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Fluid-Structure Interaction Analysis of Vibration Phenomena and Verification of its classification and Prediction Accuracy using Modular Network Self-Organizing Map

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This research aims to classify the analysis of fluid-structure interaction and to visualize and predict it. The Researches on the vibration phenomena in the fluid-structure interaction problem was performed. The vibration causes lock-in phenomena and destroys things. Then, analysis conditions are changed and the data of analysis results are collected. And they are classified.

The modular network Self-Organizing Map (mnSOM) is used for a classification and prediction. At first, the Self-Organizing Map (SOM) is kind of Neural Network, and it is available for mapping the high-dimensional vector data into two-dimensional space[1]. The map that similar inputs are placed to near and different inputs are placed in far distance is made. Certain input data is input, each unit U are ignited by the connection weights W. It is searched for the unit that ignited most strongly from a map. The unit becomes the winner unit. A winner unit and the units around it are corrected according to the distance form the winner unit (Fig.1). While changing the input, this will be repeated enough number of times. The map that classifies inputs is made.

The mnSOM changed units into modules[2]. MLP (Multi Layer Perceptron) is generally used for the module. mnSOM keeps input-output relation and can deal with nonlinear problems by MLP. If this mnSOM is used, classification of output vectors and interpolation between output vectors can be performed. As a result, classification, visualization and prediction are possible.

Analysis is fluid and rigid body. And it is moving boundary problem. An object is vibration of a two-dimensional cylinder. Analysis changed condition and collected 48 results. The breakdown is mass of cylinder, spring constant, dumper coefficient, flow velocity, and Reynolds number. The ADVENTURE_Fluid[3] was used in this analysis. ADVENTURE_fluid was rewritten in ALE notation. Moving boundary problem was solved using it.Fig.2 is an example of the analysis results. The horizontal axis is time, the vertical axis is displacement. The cylinder is vibrating.

The item of the inputs and outputs of mnSOM is shown in Table 1. Using these 48 data, a map is created by mnSOM, and it visualizes according to the item of output. And looks for important factor. Moreover, Prediction accuracy will be considered.

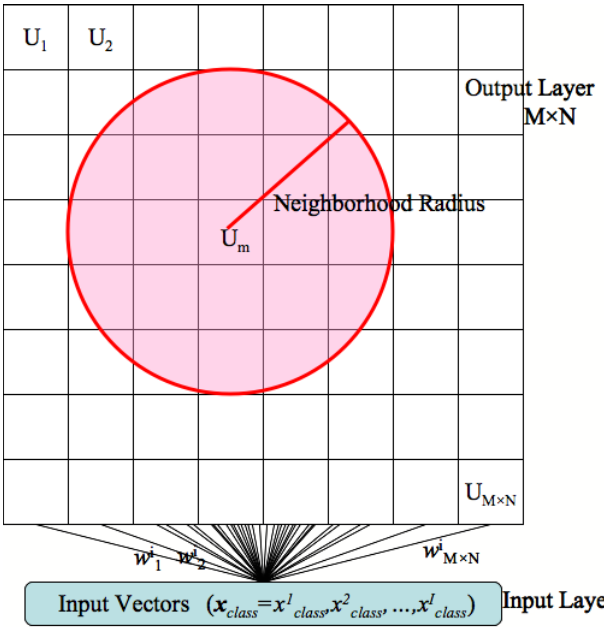

Fig.1 Conceptual Diagram of SOM (U are map units, m is an unit number, w are unit weights, x is input signal. M and N are map size, Index I is number of input vector, class means input signal index)

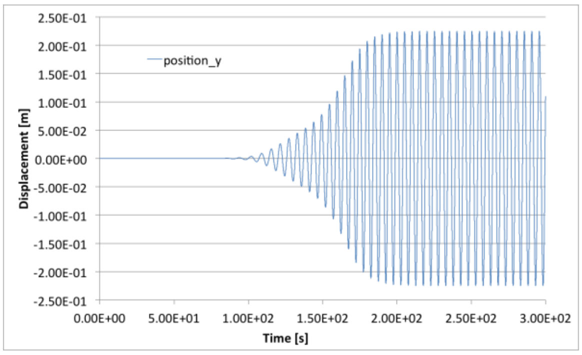

Fig.2 Graph of Displacement of cylinder (Mass of Cylinder = 1.0, Spring Constant = 1.0, Dumper Coefficient = 0.0, Flow Velocity = 1.0, Reynolds Number = 100)

Table 1 Input-Output Relationship of mnSOM

Input			Output	
Items	**Unit**	**Ways**	**Items**	**Unit**
Mass of Cylinder	**[kg]**	**0.5 1.0**	**Amplitude of Cylinder**	**[m]**
Spring Constant	**[kg/s]**	**0.5 1.0**	**Frequency of Cylinder**	**[Hz]**
Dumper Coefficient	**[kg/s^2]**	**0.0 0.01**	**Maximum Coefficient of Lift**	**[-]**
Flow Velocity	**[m/s]**	**0.5 1.0**	**Strouhal Number**	**[-]**
Reynolds Number	**[-]**	**100 500 1000**	**Average Coefficient of Drag**	**[-]**
Natural Frequency	**[Hz]**	**-**		

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