Process Monitoring

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Chapter 4
Industrial Monitoring Review

Process Monitoring

Chapter Description

- Aims
  - Analyze the current progression of industrial monitoring application.
- Expected Outcomes
  - Conduct a critical review of the current industrial monitoring issues particularly on the MSPM extensions.
- Other related Information

Subtopics

4.1 Desirable Characterization of Monitoring System

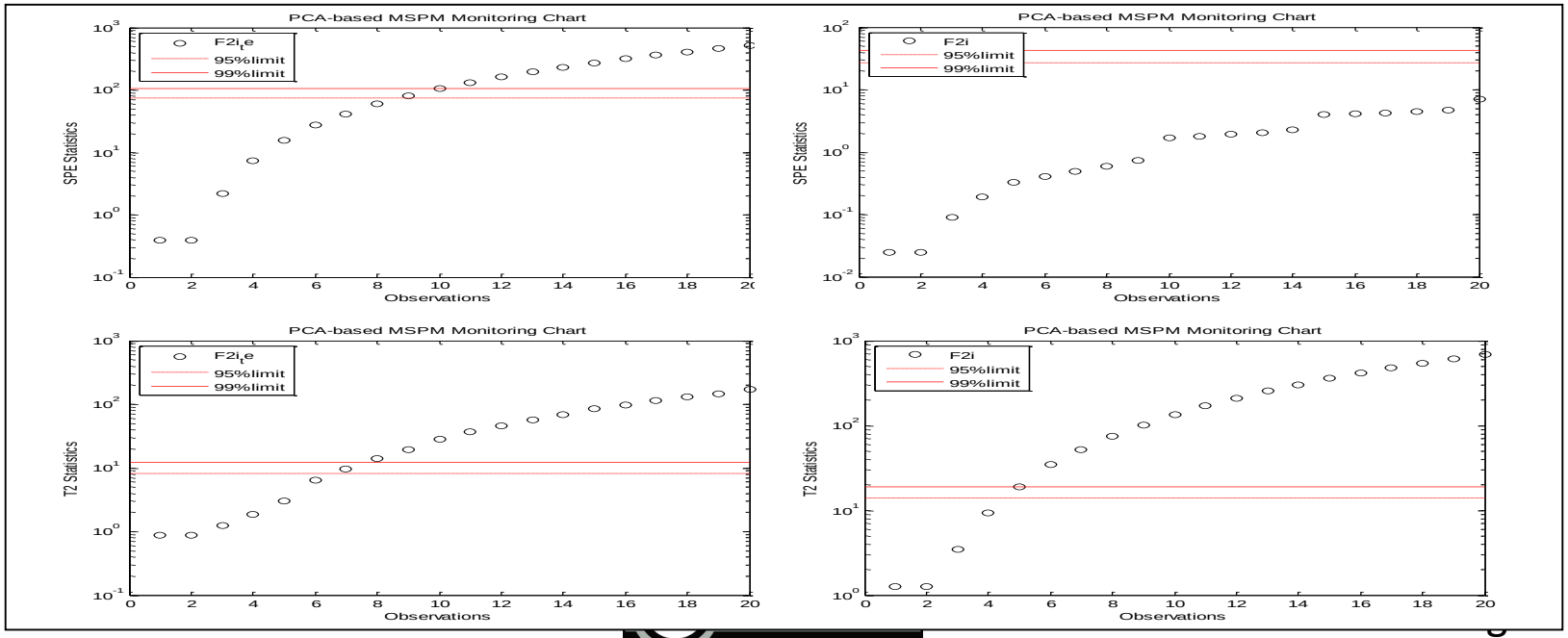
4.1 Characterization of Monitoring

10 Characteristics of Monitoring Performance (Venkatasubramaniam, 2003a)

1. Quick Detection & Diagnosis
2. Isolability
3. Robustness
4. Novelty identification
5. Classification error estimation
6. Adaptability
7. Explanation facility
8. Modelling requirements
9. Storage and computational requirements
10. Multiple fault identification

4.1 Characterization of Monitoring

1. Quick Detection & Diagnosis
   - ➢ The diagnostic system should respond quickly in detecting and diagnosing process malfunctions



4.1 Characterization of Monitoring

1. Quick Detection & Diagnosis…cont.
   - Fault Detection Time: The difference in terms of sampling time between the first sample cross the limit and the time of the fault signal introduced into the system/process.

Faults	PCs		
	3	5	7
1	2	4	5
2	3	7	8
3	2	2	1
4	29	25	15
5	10	9	22
6	40	34	21
7	39	32	21
8	27	24	15
9	29	24	14
10	30	25	16
11	3	3	9

4.1 Characterization of Monitoring

2. Isolability

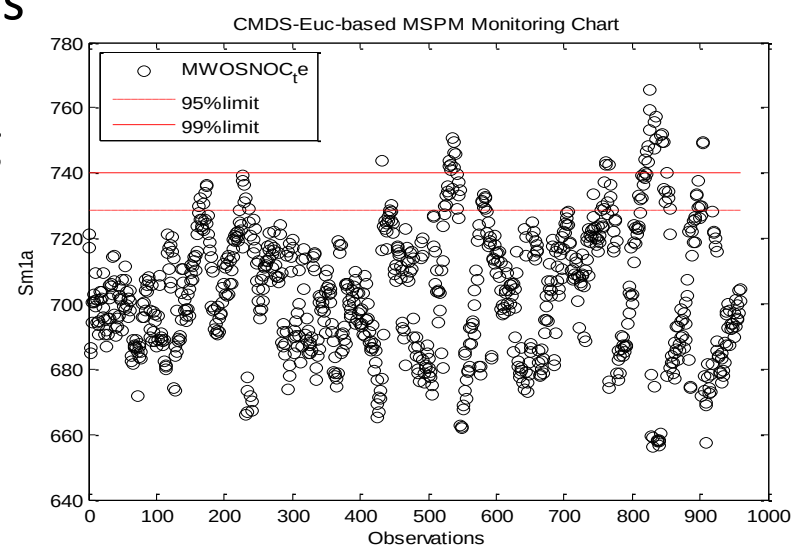
- Isolability is the ability of the diagnostic system to distinguish between different failures

Fault Cases	Fault Causes
1	Pipe 1 blockage
2	External feed-reactant flow rate too high
3	Pipe 2 or 3 is blocked or pump fails
4	Pipe 10 or 11 is blocked or control valve 1 fails low
5	External feed-reactant temperature abnormal
6	Control valve 2 fails high
7	Pipe 7, 8, or 9 is blocked or control valve 2 fails low
8	Control valve 1 fails high
9	Pipe 4, 5, or 6 is blocked or control valve 3 fails low
10	Control valve 3 fails high
11	External feed-reactant concentration too low

4.1 Characterization of Monitoring

3. Robustness

- One would like the diagnostic system to be robust to various noise and uncertainties covering the whole mode of operations as much as possible.
- False alarm rate (FAR) analysis is conducted to evaluate the robustness of the monitoring statistics
- High FAR indicates that the developed limit settings are unsuitable to be used for monitoring



4.1 Characterization of Monitoring

4. Novelty identification

- One of the minimal requirements of a diagnostic system is to be able to decide, given current process conditions, whether the process is functioning normally or abnormally.
- If abnormal, whether the cause is a known malfunction or an unknown, novel, malfunction.

4.1 Characterization of Monitoring

5. Classification error estimation

- Such error measures would be useful to project confidence levels on the diagnostic decisions by the system giving the user a better feel for the reliability of the recommendations by the system.

4.1 Characterization of Monitoring

6. Adaptability

- Processes in general change and evolve due to changes in external inputs or structural changes.
- Process operating conditions can change not only due to disturbances but also due to changing environmental conditions such as changes in production quantities with changing demands, changes in the quality of raw material etc.

4.1 Characterization of Monitoring

7. Explanation facility

- Besides the ability to identify the source of malfunction, a diagnostic system should also provide explanations on how the fault originated and propagated to the current situation.
- This is a very important factor in designing on-line decision support systems.

4.1 Characterization of Monitoring

8. Modelling requirements

- For fast and easy deployment of real-time diagnostic classifiers, the modelling effort should be as minimal as possible.

9. Storage and computational requirements

- Usually, quick real-time solutions would require algorithms and implementations which are computationally less complex, but might entail high storage requirements.
- One would prefer a diagnostic system that is able to achieve a reasonable balance on these two competing requirements.

4.1 Characterization of Monitoring

10. Multiple fault identification

- The ability to identify multiple faults is an important but a difficult requirement. It is a difficult problem due to the interacting nature of most faults.

References

- Venkatasubramanian, V., Rengaswamy, R., Yin, K., Kavuri, S.N., (2003a). A Review of Process Fault Detection and Diagnosis. Part I: Quantitative model-based methods. *Computers and Chemical Engineering*, 27, 293 – 311.
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Authors Information

Credit to the authors: