Variable Structure IMM

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Under Supervision of:

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Outline

- Interacting Multiple-Model (IMM)
- Variable Structure IMM
  - Maximum Likelihood Estimation (MLE)
- Proposed algorithm 1
- Proposed algorithm 2
- Simulation Results

Outlines

- IMM
- Variable Structure IMM
  - MLE

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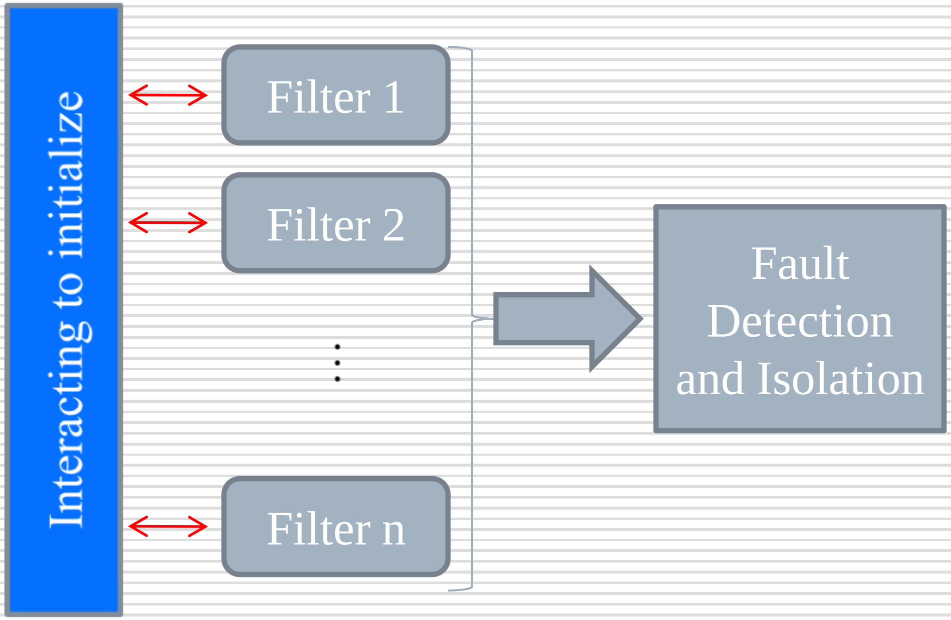
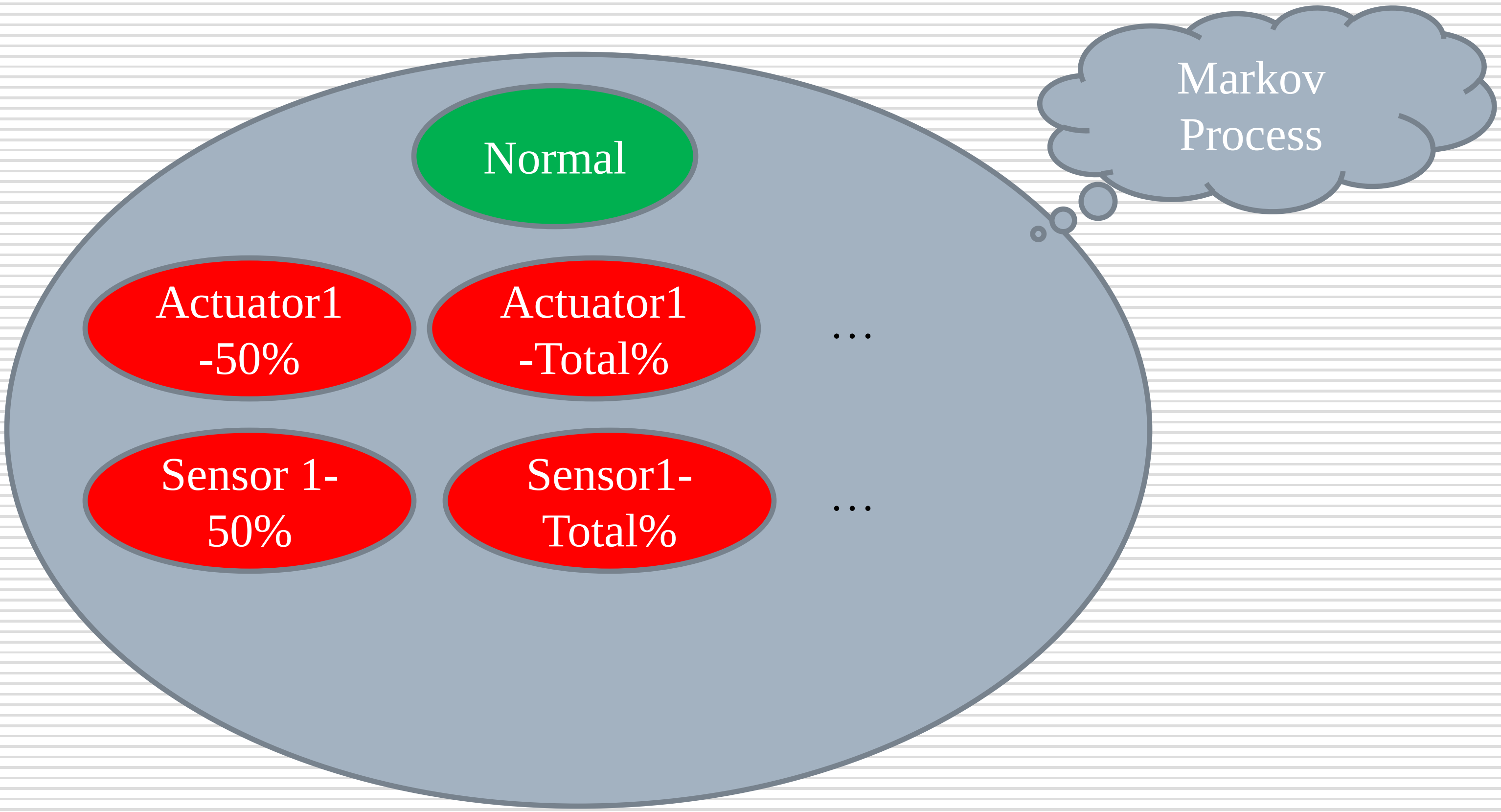
IMM

- A bank of filters
- Interacting



IMM


Markov
Process
Normal
Actuator1
-50%
Actuator1
-Total%
…
Sensor 1-
50%
Sensor1-
Total%
…

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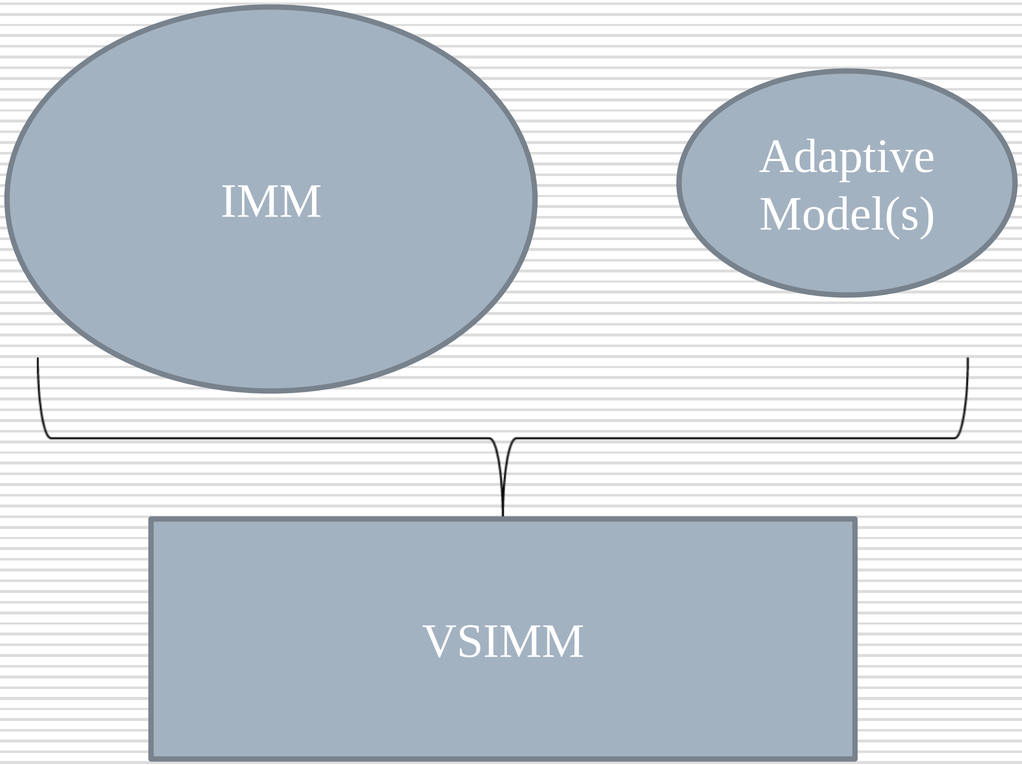
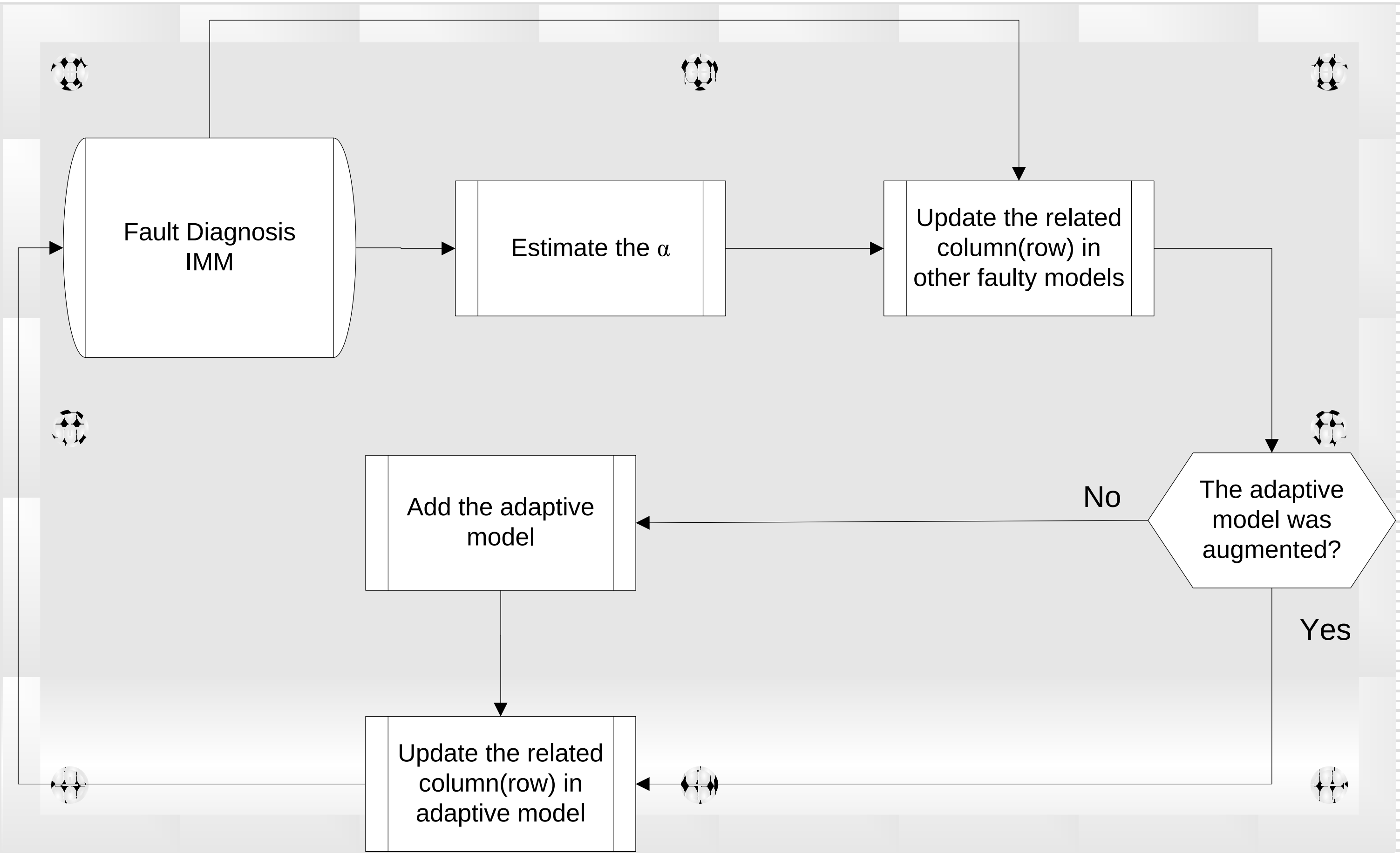
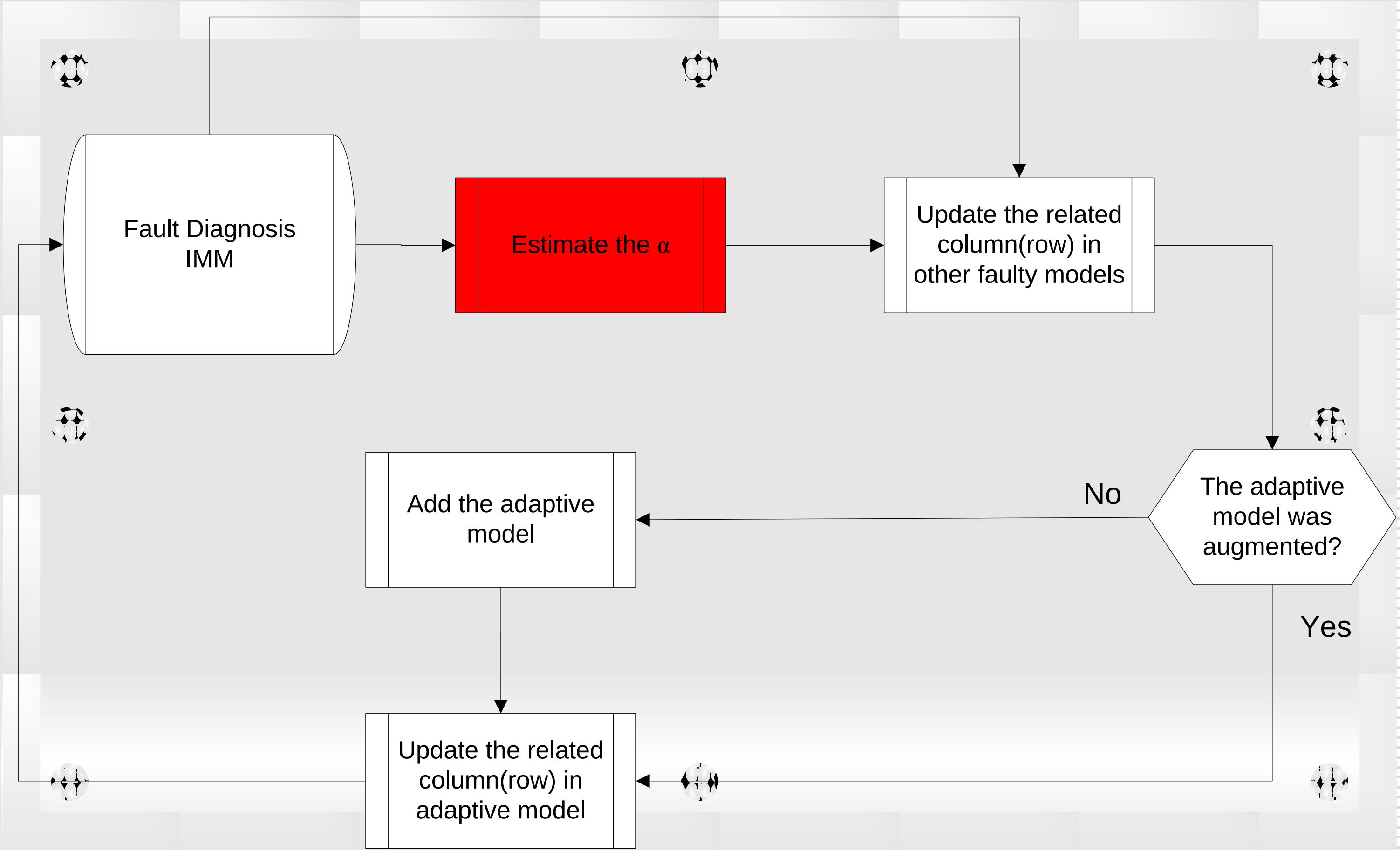
Variable Structure IMM



Variable Structure IMM



Variable Structure IMM



Maximum Likelihood Estimation

- Estimation of ‘α’ by maximizing the likelihood function. Using the Bayes theorem we have:

$$f\left(z^k \mid \alpha\right) = f\left(z_k \mid z^{k-1}, \alpha_k\right) \prod_{t=1}^{k-1} f\left(z_t \mid z^{t-1}, \alpha_t\right)$$

- Regarding the fact that we don’t change parameter estimation at previous times , we will have,

$$\hat{\alpha}_k = \arg_{\alpha_k} \left\{ \max \left(f\left(z_k \mid z^{k-1}, \alpha_k\right) \right) \right\}$$

Maximum Likelihood Estimation

- One Fault occurrence

$$f(\alpha) = e^{-g(\hat{x})(\alpha-\alpha_0)^2}$$

$$g(\hat{x})(\alpha-\alpha_0) = 0$$

- Two faults are occurred at the same time
  - Not unique solution

$$f(\alpha_1,\alpha_2) = e^{-(g_1(\hat{x})(\alpha_1-\alpha_{10})+g_2(\hat{x})(\alpha_2-\alpha_{20}))^2}$$

$$g_1(\hat{x})(\alpha_1-\alpha_{10}) + g_2(\hat{x})(\alpha_2-\alpha_{20}) = 0$$

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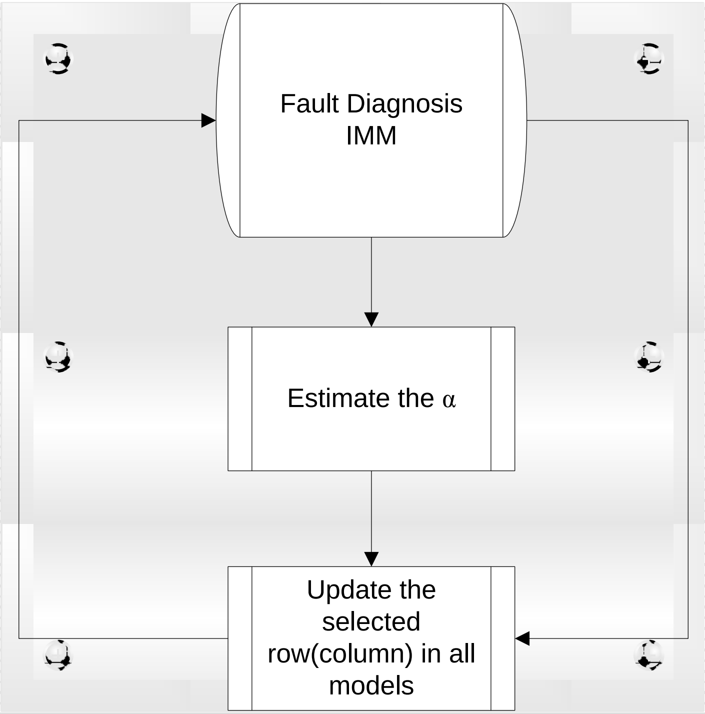
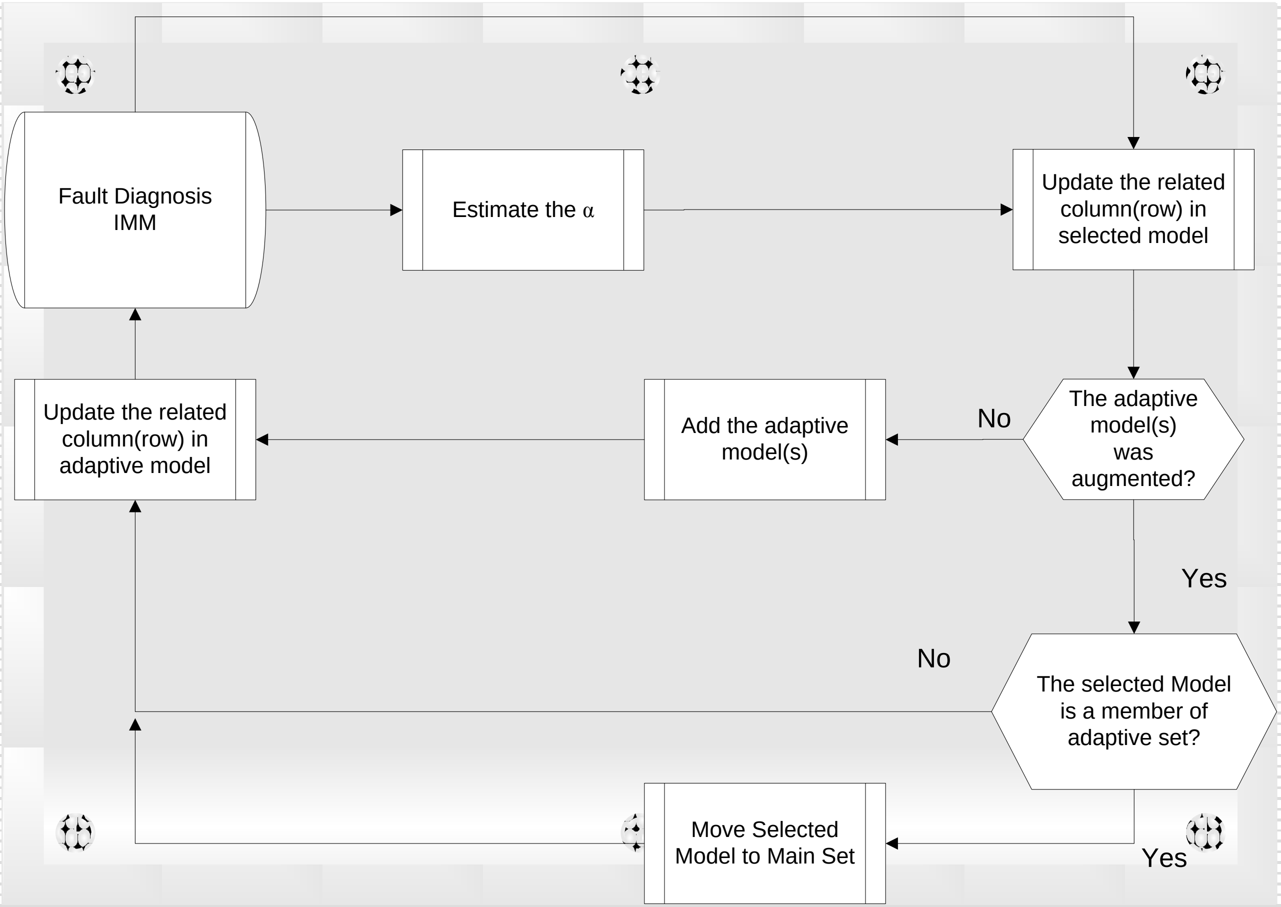
Proposed Algorithm 1

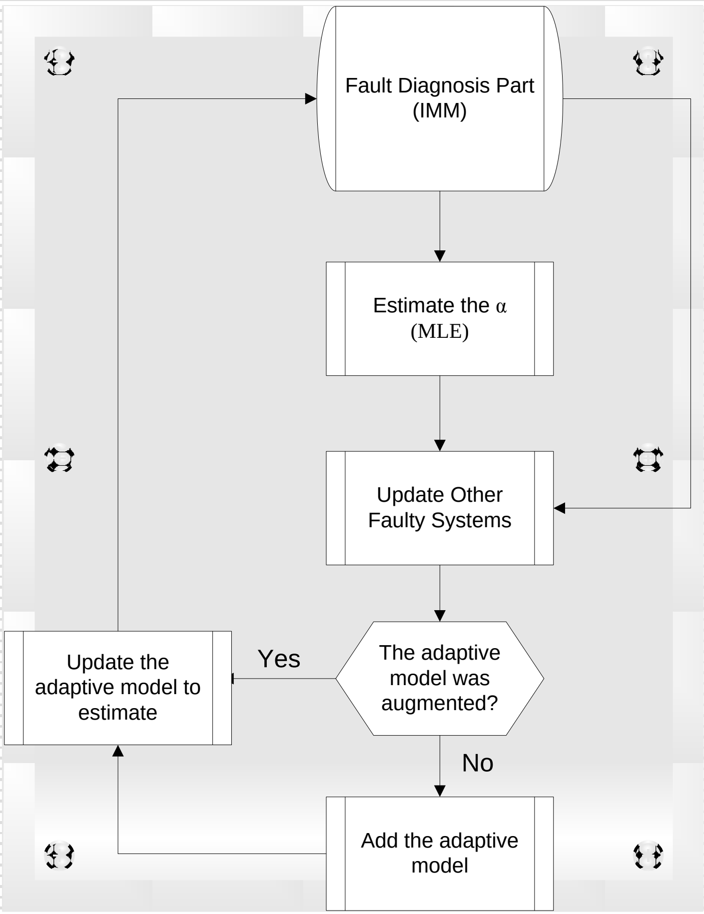
- A Fixed Model Set- adaptive model

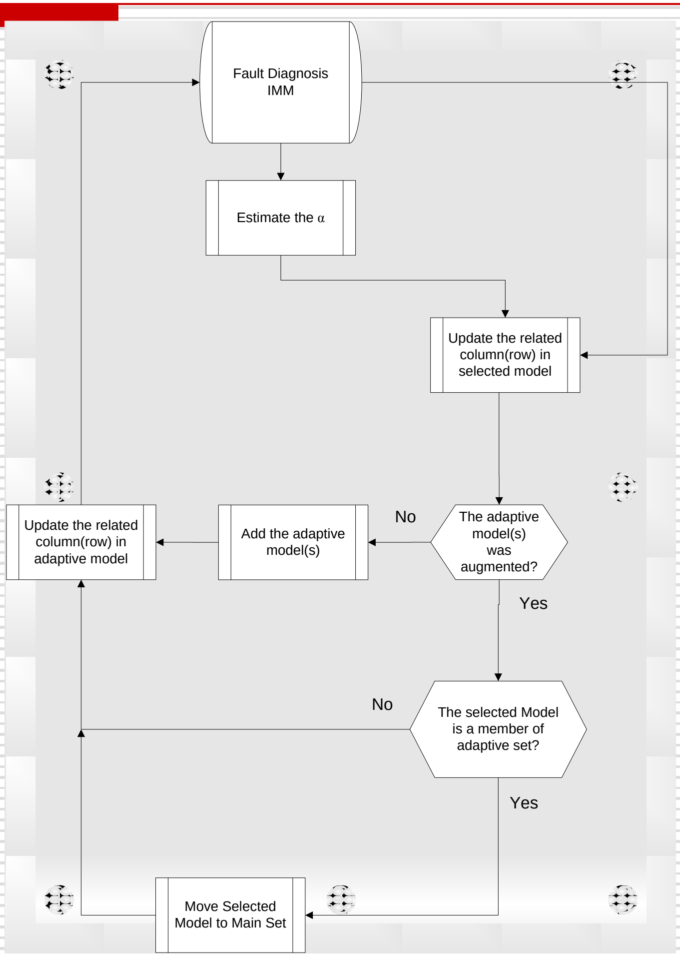


Proposed Algorithm 2



Comparing


Fault Diagnosis Part (IMM)
Estimate the α (MLE)
Update Other Faulty Systems
The adaptive model was augmented?
Yes
No
Update the adaptive model to estimate
Add the adaptive model


Fault Diagnosis IMM
Estimate the α
Update the related column(row) in selected model
The adaptive model(s) was augmented?
No
Yes
Add the adaptive model(s)
Update the related column(row) in adaptive model
The selected Model is a member of adaptive set?
No
Yes
Move Selected Model to Main Set

Comparing

- Notation
  - [α|β]
  - [0|β]

- Senario : Both Actuator
  - Without Recovery Action

Models	VSIMM	Proposed method1	Proposed method2
m_2	$[0 \mid \hat{\beta}]$ $[0 \mid 1]$	$[\hat{\alpha} \mid \hat{\beta}]$ $[0 \mid 1]$	$[\hat{\alpha} \mid 1]$ $[0 \mid 1]$
m_3	$[\hat{\alpha} \mid 0]$ $[1 \mid 0]$	$[\hat{\alpha} \mid \hat{\beta}]$ $[1 \mid 0]$	$[1 \mid \hat{\beta}]$ $[1 \mid 0]$
m_8	$[\hat{\alpha} \mid \hat{\beta}]$ $[\hat{\alpha} \mid 1]$	-	$[\hat{\alpha} \mid \hat{\beta}]$ $[\hat{\alpha} \mid 0]$

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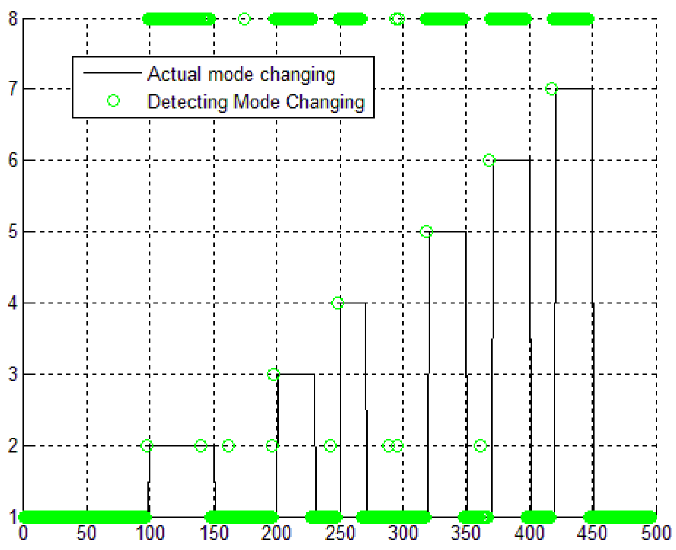
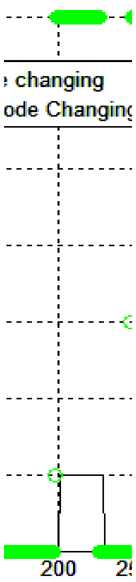
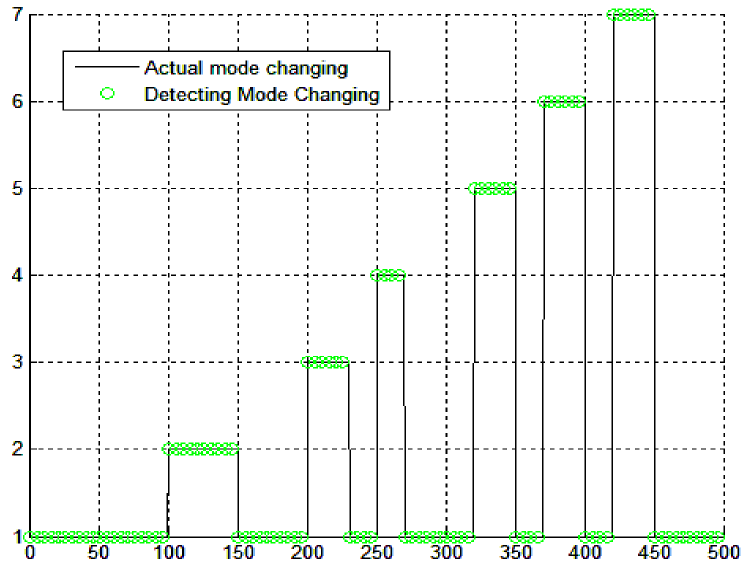
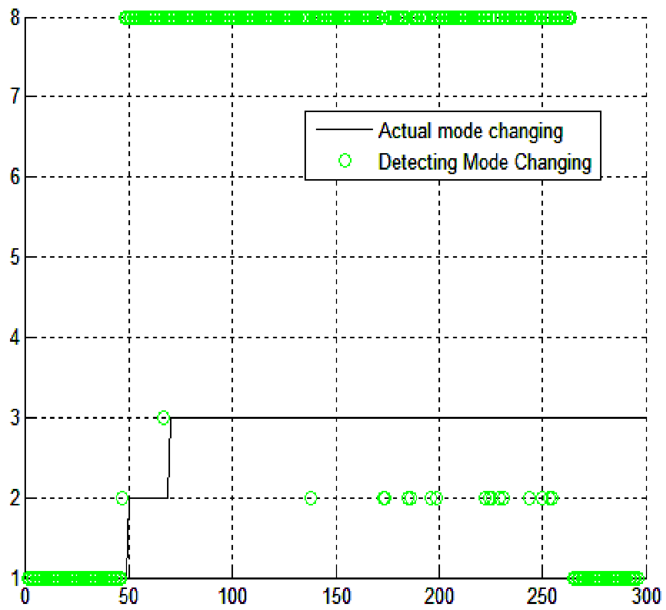
Simulation Result-Scenario1

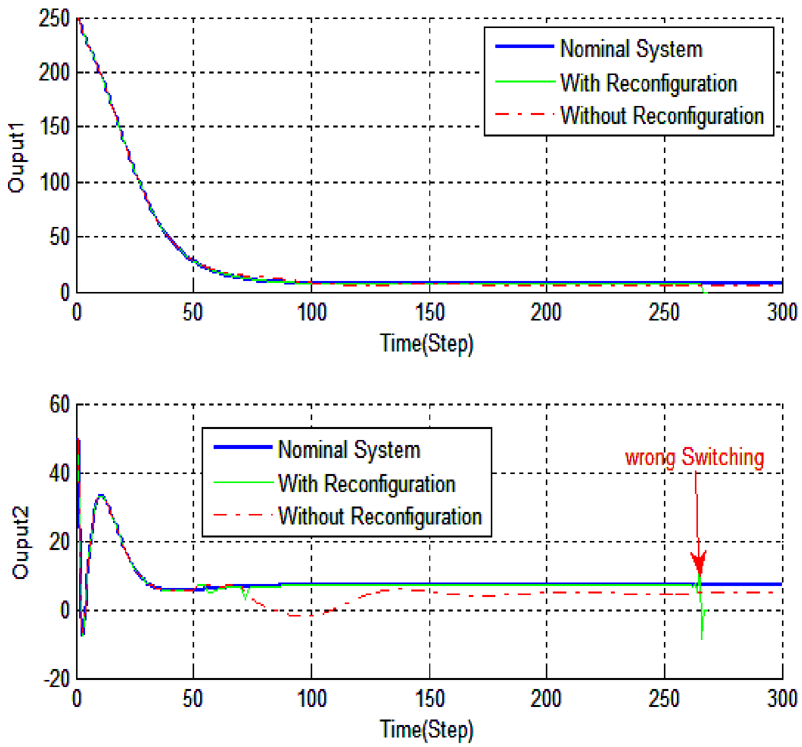




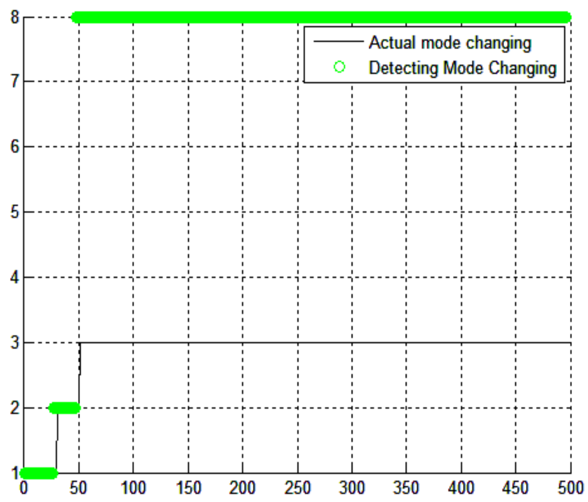


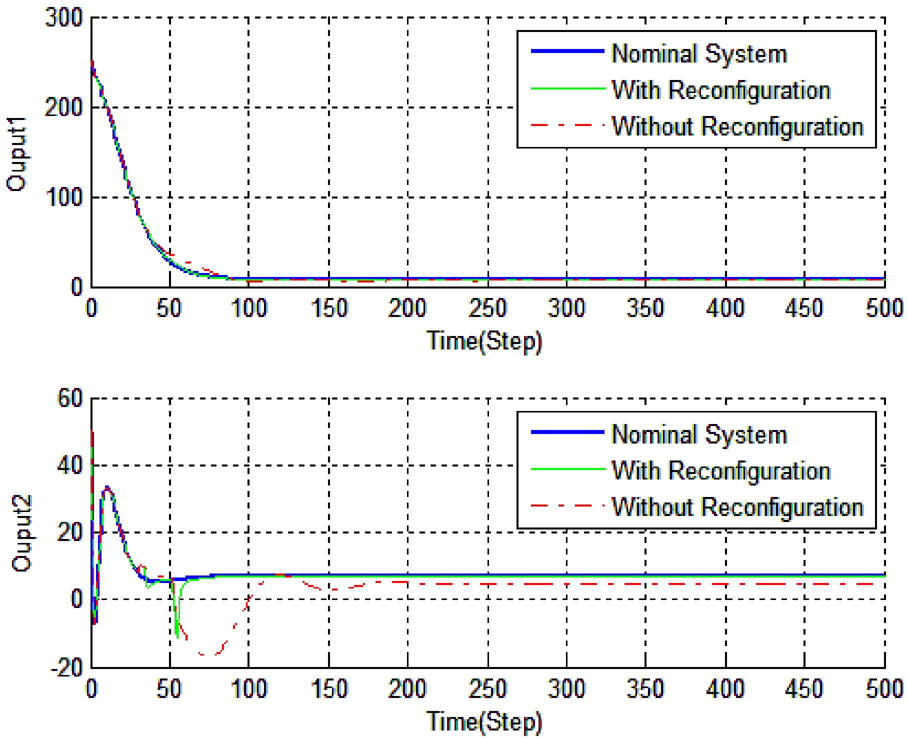
Simulation Result-Scenario2





Simulation Results-Scenario2





Conclusion

- VSIMM in FDD part
  - Some Modifications needed to be utilized in AFTC

- Proposed Algorithm2
  - Applicable for High-Magnitude Faults
  - Minimum miss-alarm

Thanks for Your Attention