Literature Review

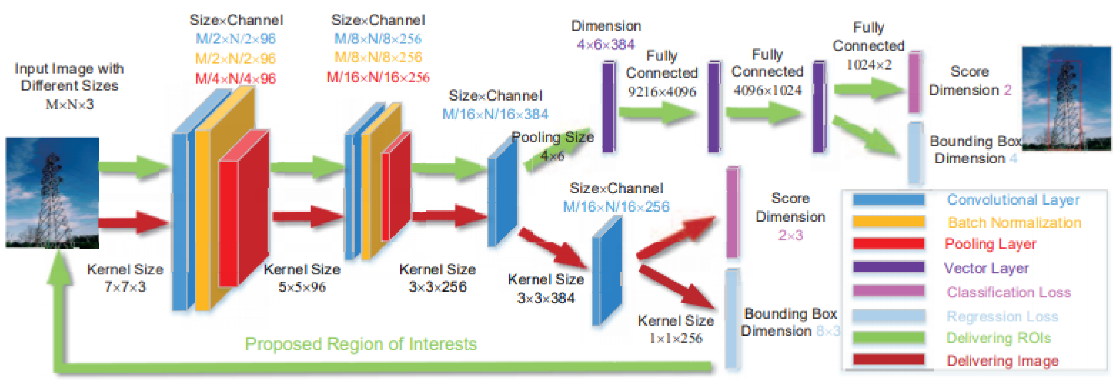
Paper: 1

A Novel Monocular-based Navigation Approach for UAV Autonomous Transmission-line Inspection

The paper implies their main approach is to provide great flexibility for refined inspection and effectively improves inspection safety. In the whole system in a real-world transmission-line inspection scenario under different weather condition and achieve an encouraging result

Problem statements:

1. To locate the effective landmark – transmission tower timely and reliably, they customize a neural network for tower detection and combine it with a fast and smooth tracking.
2. To provide UAV with a robust and precise heading, to detect the transmission lines and compute and optimize their vanishing point.
3. To keep a safe distance from transmission lines, they optimize a homography matrix to restore the parallel nature of transmission lines and perceive the distance variation by a point set registration model.



The tower is regarded as a landmark and robustly located by a customized DL-based Tower R-CNN. Vanishing Point of Power Transmission Lines is calculated and optimized by the Levenberg-Marquardt algorithm used.

Detection Method	Average Precision	Frame Per Second
Faster R-CNN (VGG16)	89.6%	0.8
Faster R-CNN (ZF)	89.5%	2

SSD300	88.9%	6
SSD512	89.2%	2
YOLOv2	86.8%	5.6
Tower R-CNN	89.6%	5

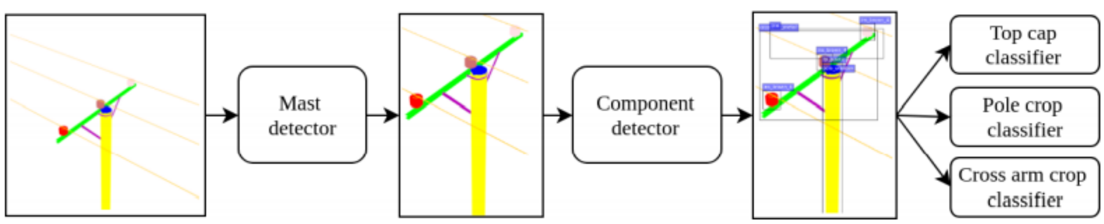
Paper: 2

Intelligent Monitoring and Inspection of Power Line Components Powered by UAVs and Deep Learning

This paper presents a novel automatic autonomous vision based power line inspection system that uses UAV inspection as the main inspection method, optical images as the primary data source, and deep learning as the backbone of the data analysis.

Problem statements:

1. The lack of training data
2. Class imbalance
3. The detection of small components and faults.



Methodology used:

They build their own dataset for training component detection and classification models. And then applied the data augmentation techniques to balance out the imbalanced classes. Finally, they propose multi-stage component detection and classification based on Single Shot Multibox detector(SSMD) and deep Residual Networks (D-ResNet) to detect small components and faults. The model shows the defects on power line components including missing top caps, cracks in poles and cross arms, woodpecker damage on poles, and rot damage on cross arms.

Compared with simple SSD detectors and ResNet50 classifiers, the proposed pipeline with data augmentation achieves 1.2% improvement in terms of mAP on the component detection task; using augmented data to balance out the imbalanced classes improves score in the pole crop classification and cross arm crop classification tasks by 8.7% and 2% respectively.

Paper: 3

Unmanned aerial vehicle vision-based detection of powerline poles by cpu-based Deep learning method

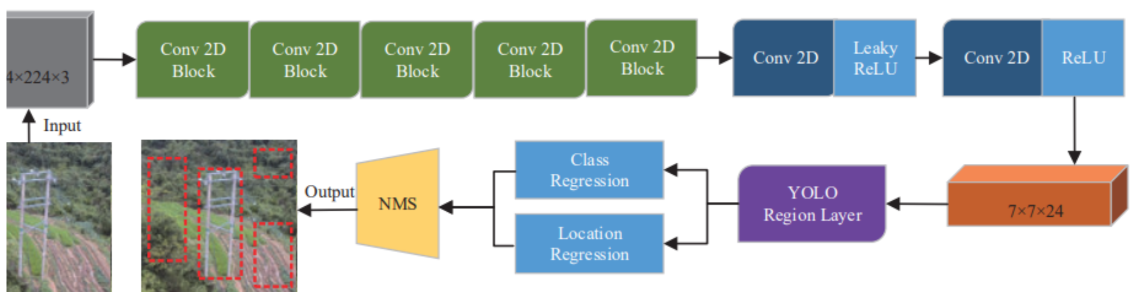
Methodology used :

Yolo-lite, for images recognition HOG algorithm

In this paper they presented the detection model for abnormal line poles from the UAV vision data.

This process they divided into two parts:

1. Generating boxes of poles based on the yolo-lite model.
2. Filter the background boxes based on classification of spatial pyramid pooling model structure.



This model achieves a detection precision of 75.80%, an increase of 26.85% compare to the yolo-lite model alone. The combined poles detection for processing video streaming on a cpu-only computer.

Paper 04:

Automated Inspection of Monopole Tower using Drones and Computer Vision.

In this paper they approach the rust and crack detection formed in monopole towers and also estimate its length and breadth. This paper lies in the real time detection of cracks and saving the altitude for further rectification. Also, edge identification allowed for greater distinction. As a result they successfully detected black, brown, red and yellow rust using tensorflow with 90% accuracy.

For image processing they used openCV for integrating ROS and analyzing images in real time. For crack detection, Haar cascade classifier is used and computer vision is for rust detection.

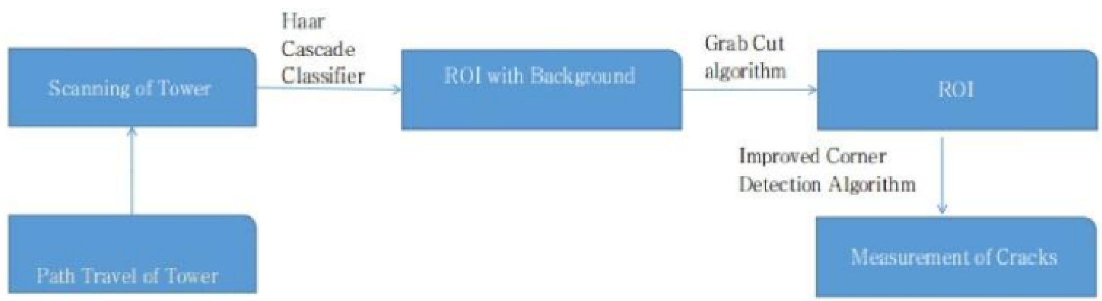
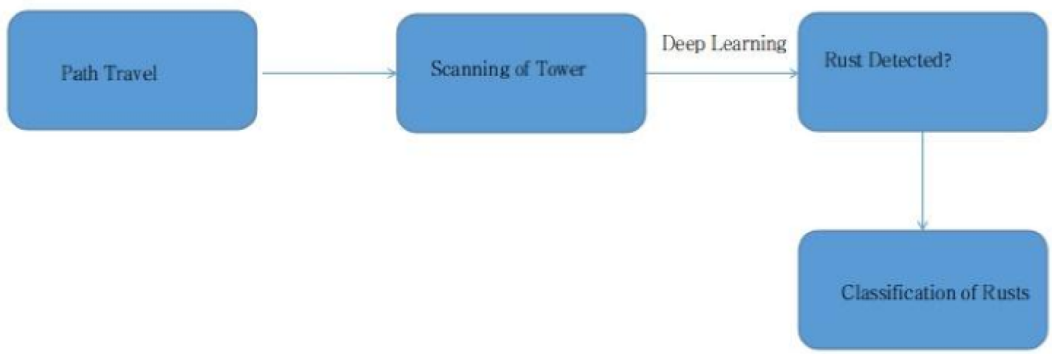


Figure 4.1. Crack detection system



In the results this system measures the detected cracks, and classifies the types of rusts found using Deep Learning Techniques.

Paper 05:

Development of UAV System for Autonomous Power Line Inspection.

The objective of this paper is a new UAV system for autonomous inspection of electrical energy transmission and distribution networks. The hardware and software configurations, as well as the inspection concept realized into the developed quadrotor helicopter based system were briefly reported. The developed GUI allows easily and safely to set the inspection plan.

In results full inspection of the transmission lines together with towers could be automatically performed. In the autonomous inspection presented in this paper it can be successfully positioned at some lateral offset to allow image acquisition of both sides of the wires.

Methodologies used in this paper are Computer vision techniques for transmission towers recognition, for detection of power transmission lines based on Pulse-Coupled Neural Network.

Paper 06:

High-Voltage Power Transmission Tower Detection Based on Faster R-CNN and YOLO-V3.

Automatic detection and classification of the power towers is the prerequisite for automatic inspection. Automatic inspection by robots or UAVs for the power transmission infrastructures is an essential way to ensure the safety of power transmission.

In this paper they compare two state-of-art deep learning methods to realize the high-voltage power transmission tower detection. dataset of the power towers for multi-object detection, including data collection, preprocessing and annotation is customised.

The models of YOLO-v3 and Faster R-CNN are used to solve multi-object detection on the collected dataset. The performances of the two models are evaluated under different indicators. It is verified that Faster R-CNN has a better detection performance in accuracy. However, the detection speed of the YOLO-V3 model is faster and can be used in real-time detection. Used Matlab to expand and enhance the dataset.

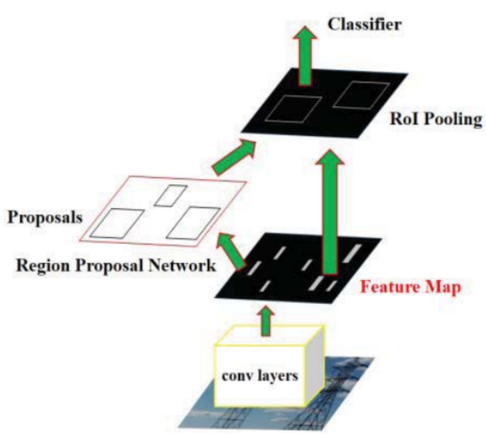


Fig. 3: The structure of Faster R-CNN

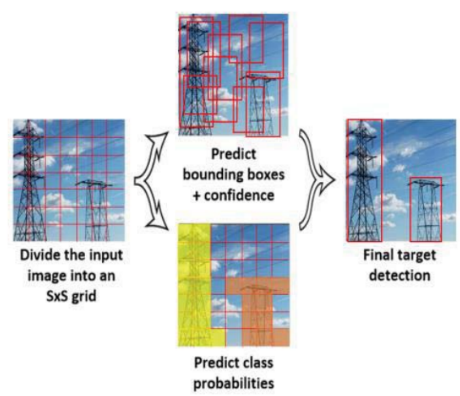


Fig. 4: The method of YOLO detection

Table 2: Confusion matrix of Faster R-CNN model

Predicted class \ Actual class	Drum shape	Umbrella shape	Wineglass shape	Cathead shape
Drum shape(%)	100	0	0	0
Umbrella shape(%)	0	100	0	0
Wineglass shape(%)	0	0	94	4
Cathead shape(%)	0	0	6	96

Table 3: Confusion matrix of YOLO-V3 model

Predicted class \ Actual class	Drum shape	Umbrella shape	Wineglass shape	Cathead shape
Drum shape(%)	96	2	2	2
Umbrella shape(%)	4	98	2	0
Wineglass shape(%)	0	0	88	6
Cathead shape(%)	0	0	8	92

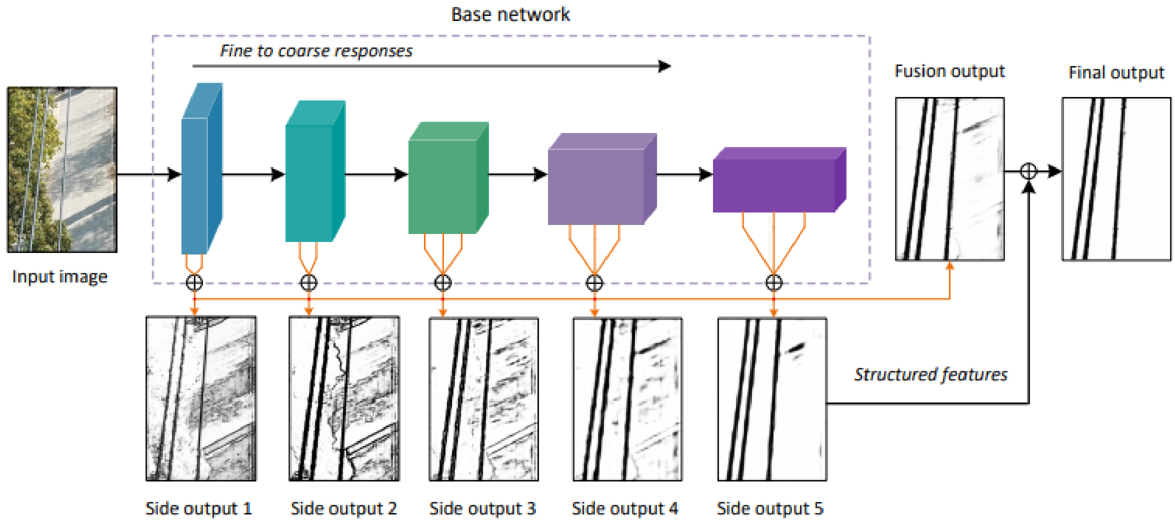
Table 1: Detection Indicators of Two Models

Model Types \ Detection indicators	Average IoU	Average time （s）
Faster R-CNN	0.882	2.136
YOLO-V3	0.874	0.0215

Paper 07

Combined convolutional and structured features for power line detection in UAV images.

Power line detection plays an important role in automated UAV inspection systems, which is crucial for real-time motion planning and navigation along power lines. To overcome from traditional filters and gradients may fail to capture complete power lines due to noisy backgrounds. This method develops an accurate power line detection method using rich convolutional and structured features.



In this paper, it accomplishes deep supervised neural networks and structured features, for accurate power line detection from UAV images.they used customized two datasets with pixel-level annotations for evaluation. Leveraging hierarchical and structured features, the method produces both accurate and efficient results, which makes it possible to be applied in practice on UAV onboard platforms.
Datasets : https://github.com/SnorkerHeng/PLD-UAV

Table 1. The comparison with baselines on two datasets

Method	PLDU		PLDM	
	ODS	OIS	ODS	OIS
Ours	**0.914**	**0.938**	**0.888**	**0.902**
RCF	0.907	0.931	0.865	0.893
SE	0.850	0.898	0.351	0.340
Gestalt Grouping	0.629	0.629	0.808	0.808
LSD	0.593	0.593	0.796	0.796
Crisp	0.535	0.622	0.641	0.752
Canny	0.466	0.643	0.796	0.866

Paper 08

Power Transmission Lines Inspection using Properly Equipped Unmanned Aerial Vehicle (UAV)

This paper focuses on providing an automated way for fault detection at the Hellenic Electricity Distribution Network that will help on the network maintenance, especially in areas that are not easily accessible by humans.This task can be performed in a low-cost way using unmanned aircrafts

They examine the effectiveness of using basic image processing methods on image data of the power lines acquired by an unmanned aerial vehicle (UAV).
Two methodologies are proposed

1. Power transmission lines detection using Hough transform
2. Regions of Interest Definition using Image information

Both proposed methodologies were tested in real-world cases, with the image background in each case to be characterized by non-uniform texture, i.e. the natural terrain is rugged at some locations, wooded land at some other or it is road that appears at the same hue as the aerial power lines.

In the result successful detection of the power lines before and after the discontinuity of the power line. The accuracy of the power line detection and the processing time are close to expectations. The proposed work offers a robust and low-cost way for the inspection of power transmission lines and so an effective way to detect the location where a cable fault has occurred.

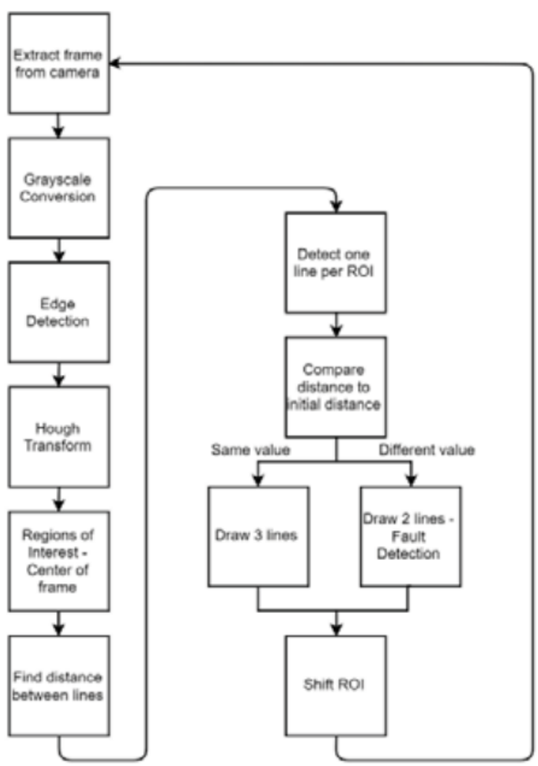


Fig. 6. Block Diagram of the power lines fault detection procedure using the Hough table values.

Paper 09

Image Acquisition of Power Line Transmission Towers Using UAV and Deep Learning Technique for Insulators Localization and Recognition.

This paper presents research results about autonomous inspection of power transmission towers and insulators using unmanned aerial vehicles (UAV). the proposed approaches for image acquisition of power line insulators

The process of acquiring the insulator image consists of following steps:

1. Acquire an image of an insulator and respectively calculate its center of gravity.
2. Control the quadrotor position in a way that the center of gravity of every insulator comes in the center of the image to be taken.
3. Correct the focus and zoom of the camera to acquire image with maximal possible resolution.

In this paper used methodologies areYOLO (You Only Look Once) system for detecting and recognizing the towers and the insulators. It is based on CNN and is using a single neural network for prediction. YOLO has simple construction and very good real-time performance for object detection. Compared to Fast R-CNN, YOLO has much higher detection accuracy and YOLO is “more than 1 000× faster than R-CNN.

The results show that the proposed scheme is applicable but there is a need to do some improvements concerning proper recognition in complicated backgrounds.

Paper 10

Research on Details Enhancement Method of UAV Inspection Image for Overhead Transmission Line.

In this paper they focused on the problem of poor processing effect of man-machine inspection image details. Purpose of this paper is a method for enhancing the details of aerial transmission line unmanned aerial vehicle inspection images.

By collecting and calculating the characteristic parameters of the UAV patrol image, the regional gray level and the optimal gain function value of the image are obtained. This paper is purely based on the principle of neural networks.

Results:

Multidimensional image data	File name	File size	After compression File size	Compression ratio
Image background test data	2#_w w1.0	158k	1068k	96.7%

Pixel test data	dat 02003.	23k	1085	68.9%
Dimension test data test data	0 dat 11& bh 12.0da t	247k	1098k	60.5%

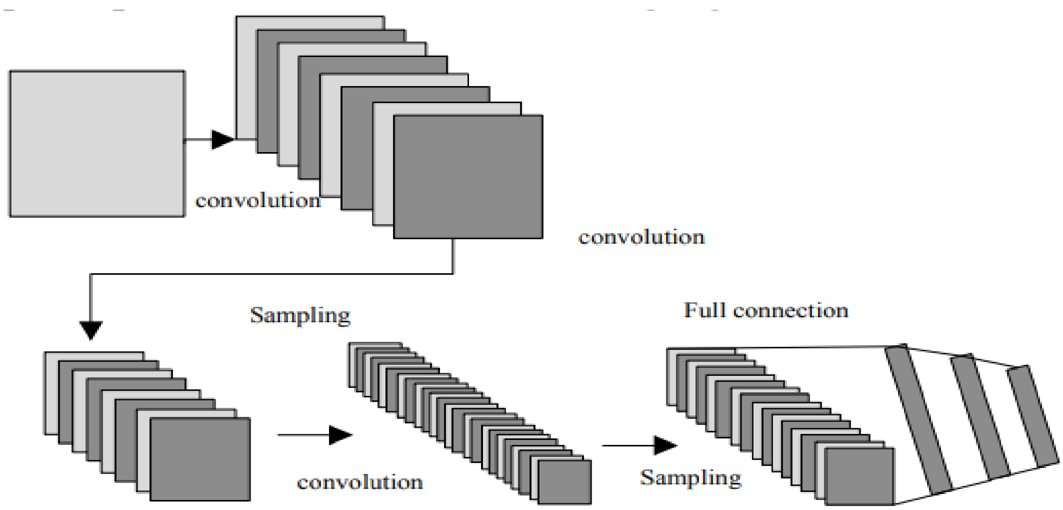


Fig. 1 principle of neural network information