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(Satyendra Pratap Singh)

Nomenclatures

ω_s	Signal frequency in radians per second
ϕ	Phase angle in radians
Ψ	Calculated phasor
N	Total number of samples in one cycle
Ψ_m	Signal magnitude
ψ	Pure sinusoidal signal
w_{t_i}	Weight factor corresponding to bus i
c_i	If $c_i=1$, it means PMU is installed at bus i , otherwise $c_i=0$.
n	Number of the buses in the system
e_i	Significance of bus i
f_i	Observability function at bus i
a_{ij}	Elements of connectivity matrix between buses i and j
A	Connectivity matrix
b	Unit vector matrix
I	Set of buses
$Obs.$	Observability of the system
z_i	$z_i=1$ if bus i is a zero injection (ZI) bus; otherwise $z_i=0$.
y_{ij}	Auxiliary binary variable of buses i and j
f_i^k	Observability function at bus i when line k is out
a_{ij}^k	Elements of connectivity matrix between buses i and j when line k is out
y_{ij}^k	Auxiliary binary variable of buses i and j when line k is out
L	Set of lines
c_{cl}	Cost of per channel
c_p	Cost of per PMU
NC_i	Number of channels at bus i
l_i	Length of fiber optics from PDC which is installed at bus i to PMU
c_{fb}	Cost of optics fiber per km.

c_{sw}	Cost of switches in path
C_{EC}	Extra channel cost
sw	Number of switches
EC	Number of extra channels
p	Total number of PMUs
Lp	Location of optimal PMUs
Q	Number of agents (masses)
F_{ij}	Gravitational force between two masses i and j
F_{ij}^d	Gravitational force between two masses i and j in d^{th} dimension
R	Distance between two particle
Acc	Particle acceleration
Acc_i^d	Acceleration of agent i in d^{th} dimension
M_1, M_2	Masses of the 1 st and 2 nd particle respectively
T	Total number of iterations
k	Index of line
M_{ii}	Inertial mass of particle i
M_a	Active gravitational mass
M_p	Passive gravitational mass
x_i	Position of agent i
x_i^d	Position of i^{th} agent in the d^{th} dimension
x_j^d	Position of j^{th} agent in the d^{th} dimension
$rand$	Random number in the interval [0, 1]
k_{best}	Set of k agents with the best fitness and biggest mass
v_i	Velocity of agent i
v_i^d	Velocity of agent i in the d^{th} dimension
v_{crit}	Critical voltage
G	Gravitational constant
G_o	Initial gravitational constant

β	User specified constant
ε	Small constant
E	Sending end voltage
V_r	Receiving end voltage
I	Current
S	Complex power
P_a	Active power
Q_r	Reactive power
X	Line reactance
θ	Bus voltage angle in radian
V	Node bus voltage
Lambda, δ	Loading parameter
u	Loading instant

List of Acronyms

Acronym	Full form
WAMS	Wide Area Measurement System
SCADA	Supervisory Control and Data Acquisition System
PMU	Phasor Measurement Unit
PDC	Phasor Data Concentrator
GPS	Global Positioning System
OPP	Optimal PMU Placement
ZIB	Zero Injection Bus
ZI	Zero Injection
CI	Communication Infrastructure
MO	Maximum Observability
GSA	Gravitational Search Algorithm
BGSA	Binary Gravitational Search Algorithm
LNG	Location Not Given
RB	Radial bus
LNG	Location Not Given