

# Fitness test of vehicles using CNN

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**Abstract-** This paper presents a vehicle fitness test using Convolutional Neural Network (CNN). All commercial vehicles must periodically endure fitness tests in accordance with the Motor Vehicle Act, based on the age of the vehicle. Bring the cars to fitness facilities for inspection and certification. Additionally, there are only a few centres in each district, so there are frequently lengthy lines and some hassles with the process. In order to reduce human effort and increase productivity, a creative answer is needed. To make this procedure easier for everyone, an efficient solution is needed. We needed to create an online system because everything in this day and age is online, making it easier to manage this process and requiring less human effort. This device allows us to compare to the current system and gives vehicle owners the best means to finish the vehicle fitness test. The online system, where the entire fitness testing will be automated, is implemented because the current system takes more time to complete a piece of work. The system would respond in accordance with the criteria if the damage was discovered, which was our main objective. He was free to go through more scrutiny at the inspection centre if no damage was discovered. As a result, we have created a system that perfectly fits the criteria for properly conducting vehicle fitness testing. the procedures required for an automated inspection of vehicle damage.

**Keyword:** Convolutional Neural Network (CNN), R-CNN (Regions Convolutional Neural Network), You Only Look Once (YOLO).

## I. INTRODUCTION

Most commercial sectors depend heavily on technology because it streamlines processes and minimizes the need for human labour. Another industry where businesses are attempting to streamline efforts and offer car owners better solutions is the automobile. Additionally, integrated technologies contribute to problem-solving, enhancing existing solutions, achieving specific company objectives, and carrying out specific

functions. One of these technologies and tools is the camera, which is employed in a variety of areas, including security, to shield organizations or nations from unauthorized access. One of the most important and well-liked modes of transportation for quickly moving from one location to another is the automobile [14][15]. As reliance on automobiles becomes more and more necessary, in order to guarantee the safety of their passengers, routine inspections must be carried out. Additionally, the vehicle may be involved in accidents, necessitating repair, for which regular vehicle inspections are conducted. Nowadays, as part of the car's admission to maintenance, car maintenance businesses or examination centers spend a lot of time inspecting the body of the vehicle [16]. The primary goal of this project is to use the CNN technique to identify body damage on the vehicle from the captured images, making basic inspection possible without human involvement and reducing the time needed to perform this vehicle fitness test [17]. The goal of the initiative is to reduce the time needed for each vehicle inspection while also focusing on vehicle maintenance that will significantly contribute to accident prevention. A computer vision system called a CNN-based vehicle fitness test employs deep learning methods to autonomously assess the condition of automobiles. By identifying and categorizing different flaws or problems, such as dents, scratches, broken lights, and more, this technique can be used to check the mechanical condition of automobiles. The system may be taught to spot problems in vehicles with a high degree of accuracy by training it on a sizable dataset of photos of vehicles with various types of flaws. Once taught, the system can assess photos of the cars taken at various angles and distances in order to assess the fitness of the vehicles rapidly and reliably. A CNN-based vehicle fitness exam has a lot of benefits. It can save time and lowering the need for human intervention can lead to higher productivity and lower expenses. Also, it can improve vehicle fitness tests' accuracy and decrease the possibility of human error. The method can also be applied in several contexts, such as car rental agencies, vehicle inspection stations, and more. To make sure that the vehicles on the road are secure and adhere to legal requirements, vehicle fitness inspections are crucial. Human inspectors do visual examinations of vehicles using

traditional methods, which can be time-consuming and susceptible to missing little problems. A CNN-based system, on the other hand, can swiftly and precisely examine a variety of auto parts, including crucial safety systems like brakes, tyres, and lights. Typically, a CNN-based vehicle fitness evaluation system combines cameras and sensors to collect images and data from various vehicle components. These sensors are strategically positioned throughout the car and record data on things like braking function, tyre pressure, and pollutants. Convolutional neural networks, a subset of deep learning algorithms made specifically for image recognition applications, are then used by the system to process this data. To recognise and identify potential problems, the neural network is trained on a sizable dataset of photos and data from several automobiles. For instance, the system is capable of spotting worn-out brake pads, damaged tyres, and broken lights. The system can notify the owner or operator of the vehicle to take proper action after it has detected a potential problem. A CNN-based vehicle fitness test system can decrease costs associated with conventional inspection methods in addition to improving accuracy and efficiency. As a result of the system's deployment in automated inspection centres, fewer human inspectors are required, and 24-hour operation is made possible.

## II. LITERATURE SURVEY

The process of inspecting a car begins when it is brought to the inspection location. An employee first goes around the vehicle to look for dents and scratches on its body. The customer can take a copy of the manual inspection form that includes the general body of the vehicle after which the employee records the scratches and dents. As a result, conducting the inspection takes more time and effort, and the inspection's accuracy suffers. As a result, it is challenging to accurately detect vehicle damage with the naked eye. Some incidents arise when customers dispute the assertion that a scratch was caused by them, as there are no reliable methods for determining scratches and before and after looking at the vehicle for dents. These issues might become worse during the festive seasons, when driving is typically more prevalent. In addition to these issues, when the owner of the vehicle returns to examine his car after some time has passed, it will be challenging to see how the scratch that was previously marked has changed. Automated Vehicle Inspection System Based on Deep Learning and Image Processing," proposes an automated vehicle inspection system that employs deep learning and image processing methods to identify a variety of defects in a vehicle, including dents, scratches, cracks, and other physical damages. Using the YOLO (You Only Look Once) technique for object detection and localization in images, the research seeks to increase the precision and effectiveness of the vehicle inspection procedure. Hao Wang and colleagues present a vehicle fitness test system in their work titled "Vehicle Fitness Test System Based on Machine Learning Algorithms and Image Processing." This system makes use of machine learning algorithms and image processing methods to identify and diagnose vehicle issues. The method seeks to decrease the time and expense involved with human inspection and increase the accuracy and efficiency of vehicle fitness testing.

To identify and categorize car issues, the scientists combined machine learning methods Random Forest (RF) and Support Vector Machine (SVM). The system uses image processing techniques to extract pertinent information from the collection of vehicle photos on which it was trained. Based on measures for accuracy, sensitivity, specificity, and F1-score, the authors assessed the system's performance. To find and categorize car flaws, the suggested method uses a convolutional neural network (CNN). Using a dataset of photos with various car flaws, the system is trained.

The paper provides a detailed description of the proposed system, which uses a set of cameras to capture images of the vehicle from multiple angles. These images are then processed using a CNN to identify any defects in the vehicle, such as scratches, dents, or cracks. The authors describe the architecture of the CNN used in their system and explain how it was trained using a large dataset of vehicle images.

The paper also presents the results of experiments conducted to evaluate the performance of the proposed system. The authors report that their system achieved a high level of accuracy in detecting defects in vehicles, and that it outperformed traditional machine learning methods in terms of accuracy and speed.

We discuss the practical implications of their system, noting that it has the potential to significantly reduce the time and cost associated with vehicle inspection. The proposed system could have important applications in a range of industries, including automotive manufacturing, maintenance, insurance, and law enforcement.

## III. PROPOSED SYSTEM

The system's goal is to develop a system that stands out from other systems by offering exceptional goods and services. Every Owner's authentication in this case will be based on their unique car identification number. The system will then retrieve information about the vehicle, its owner, and guidelines for the vehicle fitness exam. According to specifics, the user will be permitted to continue with the damage inspection test if the car has not yet undergone any testing. The owner of the vehicle is permitted to submit photos of the vehicle after which, using CNN technology, the body inspection process will start automatically. To find dents or scrapes on the car, this camera is used. which will cut down on the time and work needed and consequently, the number of tests. is going to grow. After the body inspection is successful, the vehicle owner will receive a token for the rest manual examination. which will cut down on the owner's time and eliminate the need for him to wait in line [18][19]. The proposed system enables all vehicle owners to have their vehicle damage inspected without having to travel to an inspection facility. Instead, they simply need to visit the website, upload the necessary images, and complete the manual inspection claim form. If the applicant passes the test, he will be permitted to take additional manual inspections at the inspection facility; otherwise, the applicant must upload new images and wait for the results [4][5].

### A. CNN (Convolutional Neural Network)

It is a neural network design with many convolutional layers that are primarily used for image processing, classification, segmentation, and auto-correlation of data. In essence, a convolution involves moving a filter over the input. Over the past ten years [1], Convolutional Neural Networks have produced ground-breaking results in a range of pattern recognition-related disciplines, including voice recognition and image processing. The reduction of ANN's parameter count is CNNs' most advantageous feature. CNNs work well for PC vision tasks in AI applications, such as visual thing affirmation and acknowledgment [2].

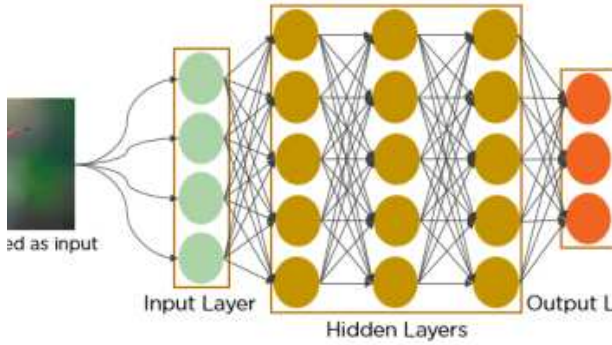


Fig1. Layers Image go Through

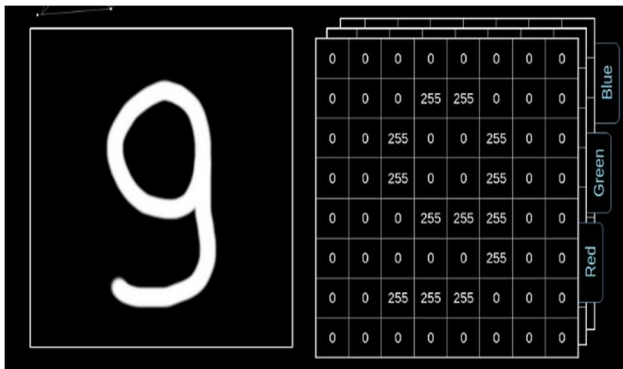


Fig2. Find out the interest area

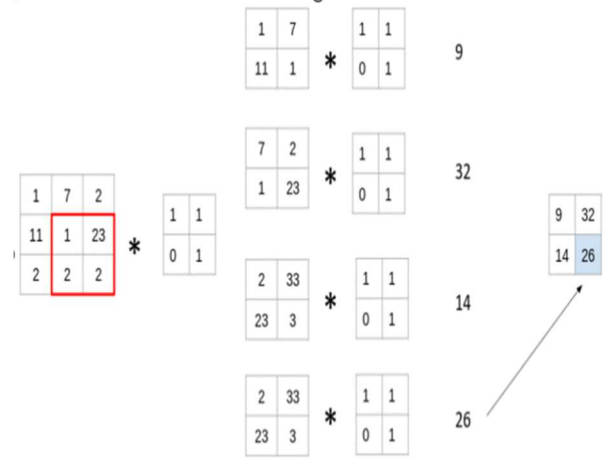
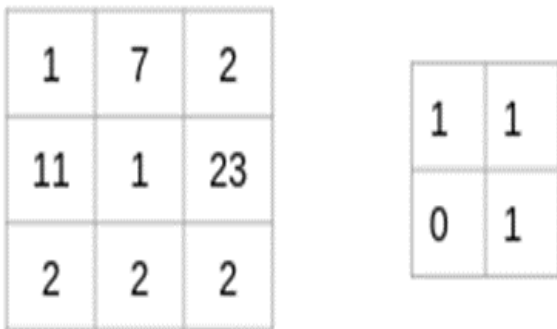


Fig3. Process of convolutional and 1D fully connected layer

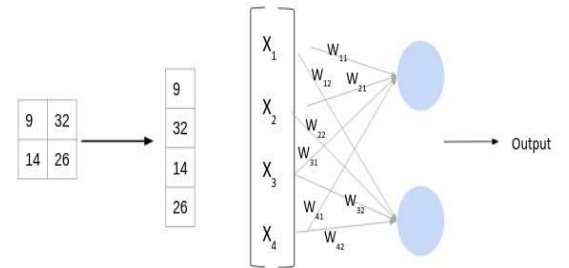


Fig 4. Output

The most important presumption about problems that are solved by CNN should not have features that are spatially dependent. This achievement has challenged both researchers and developers to approach larger models in order to solve complex tasks for particular problems, which was not possible with classic ANNs. In other words, we don't need to be paying attention, for instance, in a face detection programme [3].

### B. Damage detection using Mask R-CNN

To detect crack damage, it uses image-based deep learning. The method involves taking pictures with a camera, pre-processing them by scaling and segmenting them, and then extracting features from the segmented images to determine the shape of the damage or crack. CNN is divided into levels. Input layer and exit layer, respectively [8]. There are a few secret layers between these layers as well. There could be  $n$  hidden levels in the network. The input layer receives the data, trains in accordance with it, and then outputs it. CNN enables us to make better and more accurate use of the vast quantity of data. On ImageNet, a variety of CNN algorithms are accessible that are publicly accessible, such as Alexnet, VGG-16, VGG-19, Inception, Cars, and Resnet, among other models in CNN [6][7]. Mask RCNN is a faster version of RCNN that enables object segmentation. It has two levels: the first scans the image and produces a proposal, and the second classifies the proposal and creates a box and a mask for the image. The following constitutes the code. Use a pretrained ResNet50 and FPN network model to input the image

to be processed in order to extract features and produce matching feature maps. RPN is used to obtain a large number of regions of interest for feature map, which employs the SoftMax classifier to classify the foreground and background in binary terms and uses frame regression for more precise classification candidate-frame location data and non-maximum suppression filtering to exclude a portion of the region of interest [9][10]. The RoIAlign layer receives the feature map and all leftover ROIs so that each ROI creates a fixed-size feature map. Finally, using a single Python file, the algorithm flow splits into two branches, one of which enters a completely connected layer for object classification and frame regression, and the other of which enters a full convolution network (FCN) for pixel segmentation [11].

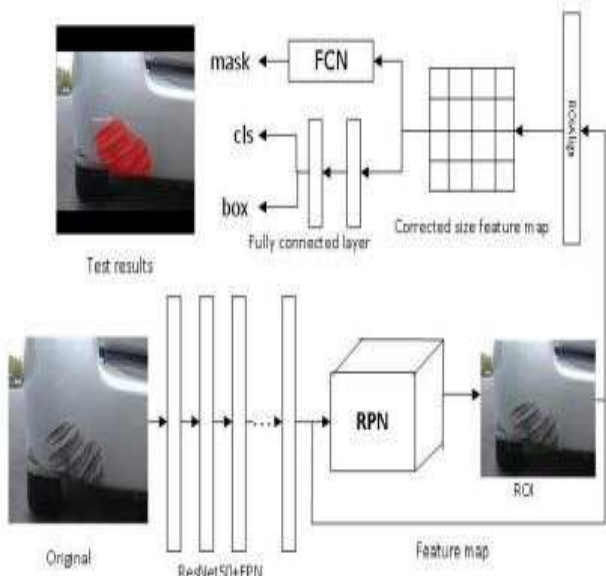


Fig 5. The network structure block diagram of the Mask R-CNN algorithm

## IV. Result & Discussion

Any non-technical individual can understand how a system's workflow is represented by a use case diagram, which depicts user interaction with the system.

### A. DATA ANNOTATION

To identify the region of damage in an image and indicate the boundary of the damaged area, a training dataset in Mask R-CNN is required. The VGG Image Annotator is one such annotation application. It shapes the area in a rectangle pattern. Annotations are then stored in the dataset directory as a json file for later classification.

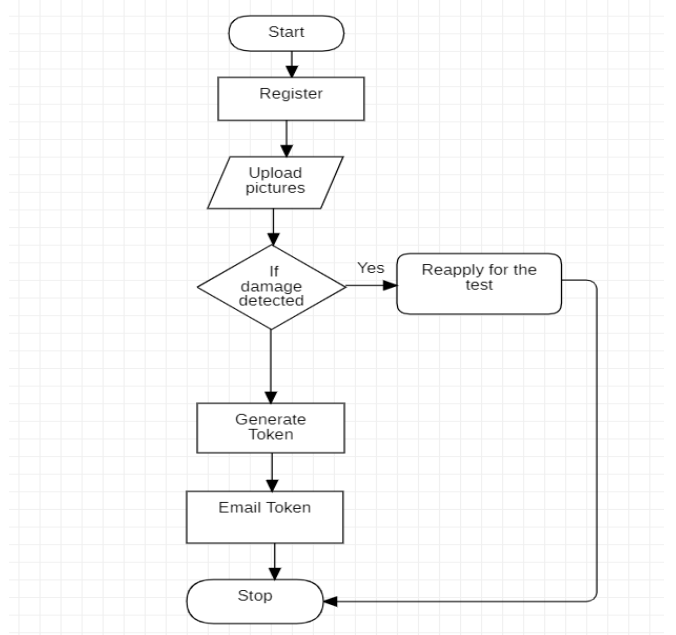
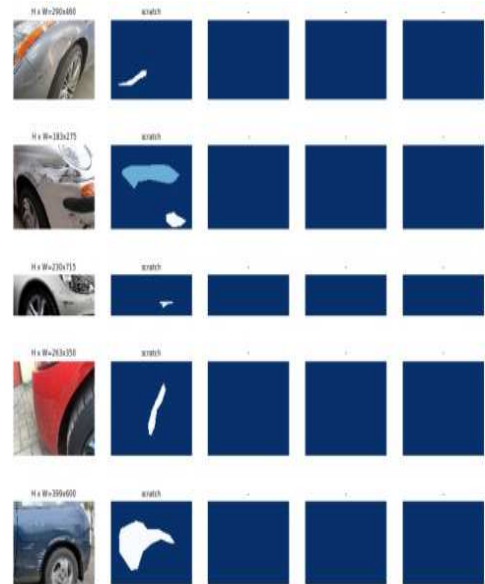


Fig 6. System work flow



Bounding Box(BB) with annotated damage mask for typical car images

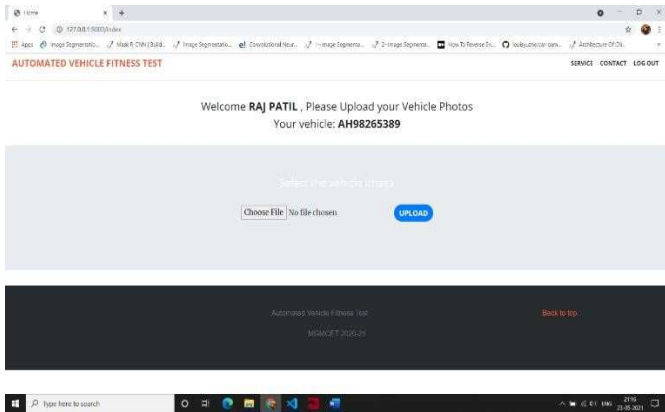
Fig 7. Import Data set and Visualization

The dataset must be trained on in order to create a model for the specified method. Evaluating the model's accuracy through prediction on test and confirmation.



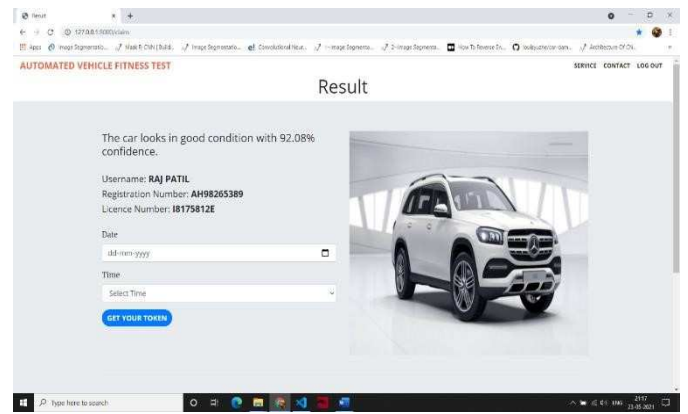
**Fig 8. Prediction in inference mode**

Our primary goal was to find damage on the car, and the system would react in accordance with the parameters if damage was found. If no damage was found, he was free to undergo additional inspection at the inspection centre. As a result, we have successfully developed a system that completely satisfies the requirements for conducting vehicle fitness tests effectively. The necessary processes for the automated car damage inspection. Flask is a lightweight framework that enables the integration of a model in a manner that makes it useful for interacting with real-world issues. It offers developers flexibility because it is an easier framework for beginning developers to use because you can rapidly build a web application. Last time, Flask offered the jinja2 template engine to build websites for model interaction [12][13].

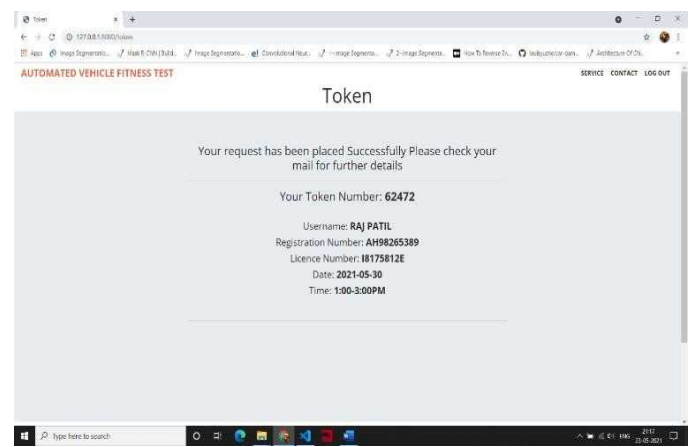


**Fig 9. Uploading the car image**

Figure 8 shows the prediction in inference mode. This is possible through train data and test data. Figure 9 shows the picture of the broken car has been uploaded. Then the booking slot and inspection of the vehicle. It is expected that there will be many benefits for both the insurance company and the car owner. This is done through Figure 10. This process will take much less time by uploading pictures of the damage or breaking of a vehicle and how much percentage of it has been damaged or broken.



**Fig 10. Booking slot for the inspection**



**Fig 11. Token For further inspection.**

According to the suggested system, the owner of the vehicle will register on a webapp, submit a photo, and our model will assess the accuracy of the damage and display the results appropriately [20].

## V. CONCLUSION

In this paper, we proposed a deep learning-based solution for the vehicle inspection centre where, as required by regulation, you must have your vehicle's fitness test completed, but where there was only one centre per district, creating a lot of congestion at the centre and requiring all vehicle owners to go through this stressful process, we came to the conclusion that it was necessary to develop such a model which will automate this damage inspection process and compatibility of the model allows to integrate.

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