**Hand Keypoints Labeling - Documentation**

**Objective**

The objective of this task is to **detect and annotate hand keypoints** for all images in the dataset. The detected keypoints are:

1. **Drawn on images** and saved in a dedicated folder.
2. **Stored in a CSV file** containing normalized keypoint coordinates (X, Y, Z).

This dataset is essential for applications like **gesture recognition, sign language detection, human-computer interaction, and AI-based hand tracking**.

**Process Overview**

The workflow begins by reading all images from the dataset folder. The system scans for image files and loads them for processing. Any non-image files are ignored.

Once an image is loaded, the **MediaPipe Hands** model is applied to detect hand landmarks. The model can detect up to **two hands per image**, and it assigns an index to each detected hand.

Each hand is composed of **21 keypoints**, representing different parts of the fingers and palm. These keypoints are assigned **X, Y, and Z coordinates**, where:

* **X and Y** represent the position relative to the image size.
* **Z** provides depth information.

The detected keypoints are drawn on the image, forming a skeleton-like representation of the hand. These annotated images are saved separately for visualization.

The extracted keypoints are also stored in a CSV file, which includes the image filename, hand index, keypoint index, and normalized coordinate values. This structured format makes it easier to use the data for further analysis or machine learning training.

**Output**

The annotated images clearly display the detected keypoints, helping visualize the hand structure. Each detected keypoint is labeled and connected to its corresponding finger joints.

The CSV file stores the **hand keypoint data**, enabling numerical analysis or integration into machine learning models.

**🚀 How to Use This Workflow**

1️- **Ensure Dependencies are Installed**

* The system requires **MediaPipe** and **OpenCV** for processing.

2️- **Place Your Images in dataset\_test/ Folder**

* The dataset should contain images of hands in different poses.

3️- **Run the Keypoint Detection Script**

* The script processes each image and detects hand keypoints.

4️- **Check the Outputs**:

* **Annotated images** in dataset\_test\_keypoints/.
* **Hand keypoint data** in hand\_keypoints.csv.