Detection of asphalt roads degradation using Deep Learning applied to Unmanned Aerial Vehicle imagery

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Introduction

- Road infrastructures are a factor in the economic and social development.
- Good quality bituminous pavements contribute to the safety and comfort of road users.
- Pavements are subject to deterioration due to wear and tear, poor operation or poor quality of work.
- Road preliminary evaluation is tedious, slow and costly, especially when large sections of road are to be inspected.
- **Objectives:** to propose a Deep Learning approach based on drone imagery for the detection of asphalt road deterioration.

Materials and method

1. Forms of pavement damage

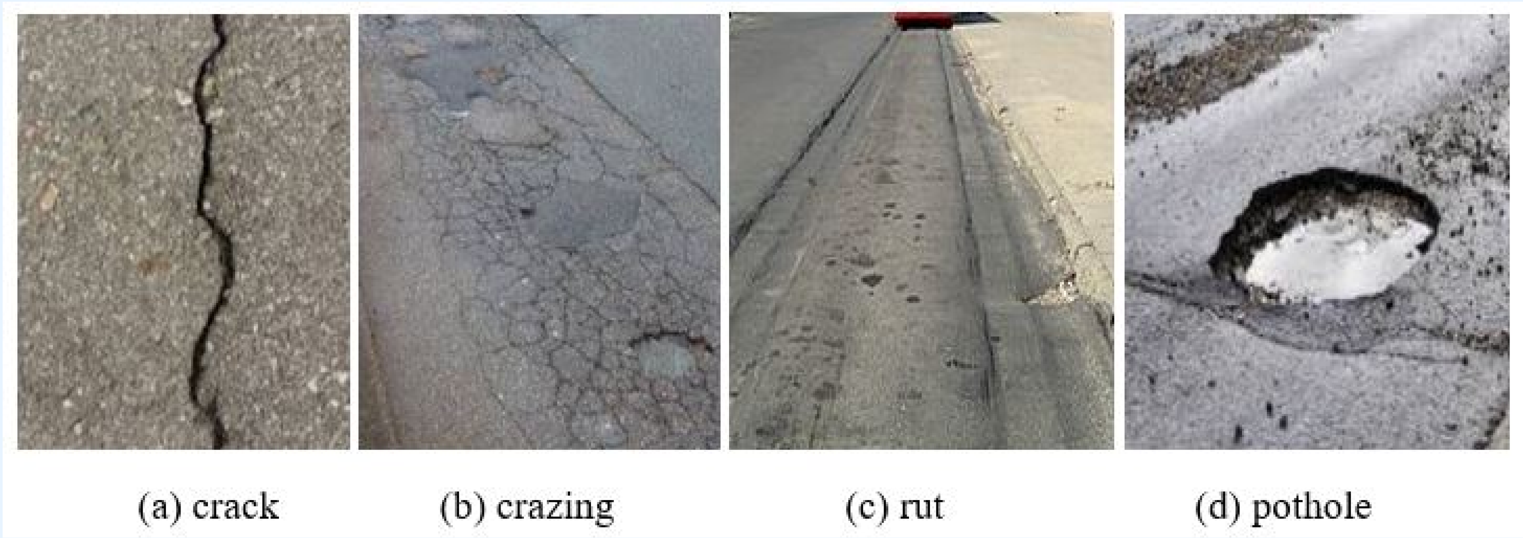

Figure 1. Distress typ

This study deals with the detection of surface distresses classified into three groups:
- **cracking** as evidenced by cracks and crazing;
- **pavement deformation** as evidenced by ruts;
- **pothole tearing:** pothole.

. These forms of deterioration are the most frequent on the road network.

2. Method

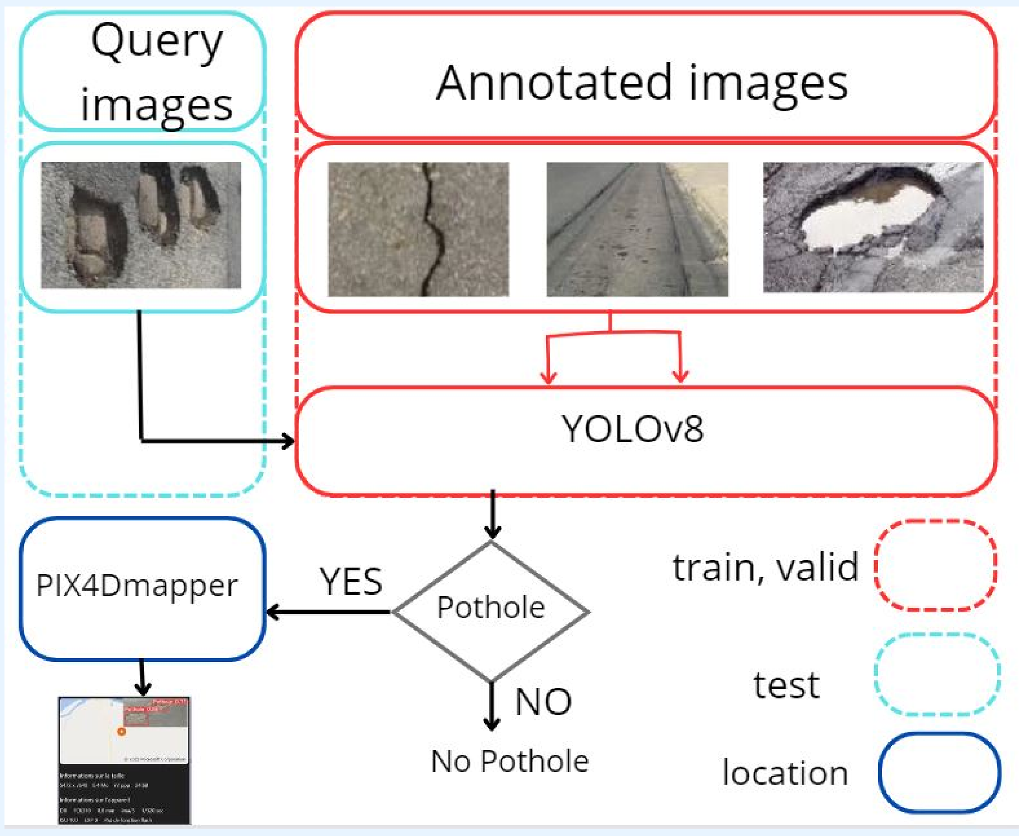

Figure 2. Method algorithm

The method proposed in this work is an approach to detect, count and locate pavement degradations. It includes the collection of images, the processing (annotation, training and detection) and the positioning of the damage.

3. Materials and tools

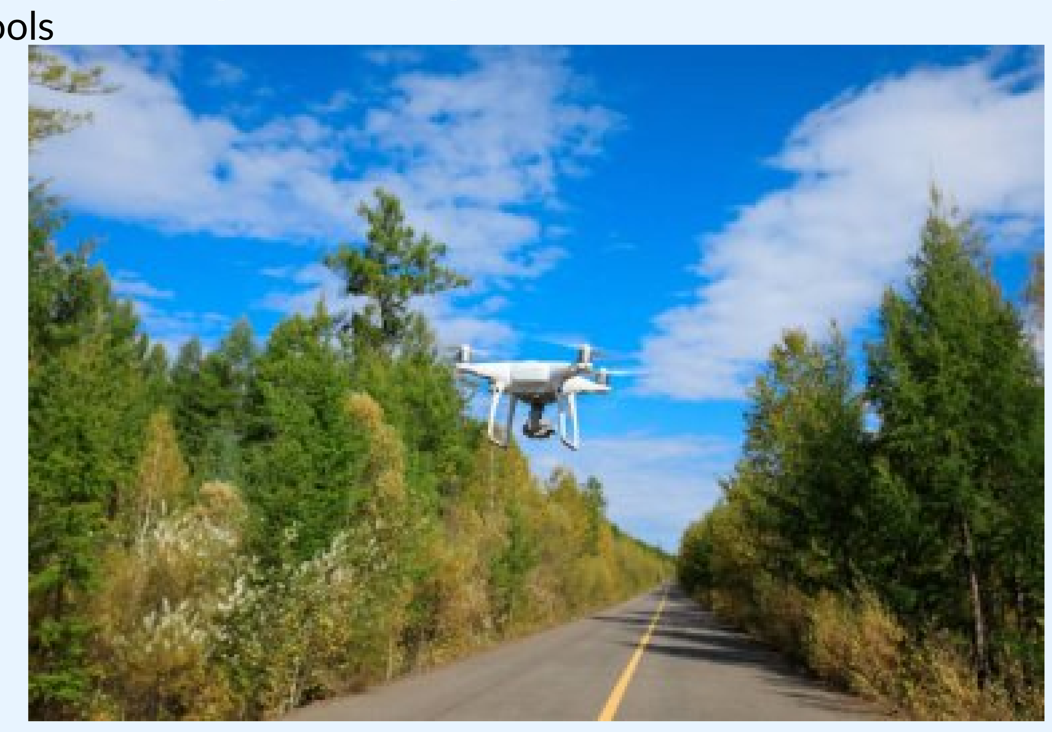

Figure 3. UAV collecting data

- **DJI Phantom 4 RTK UAV:** data collection;
- **YOLOv8:** model for train, validation and ;
- **HP EtestliteBook Intel(R) Core(TM) I7-7600U, CPU @ 2.8GHz 2.9GHz with 16GB of RAM**;
- **Python3 under the Google Colab Notebook**;
- **Pix4Dmapper 4.7.5 software:** localize the degradations.

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4. Dataset

The model was trained and tested on an image database consisting of a set of 9240 pavement images distributed as follows:
- **6091 images for training** ;
- **2094 images for validation**;
- **1055 test images**.
- **The images are annotated with Roboflow and a part of the dataset (train, valid) has been provided in open access by the Roboflow platform.**
- **The images collected by the drone are used to test the detection.**

Results

The pre-trained weight yolov8x was used for training, validation and testing of the model due to its performance.

1. Train and validation

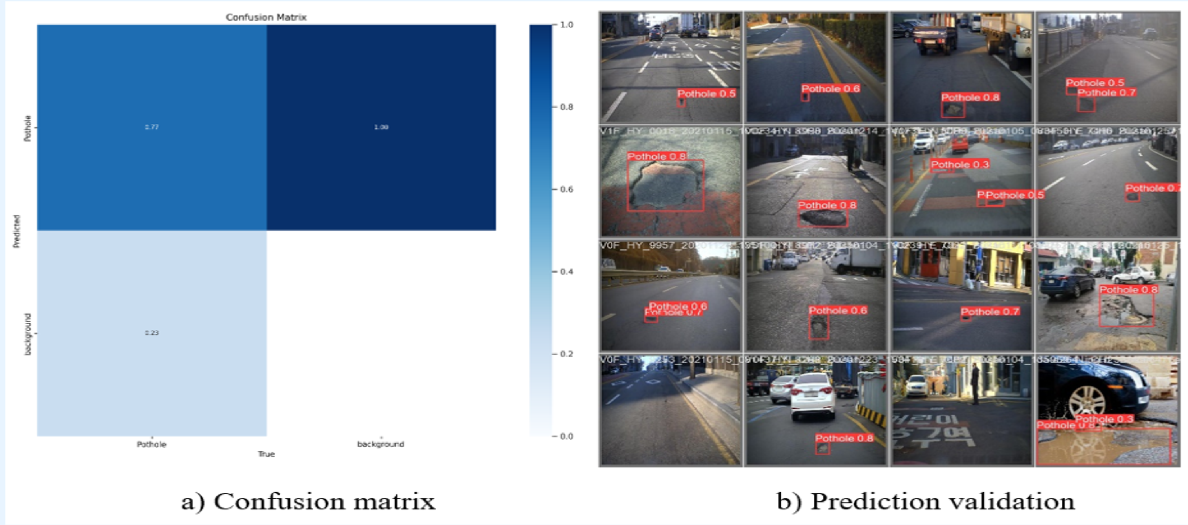


Figure 4. Train and validation results

- The number of epochs was set to 100 and the image size to 1280 for training.
- The model detected each drone image at a speed of 1.3 ms.

2. Detection test

Figure 5. Detection results

- The four forms of degradation are detected with a confidence threshold varying between 0.25 and 0.98.
- The metrics used to evaluate the performance of our model were computed by Roboflow 100 and are: mean accuracy (mAP), precision, recall and F1 score. The model performance are showed in table below:

mAP	Precision	Recall	F1 score
84.4%	86.7%	78.8%	82.5%

Table 1. Performance table

- These rates show a good performance of the model.
- The results are satisfactory in spite of some cases of false negatives observed on roads with an advanced level of deterioration.

3. Location of degradations

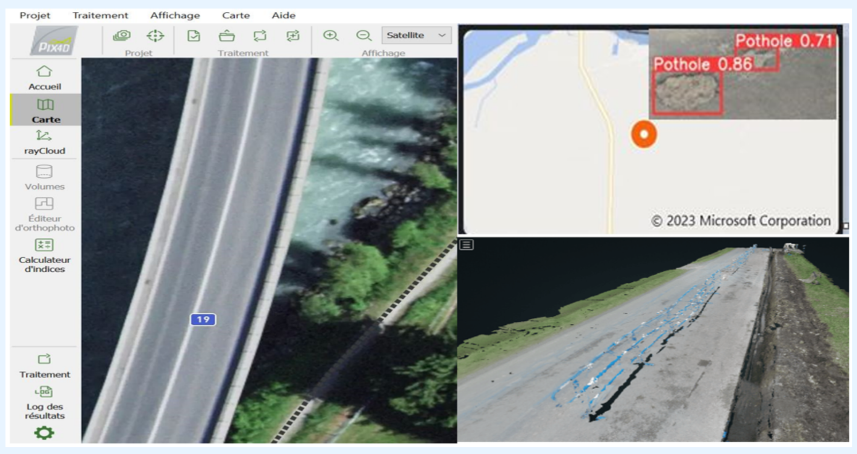
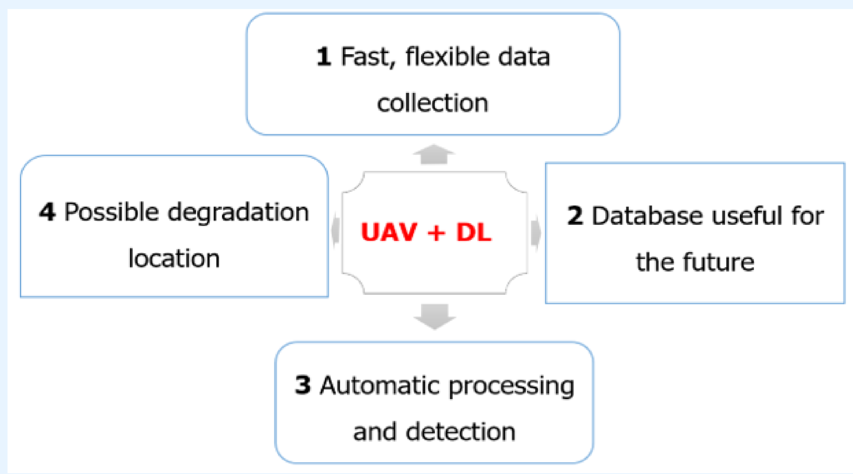


Figure 6. GeoTiff result

The coordinates of the location of the degradation area are given with enough precision after the alignment of the images in GeoTiff format.

Conclusion



This work boosts road condition inspection resources.

References

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[2] Schnebele, E. Tanyu, B. F. Cervone, G. Waters, N. (2015) Review of remote sensing methodologies for pavement management and assessment. *Springer* **7**:1–19.

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