**Libraries Used in Road Defect Detection Project**

This document summarizes all Python libraries used in the road defect detection project, categorized by their functionality, with brief descriptions of each.

### 1. Core Python Libraries

* **os**: For interacting with the operating system, file and directory management.
* **shutil**: For copying and moving files and directories.
* **re**: For regular expression operations.
* **csv**: For reading and writing CSV files manually.
* **random**: For generating random numbers (used in image coloring, augmentation, etc.).
* **glob**: For finding file paths matching a specified pattern.
* **collections.defaultdict**: For handling dictionaries with default types like int or list.

### 2. Data Handling and Analysis

* **pandas**: Used for reading, writing, and manipulating CSV data; powerful DataFrame structure for summarizing and cleaning data.
* **numpy**: Used for numerical operations, arrays, and tensor conversions.

### 3. Computer Vision

* **cv2 (OpenCV)**: Used to read, process, and write image files. Also used for drawing bounding boxes and adding text on images.

### 4. Deep Learning and Object Detection

* **torch**: Core PyTorch library for loading and running deep learning models.
* **ultralytics**: Contains the YOLO models (YOLOv5, YOLOv8, etc.); used to load and run YOLO(model\_path) for inference.

### 5. Optical Character Recognition (OCR)

* **pytesseract**: Python wrapper for Google’s Tesseract-OCR engine. Used for extracting GPS and other text from image frames.

### 6. Mapping and Geolocation Visualization

* **folium**: Used to create interactive Leaflet-based maps from data stored in CSV files. Shows defects on satellite or street maps with location popups.

### 7. Notebook Display Utilities

* **IPython.display.IFrame**: Used to embed HTML maps (e.g., generated by Folium) inside Jupyter Notebooks.

### 8. (Optional/Future) Useful Utilities

* **pathlib.Path** *(optional)*: Better, object-oriented way to manage file paths. Can replace os.path.
* **tqdm** *(optional)*: Shows progress bars during long processing tasks like iterating over frames.

### Installation Instructions

To install all necessary libraries in one go, use:

pip install pandas numpy opencv-python torch torchvision torchaudio ultralytics pytesseract folium tqdm

This list and setup ensure your project is reproducible and that all dependencies are clearly documented for others or for deployment.