

## Aerospace and Automotive Industry

### Introduction

The API `/virtualbot/analysis_image_report/` can be adapted for the Aerospace and Automotive Industry, providing an efficient tool for inspecting parts, detecting defects in components, and ensuring quality in manufacturing processes. By analyzing images of mechanical or structural parts, the API can identify cracks, deformations, and other critical defects before assembly, contributing to safety and efficiency in the production of aircraft and vehicles. It is important to note that the API does not store images or any sensitive data, ensuring confidentiality and security of industrial information.

### Functionality of the API `/virtualbot/analysis_image_report/`

Endpoint: POST `/virtualbot/analysis_image_report/`

#### Input Parameters:

1. Component Images: A .zip file containing images of the parts or components to be inspected (which may include X-ray images, industrial tomographies, high-resolution images, etc.).
2. Part or Component Data: Basic information in JSON format that may include:
  - Part Name or Identifier
  - Material Type
  - Technical Specifications
  - Manufacturing History (if available)
3. User Instructions: A JSON specifying the type of analysis requested for the images. For example, detect cracks, porosities, deformations, corrosion, etc.

Example Request:

```
{  
  "user": "engineer@aeroindustrias.com",  
  "type": "quality_inspection",  
  "analysis": "Analyze the images to detect cracks or defects in the metal alloys of the parts."  
}
```

#### Process:

1. The API receives the .zip file with the images and part data.
2. It uses the provided information to contextualize the analysis.
3. It analyzes each image to:
  - Detect cracks, fissures, or microfissures in materials.
  - Identify deformations, porosities, inclusions, or structural defects.
  - Evaluate conformity with technical specifications.
4. It generates a detailed report of the findings in each image.
5. It provides recommendations based on the findings, such as rejecting the part, repairing it, or subjecting it to additional treatments.

**Output:**

A report in JSON format detailing the findings for each image and offering recommendations for quality control and the manufacturing process.

Example JSON Response:

```
{
  "report": {
    "part_1": {
      "findings": "A longitudinal crack of 2 mm is detected on the inner surface of the component.",
      "conclusions": [
        "The crack exceeds the tolerable limits according to technical specifications.",
        "The component does not meet the required quality standards."
      ],
      "recommendations": [
        "Reject the part and remove it from the assembly process.",
        "Investigate possible causes in the manufacturing process to prevent recurrence."
      ]
    },
    "part_2": {
      "findings": "No significant defects detected; the component meets the specifications.",
      "conclusions": [
        "The part is suitable for assembly."
      ],
      "recommendations": [
        "Proceed with the assembly process."
      ]
    }
  }
}
```

**Applications in the Aerospace and Automotive Industry****1. Quality Inspection of Mechanical or Structural Parts in Aircraft and Vehicles**

- Description: The API can analyze images of critical components, such as engine parts, wings, fuselages, chassis, and other structural elements, to detect defects that could compromise safety and functionality.

- Benefit: Ensures that only parts meeting the highest quality standards are used, reducing risks and improving the reliability of products.

**2. Detection of Cracks, Deformations, or Defects in Critical Components Before Assembly**

- Description: Through detailed image analysis, the API identifies defects such as cracks, porosities, deformations, or corrosion that are not visible to the naked eye.

- Benefit: Allows early detection of defects, avoiding costly reworks, service failures, and ensuring the safety of the final product.

### 3. Optimization of Quality Control in Production

- Description: By automating image analysis, the API streamlines the quality control process, allowing for faster and more accurate inspections.

- Benefit: Increases production efficiency, reduces inspection times, and frees human resources for more specialized tasks.

### 4. Materials and Welding Analysis

- Description: The API can evaluate the integrity of composite materials, alloys, and welds, detecting internal imperfections and ensuring the strength and durability of components.

- Benefit: Improves the quality of assemblies and structures, prolonging the lifespan of products and reducing premature failures.

## Practical Examples of API Usage

### Example 1: Inspection of Engine Parts in the Automotive Industry

Request:

- Instructions: "Analyze the images of the engine parts to detect possible defects in the pistons and connecting rods."

Part Data:

```
{  
  "part": "Piston Model X",  
  "material": "Aluminum alloy",  
  "specifications": "Dimensions and tolerances according to ISO standard 1234"  
}
```

API Response:

```
{  
  "report": {  
    "piston_1": {  
      "findings": "Porosity is detected on the side surface of the piston.",  
      "conclusions": [  
        "The porosity may affect the piston's strength under operational loads.",  
        "The component does not meet quality specifications."  
      ],  
      "recommendations": [  
        "Replace the piston with one that meets the standards.",  
        "Review the casting process to correct the source of the porosity."  
      ]  
    }  
  }  
}
```

```
}
```

## Example 2: Detection of Defects in Wing Panels in the Aerospace Industry

Request:

- Instructions: "Analyze the X-ray images of the wing panels to identify possible delaminations or inclusions in the composite material."

Part Data:

```
{  
  "part": "Wing Panel Model A320",  
  "material": "Carbon fiber",  
  "specifications": "ASTM D1234 standard for composite materials"  
}
```

API Response:

```
{  
  "report": {  
    "wing_panel_1": {  
      "findings": "A delamination of 5 cm² is detected in the central section of the panel.",  
      "conclusions": [  
        "The delamination compromises the structural integrity of the panel.",  
        "It is not suitable for use in assembly."  
      ],  
      "recommendations": [  
        "Repair the panel following approved procedures.",  
        "Conduct an additional inspection after the repair."  
      ]  
    }  
  }  
}
```

## Advantages of Using the API in the Aerospace and Automotive Industry

### 1. Improved Quality and Safety

- Description: Detects defects that may go unnoticed, ensuring that only high-quality components are used.
- Benefit: Increases the reliability and safety of aircraft and vehicles, reducing the risk of service failures.

### 2. Operational Efficiency

- Description: Automates inspection and analysis processes, reducing the time and effort required.

- Benefit: Optimizes production, decreases operational costs, and enhances competitiveness.

### 3. Reduction of Costs Due to Rework and Warranty Claims

- Description: Identifies defects before assembly, avoiding costs associated with rework, repairs, and warranty claims.

- Benefit: Improves profitability and customer satisfaction by delivering high-quality products.

### 4. Regulatory Compliance

- Description: Helps meet international quality standards and regulations, such as ISO, ASTM, SAE, among others.

- Benefit: Avoids penalties, ensures acceptance in global markets, and strengthens the company's reputation.

### 5. Flexibility and Adaptability

- Description: The API can adapt to different types of components, materials, and specific requirements of each industry.

- Benefit: Provides a versatile solution that can be integrated into various processes and production lines.

### 6. Traceability and Documentation

- Description: Generates detailed reports that can be stored for auditing and follow-up purposes.

- Benefit: Facilitates the traceability of components and the identification of areas for improvement in processes.

## **Summary**

The API `/virtualbot/analysis_image_report/`, adapted for the Aerospace and Automotive Industry, offers an advanced solution for inspecting parts, detecting defects in components, and ensuring quality in manufacturing processes. By analyzing images of mechanical or structural parts, the API identifies cracks, deformations, and other critical defects before assembly, improving safety and efficiency in the production of aircraft and vehicles. Its implementation contributes to raising quality standards, optimizing processes, and reducing costs, strengthening companies' competitive position in the global market, all while ensuring confidentiality and security of information.