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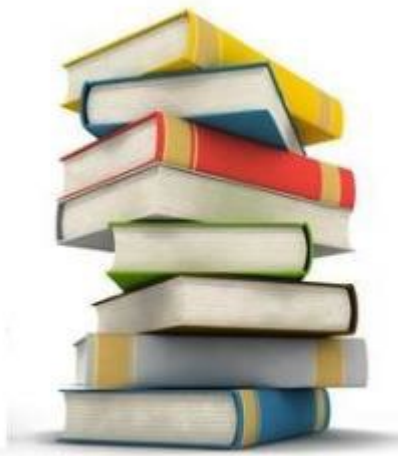
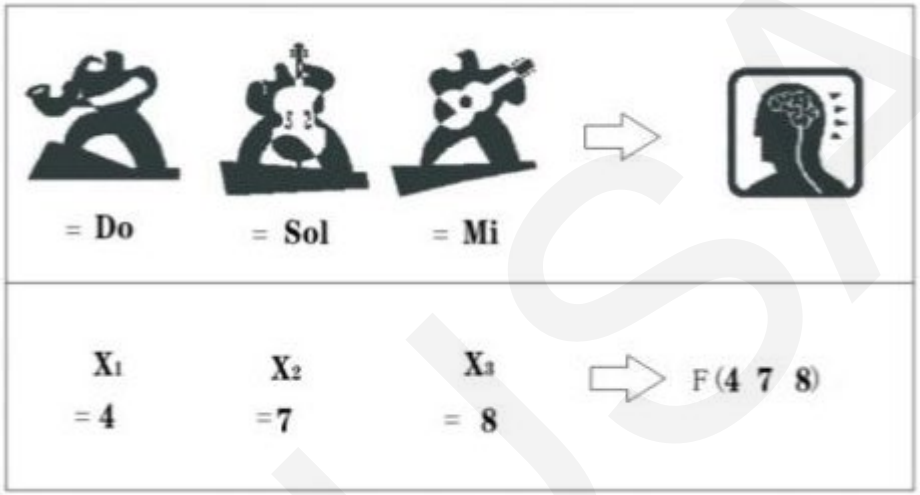
Optimal sensor placement for space modal identification of crane structures based on an improved harmony search algorithm

Key words: Harmony search algorithm,
Optimal sensor placement,
Gantry crane,
Modal assurance criterion,
Structural health monitoring

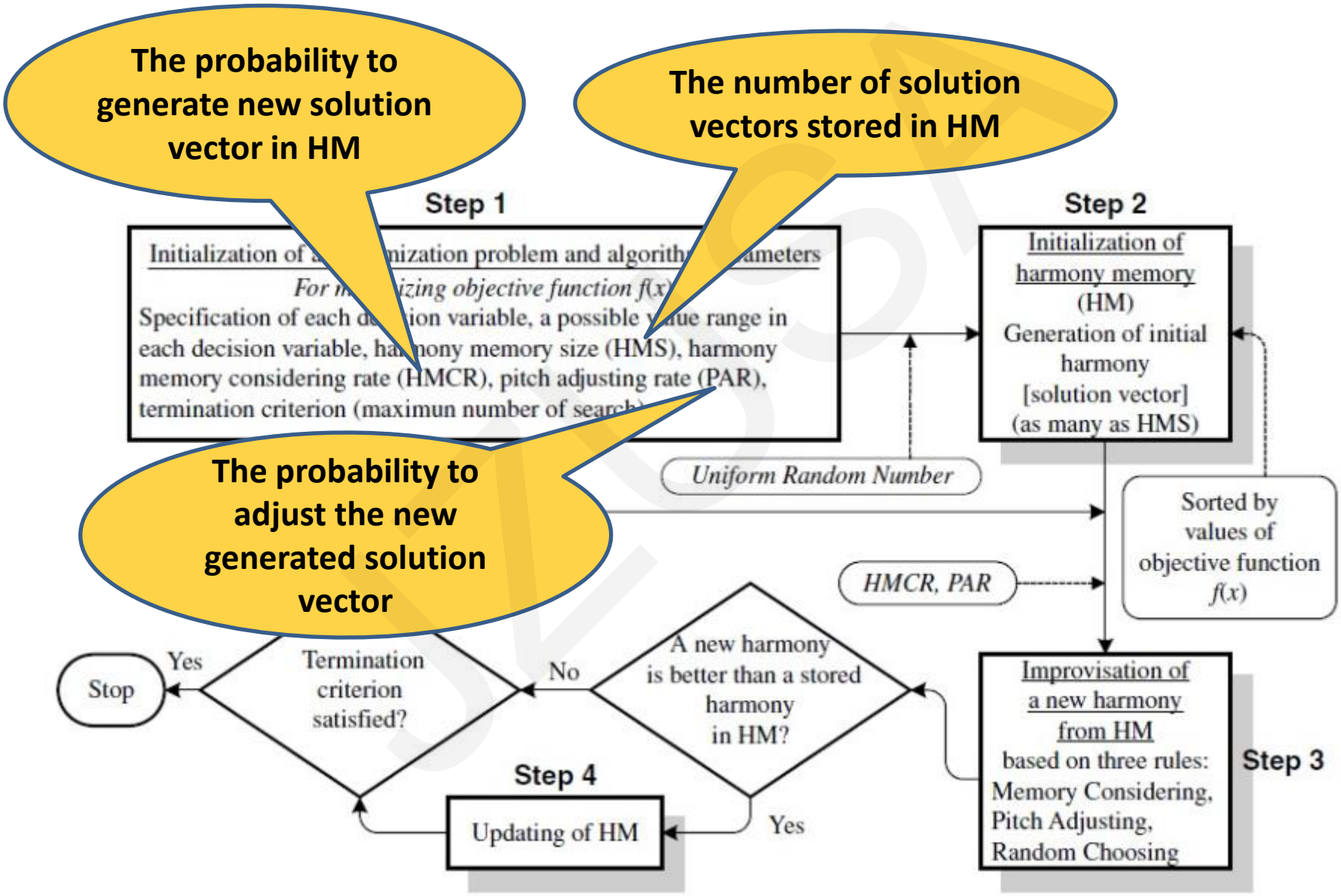


Introduction of harmony search algorithm



- Harmony search (HS) meta-heuristic algorithm was developed by Geem Z. W. in 2001.
- It was conceptualized using the musical process of searching for a perfect state of harmony.

Optimization procedure of the HS algorithm



The necessity of improved work for HS

The reasonable selection of HS algorithm parameter value is considered as one of the challenging task not only for HS algorithm but also for other met-heuristic algorithm.

Absence of appropriate general rules that governing this aspect.

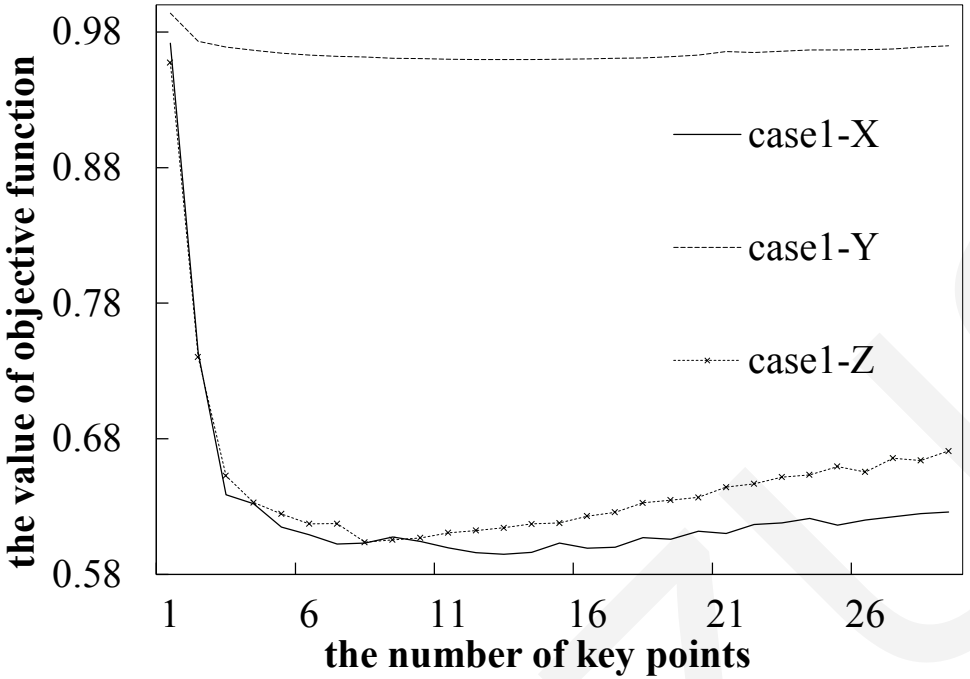
Actually, the problem of parameter setting was guided by experiential trial that insufficient to mathematical calculation.

Application for engineering optimization problems

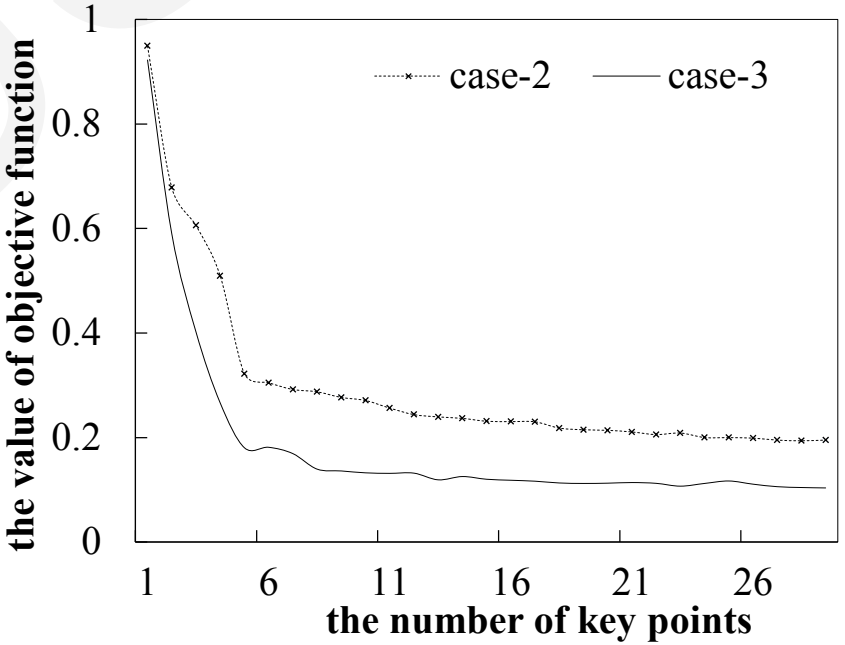
Optimal sensor placement for space modal identification of crane structures

- Dynamic analysis

Research and discussion



- Case studies for optimal sensor placement



Conclusions

- According to the research, a reasonable range for the value of the harmony considering rate (HMCR) is proposed at 0.6–0.8; the value of the pitch adjusting rate (PAR) is set from 0.3 to 0.5. The conclusions are of significance in solving the problem of engineering optimization.

- For the general HS algorithm, the new harmony memory size (NHMS) must be set as a new parameter in an improved program. The conclusion shows that the parameter value should be set appropriately in accordance with the value of the harmony memory size (HMS) as well as the complexity of engineering optimization problems in practice.

- From the perspective of engineering application, the conclusion reveals that ability of distinction and visualization. Parameter identification is significantly affected by the eigenvectors selected in the calculation and the distribution of selected points. Because the crane structure operates in a three-dimension space, it is capable of contributing greatly to enhance the ability of distinction and parameter identification if the orientation of the vibration is considered in the calculation.

- The more eigenvectors selected in the calculation, the more sensors are needed in the measurement process to meet the qualification of threshold for the acceptable value.