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Survey On Algorithms Used To Detect Multiple Defects on Disk Brakes

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ABSTRACT— The Convolutional Neural Network (CNN) is a kind of network architecture for deep learning algorithms and is specifically used for image recognition and tasks that involve the processing of pixel data. There are other types of neural networks in deep learning, but for identifying and recognizing objects, CNNs are the network architecture of choice.

Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.

The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane.

Keywords: Machine - Learning algorithms, Regression, Fault Detection.

I. INTRODUCTION

The automotive industry has been constantly evolving, and the demand for more reliable and safer vehicles has increased. Disk brakes are an essential component of the vehicle's braking system. However, disk brakes are prone to wear and tear, leading to defects that can result in brake failure.

Traditional methods of inspecting brake disks are time-consuming and often not accurate. Therefore, the development of an automated system that can detect multiple defects on disk brakes using CNN (Convolutional Neural Networks) can be of great importance. This survey paper aims to review the recent developments in the field of disk brake defect detection using CNN.

II. RELEVANCE

Several research works have been conducted in the field of disk brake defect detection using CNN. In 2017, Gao et al. proposed a CNN-based method for defect detection on brake disks. The proposed method consisted of two CNNs: one for the detection of the brake disk region and the other for defect detection. The method achieved a high accuracy rate of 97.4%.

In 2018, Xu et al. proposed a deep learning-based approach for defect detection on brake disks. The proposed method utilized a pre-trained ResNet-50 model and achieved an accuracy rate of 98.3%. The method was also evaluated on real-world data, and the results showed that it outperformed traditional methods.

CNN Brake Defect Detection:

In 2019, Zhang et al. proposed a multi-task learning approach for defect detection on brake disks. The proposed method consisted of two tasks: brake disk region detection and defect

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detection. The method achieved an accuracy rate of 98.9% for brake disk region detection and 96.9% for defect detection.

In 2020, Wang et al. proposed a novel approach for brake disk defect detection using a two-stage CNN. The first stage detected the brake disk region, and the second stage detected defects within the brake disk region. The proposed method achieved an accuracy rate of 99.2% on the test dataset.

Convolutional Neural Networks (CNN) are a type of deep neural network that can automatically extract features from images. CNNs have been widely used in the field of computer vision for object detection, classification, and segmentation. In recent years, CNNs have also been used for defect detection in various industrial applications.

III. MOTIVATION

Brakes are a very important part of any transportation vehicle and it is highly important that the developed brake parts are of good standard to stop any accidents. According to a recent survey, it is saddening to know that the largest number of accidents in the world occurs in India. In 2017 alone, there were 147913 accidents on the road, of which 48764 were on 2-wheelers, 26869 happened on cars, 20457 happened to people walking on roads and 3559 were on cycles. Approximately, 400 people die every day on our Indian roads due to different types of accidents. Based on the analysis done by the National Highway Traffic Safety Administration (NHTSA), it is observed that 22 percent of fatal accidents happen due to brake failure. This shows that one of the primary reasons for road accidents is the failure of Brakes. Therefore, it is crucial that all the developed brakes are of good quality without any defects or damages.

IV. RELATED WORK

In [1], the fused model (SVM+ANN) incorporates two commonly used machine learning approaches through the use of fuzzy logic. The proposed ambiguous choice system has outperformed the previous system in accuracy, achieving a score of 94.87.

In [2], a validated RF-SMA-SVM model was created. Based on the experimental findings, the suggested method outperforms the SVM method based on other optimization algorithms in terms of prediction accuracy and performance stability while filtering out the important variables with strong discriminatory power.

In [3], The study used a variety of classifiers, such as Decision Tree (DT), Support Vector Machine (SVM), Random Forest (RF), K-Nearest Neighbor (KNN), Naive Bayes (NB), Multiple Perceptron (MP), J48 Trees, and Logistic Regression (LR) classifiers. In comparison to other classifiers, the proposed ensemble classifier beat individual classifiers in performance evaluation, achieving the best accuracy of 94%.

In [4], The four separate MSVM kernel functions of the support vector machine's MSVM model were used to categorize the six significant circumstances. For six sensor scenarios, the RBF kernel model provides the highest classification accuracy. The classification outcomes and statistical measurements were applied to the RBDT-MSVM model's evaluation. The overall accuracy of the categorization was 92.8571%. We may infer from the results above that an MSVM classifier with an RBF kernel function and RBDT is a top candidate for fault diagnosis of water quality monitoring equipment.

In [5], In order to accurately assess the patients' heart-disease status, the suggested HDPM was created and developed for the Heart Disease Clinical Decision Support System. The patient data, together with additional diagnosis data, were acquired by the HDCDSS and sent to a secure web server. After being transmitted, the data was saved in MongoDB, which can efficiently deliver a prompt answer. The patient's current heart disease status was then determined using the proposed HDPM, and the results were then communicated back to the HDCDSS's diagnosis result interface. A statistical review was also provided to support the model's significance. Experimental outcomes showed that the suggested model performed better than leading models and earlier study findings, with accuracy up

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to 95.90% and 98.40% for datasets I and II, respectively.

In [6], By using RBF-SVM decision classification and covariance matrix Cholesky decomposition, an effective method for blind spectrum sensing at low SNRs is described. An established SVM classification model is easily used to make the decision. The actual decision threshold has a self-learning capability based on the SVM, which successfully distinguishes signals from sounds. In terms of computational complexity, the suggested approach performs better than the traditional MME scheme. Simulation findings show that the suggested technique performs better than traditional detection ones, especially at low SNRs, demonstrating its potential for 5G communications.

In [7], Regarding data imputation and sample diagnosis, the suggested CKD diagnostic methodology is workable. The integrated model could reach a sufficient level of accuracy after KNN imputation was used to impute missing values in the data set without supervision. So, it is hypothesized that using this technology to really diagnose CKD would produce favorable results. Unfortunately, only 400 samples of the available data were used in the model-building procedure because of the constraints imposed by the requirements. As a result, the model's ability to generalize may be constrained.

In [8], To distinguish AD from HC, a machine learning classifier based on SVM was created. The outcomes demonstrated that examining the spatiotemporal information of the body joints as it changed while being captured by a Kinect V.2 camera yielded significant features from several TUG test subtasks. The SVM classifier's average accuracy and F-score were 97.75% and 97.67%, respectively, when evaluated using five-fold cross-validation, and 98.68% and 98.67% when evaluated using leave-one-subject out cross-validation. Their results confirmed the possibility of the thorough analysis of TUG utilizing a Kinect V.2 camera and machine learning as a simple and affordable complementary tool for the detection and routine quantitative assessment of AD in clinical or home settings.

In [9], A stacked SVM-based expert system was suggested to help with the diagnosis of heart failure. While the second SVM model served as a prediction model, the first SVM model was utilized to remove unnecessary characteristics. It was demonstrated that the suggested strategy outperformed eleven well-known methods that were already in use in the literature and other cutting-edge machine learning models. Also, it was noted that the strength of the suggested model outperforms the standard SVM model by 3.3%. The suggested approach is also effective in terms of time complexity. because the predictive model's training period is shortened. So, it can be inferred from the dataset's results that the suggested expert system can help doctors diagnose heart failure by improving their decision-making process.

In [10], The investigation on the identification and categorization of lamination flaws in the power transformer core was reported in this publication. Using a 15 kVA transformer, experimental results from a prior study were used. The conclusions are as follows.

1. For the detection purpose, where two classes were taken into consideration, SVM, KNN, and DT classifiers provided a good accuracy rate of around 82%.

2. The SVM method produced an accuracy rating for the categorization of 84.26%. For KNN and DT classifiers, it was 84.04%. In particular, for the DT method, the classification process was sensitive to data decomposition.

3. It was discovered that, in comparison to other classes, the insulating lamination fault exhibits a good accuracy rate. For this class, higher precision and recall were attained.

V. LITERATURE SURVEY

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Sr. No	Title	Author/ YOP	Strength	Weakness
1.	Harald Straky, Marco Muenchhof Rolf Isermann Publication:2021	Model based fault detection and diagnosis [1]	The model was used for fault detection and diagnosis scheme; A correlation analysis method is used which is able to discern and diagnose air enclosures and leakages.	Can not detect force balance at the particular piston which allows to locate the fault
2.	John Grezmaka, Jianjing Zhanga, Peng Wanga, Robert X. Gao Publication:2020	"Multi-stream convolutional neural network-based fault diagnosis for variable frequency. "[2]	The model was used for fault detection and diagnosis scheme; A correlation analysis method is used which is able to discern and diagnose air enclosures and leakages.	Can not detect force balance at the particular piston which allows to locate the fault
3.	Authors: Jing Yang, Shaobo Li, Zheng Wang, Hao Dong, Jun Wang, and Shihao Tang Publication:2021	"Using Deep Learning to Detect Defects in Manufacturing: A Comprehensive Survey and Current Challenges "[3]	Automatic defect detection technology not only adapts to an unsuitable environment but also works in the long run High precision and efficiency.	Can not design defect information feedback technology that is based on defect detection technology.
4.	Authors: Helly. N. Desai , Prof. Rakesh Patel Publication:2020	"A Study of Data Mining Methods for Prediction of Personality Traits "	Fault detection and diagnosis of induction motors in variable frequency drive (VFD) applications Minimizing unexpected downtime, material waste and equipment damage	The relative amount of positive or negative relevance between sensor inputs is different for each speed.
5.	Authors: Mufti Reza Aulia Putraa, Pandu Sandi Pratamab, Aditya Rio Prabowo Publication:2021	'Failure of Friction Brake Components against Rapid Braking Process "	The use of a good braking system will provide safety and comfort in its use.	A better cooling system can maintain the performance of a braking system

V. CONCLUSION

In conclusion, CNN-based approaches have shown promising results for defect detection on brake disks. These approaches have the potential to improve the efficiency and accuracy of traditional inspection methods. However, there is still room for improvement, especially in more rah in CNN models that can handle a wide range of Henke disk defects.

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