A Trial of Disaster Risk Diagnosis Based on Residential House Structure by a Self-Organizing Map

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ABSTRACT

A self-organizing map (SOM) is a good tool to visualize applied data in the form of a feature map. With the help of such functions, a disaster risk diagnosis based on the residential house structure is tried in this study. According to some computer simulations with actual residential data, it is found that overall tendencies in the developed feature map are acceptable. Then, it is concluded that the proposed method is an effective means to estimate disaster risk appropriately.

Keywords : disaster risk diagnosis, residential house structure, neural network model, self-organizing map (SOM), feature map.

1. Introduction

From the viewpoint of disaster prevention design, a disaster risk diagnosis of residential houses is quite important. It is true that the disaster risk is estimated based on quite a lot of factors, but most of them must have a close relationship to their structure.
By the way, a self-organizing map (SOM) [1] is well-known as a good tool for clustering. It is one of the neural network models, and its major feature is to visualize applied data as a sort of map based on their similarity. At that time, the SOM can find out some underlying rules in the data set simultaneously.
Then, with the help of such functions the SOM possesses, the disaster risk diagnosis based on the residential house structure is tried here. Especially, flammable risk in case of fire is considered in this paper.

2. Self-organizing map (SOM)

As shown in Figure 1, the SOM consists oftwo layers. One is an input layer to import the training data samples. Each of them is represented by a binary code depending on its attribute. The other is an output layer to export the analyzed result. It is a feature map organized by itselfthrough training, which is a repetition of the two modes, i.e., competitive and corporative modes. At first glance, we can see several regions reflecting the applied sample's attribute in the developed feature map. And, some underlying rules are observed among the alignment of the above-mentioned regions.

Table 1. All attributes for training data samples.

ID	category (choices)
i	road width of front road (01. narrow / 02. wide)
ii	number of adjoining building (03. few / 04. many)
iii	nearby river (05. any / 06. none)
iv	structure (07. shinkabe / 08. okabe)
v	roof (09. thatch / 10. tile / 11. flat)
vi	wall finish (12. clay / 13. wood / 14. block / 15. brick / 16. RC)
vii	building coverage (17. low / 18. high)

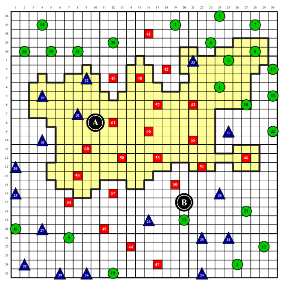
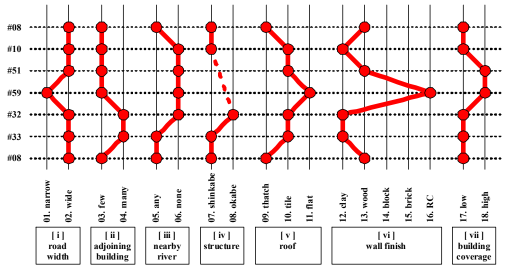


Figure 2. An example of developed feature map on the torus-type output layer.

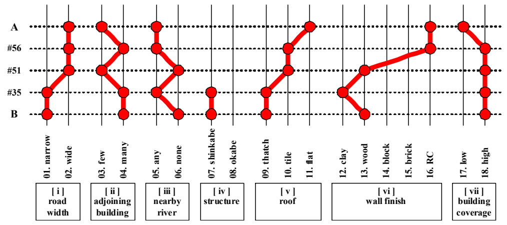
3. Computer simulations

3.1 Experiment --- Developed feature map

As a part of the Bilateral Joint Research Project, a ten-day field survey to visit three Korean folk culture villages,



(a) along a boundary line between the two regions --- anti-flammable region side ---



(b) along a pathway from A (*anti-flammable*) to B (*flammable*) --- front side ---

Figure 3. Analyzed results of flammable risk tendencies based on the developed feature map.

- Asan Oeam Folk Village (A.O.F. Village),
- Andong Hafoe Village protected as a world heritage by UNESCO (A.H. Village), and
- Jeoju Hanok Village (J.H. Village),

was conducted from August 28 to September 6, 2014 [2]. Among them, 61 samples are selectedfor training. Each of them is represented by a binary code (0/1) based on the seven categories, 18 choices in total as summarized in Table 1.

Each training sample is applied to the input layer consisting of 18 neurons, and a feature map is developed on the output layer whose configuration is a torus with 30x30-grid arranged neurons. An example of developed feature map after 3000-epoch training is shown in Figure 2. Most samples for J.H. Village (red squares, #41-61) are located at the center of the developed feature map. In contrast, both of samples for A.H. Village (dark blue triangles, #24-40) and A.O.F. Village (green circles, #1-23) are located around them in this order.

3.2 Experiment --- Disaster risk diagnosis

There are no actual samples corresponding to both aperfect anti-flammable house and a perfect flammable house here. Then, two virtual examples (A and B in Figure 2) are prepared instead, and the further considerations are carried out. With these two samples, the developed feature map is divided into two regions, i.e., an anti-flammable one (yellow area) and a flammable one (white area).

As a next step, in order to confirm flammable risk tendencies, several samples are chosen and their components are inspected carefully. Two major viewpoints are considered here as follows:

- some samples along a boundary line between the two regions
  - anti-flammable region side :
    #08 - #10 - #51 - #59 - #32 - #33 - #08
  - flammable regionside :
    #17 - #37 - #50 - #54 - #45 - #06 - #17
- some samples along a pathway from A (anti-flammable) to B (flammable)
  - front side : A - #56 - #51 - #35 - B
  - rear side : A - #31 - #32 - #20 - B

The former case is a series of samples whose risk is almost the same. As can be seen from Figure 3(a), each sample seems to change its attribute in a trade-off manner to maintain its moderate-risk constantly. In contrast, the latter case is a series of samples whose risk increasesrapidly. As can be seen from Figure 3(b), each sample seems to change its attribute from low-risk to high-risk gradually.

It is noticeable here that every remark mentioned above representsoverall tendencies of the developed feature map as a result of the inspections. Even though some portions are not consistent with such tendencies, it does not means that the proposed method is useless. Its main reason must come from an insufficient training of the SOM, therefore the further considerations are required to revise its performance.

4. Conclusions

A disaster risk diagnosis based on the residential house structure is tried in this study. Especially, flammable risk in case of fire is considered here with the SOM's feature map developed through training. As a result of some computer simulations with actual sample data, it is found that overall tendencies are confirmed successfully. It is true that there are some problems to be solved, so the further considerations are required to brush up the proposed method.

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6. References

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