Enhancement of Night Vision IR Images

**Team Members:**

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**Project Brief:**

***Aim:*** To apply image enhancement algorithms on Night vision IR images using Vivado. The algorithms that were used perform **contrast enhancement** of the image.

***Algorithms used:***

1. Histogram Equalization
2. Histogram Matching
3. Double Plateaus Histogram Equalization
4. Top Hat Transform

These algorithms were first implemented on Python and their performance was compared. The two best performing algorithms - **Histogram Equalization** and **Double Plateaus Histogram Equalization** were implemented on *Vivado*.

***Comparing the performance of the algorithms:***

* We used the Peak Signal to Noise Ratio (**PSNR**) values to compare the performance of the algorithms.
* The PSNR values of the output from all images were calculated with respect to the output obtained from enhancing the image using an advanced, inbuilt algorithm on MATLAB.
* The **higher the PSNR value**, more the similarity with the reference image and hence **better the enhancement.**

**Weekly progress and tasks implemented:**

1. ***Week 1:***
   1. Understanding and implementing Histogram Equalization and Histogram Matching on Python.
2. ***Week 2:***
   1. Understanding and implementing Double Plateaus Histogram Equalization and Top Hat Transform on Python.
3. ***Week 3:***
   1. Comparing the results obtained from all four algorithms and choosing the best performing algorithms to implement on Vivado.
   2. Converting images to binary files and reading them on Vivado.
4. ***Week 4:***
   1. Implement Histogram Equalization and Double Plateaus Histogram Equalization on Vivado.
   2. Convert the text files obtained from Vivado into images.

**Division of Labour:**

1. Converting images to binary files and reading them on to Vivado- **Sanjay**
2. Converting the output from Vivado into an image using Python- **Sanjay**
3. Debugging the code for both algorithms on Vivado- **Saagar**
4. Implementing Histogram Equalization on Vivado- **Aadesh**
5. Implementing Double Plateaus Histogram Equalization on Vivado- **Eshan**
6. Comparing the PSNR values for all images and finding the best performing algorithm - **Aadesh** and **Sanjay**
7. Performing Histogram Equalization and Double Plateaus Histogram Equalization on Python - **Saagar**
8. Performing Top Hat Transform and Histogram Matching on Python - **Eshan**

**Conclusion:**

Since the PSNR values for images enhanced by Double Plateaus Histogram Equalization are more than those enhanced by other algorithms, we can conclude that Double Plateaus Histogram Equalization is the best algorithm for contrast enhancement of night vision IR images amongst the selected ones.

**Challenges Faced**:

1. We faced difficulty in finding the reference image to compare our algorithms.
2. Finding a convention while converting images to binary files containing the stream of all the bits and vice versa was difficult.
3. We found it difficult to find the proper function in Vivado for reading the text files of the images.

**Future Scope:**

If we can implement these algorithms on each frame of a video fast enough, we will be able to enhance the video in real time. These algorithms can also be used in Military Night Vision Goggles.