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Hybrid Computerized Decision Support System for Infrastructure Assessment

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Hybrid Computerized Decision Support System for Infrastructure Assessment

The Need

Currently, assessment techniques are performed subjectively, time consuming, and rely mostly on human visual inspection. Such subjective assessment methods have been identified as a critical obstacle to effective infrastructure management. These techniques have not taken advantage of advanced technologies, especially computer technology. Therefore, more objective, accurate, and reliable assessment techniques using advanced technologies need to be explored to improve the quality of infrastructure and constructed facilities.

The Technology

The hybrid computerized decision support system for construction quality assessment applies concepts in the fields of machine learning, pattern recognition, and image processing. The system will automate the assessment process by acquiring digital images of the areas to be assessed and analyzing the images to identify and measure defects. Moreover, sample images will be used to train the system to acquire expert knowledge in identifying the defects and using this knowledge to later assess other cases.
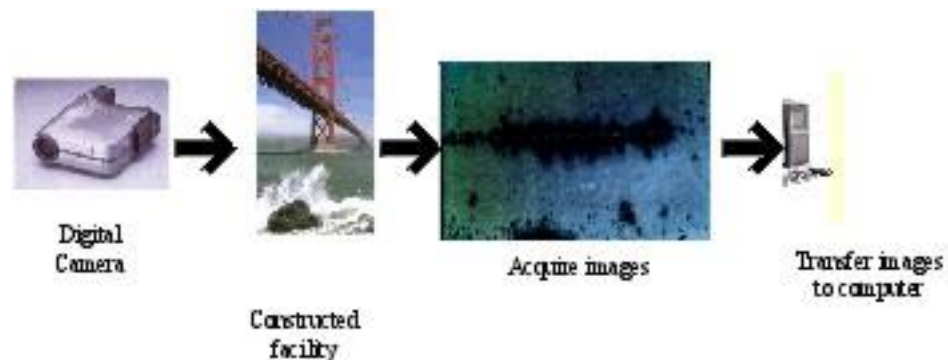

Digital Camera

Constructed facility

Acquire images

Transfer images to computer

Figure 1 General Process

The system consists of several stages: data acquisition, pre-processing, processing and assessment result (see Figure 2). Data acquisition can be obtained from various sources: the design specifications, the objects' digital images, and the experts' knowledge. After

acquisition, the images can be transferred to the computer on site or in a remote office via any communication protocol.

In the next stage, which is the pre-processing stage, image analysis techniques are used to analyze and enhance the image by applying algorithms such as filtering and edge detection. The image pre-processing is used to obtain the numerical parameters of the image such as the gray level and brightness in a numerical format. At this stage, a statistical pattern recognition algorithm is utilized to identify defects according to the numerical representation of images.
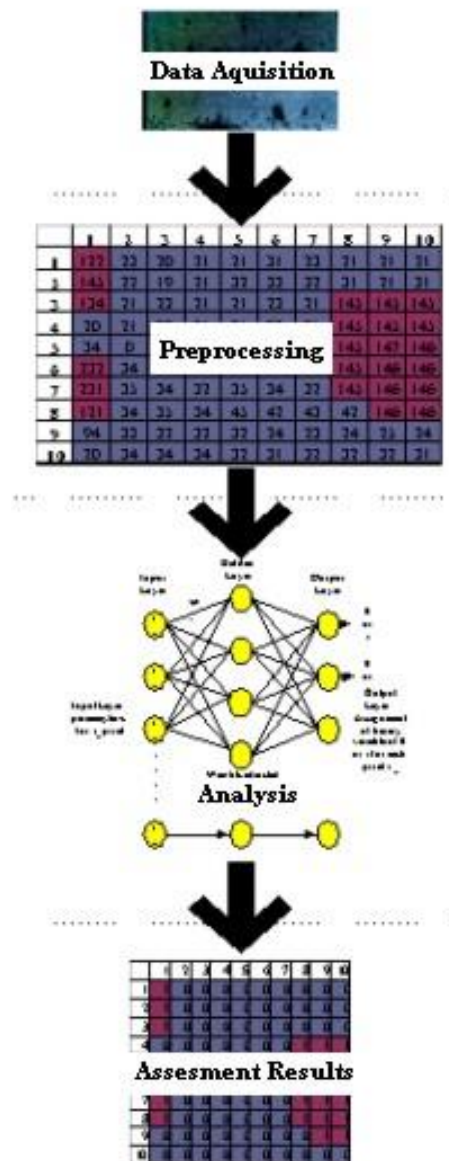

FIGURE 2 SYSTEM PROCESS

The next stage is the Processing stage. After being trained, neural networks are used to identify defects in the images by assigning binary variable of 0 or 1 for each pixel in the image. During the network training, the neural network is fed with different images and their parameters such as the pixels' gray levels. The network is also fed mapped values of 0 or 1 for each pixel value. The network will learn to assign the binary variable 0 or 1 for different scenarios according to image parameters.

The final stage is the Assessment Results stage, where quantitative measures of defects are obtained from the output of the previous stage. From mapped output of the neural network, the whole image is represented as 0's or 1's. The 1 values represent the defect; hence, defects can be identified and quantitatively measured. The system can be trained to identify different types of defects according to the specific application.

Benefits

By the mean of advanced technologies such as digital camera, optical scanner, gyroscopic technology, machine learning, pattern recognition, and image processing, the hybrid computerized decision support system for construction quality assessment could produce objective, quantitative, and reliable results of assessment, and could reduce the time needed to interpret the results.

Status

Currently, the applications of this system has been investigated in the School of Civil Engineering at Purdue University. Number of researches in this area are performed for specific applications in the field of steel bridges quality inspection and underground infrastructure assessments.

Barriers

The system is still under investigation, not yet widely implemented in construction industry.

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REVIEWERS

Peer reviewed as an emerging construction technology

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