Toolbox for Power System Computations - TPSC

I. Next Steps

- Adjust data filter to the psat based disturbance location algorithm after I finsih its implementation.
- Updata static state estimation in complex variables algorithm with respect to the new data format.
- State estimation in real variables.

II. DATA

A. General Data of Power Systems

The power system is represented as a structure within the Matlab software package. When loading a specific power system, a variable of structural type named "data" is loaded into the workspace. The names and descriptions of the structure's fields are displayed in the table below.

Table I
Fields of the structure used to describe the power system (*data*).

Field	Description
data.nBuses	number of nodes
data.fn	nominal system frequency
data.nBranches	number of branches
data.nGens	number of generators
data.slackNo	number of a slack bus
data.baseMVA	base power
data.bus	matrix whose rows represent groups of information used to describe nodes in the system
data.branch	matrix whose rows represent groups of information used to describe branches in the system.
data.generator	matrix whose rows represent groups of information used to describe generators in the system.
data.gencost	matrix whose rows represent groups of information used to describe generators in the system from an economic perspective

The matrix containing information about the nodes of the corresponding power system consists of fifteen columns. The column number, description, and unit of measurement are shown in the table below.

Table II
BUS DATA (*data.bus*).

Column	Description	Unit
1	bus number	
2	bus type (1=PQ, 2=PV, 3=slack)	
3	active power demand	p.u.
4	reactive power demand	p.u.
5	active power of shunt conductance at the voltage 1 [p.u.]	p.u.
6	reactive power of shunt conductance at the voltage 1 [p.u.]	p.u.
7	area number	
8	voltage magnitude	p.u.
9	voltage angle	rad
10	base voltage	kV
11	loss zone	
12	maximum voltage magnitude	p.u.
13	minimum voltage magnitude	p.u.
14	active power generation	p.u.
15	reactive power generation	p.u.

The matrix containing information about the branches of the corresponding power system consists of thirteen columns. The column number, description, and unit of measurement are shown in the table below.

Table III
BRANCH DATA (*data.branch*).

Column	Description	Unit
1	from bus	
2	to bus	
3	resistance	p.u.
4	reactance	p.u.
5	total line susceptance	p.u.
6	long term rating (0=unlimited)	p.u.
7	short term rating (0=unlimited)	p.u.
8	emergency rating (0=unlimited)	p.u.
9	transformer off nominal turns, taps at “from bus”, pi equivalent at “to bus”; value 0 indicates transimission line rather that transformer	p.u.
10	transformer phase shift angle (positive $\Rightarrow$ delay)	rad
11	branch status (0=in service, 1=out of service)	
12	minimum bus voltage angle difference	rad
13	maximum bus voltage angle difference	rad

The matrix containing information about the generators of the corresponding power system consists of ten columns. The column number, description, and unit of measurement are shown in the table below.

Table IV
GENERATOR DATA (*data.generator*).

Column	Description	Unit
1	bus number	
2	active power output	p.u.
3	reactive power output	p.u.
4	maximum reactive power output	p.u.
5	minimum reactive power output	p.u.
6	regulated voltage magnitude	p.u.
7	base power of machine	p.u.
8	machine status (0=in service, 1=out of service)	
9	maximum active power output	p.u.
10	minimum active power output	p.u.

B. Extended Verison with Measurement Devices

This is a structure that extends the structure described in the previous subsection with data about measurement devices installed in a power system. Structure *data* is now enriched with two new fields:

data.pmu data about phasore measurement units installed in a power system, and it is presented in detail in Table.
data.scada data about conventional SCADA measurements, and it is presented in detail in Table.
data.zi vector of nodes with no load nor generation, i.e., zero injection buses.

Table V
PMUS DATA (*data.pmu*).

Column	Description	Unit
1	bus number	
2	number of current channels	
3	magnitude measurement standard deviation	%
4	phase angle measurement standard deviation	rad
5	frequency measurement standard deviation	Hz
6	RoCoF measurement standard deviation	Hz/s
7	Reporting frequency	Hz

Table VI
SCADA DATA (*data.scada*).

Column	Description	Unit
1	bus number	
2	measurement type (1-active power flow, 2-reactive power flow, 3-active power injection, 4-rective power injection, 5 - branch current magnitude, 6- bus voltage manitude	
3	line number (type 1, 2 and 6) or bus number (type 3, 4 and 5)[1]	
4	standard deviation	p.u.
5	Reporting frequency	Hz

[1]Line number corresponds to a row number of the given line in *data.branches* matrix. When a measurement device is on a "to" side of a line, its number is given with a minus sign.

C. Measurement Data

In this subsection, the data structure of the measurements generated by the power system toolbox will be defined. The measurements are generated by running power flows and perturbing the true quantities with random Gaussian noise. As defined in the previous subsection, two types of distinguishable measurement types are supported, namely legacy (SCADA) measurements and measurements from PMUs. The primary user of the generated measurement values are different state estimation algorithms. In this regard, the measurements can be generated in a static or tracking (dynamic) manner. In the 'tracking' mode, measurements are taken over a specific time period, while in the 'static' mode, measurements are taken for a single, distinct moment in time.

Measurements from PMUs are separeted in two different tables: synchrophasor measurements VII, and frequency and rocof measurements VIII.

Table VII
PMU MEASUREMENTS (*measurements.synpmu*).

Column	Description	Unit
1	time index	
2	bus number	
3	phasor measurement type (1-current flow, 2-current injection, 3-voltage)	
4	line number (type 1) or bus number (type 2 or 3)	
5	magnitude measurement value	p.u.
6	phase angle measurement value	rad
7	magnitude exact value	p.u.
8	phase angle exact value	rad

Measurements from a SCADA system are collected in a matrix whose columns are described in Table below.

Table VIII
PMU MEASUREMENTS (*measurements.fpmu*).

Column	Description	Unit
1	time index	
2	bus number	
3	frequency measurement	Hz
4	frequency exact value	Hz
5	rate of change of frequency (rocof) measurement	Hz/s
6	rate of change of frequency (rocof) exact value	Hz/s

Table IX
SCADA MEASUREMENTS (*measurements.scada*).

Column	Description	Unit
1	time index	
2	bus number	
3	measurement type	
4	line number (type 1, 2 and 6) or bus number (type 3, 4 and 5)	
5	measurement value	p.u.
6	exact value	p.u.

III. Routines

A. *Power Flows*

B. *Measurements Generator*

C. *Static State Estimation*

Not up to date with new data formats!

D. *Dynamic State Estimation*