





Advanced Identification and Data Analysis

General Technical Description

AIDA (Advanced Identification and Data Analysis) is a software package used to estimate a linear dynamic model for a process unit. AIDA is one component of Shell's Off-line Advanced Control general package PCTP (Process Control Technology Package). A linear dynamic model of a process unit is for instance required to implement a Model Predictive Control application such as SMOC or QDMC.

Deriving a dynamic model for a plant on the basis of plant data is called Identification. A plant test is performed on the unit of interest while process data is collected at a given sampling period, typically one minute. Collected data include the set-point of the plant operating handles (the process inputs, or independent variables), the plant operating variables that are affected by changes in the process inputs and for which there are regulation or optimisation objectives in the future advanced control scheme (the process outputs, or dependent variables), and a number of associated variables that provide information on the current plant conditions and help obtain a more accurate model (the measured disturbance variables).

For example, typical independent variables are :

- PID controller setpoints (flow, temperature, pressure),
- desired control valves position.

Typical dependent variables are :

- process performance or constraint measurements (flow, temperature, pressure, on-line analyser measurement, valve position),
- calculated variable (e.g. inferred measurement) .

Typical disturbance variables are :

- feed rate, feed temperature, feed quality,
- temperature or pressure correlated to on-line analyser measurement,
- process measurement of a PID controller.

The plant test involves stepping the independent variables of interest, multiple times, generally one after the other. The step size and number of repetitions is selected and monitored closely, in order to minimise the plant disturbances, while achieving the desired level of excitation to obtain a useful model. Different types of disturbance signals can be used for plant tests depending on the application and conditions of operation (step tests, PRBS sequence).



AIDA identification : plant test data plots



AIDA identification : step response models

Identification with AIDA generally involves the following sequence of tasks :

Analysis and manipulation of process
data file :

selection of variables to be included in the identification, removal of unusable data segments as required, generation of calculated variables, plotting of data for visual inspection and detection of abnormal conditions.

• Fitting of Finite Impulse Response Model (FIR) :

FIR analysis is useful in screening the data. It can provide insights into data quality, level of input excitation, and a rough idea of the order of the process dynamics. It can also provide valuable information on the presence (or lack of) a significant causal relationship between two variables in the data. A nonparametric Impulse Response model is fitted to the data. The user need only specify the expected settling time. The Impulse Response model is converted to a standard parametric form (1st order + time delay) and presented to the user. F-statistics are calculated to quantify the quality of the model and help select the significant model inputs.

Estimation of the Model :

The model is estimated using the technique of constrained non linear optimisation. User's intervention is in practice limited to selecting the model type (1st order, 2nd order, ramp) and the model inputs. Values by default of other identification parameters are provided and cover the majority of practical cases. Model parameters confidence bands are calculated and displayed to evaluate the final model accuracy.

Model validation :

A number of tools are available to validate the calculated model. F-statistics are provided to quantify the model accuracy. A plot of actual and predicted process outputs is generated automatically, and can be used to visually inspect the quality of the model. For advanced users, auto- and cross-correlation analysis of the residuals can also be used.



AIDA identification : model validation

SUMMARY OF THE DIFFERENT FUNCTIONS AND FEATURES OF **AIDA**:

AIDA is ...

A dynamic model identification package, AIDA calculates linear dynamic models for process control purposes, and in particular for model predictive controls such as SMOC and QDMC.

Running in the Windows 3.x or Windows 95 environment, AIDA is a user friendly interactive package, with option menus, graphics and online help information.

Pre-Fit is done using Finite Impulse Response (FIR) models. FIR models are calculated to quickly and easily evaluate the data quality, level of input excitation, rough order of process dynamics, and select the significant inputs.

Model estimation is done via constrained non linear optimisation. This technique allows automatic estimate process time delays and setting of minimum and maximum limits on model parameters. In particular, model parameters can optionally be fixed ("frozen") at desired values.

Model types include first order, second order and ramp, with time delay. First order models can be specified for simple processes. Second order models (with one term in the numerator and two terms in the denominator) cover the cases of responses with overshoot, oscillatory responses and inverse responses. A ramp model, with an additional lag term, can be specified for integrating processes (e.g. levels).

A noise model is estimated as part of the identification calculations. In addition to the causal model between inputs and output, an ARMA (Auto-Regressive Moving Average) noise model with integrator is automatically estimated. This model component improves the identification performance in the presence of noise and non stationary disturbances (i.e. drifts) in the data.



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