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Image-Based Analysis of Evolution by Using a Neural Network

Réseau neuronal pour l'analyse de l'évolution avec base en images

Entwicklungsanalyse durch Bildauswertung mittels eines neuronalen Netzwerks

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SUMMARY
A system is developed to automatically detect changes in parameters among several measures taken at different times. It is assumed that the variables characterise the system which has been studied regardless of the nature of these variables. A neural network is used which learns a sequence of events and marks a representative set of changing parameters. The neural network recognises whether the new set of parameters, representing the actual state of the object being studied, falls in the admissible range, or if these values are not suitable. In this paper, the parameters are the pixels of images (photographs) and a system is proposed to check the evolution of the surfaces by using a video-camera.

RÉSUMÉ
Un système est développé pour la détection automatique des variations de paramètres lors de différentes mesures faites à divers moments. Il est admis que les variables caractérisent le système étudié mais que celui-ci ne dépend pas de la nature de ces variables. Un réseau neuronal apprend une séquence d'événements et établit une formule représentative de paramètres variables. Le réseau neuronal reconnaît si la nouvelle formule de paramètres représentant l'état actuel de l'objet à étudier se trouve dans le domaine de valeurs admissibles ou non. Dans cet article, les paramètres sont les pixels des images, dont l'évolution est contrôlée par magnétoscope.

ZUSAMMENFASSUNG
Es wird ein System vorgestellt, das automatisch die Veränderung von Zustandsgrössen entdeckt, die in verschiedenen Messungen zu unterschiedlichen Zeiten ermittelt wurden. Dabei wird vorausgesetzt, dass das System durch diese Grössen charakterisiert ist, aber nicht von ihrem Wesen abhängt. Ein neuronales Netzwerk lernt aus der Abfolge von Ereignissen und bezeichnet einen repräsentativen Satz sich ändernder Zustandsgrössen. Später soll es auch erkennen können, ob ein neuer Satz, der den aktuellen Zustand beschreibt, in den zulässigen Bereich fällt oder nicht. Im vorliegenden Fall sind die Zustandsgrössen Bildpixel, deren Entwicklung auf den Oberflächen durch eine Videokamera geprüft werden.

1. INTRODUCTION

In civil engineering many efforts are being oriented to carry out quality controls and defects finding, during the construction process as well as when the construction is finished, referring to the constructions development and maintenance.

These diagnosis tasks need, in general, laborious and expensive methods, specially in singular building.

This work develops a method to detect changes (alterations in structural joints, fissures and other defects, normal or abnormal movements of the elements, etc.) from sequences of images.

The kernel of the system is a type RHI artificial neural network, which has the property to extract characteristics that leave us discriminate among several patterns in a set. It can be used in two ways:

- **To detect changing characteristics**: A set of photographs of the same scene taken in several times are used in the learning process. The significant fragment that results will be located inside the set of pixels that have changes among the photographs; that is, in the portions of the scene where fissures, shifts, deformations, etc. are produced.

- **To detect abnormal changes**: to detect unusual changes (not due to temperature,wind, etc.), the system consists of two phases:

- Learning: this is the same described in the precedent paragraph. The learning process will be a preprocessing operation.

- Recalling: In future the actual photograph will be used to ask the system. If there are abnormal changes, the response will be corrupted.

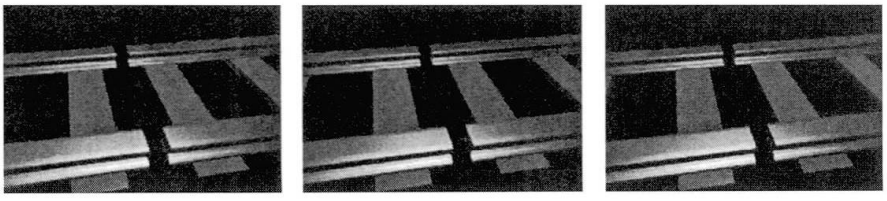
The RHI considers the components of each pattern which allow us to distinguish one pattern from the other and through these components, the model can infer, at least partially, the associated pattern to a given one. New components of this given pattern are then inferred in new iterations.

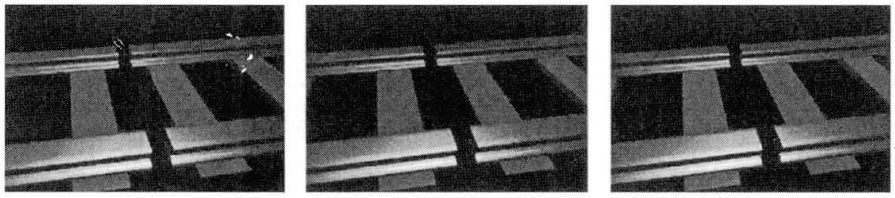
Total recall is not always possible, however, the model can indicate which components can not be obtained in an incremental manner.

Other artificial neural network models [1,2,3,7,8,9,10,11,12,13,14] use all the componente of the patterns and, as a consecuence, they can not used to extract the changing pixels in a set of images.

2. EXAMPLE

In order to demostrate the efectiveness of the proposed system, we have simulated the movement of a joint in a railway. We have taken 80 events that correspond to different positions to make a learning set of a RHI neural network.





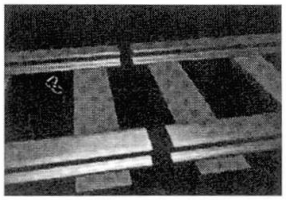
Several elements of the learning set that correspond to different positions of the railway.

The significant fragment of the RHI contains 75 pixels which positions are the zones where are the changes in the scene.

Significant fragment indicating the changing joint in the railway.

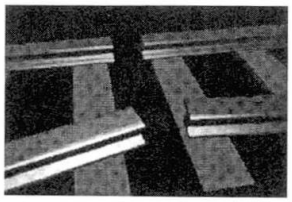
2.1 Detection of abnormal changes

This phase corresponds to maintenance tasks. In future, if a new photograph will be used to ask the RHI, the response will be either one of the corresponding to correct position of the railway if the railway is right or a corrupted response if the railway should an abnormal deformation.

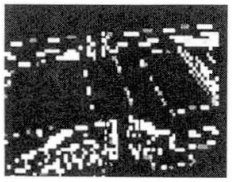


Scene showing the actual situation (normal movement)

Response given by the RHI neural network



Scene showing the actual situation (abnormal movement)



Response given by the RHI neural network

3. CONCLUSIONS

A prototype has been developed and an example is showed about the evolution of a surface: The RHI tells us which areas of the scene have suffered changes. Besides, the system could inform us about abnormal evolutions of the surface. This work could be of great interest as a system for helping on diagnostic based on superficial changes (or other) and in automated monitoring of a construction, in maintenance tasks.

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