### 1. **Objective**

Develop an automated system to identify and classify images captured by cameras that are affected by visual obstructions like dirt, fog, stickers, or smudges. The system should process images, detect obstructions, classify them, and generate a report in Excel format for further analysis and action.

### 2. **Process Overview**

The pipeline consists of the following key stages:

1. **Image Acquisition**: Collect images from various camera sources.
2. **Preprocessing**: Standardize and prepare images for analysis.
3. **Obstruction Detection**: Analyze images to detect and classify obstructions.
4. **Result Compilation**: Aggregate results and generate reports.
5. **Reporting**: Export findings to an Excel file for stakeholder review.

### 3. **Detailed Process Flow**

#### Step 1: Image Acquisition

* **Input**: Images captured from surveillance or operational cameras.
* **Process**:
  + Automate the collection of images at regular intervals.
  + Store images in a centralized repository for processing.
* **Output**: Batch of images ready for preprocessing.

#### Step 2: Preprocessing

* **Input**: Raw images from the acquisition step.
* **Process**:
  + Resize images to a uniform dimension (e.g., 224x224 pixels).
  + Normalize pixel values to standardize image data.
  + Apply noise reduction techniques to enhance image quality.
* **Output**: Preprocessed images suitable for analysis.

#### Step 3: Obstruction Detection

* **Input**: Preprocessed images.
* **Process**:
  + Utilize a trained Convolutional Neural Network (CNN) model to analyze images.
  + Classify each image into categories: 'Clear', 'Dirty', 'Foggy', 'Sticker/Smudge'.
  + Assign a confidence score to each classification.
* **Output**: Classification results with confidence scores for each image.

#### Step 4: Result Compilation

* **Input**: Classification results.
* **Process**:
  + Aggregate results into a structured format.
  + Include metadata such as image filename, timestamp, and camera ID.
* **Output**: Structured data ready for reporting.

#### Step 5: Reporting

* **Input**: Compiled results.
* **Process**:
  + Export data to an Excel file with appropriate formatting.
  + Include filters and summaries for ease of analysis.
* **Output**: Excel report distributed to stakeholders.

### 5. **Tools and Technologies**

* **Programming Language**: Python
* **Libraries**:
  + OpenCV: Image processing
  + TensorFlow/Keras: Model development
  + Pandas: Data manipulation and Excel export
* **Infrastructure**:
  + Centralized storage for images
  + Computing resources for model inference

### 6. **Appendix**

**Sample Excel Report Structure**:

| **Image Filename** | **Timestamp** | **Camera ID** | **Classification** | **Confidence Score** |
| --- | --- | --- | --- | --- |
| cam1\_20250519.jpg | 2025-05-19 10:00:00 | CAM001 | Foggy | 0.92 |
| cam2\_20250519.jpg | 2025-05-19 10:05:00 | CAM002 | Dirty | 0.88 |