## ****Project Report Structure****

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**Abstract**  
The quality of satellite images plays a critical role in a variety of applications such as environmental monitoring, disaster assessment, and urban planning. However, satellite images often suffer from low contrast, which limits the visibility of important features. This project proposes an edge-preserving contrast enhancement method for satellite images using a combination of **Discrete Wavelet Transform (DWT)**, **Adaptive Intensity Transformation**, and **Principal Component Analysis (PCA)**. The proposed method overcomes the drawbacks of traditional contrast enhancement techniques like histogram equalization, which often distort edge details. The process involves decomposing the image into multiple subbands using DWT, performing brightness analysis, applying intensity transformations on the subbands, and reconstructing the image using **Inverse DWT (IDWT)**. Finally, **PCA** is applied to reduce noise and improve clarity. The proposed approach preserves edge details while achieving effective contrast enhancement. The results demonstrate significant improvements in contrast and edge visibility when compared to conventional methods.

**Introduction**  
Satellite images are essential for a wide range of applications, including urban planning, environmental monitoring, and disaster response. However, due to environmental conditions, sensor limitations, and atmospheric interference, satellite images often suffer from poor contrast. Low contrast makes it difficult to identify objects and analyze the image effectively. Enhancing the contrast of satellite images is, therefore, a crucial task for image analysis.

Traditional image enhancement techniques like **Histogram Equalization (HE)** and **Adaptive Histogram Equalization (AHE)** attempt to improve contrast, but they often fail to preserve edge details, resulting in distorted images. This project addresses the problem using an edge-preserving contrast enhancement method based on **Discrete Wavelet Transform (DWT)**, **Adaptive Intensity Transformation**, and **Principal Component Analysis (PCA)**.

The proposed method decomposes the satellite image into subbands using **DWT**, and the LL subband is used for brightness level analysis. The image is divided into low-, middle-, and high-intensity layers. Each of these intensity layers undergoes contrast enhancement using a combination of the **Knee Transfer Function** and **Gamma Adjustment Function**. Finally, the image is reconstructed using **Inverse DWT (IDWT)**, and **PCA** is applied to reduce noise and sharpen image details. This method addresses the limitations of traditional techniques by enhancing the contrast while preserving edge details.

The following sections will present the problem statement, objectives, scope, methodology, and implementation details. This project aims to develop a tool that improves the visibility and interpretability of satellite images for critical applications like environmental analysis, vegetation mapping, and disaster response.

**Problem Statement**  
Satellite images are often degraded by poor contrast, caused by atmospheric interference, low illumination, and sensor limitations. This low contrast affects the visibility of key features and reduces the ability to perform accurate image analysis. Existing methods like **Histogram Equalization (HE)** and **Adaptive Histogram Equalization (AHE)** aim to improve contrast but frequently distort edge details, resulting in the loss of essential image information. Therefore, it is necessary to design an approach that enhances image contrast while preserving edges.

This project proposes an advanced method for **Edge-Preserving Contrast Enhancement** using **Discrete Wavelet Transform (DWT)**, **Adaptive Intensity Transformation**, and **Principal Component Analysis (PCA)**. The proposed method retains important image features, improves edge clarity, and enhances visibility, making it suitable for applications in **urban mapping**, **environmental monitoring**, and **disaster assessment**.

The main challenge in satellite image enhancement is to improve visibility without introducing noise or edge distortion. The goal of this project is to apply a **multi-layered image processing pipeline** to achieve optimal contrast enhancement.

**Objective**  
The main objective of this project is to develop a method to enhance the contrast of satellite images while preserving edge details. This will be achieved using a combination of **Discrete Wavelet Transform (DWT)**, **Adaptive Intensity Transformation**, and **Principal Component Analysis (PCA)**.

The specific objectives are as follows:

1. **Image Decomposition**: Use **DWT** to decompose the satellite image into frequency subbands.
2. **Brightness Analysis**: Divide the LL subband into low-, middle-, and high-intensity layers using **log-average luminance**.
3. **Intensity Transformation**: Apply the **Knee Transfer Function** and **Gamma Adjustment** to enhance contrast.
4. **Image Reconstruction**: Reconstruct the image using **IDWT** to combine the enhanced layers.
5. **Noise Reduction**: Apply **PCA** to reduce noise and enhance the final image.

This project aims to demonstrate the superiority of the proposed approach over traditional methods like **Histogram Equalization (HE)** in terms of contrast enhancement and edge preservation.

## ****7. Scope of the Project****

**Scope of the Project**  
This project aims to implement a method for enhancing satellite images using **DWT, IDWT, Adaptive Transformation, and PCA**. The scope includes:

1. **Input**: Satellite images of varying quality, which may contain low contrast or degraded details.
2. **Image Processing**: Apply **DWT** for decomposition, **Knee Transfer Function** for intensity transformation, and **PCA** for noise reduction.
3. **Output**: Enhanced images with better contrast, clear edges, and reduced noise.
4. **Performance**: Compare the output with traditional methods like **Histogram Equalization (HE)** to demonstrate improvement.

The project will focus on static satellite images and will not include video processing. The primary programming language will be **Python**, and libraries like **OpenCV, NumPy, PyWavelets, and Scikit-learn** will be used.

## ****Next Steps****

Here’s what we’ll do next:

1. Write the **Literature Review** to justify why DWT, PCA, and other methods are used.
2. Write the **Proposed Methodology** in detail, focusing on DWT, IDWT, Brightness Analysis, Knee Transfer, and PCA.
3. Create **Flowcharts** and **Block Diagrams** to explain the workflow.
4. Provide **Implementation Details** and **Sample Code** (if needed).
5. Complete the **Results and Conclusion** sections.