industry.

"We hope to incorporate our new model into existing software that is used by manufacturers to monitor their shop floors," says Gan. "We aim to validate the model with experiments at a number of industrial companies in Singapore in the near future."

More information: Le, C. et al. Classification of energy consumption patterns for energy audit and machine scheduling in industrial manufacturing systems, *Transactions of the Institute of Measurement and Control* 35, 583–592 (2013). dx.doi.org/10.1177/0142331212460883

Provided by Agency for Science, Technology and Research (A*STAR), Singapore