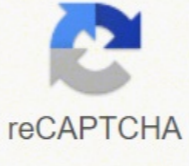




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# Pattern recognition and machine learning pdf pdf full crack

Recently, various novel algorithms have been successfully utilized including artificial bee colony [66], differential flower pollination [67], Henry Gas Solubility Optimization [68], Harris hawks optimization [69], symbiotic organisms search [70], monarch butterfly optimization [71], and social spider optimization [72]. Among such distresses, cracking (refer to Figure 1(a)) is observably the most widely encountered one in asphalt pavements [8, 13–15]. The main advantage of SVM is good capability of data generalization, guarantee of global convergence in model training, and handling of high dimensional datasets. Therefore,  $c1$  determines the balance between exploration and exploitation processes; it is computed as follows: where  $l$  denotes the current searching iteration and  $L$  specifies the maximum number of searching iterations. The SSA metaheuristic employs Newton's law of motion to update the position of the followers in the swarm. This table summarizes the predictive performances of the models when they are employed to categorize novel image samples in the testing sets. Nowadays, intensive traffic loads and inclement weather conditions expedite the deterioration rate of asphalt pavement roads. When predicting samples of the 1st class (noncrack), the proposed method also achieves the highest accuracy rate of 90.5%; the Adam-DCNN is the second best model with CAR = 89.50%. In addition, sealed cracks and cracks are treated differently in pavement condition assessment [20]. This method is an integration of feature extraction based on image processing and metaheuristic optimized machine learning. Zhang et al. Moreover, the labels of the image samples have been assigned by human inspectors: (a)(b)(c)(a)(b)(c)4.2. Feature Extraction Based on Image Processing and Texture ComputationAn overview of the feature extraction process is provided in Figure 9. The last column is the label of the data instances with 0 = "noncrack," 1 = "sealed crack," and 2 = "crack."Conflicts of InterestThe author declares that there are no conflicts of interest regarding the publication of this article.Supplementary MaterialsThe first 28 columns of the data are features extracted from image samples. [16], accurate and timely detection of crack is essential for the process of asphalt pavement condition survey. Herein, the lower and upper boundaries of the SVM's hyper-parameters are 0.01 and 100, respectively. Moreover, different from the model construction phase of the SVM that is based on quadratic programming, the model training process of CNN models relies on gradient descent algorithms. To compute this descriptor, analyses on attractive and repulsive relationship is performed with a local structure of the size  $3 \times 3$  pixels for all of the pixels in an image sample. Accordingly, previous works have resorted to metaheuristic algorithms to tackle the task of interest. Adam-BPANN0.0004 CV-SSA-SVM vs. The number of collected image samples is 300; hence, the number of samples in each category is 100 to guarantee a balanced classification problem. The penalty coefficient  $C$  essentially controls the amount of penalty suffered by misclassified data samples during the model training phase. In order to train and validate the usefulness of the proposed framework, we have collected an image dataset including 300 samples of asphalt pavement surfaces during field trips in Danang city (Vietnam).The rest of the article is organized as follows: The next section reviews previous studies pertinent to the current research. [43, 44] relied on convolutional neural network (CNN) classifier to recognize pavement cracks; the CNN was found to be highly suited for the collected image dataset. As pointed out by Dong and Catbas [9], the advantages of such state-of-the-art methods are safety for inspectors, fast data processing, low equipment cost, high degree of automation, and low interference to the daily operation of the surveyed road sections.Hence, advanced methods based on 2D pavement analyses have been developed to recognize various pavement distresses [10–12]. The feature extractor used in this study relies on CSF coupled with PI to analyze the visual appearance of object within a image scene.Image-processing techniques including image thresholding, and morphological operators are used to extract the region of interest. In addition, we also put forward a novel framework that utilizes the nature-inspired metaheuristic of SSA for optimizing the crack and sealed crack detection model.3. Research MethodologyThis section of the article presents the research methodology of the current study. Within this high-dimensional feature space, data drawn from different class labels can be separated by a hyperplane (refer to Figure 6). However, a sealed crack itself is considered a form of surface defect and the detection of its appearance is also important for pavement management system [19]. Adam-DCNN0.0075 CV-SSA-SVM vs. The novel integrated feature extraction operator is therefore crucial in our study because it helps to recognize objects of interest within cluttered scenes of asphalt pavement surfaces [55]. Prasanna et al. This study employs the statistical measurements of color channels and ARCS-LBP histogram as means of texture description methods. Accordingly, the statistical measurements attained from the 20 independent runs are used to assess the model predictive capability in the task of detecting pavement crack and sealed crack. However, the task of hyper-parameter adjustment is data-dependent and challenging because the hyper-parameters are continuous values; thus, there is an infinite number of possible candidates. RFC0.0401The Wilcoxon signed-rank tests with value = 0.05 show that the CV-SSA-SVM is significantly superior to the RFC, Adam-BPANN, and Adam-DCNN in detecting crack and sealed cracks (





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