TNB RESEARCH

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2017 IERE-TNB Putrajaya Workshop

Development of an Auto-Milling Control System to Improve Coal Power Plant Combustion Efficiencies

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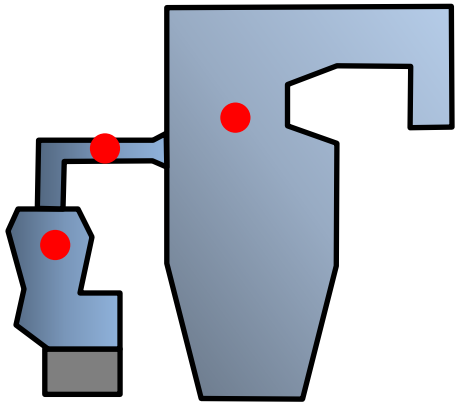
TNB Research

Background - operations

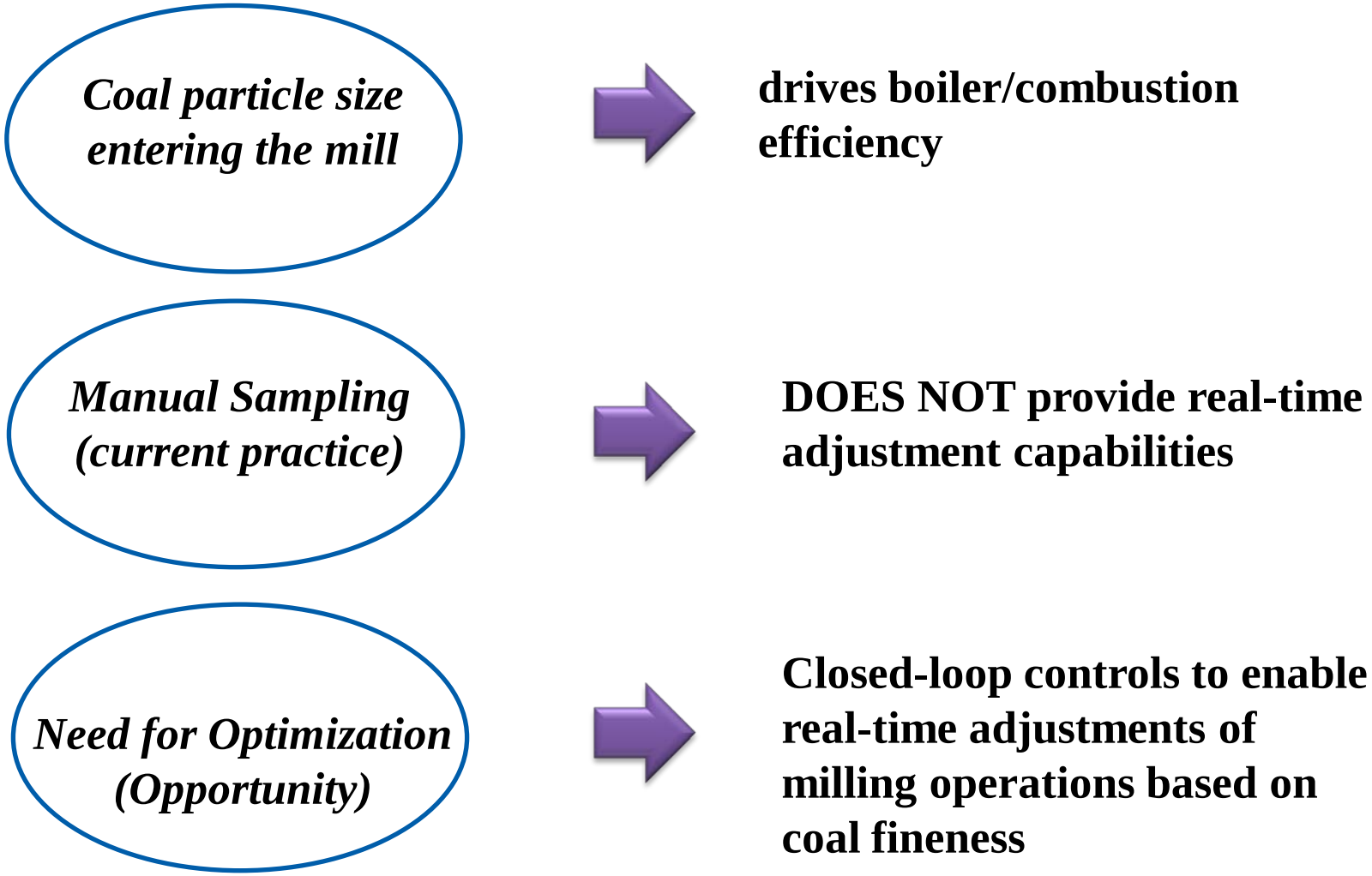
Pulverizing coal power plants in Malaysia

- For a coal-fired plant, fuel is by far the largest expense item; representing about 55% to 75% of total plant expenses
- Coal pulverizing mills consume ~1-5 % of gross power generation i.e. “parasitic power”
- Coal fineness drives combustion efficiency and operation flexibility
- Inconsistencies and off-specs fineness creates operational issues
- Fineness sampling is typically done manually – constraints on resources and impact of time delay for analytical results



Background – R&D

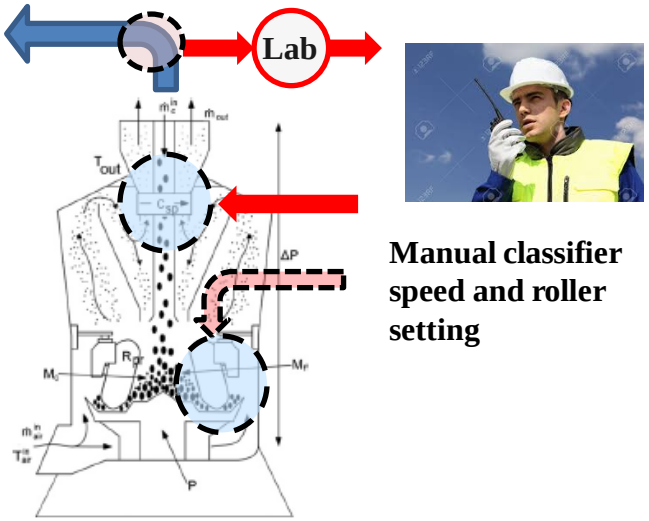
An R&D project driven by opportunities for energy efficient operations



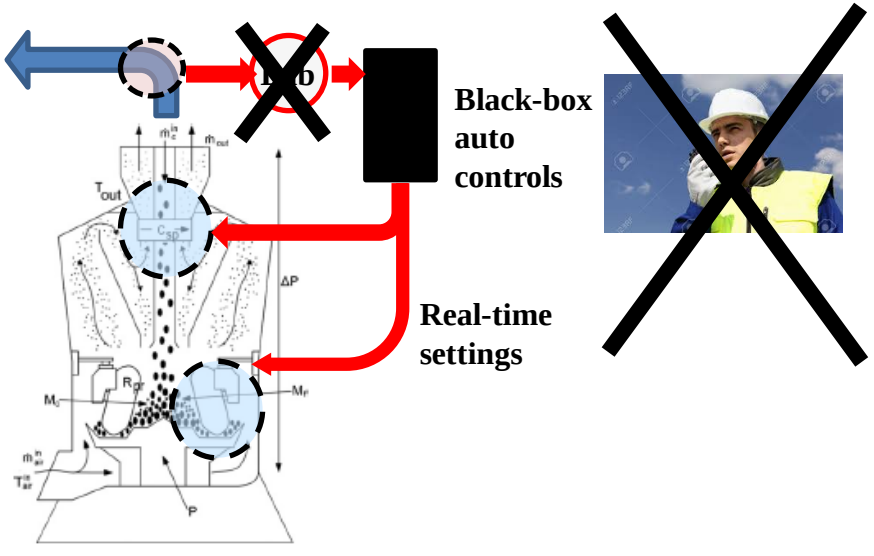
Overall aim

A combination of advanced analytics and energy management system to optimize the operations of pulverizing mills in coal fired power plants

Manual iso-kinetic sampling



In-situ/continuous image based coal fineness measurements



- **Fast response to coal fineness**
- **Operation flexibility (wide range of coal type)**
- **Energy efficient operations – improved overall plant efficiency**

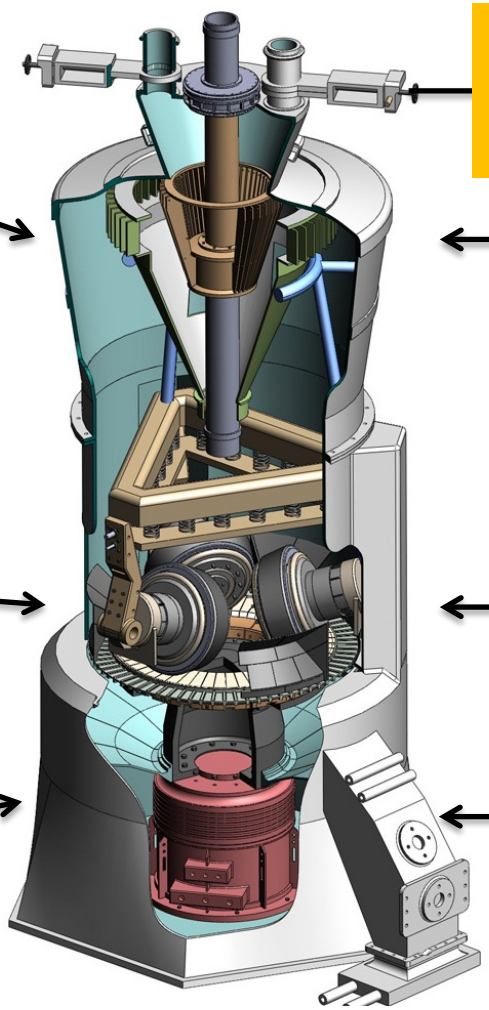
Targets

Project objectives to realize adaptable deliverables

- To develop a control scheme that **completely automates** the pulverizer mill.
- **Increase mill response** while accommodating coal with different hardness values (HGI).
- Increase coal plant **generation efficiency** from the supply of “within-spec” fineness

Pulverizer controls

Milling optimization opportunities



Classifier Opening/ Speed

Roller Pressure

Air Inlet Flowrate

Image processing technology

Data Acquisition

Control Strategy

MATLAB SIMULINK

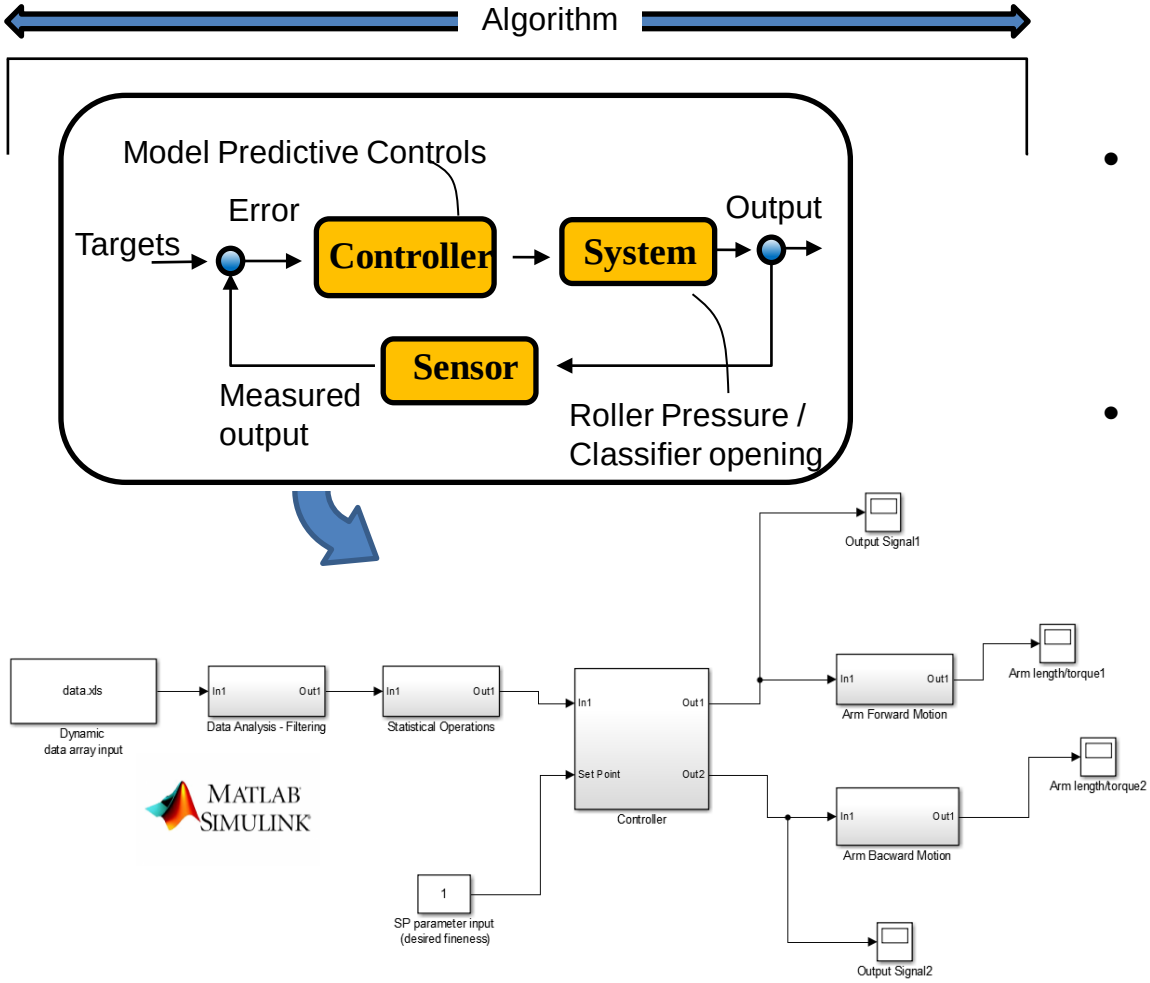
Control Action

Mill driving parameters

Development opportunities

Control system development

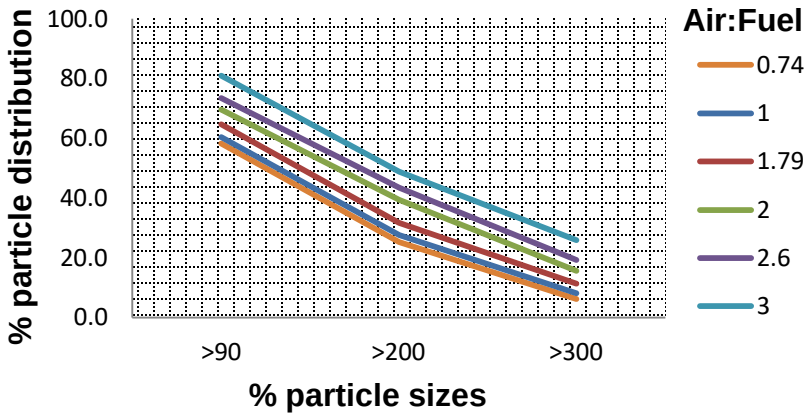
Control system algorithm



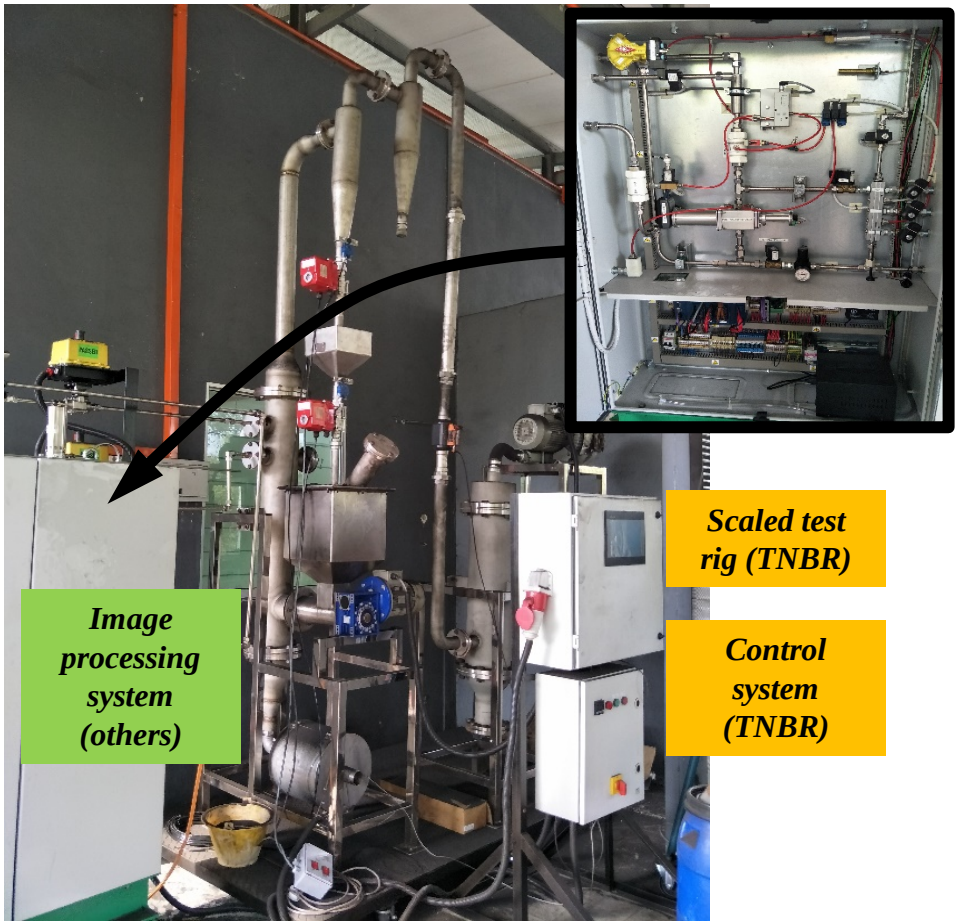
- **Process modeling and control system simulation in Matlab Simulink.**
- **Implement Model Predictive Control (MPC)/PID framework.**

Scaled test rig

Validation of control system in a simulated environment (scaled testing)

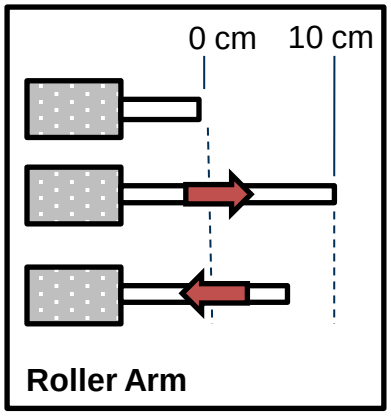


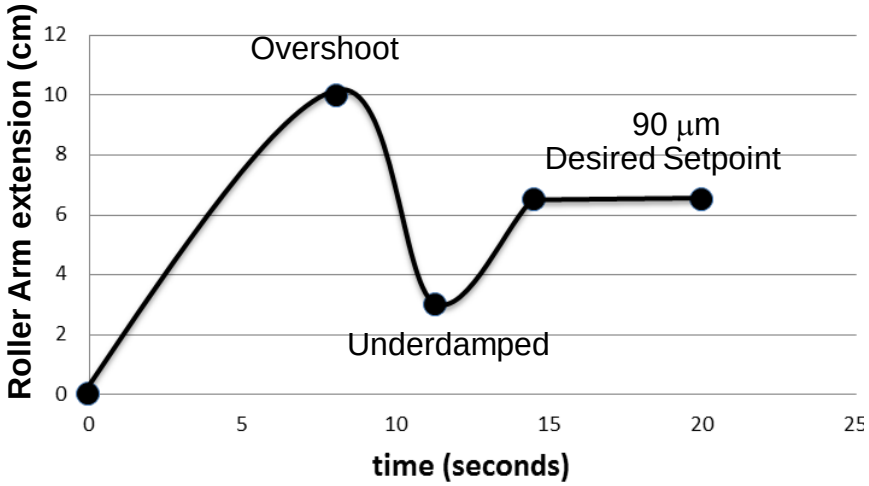
- Variation of Air/Fuel to obtain “real” operating range.
- Data was captured and transferred to control system seamlessly.
- Response of roller arm was measured for different coal fineness



Results

A control system to analyze data and provide response instructions





- Response time of the roller arm gave an indication of actual auto-milling capabilities:
  - Distance: 0 – 10 cm
  - Time: 2 sec response (compared to manual sampling and adjustments - “days” scale)

- Model predictive controls (MPC) finds the optimum operating point and sends instructions to move roller arm

- Testing carried out in a test rig confirm controls capability and integration robustness

Conclusions

- The auto-mill control system has been developed and tested on a scaled lab test rig.
- The particle size measurement technique has been successfully tested and verified.
- An integrated control system that continuously performs measurements and adjusts the roller pressure of the mill accordingly has been developed and successfully simulated.

THANK YOU

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Filed Patent

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Date Filed: 4th October 2017

Title: Real time optimization of roller arm adjustments in pulverizing milling operations based on in-line particle size measurements and analysis at the mill outlet pipes

Brief Description:
The invention integrates pulverized coal particle size measurement technology to the mill operating parameters in real-time to always maintain the pulverizing mill output within a desired range of coal fineness. The invention provides the tools and capability for plant operators to optimize performance of the mill which subsequently results in more efficient combustion at the coal burners - further improving overall equipment reliability.