QBurst

Simplifying
Tire Inspections

USING MACHINE LEARNING

Project Overview

As a critical component for vehicle performance and stability, automobile manufacturers implement specialized inspection processes to ensure the integrity and quality of tires. Frequent quality checks on aspects such as tread depth, sidewall texture, and rigidity help determine the quality of a tire. The tire inspection system enables tread depth measurement using a mobile application. A deep learning model based on Convolutional Neural Network (CNN) was implemented and trained on thousands of images. Deep learning and traditional computer vision approaches were used to develop a custom CNN architecture that rendered the desired accuracy in tread depth measurement.

About the Client

Headquartered in Germany, our client is the research and development center for the world's largest manufacturer of premium and commercial vehicles. The center focuses on research, IT engineering, and product development.

Business Requirement

Automation of tire tread depth measurement process using images captured by a mobile device. The solution would replace the time-consuming manual inspections process currently in place.

The application needed to:

- Detect tread depth using images of the tire surface
- Replace manual inspections with automated quality inspections

Solution

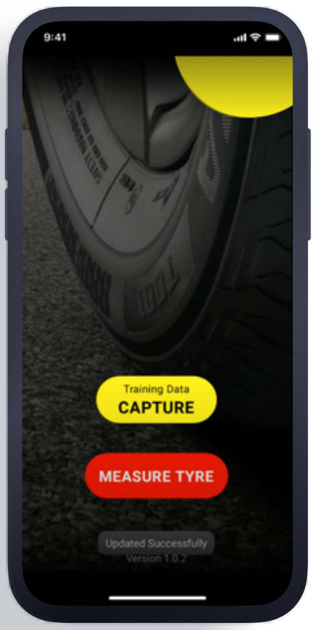
The solution measures the depth of tire treads using image processing for edge detection. Our data scientists trained the deep neural network to predict the relative depth of tires based on reference images. This proven approach in estimating measurements using a neural network helped implement a deep regression network.

CNNs are the preferred deep learning architecture used while working with image data. Measurement of tire depth requires fitting a deep regression model using state of the art variations of the CNN architecture. A combination of networks were explored to calculate depth and identify tread patterns.

We implemented a multi-stage model that detects tire tread depth from an image that displays 60 percent of the tire surface.

- **Tire Mask Model:** The first stage marks the tire boundary, separating the tire surface from images.
- **Groove Mask Model:** The second stage marks the groove boundary, separating the groove areas from the tire surface.
- **Groove Depth Model:** The third stage involves a depth model trained with relative depth maps that are created using the original images and output from the first two models. This model detects the distance to the inner points of the groove relative to the tire surface.

The model was trained on a dataset of over 50,000 images that contained variations of tread patterns and lighting conditions.



Highlights

- Custom CNN architecture development for depth detection using established architectures such as UNet and DenseNet as base
- Proved the concept of high-quality monocular image depth detection on minute relative distances (in the range of millimeters)
- Accuracy level of +/-1.5 mm on 90% of independent test images
- Ability to reject images due to reasons such as insufficient tire surface, overexposure, and poor quality

Technologies

- TensorFlow
- Pytorch
- Numpy
- Python
- Django

Benefits

- Automation resulted in reduced manual intervention and increased efficiency, with a renewed focus on productivity and product design
- 66% increase in accuracy and low defect rates resulted in reduced warranty claims and improved quality
- Preventive maintenance enabled by real-time tire analysis and monitoring
- Improved vehicle safety without requiring specialized operator training

QBurst

USA | UK | UAE | INDIA | SINGAPORE | AUSTRALIA | JAPAN

www.qburst.com | info@qburst.com