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Crack detection in tiles based on hybrid technology of GA and MLP using Image Processing

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Abstract: The problem of the crack can be avoided by detecting the cracks on the surface of tiles. Crack detection using individual Genetic Algorithm and Multilayer Perceptron can achieve the efficiency less than the hybrid or combination of these two techniques in tiles industries. The efficient use of image processing with advanced technologies Generic Algorithm and Multilayer Perceptron with self organizing maps which would be required in the real time applications of tiles surface crack detection. Till now it was possible with individual above mentioned methods. This paper shows the possibility of hybrid method combining GA and MLP. Crack/Fault detection using hybrid of GA and MLP will be helpful for deduction in the rejection ratio of the tiles at the time of packaging

Keywords: Genetic Algorithm, Multilayer Perceptron, Self Organizing Maps, Hybrid, Crack Detection.

I. INTRODUCTION

It is compared that three methods for automatically classifying pavement cracks, genetic algorithm, multilayer perceptron, and self organizing maps. The best classifier demonstrates accuracies between 86 to 98 %.

It can be improved if any two techniques combined. (Hough transforms and projection methods will be used.) So that by hybrid techniques it can be improve up from 90 to 100 % in surface crack/fault detection.

Tiles and Concrete structure are usually constructed with material that exhibits distress over time due to loading, environment conditions and normal wear. Often the distresses are present in the form of surface cracking. [3]

A multilayer perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate outputs. An MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one.

Except for the input nodes, each node is a neuron (or processing element) with a nonlinear activation function.

MLP utilizes a supervised learning technique called back propagation for training the network. MLP is a modification of the standard linear perceptron and can distinguish data that are not linearly separable.

There are main four types of crack which are focused in this review paper. Since a large part of our tiles manufacturing infrastructure, a number of distresses have been identified and their characteristics cataloged [5].

Four common crack types are illustrated in Figure 1, and form the target of our classification system.

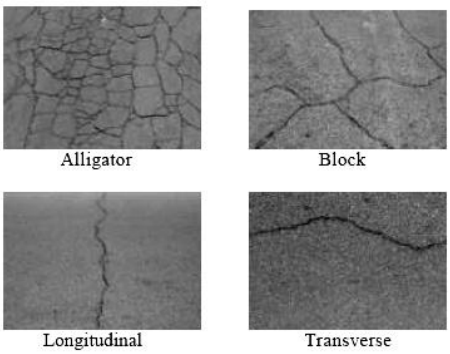

Fig. 1: Types of pavement cracks. [1]

II. ALGORITHMS & METHODOLOGY

A new method of hybrid from the combination of two techniques (Generic Algorithm and Multilayer Perceptron) will be used for the crack detection in tiles. The Hough transform and Projection method will be used for the result comparison or threshold comparison. By considering all the characteristics of crack and by unrestricting the crack orientation and forms, this method will provide good results.

A. GENETIC ALGORITHM

The GA is a stochastic global search method that mimics the metaphor of natural biological evolution. GAs operates on a population of potential solutions applying the principle of survival of the fittest to produce better and better approximations to a solution.

Individuals, or current approximations, are encoded as strings, chromosomes, composed over some alphabet(s), so that the genotypes (chromosome values) are uniquely mapped onto the decision variable (phenotypic) domain. The most commonly used representation in GAs is the binary alphabet 0, 1 although other representations can be

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used, e.g. ternary, integer, real-valued etc. For example, a problem with two variables, x1 and x2, may be mapped onto the chromosome structure that is shown in Figure 2.

Fig. 2: A Simple GA sequence

The simple genetic algorithm (SGA) is described by Goldberg and is used here to illustrate the basic components of the GA. A pseudo-code outline of the SGA is shown in Figure. The population at time t is represented by the time-dependent variable P, with the initial population of random estimates being P(0). Using this outline of a GA, the remainder of this Section describes the major elements of the GA.

$$f1(x) = \sum_{i=1}^{n} (x_i{}^2), \qquad -512 < x_i < 512$$

Where n define as the number of dimensions of the problem. For this example, we choose n = 20. The minimum of this function is, of course, located at x_i = 0.

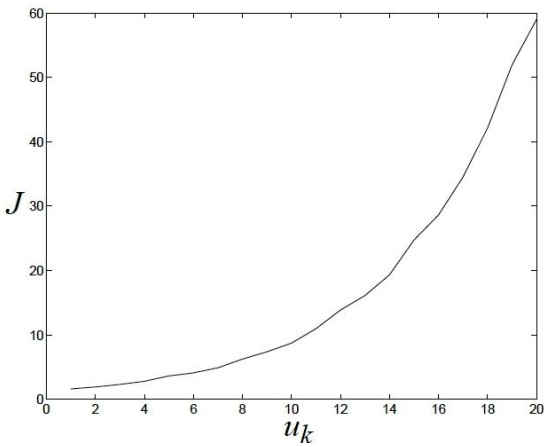

Fig. 3: Optimal Solution Obtained by mpga [15]

B. MULTILAYER PERCEPTRON

A multilayer perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate outputs. An MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. Except for the input nodes, each node is a neuron (or processing element) with a nonlinear activation function. MLP utilizes a supervised learning technique called back propagation for training the network. MLP is a modification of the standard linear perceptron and can distinguish data that are not linearly separable. If a multilayer perceptron has a linear activation function in all neurons, that is, a simple on-off mechanism to determine whether or not a neuron fires, then it is easily proved with linear algebra that any number of layers can be reduced to the standard two-layer input-output model. What makes a multilayer perceptron different is that each neuron uses a nonlinear activation function which was developed to model the frequency of action potentials, or firing, of biological neurons in the brain. This function is modeled in several ways, but must always be normalize and differentiable.

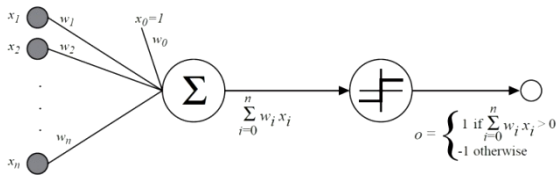

Fig. 4: Single Perceptron. [16]

A perceptron represents a hyperplane decision surface in the n-dimensional space of instances some sets of examples cannot be separated by any hyperplane, those that can be separated are called linearly separable many boolean functions can be represented by a perceptron: AND, OR, NAND, NOR. The forward propagation structure through the network in which each vertical bar represents a vector of values shown in figure 5.

Learning occurs in the perceptron by changing connection weights after each piece of data is processed, based on the amount of error in the output compared to the expected result. This is an example of supervised learning, and is carried out through back propagation, a generalization of the least mean squares algorithm in the linear perceptron.

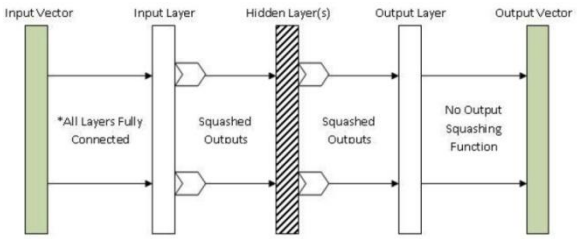

Fig. 5: Forward propagation structure through the network.

The local gradient calculation can be found in textbooks, and the implementation can be found in my extremely well commented code. This process is usually repeated until the error converges to zero.

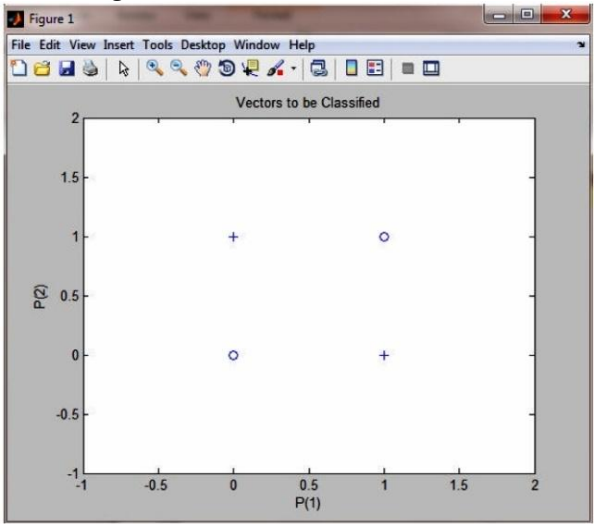

Fig. 6: XOR MLP Implementation in MATLAB

III. IMPLEMENTATION

The flow chart shown above is of the algorithm that we have developed to implement for the separation of the tiles. Code for the same is be implemented in MATLAB.

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As shown in the flow chart first we stored the standard reference image of the tiles currently in manufacturing line. Than real time image of the tiles will be capture by the camera from the manufacturing line. Than last, captured image will be compared with the standard reference image using pixel by pixel mapping algorithm. If the pixel difference value is more than the threshold level than control signal for the microcontroller will be generate and again the image of the next tiles will be capture. This entire code will run continuously and it generates the control signal on serial port of PC.

For the Microcontroller first we detect the main photocell sensor to know whether tile has been arrived or not. When microcontroller detect the signal from main photocell it will send "S" serially to the PC to in wake the MATLAB code to take a picture of tiles. After deciding the crack detection of tiles MATLAB will send the serial code of the tiles crack detection to the microcontroller. So we continuously check weather receive interrupt is generated or not. When it will be generated we have to check that which code has been received. Relay to operate solenoid will be activated only after microcontroller receives the signal from photocell C. If the receive code is rejection, it means that tiles is of more cracks and it will go to rejection. This whole code will run continuously in microcontroller.

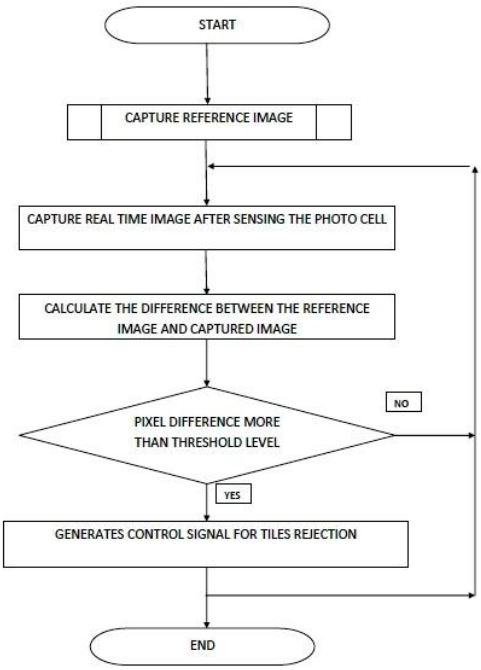

Fig. 7: Flow Chart of the System

A. RESULTS

The above mentioned methods are describing the crack detection using the individual Aenetic Algorithm and Multilayer Perceptron. Now GA and MLP will be combined and implemented in MATLAB. We are taking the tiles samples as a input. The surface of the tiles will be captured on the platform of MATLAB. The Image will be processed in the script of combined MLP and GA and the crack will be detected. The cracked area will be highlighted and it will give the surface crack detection. This system will define a crack area and it will highlight that areas. The Results in the MATLAB are shown in below mentioned figures. The crack can also be detected in the tiles having the graphics and textures.

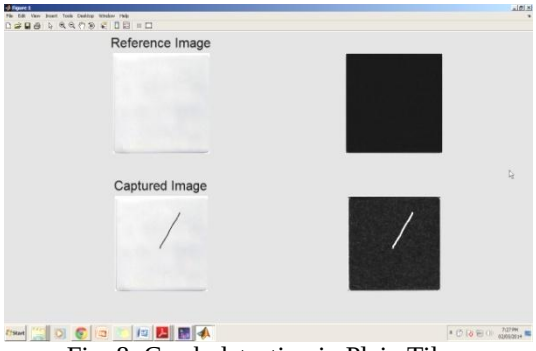

Fig. 8: Crack detection in Plain Tiles.

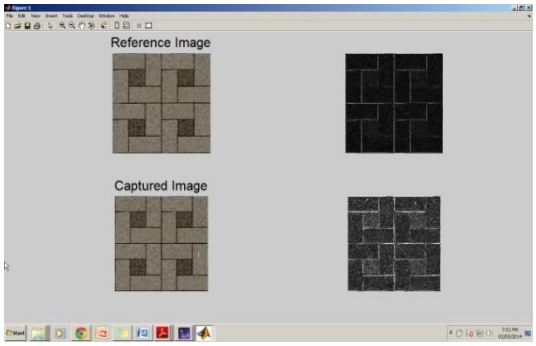

Fig. 9: Crack Detection in Squared Textured Tiles

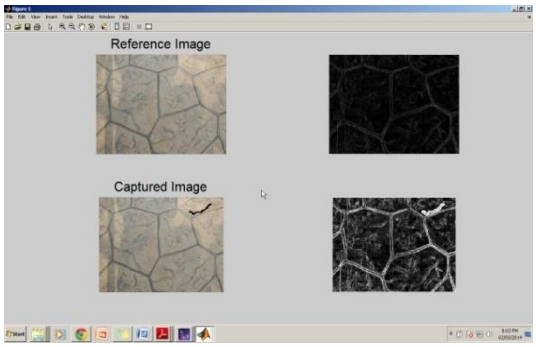

Fig. 10: Crack Detection in Simple Textured Tiles.

TABLE I
COMPARATIVE ANALYSIS OF MLP AND GA

PARAMETERES	MLP	GA	COMBINATION
Complexity	Less	More	More
Power	More	Less	Less
Accuracy	More	Less	More
Accuracy in %	92	94	>95
Information Loss	More	Less	Less
Implementation	Easy	Hard	Very Hard

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IV. CONCLUSION

The crack or fault detection will very much helpful for higher export and quality. There are many techniques to detect the cracks and from them Genetic Algorithm and Multilayer perceptron are the neural networks that can be used in the image processing to detect the cracks. Individually they can achieve the accuracy near about 90 %. To increase the accuracy these two techniques can be combined for the crack detection on the platform of the image processing in the MATLAB. By implementing the combined algorithm of the Genetic Algorithm and Multilayer Perceptron more efficiency can be achieved. This thesis shows that by combining these to technique more than 95 % accuracy can be achieved. The Crack detection in the plain tiles is very much efficient in this technique.

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