Smart Grid with STATCOM Effect Using Harmony Search

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Introduction

- In recent years, power demand has increased substantially
- The expansion of power generation and transmission has been severely limited due to limited resources and environmental restrictions.
- Some transmission lines are heavily loaded, increasing the power loss.

Introduction

•The system stability becomes a power transfer-limiting factor.

•With the increase in power demand, operation and planning of large interconnected power system are becoming more and more complex.

•Power system will become less secure.

Introduction

•Voltage instability is one of the phenomena which have result in a major blackout.

•To maintain security of such systems, it is desirable to plan suitable measures to improve power system security and increase voltage stability margins.

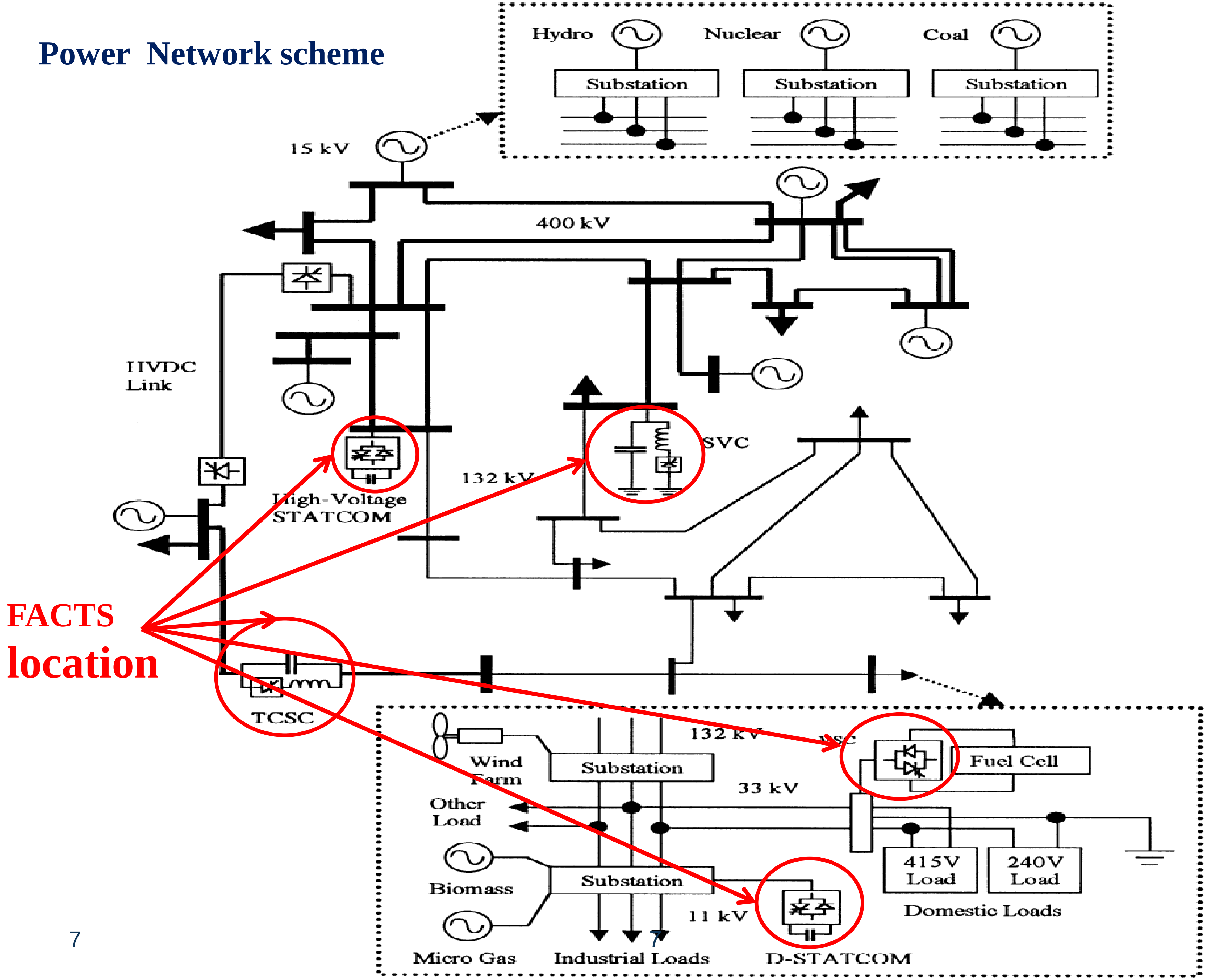
Effects of FACTS- Devices on power system

- Control the load flow as ordered. Increase the loading capability of lines to their thermal capabilities.
- Increase the system security.
- Compensate reactive power.
- Improve power quality.
- Improve stabilities of the power network.
- Increase utilization of lowest cost generation.
- Prevent blackouts.

Problem area

- The location of FACTS-devices in the Power system plays a significant role to achieve benefits of FACTS-devices

Power Network scheme



Problem area

➢The previous researches determine the optimal allocation of FACTS-devices using optimization techniques:-

-Genetic Algorithms (GA)

-Particle Swarm Optimization (PSO)

-Bees Algorithms (BA)

Previous proposed scheme problems

- **Location**

- Investigate on optimization of the location of FACTS in limited power system and

not in smart grid.

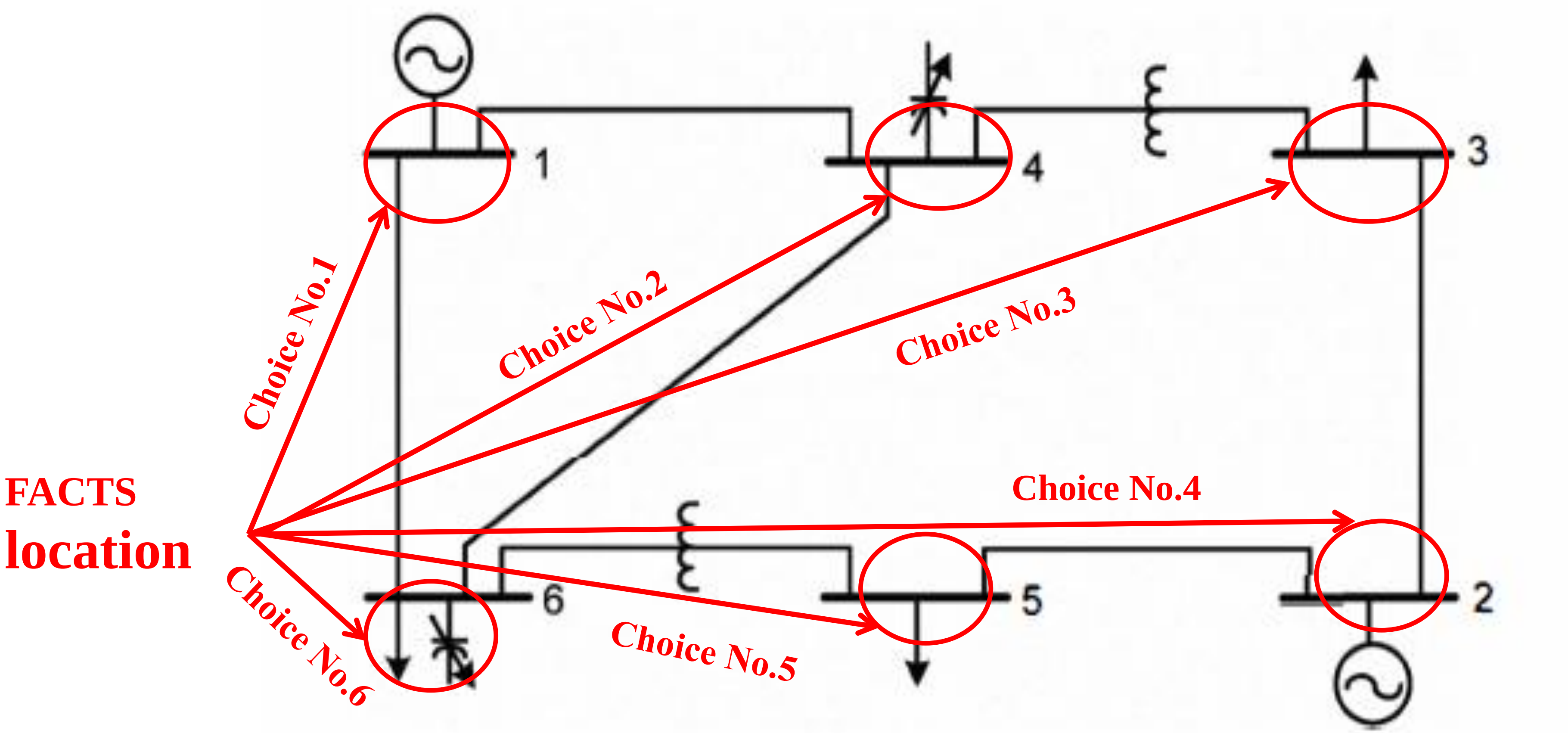
- **Number**

- The optimization for number of FACTS-devices not considered.

- **Limited (small) power system**

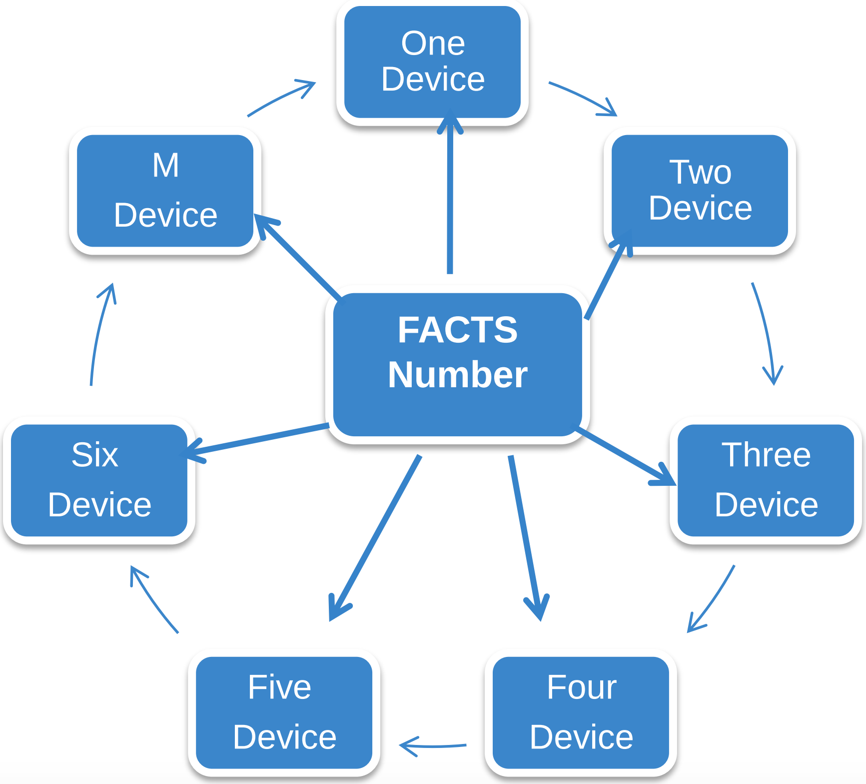
- Don’t validate the techniques on large scale power system.

Optimization of FACTS location on small power system



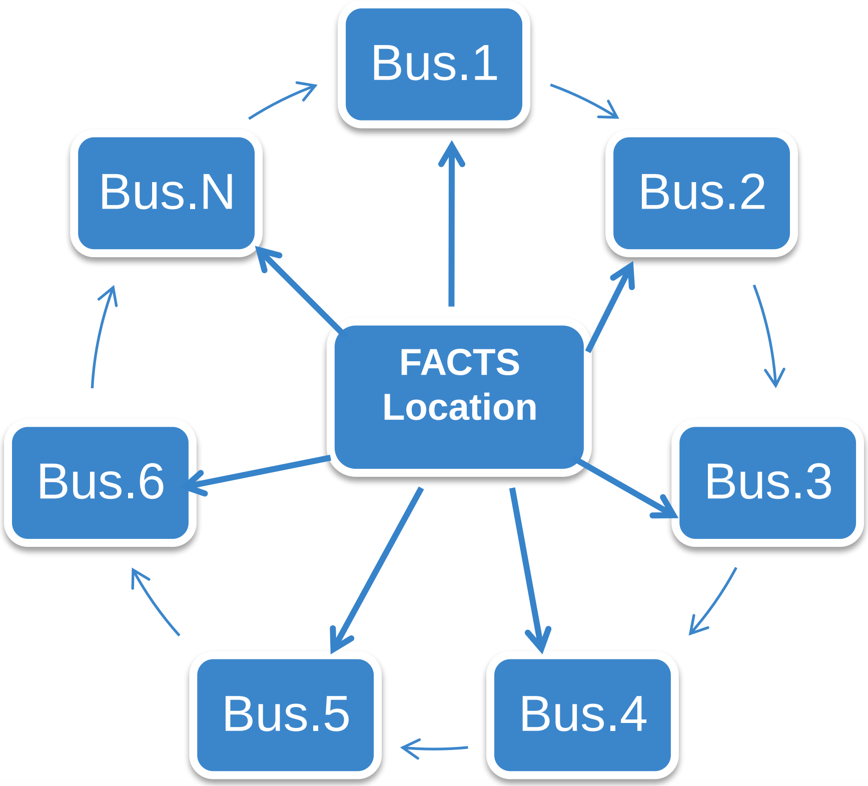
Proposed technique

- Validate the proposed techniques on SMART Grid power system
- Determine the Number Locations of FACTS-devices using Harmony search (HS)



Proposed technique

➢ Determine the Optimal Locations of FACTS-devices using Harmony search (HS)



Smart Grid

- smart grid is the upgrade and renovation of traditional power grid
- smart grid shows many specialties, such as information, automation and interoperation
- utilization of DG to power distribution system has been rapidly increased using small and clean distributed power sources, such as photovoltaic, wind energy, fuel cells.

Smart Grid

- In such a network, it is desirable to keep the voltage deviations between -,+ 5% to avoid voltage collapses during faulty conditions.
- the voltage support will be provided by a STATCOM, and its optimal location and size will be determined by using HS.

Smart Grid

$$\text{Min}\ \ J = \sqrt{\sum_{i=1}^{n}(V_i - 1)^2} + \frac{\eta}{500}$$

Subject to:

$|V_i - 1| \leq 0.05$ for i=1.45

$\eta \geq 0$

Where:

J: is the objective function value.

n: is the number of buses.

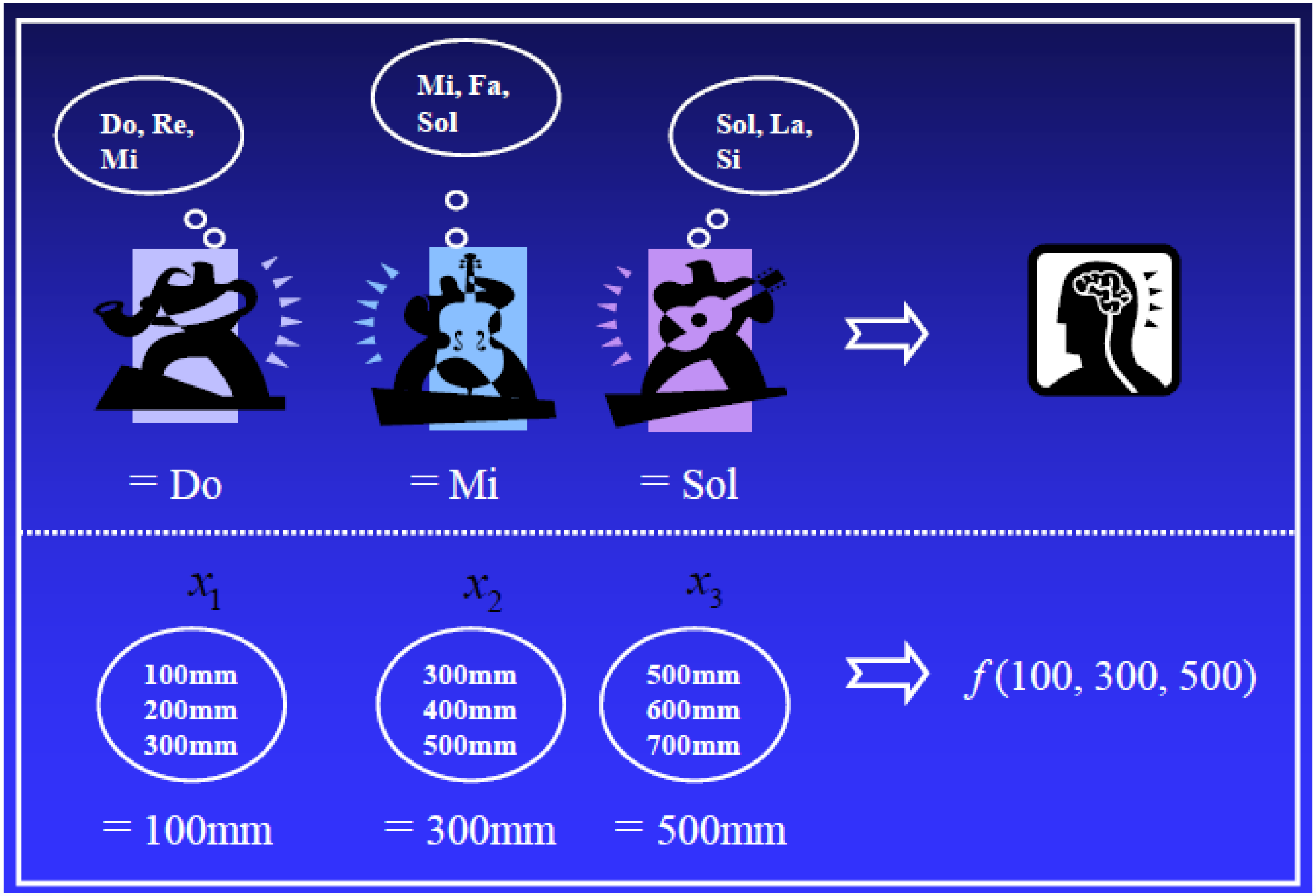
V_i: is the values of the voltage at bus i in p.u.

$V_i - 1$: is the voltage deviation as bus i in p.u.

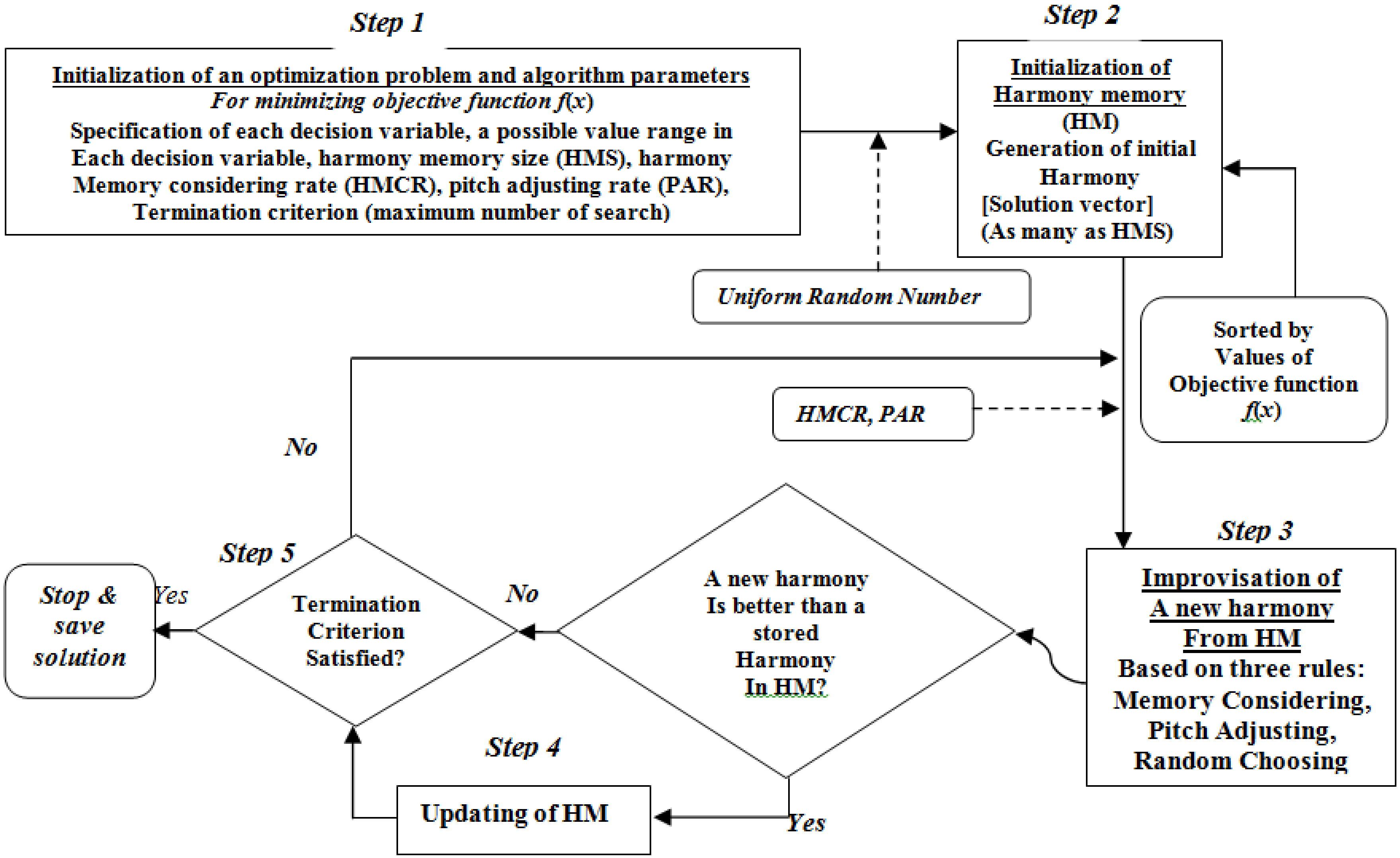
$\sqrt{\sum_{i=1}^{n}(V_i - 1)^2}$: is the total voltage deviation metric.

η: is the STATCOM size in MVAR.

Harmony Search (HS)



Harmony Search (HS)



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Harmony Search (HS)

- **why HS is better than PSO, GA and Ant / Bee Search algorithms**

- Derivative information is unnecessary.

- Simple in concept and easy in implementation.

- Few in parameters and imposes fewer mathematical requirements.

- Not require initial value settings of the decision variables.

- HS does not require differential gradients, thus it can consider discontinuous functions as well as continuous functions.

- HS can handle discrete variables as well as continuous variables.