**Literature**

Parametric

Finite number of parameters such as building mass, stiffness and damping ratio.

Non-parametric

Infinite number of parameters, estimating the model without full understanding of physical systems. This method is effective in predicting complex systems.

* Assuming linear models may be insufficient especially when the non-linear part of the process is dominating. (K & Jung Mi Kim, 2016)

1. **Process Knowledge Issue**

* Poorly understood process because of complexity
* Not sure of the process knowledge

1. **Process Identification Issue**

* The headache of off-line training that might be required.
* The trade-off between the persistent excitation of signals for correct identification and the steady-state system response for control performance.
* Assumption of the model structure.
* The model convergence.
* System stability issues in real applications.

1. Identification-based control methods are not well suited to process control because identification and control are always conflicting.
2. Good control leads to steady state of the set-point, controller output and the process variable

* The variables will not have the information about the process characteristics.

1. Good identification requires persistent excitation of the controller output and process variable. (Van Doren, 2003)

**Online Detection**

By comparing the output of the model with the true process output, one can detect when the process dynamics change.

* If the model id good, the difference between the model output and the process output is small

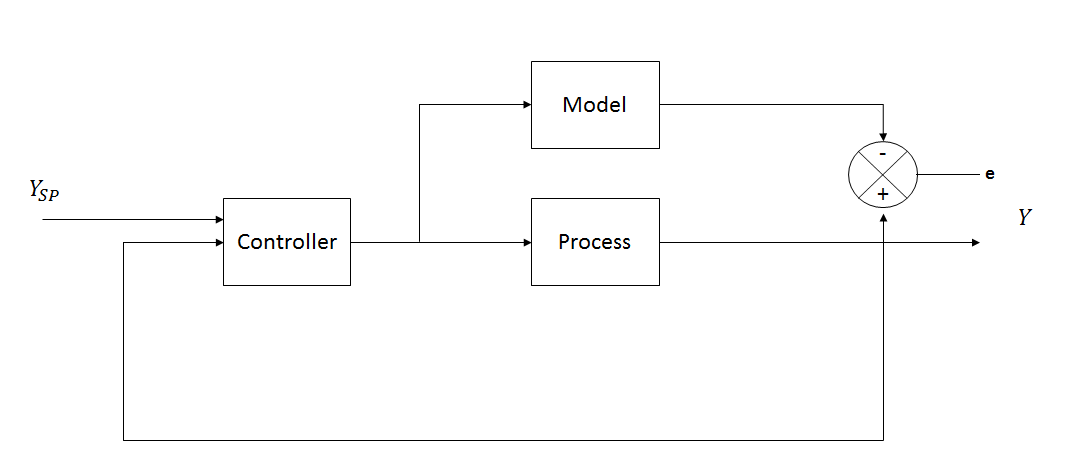


Figure 1: Model Validation

* Another fault detection approach is to use a recursive parameter estimator in the same way as the model-based continuous adaptive controller.

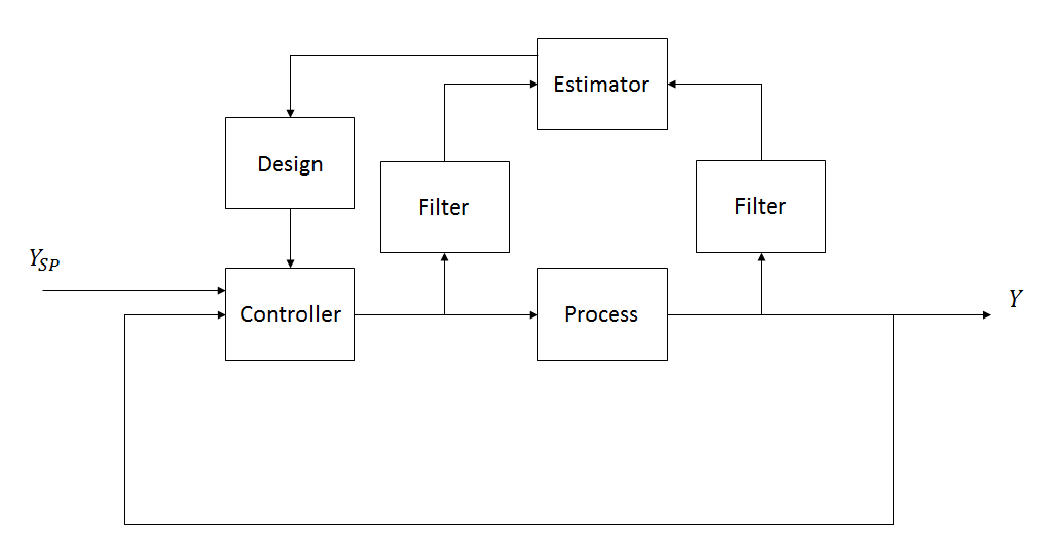


Figure 2: Adaptive Control

**Parameter Estimation Methods**

* A common tuning procedure is to use the recursive parameter estimation to determine a low-order discrete time model of the process and use it to design a controller
* Sampling period must be related to the time constant of the closed-loop system. (Astrom & Hagglund, 1995)

**Input Signals**

* Step function
* PRBS
* Autoregressive moving average process
* Sum of sinusoids

**Methods**

* RLS does not give consistent parameter estimates for systems with correlated equation errors.
* For low-order systems the deviations of the estimates from true values are often smaller.
* For high-order systems the deviations are often more substantial
* RIV algorithm gives consistent parameter estimates. (Stoicha & Soderstrom, 1989)

**Adaptive Controllers**

1. A mistuned controller may not be detected simply because the process runs at steady state
2. **On-demand Tuning**

Get the process reaction curve using the controller output as an input to the process and tune the controller based on the reaction curve.

* Requires continual attention of the user to determine when the loop needs tuning
* Requires the user’s active participation in waiting for the response.

1. Insufficient manpower
2. Frequent changes in environment

* Non-linear processes
* Plant parameters are changing with time( e.g change of process gain due to gradual fouling of a heat surface)
* One set of tuning constants cannot satisfy the entire operating range.

1. Perturbation signal

* For some sensitive processes, it is not acceptable to perturb the process for the purpose of tuning.

Not all control loops require adaptive control

* For many time-invariant systems, on-demand tuning can be very effective.
* For some slow but known time-varying processes or non-linear processes, a well-tuned gain schedule controller works well.