# Advanced Image Processing and Color Composite Analysis Using MATLAB for Remote Sensing Applications

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# 1. Introduction

Remote sensing has become a potent technique for acquiring important data on the surface and atmosphere of our planet from a distance in the field of Earth observation. Urban planning, disaster management, agriculture, and environmental monitoring are all affected by this discipline.

MATLAB's role in remote sensing image processing sheds light on how its suite of tools enables researchers, geospatial analysts, and scientists to extract usable insights from massive amounts of remote sensing data.

# 2. Objectives

The objective of this report is as follows:

a. How colors are represented in an image.
b. Role of DNs in different bands and color composites.
c. Linear stretching.
d. Understanding of the Look-Up Table (LUT)

# 3. Methodology

Data imported to MATLAB for geospatial analysis. MATLAB is employed for image processing, algorithm development, linear stretching and understanding the LUT. The various approaches used are demonstrated in the exercises below.

## 3.1 MATLAB

**Exercis-1**: Use the three images in the L4_tiff folder as provided.
-Read and show the images using imread and imshow functions.

**Exercise-2:** Read about the specification of the LISS 3 sensor and available bands. We have the images of bands 2, 3 and 4. By default, MATLAB considers R, G and B color guns as bands 1, 2 and 3 respectively for displaying images.

- LISS-3 (Linear Imaging Self-Scanning Sensor 3) is a multispectral sensor used for Earth observation and remote sensing purposes. It was developed and used by the Indian Space Research Organisation (ISRO) for its Indian Remote Sensing (IRS) satellites.
- It has four spectral bands that allow it to measure the reflectance of different materials in the visible and near-infrared spectrum.
- By mapping the different bands to different color channels, we can highlight specific characteristics of the landscape. For example, in a typical FCC using near-infrared (NIR) data as the red channel, healthy vegetation appears bright red, helping in vegetation analysis.

**Exercise-3:** Display the FCC image with RGB channels with appropriate bands in MATLAB. (NIR band will be shown in red color).

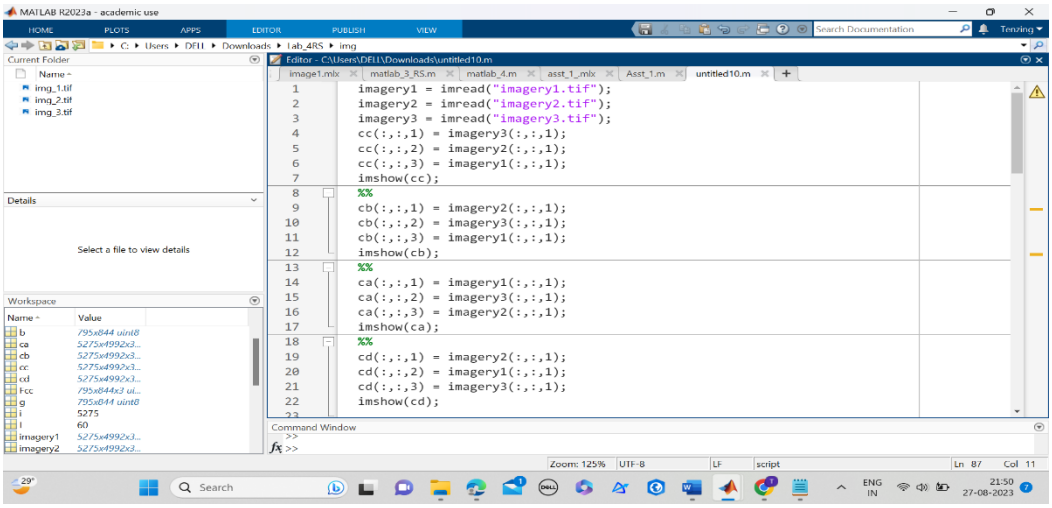



*Figure1: Coding done in Matlab to generate FCC of the imagery*

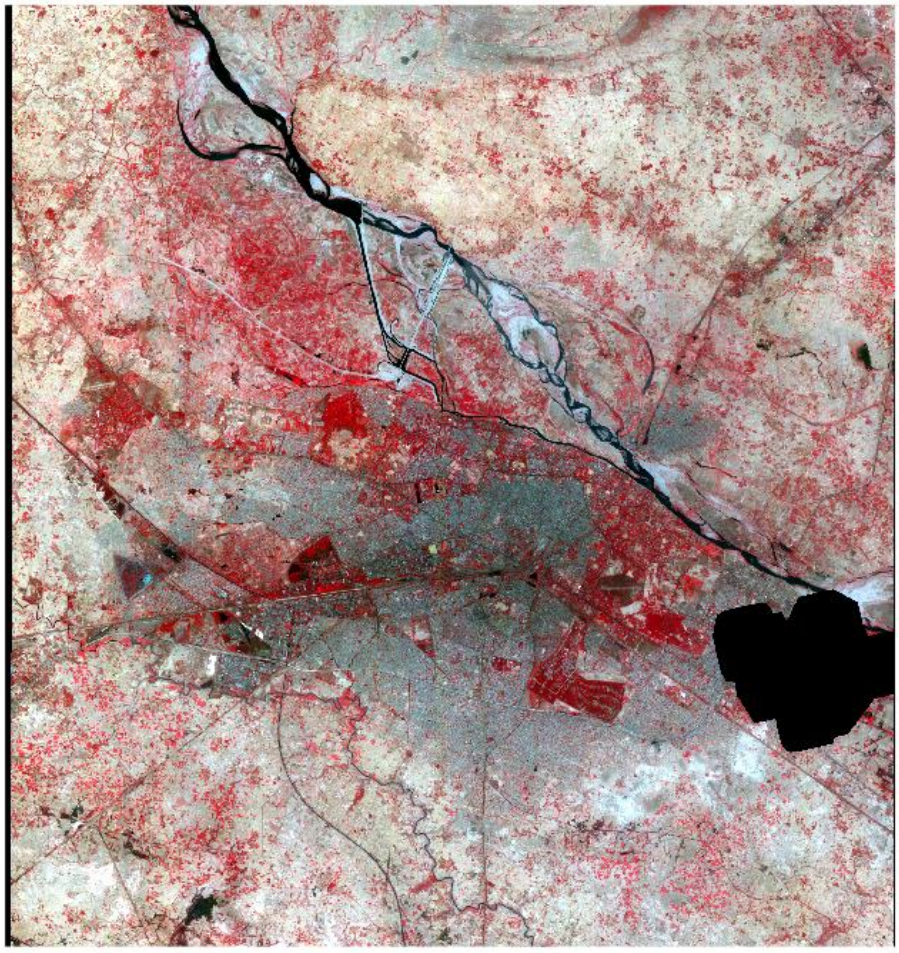


*Figure 2: Image of FCC*

**Exercise-4:** As the image is shown in a new window, check the values of pixels in different bands. Can you comment on the spread of pixel values in different bands?

- Reading various pixel values using “imtool” function.

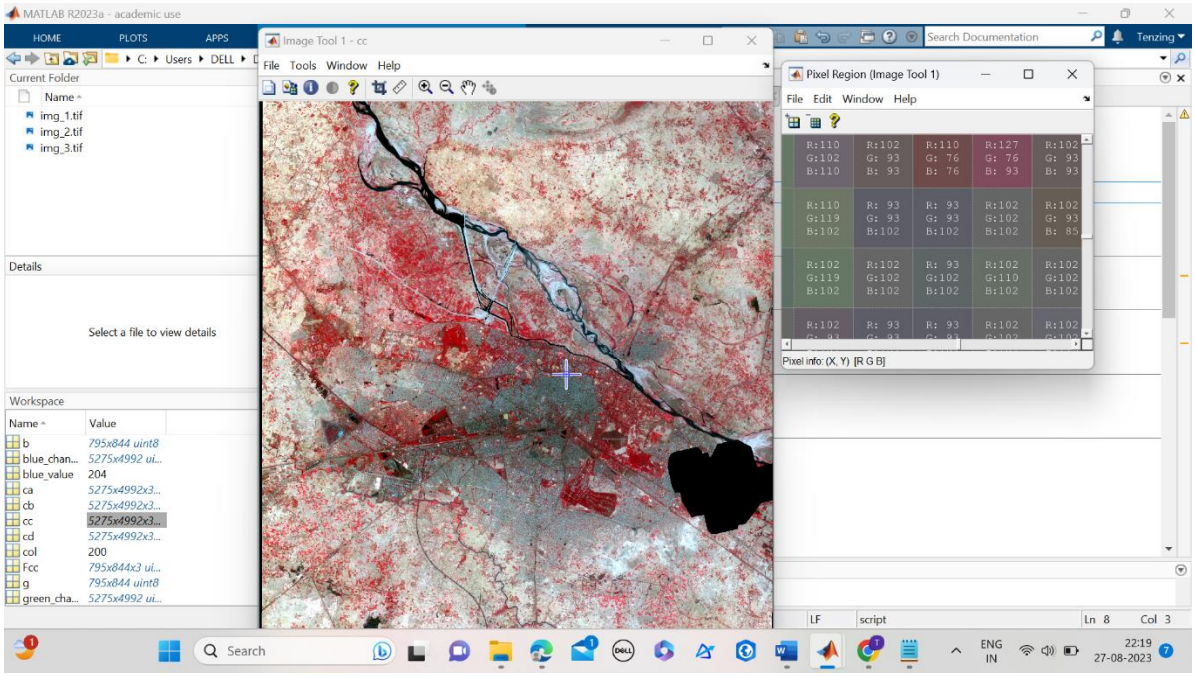



*Figure 3(a): Image displaying different pixels from that specific spot with various colours*

- In the case we can see, the light purple pixels, green pixels have similar values in all three bands, which suggests that they are composed of materials that reflect all wavelengths of light equally. This is consistent with vegetation, which is known to have a high reflectance in the visible and near-infrared spectrum.

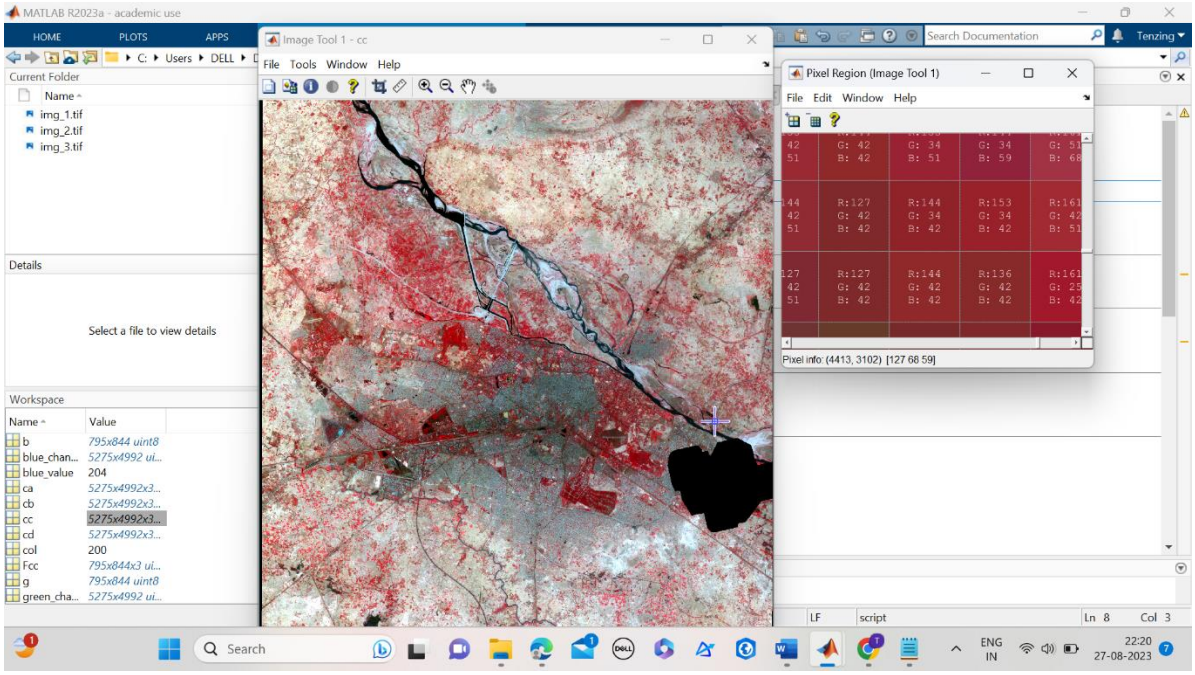



*Figure 3(b): Image displaying different pixels from that specific spot*

- The red pixels, on the other hand, have a much higher value in the red band than in the other two bands. This suggests that they are composed of materials that reflect red light more strongly than other wavelengths. This is consistent with bare soil, which is known to have a higher reflectance in the red band than in the other two bands.

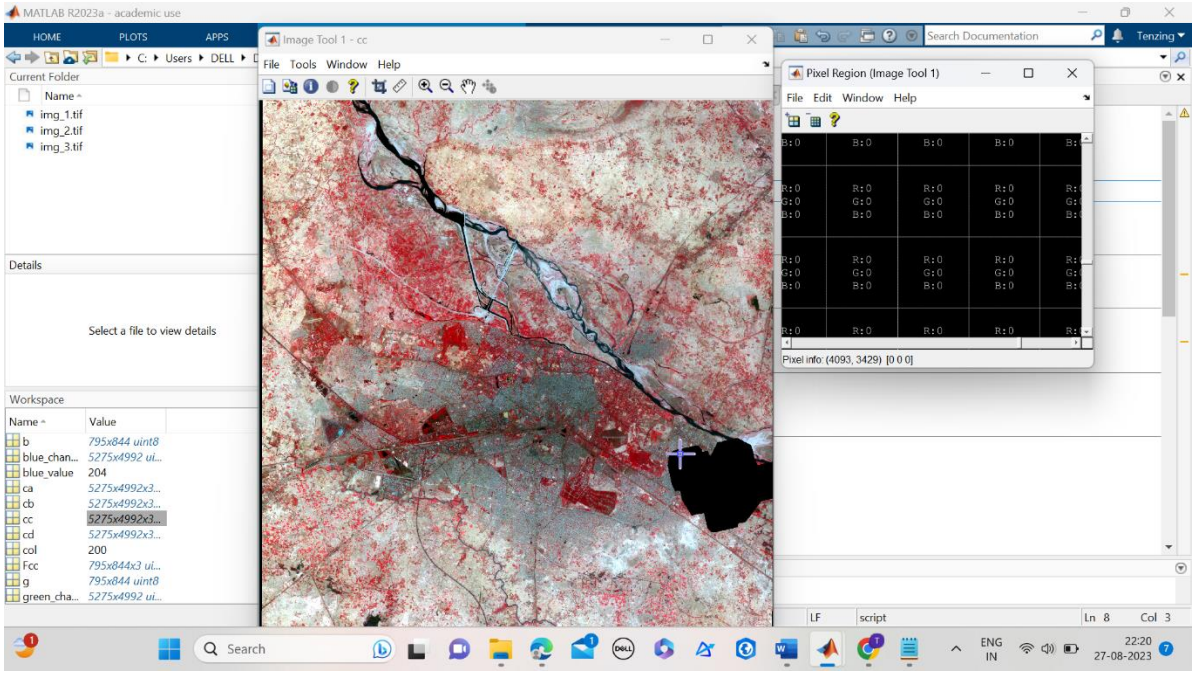



*Figure 3(c) : Image displaying pixels from the darker coloured region.*

- The dark pixels have a value of 0 in all three bands, which suggests that they are composed of materials that do not reflect any light. This is consistent with water, which is known to have a very low reflectance in the visible and near-infrared spectrum.
- Different materials in a scene can be distinguished using the variation in pixel values. For instance, whereas vegetation and bare soil often have a greater variation of pixel values, water bodies typically have a fairly limited range of pixel values.
- In conclusion, the values of the pixels in the different bands of an FCC image can tell us a lot about the materials that are present in the scene.

**Exercise-5:** Try showing the different combinations of bands in RGB. How many different combinations are possible?

- There are 6 different ways to arrange the RGB bands: RGB, RBG, GRB, GBR, BRG, and BGR. Each arrangement represents a different sequence of colors.

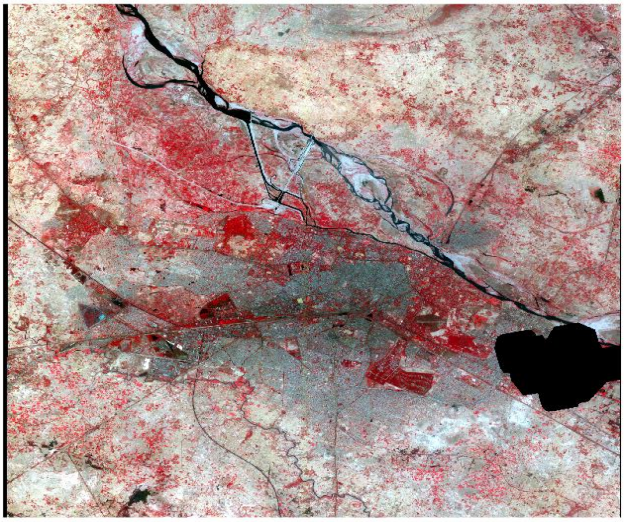
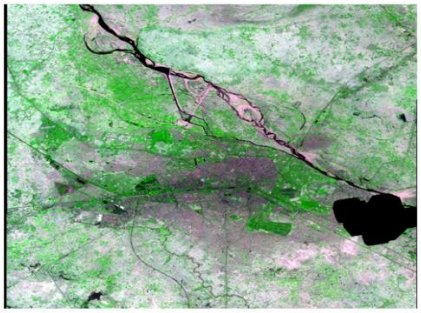
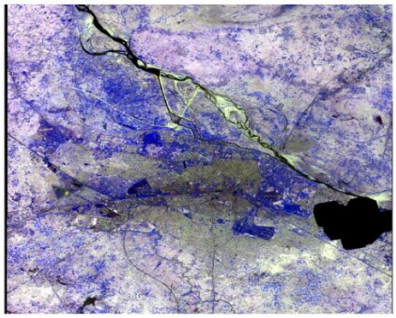
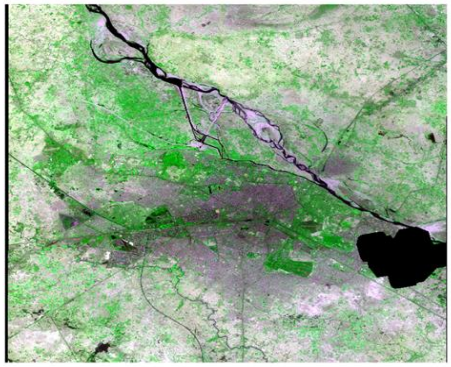


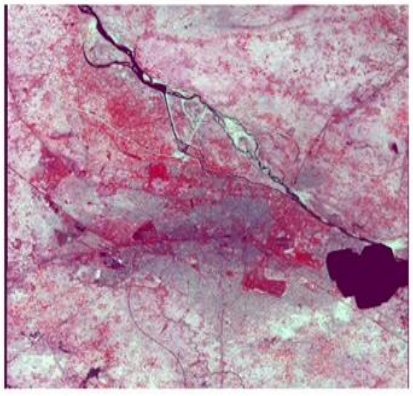
*Figure 4: FCC of the imagery with NIR bands shown in Red*

- While NIR data appears as "red" in the FCC, it's important to remember that the color is symbolic rather than literal.
- when we refer to NIR data as being "red" in an FCC, they are using a color representation that makes the most of the available color channels to emphasize specific features related to vegetation and other applications. The actual color of the NIR data isn't red in the conventional sense; it's just represented as red to provide valuable visual information to analysts and researchers.









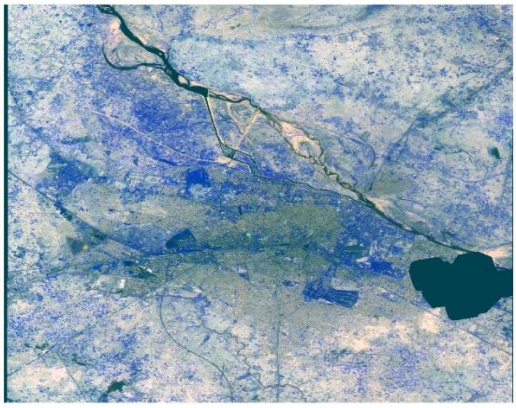


*Figure 5: displaying images with various RGB combinations.*

**Exercise -6:** Apply linear stretching with a clip on each band with the help of the following function:

IN = (I - Min) *($NewMax–NewMin/\ Max–Min$) + NewMin

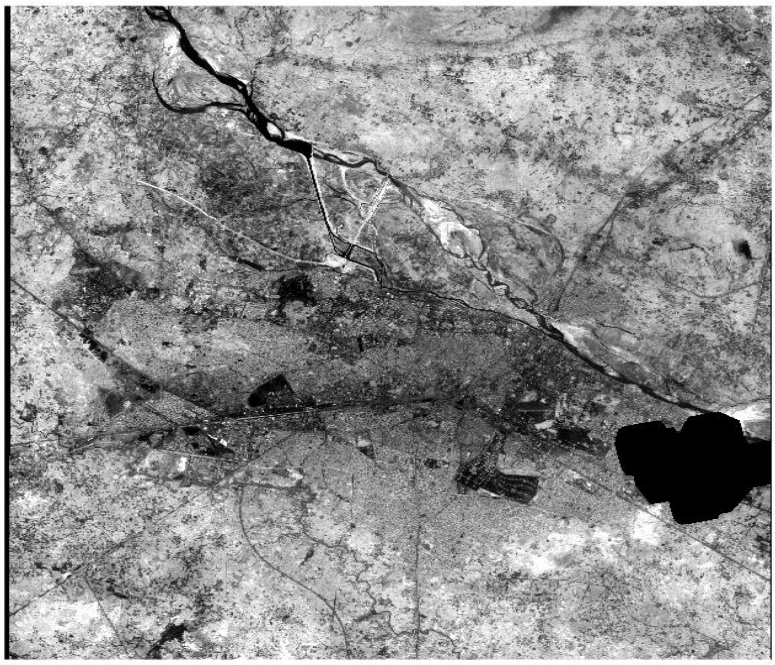


*Figure 6 : Stretched imagery1*

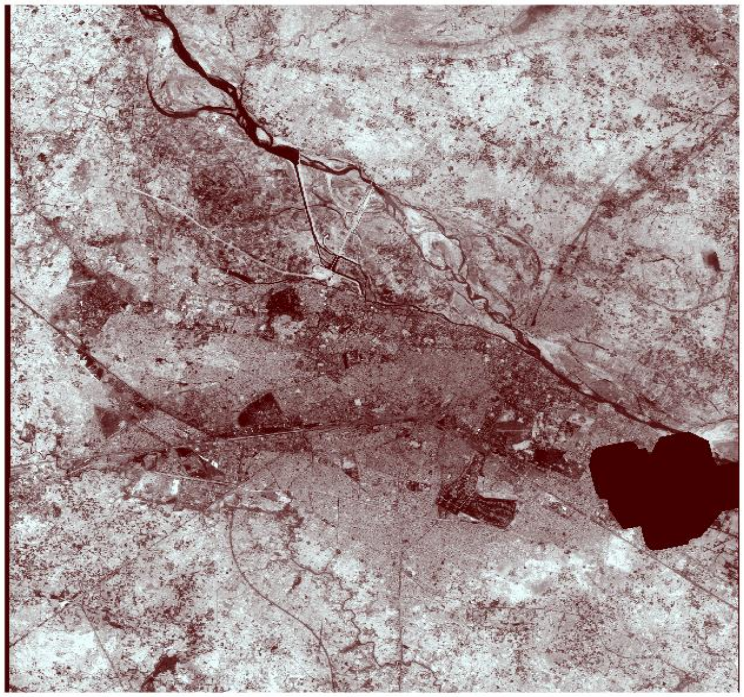


*Figure 7: Stretched imagery 2*

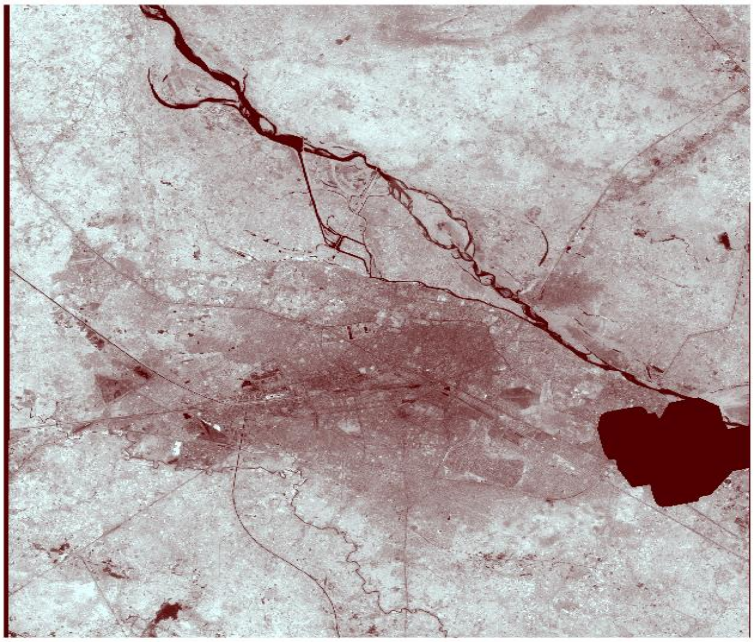


*Figure 8: Stretched imagery3*

**Exercise-7:** Display the stretched image as FCC.

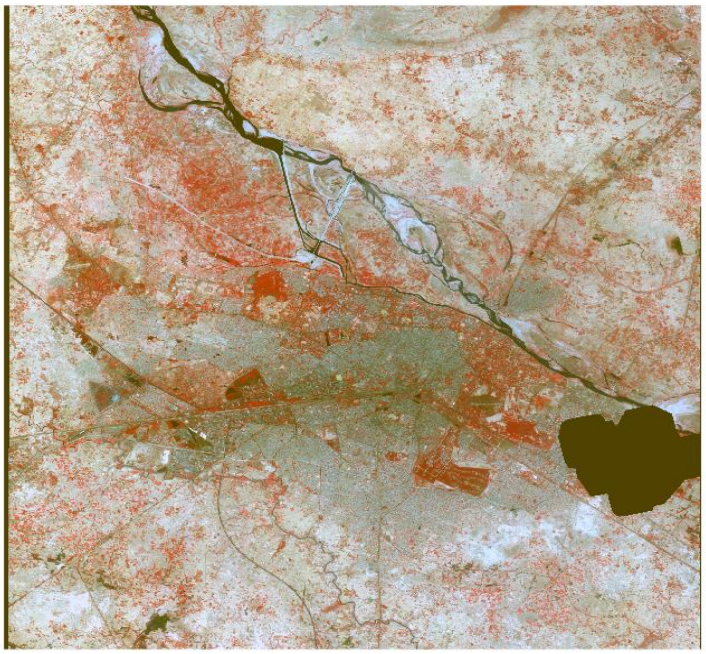


*Figure 9 : FCC of stretched image*

**Exercise 8:** Do you think that the pixels in the stretched image are representative of scene brightness in the true sense? If there is any increase in information content after stretching? Explain your answer with appropriate reasons.

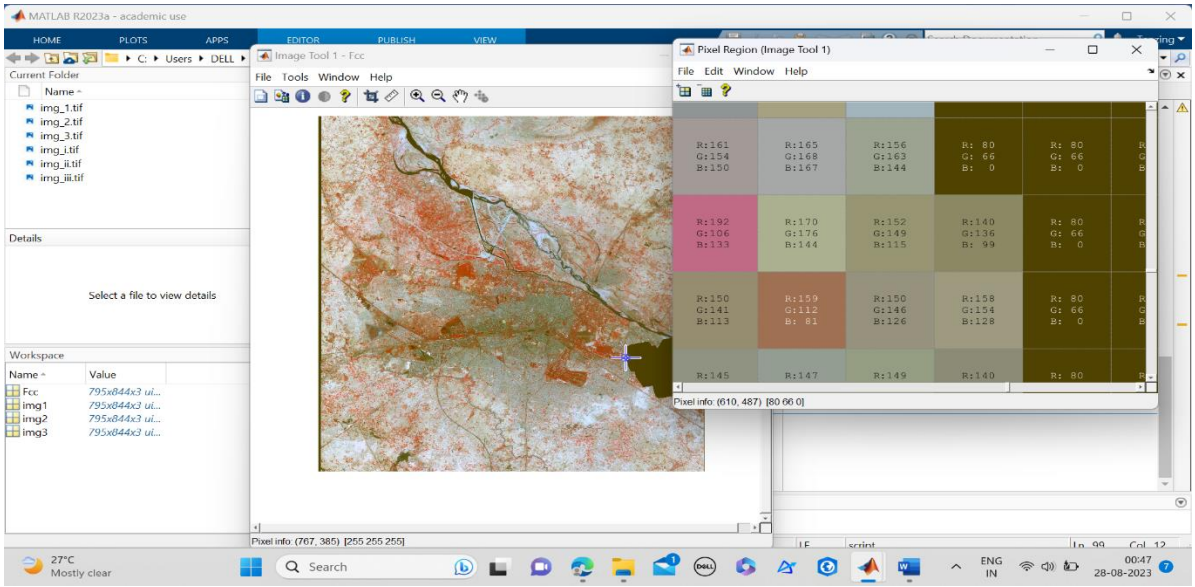



*Figure 10 : Pixel values of stretched image (FCC)*

- No, I do not think that the pixels in the stretched image are representative of the scene brightness in the true sense. This is because the stretching process has amplified the brightness of the water region, which is not actually bright in the real scene.
- The fact that the stretched image of FCC has R: 80, G: 66, B: 0 even in water, while the original FCC image has R: 0, G:0, B: 0 indicates that the stretching process has amplified the brightness of the red, green, and blue channels in the water region of the image. This is likely because the water region is relatively dark in the original image, so the stretching process has increased its brightness in order to make it more visible.

**Exercise 9:** Now, select any five pixels of normal FCC image in different areas (say top of workshop roof, water body, vegetation, road, concrete floor). Go to these pixels by zooming in till the image gets pixelated.

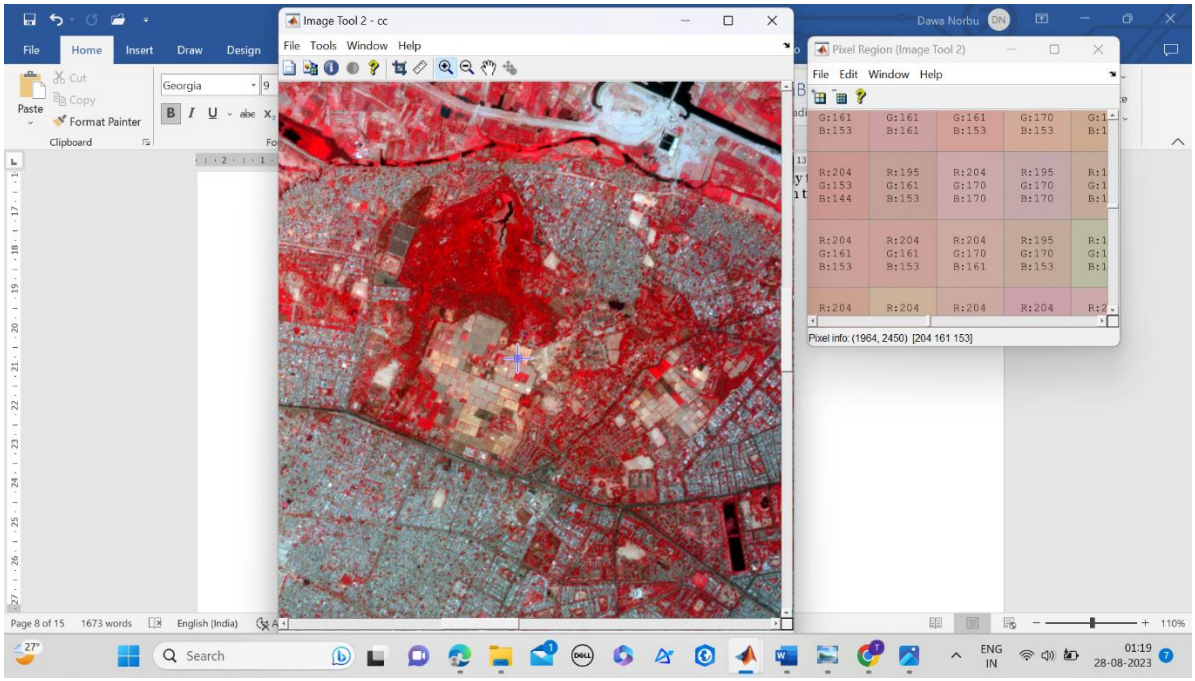



*Figure 11: Pixel values of original image (Fcc)*

**Exercise 10,11:** Make a table for these pixels as described. Fill in the values in the table for each of the pixels.
"Color from the Image" is the screenshot of the color of the pixel, "RGB values from the Image" is the RGB value given by clicking on the pixel; use these values in the blender which you can find at – http://www.rapidtables.com/web/color/RGB_Color.ht

Table 1: Look up Table

| Pixel Number (1) | Pixel Address (2) | Type of Land use/Land cover (3) | RGB values from the Image (4) | Color from the Blender (5) | Values from the Stretched Image (6) | Color from the new Imagein Blender (7) |
|---|---|---|---|---|---|---|
| 1 | Green-land | Vegetation | 170,161,144 | AAA190 | 185,168,153 | B9A899 |
| 2 | Lake | Water-body | 0,0,0 | 000000 | 80,66,0 | 504200 |
| 3 | Road | Road | 178,161,178 | B2A1B2 | 200,187,194 | C8BBC2 |
| 4 | Green-land | Vegetation | 187,204,195 | BBCCC3 | 191,154,124 | BF9A7C |
| 5 | Air-strip | Road | 221,195,187 | DDC3BB | 158,142,102 | 9E8E66 |

**Exercise 12:** Explain the significance of LUTs.

- A Look-Up Table (LUT) is a table that maps input values to output values. In the context of image processing, a LUT can be used to transform the brightness or color of an image. LUTs are used in a variety of applications, such as Image editing software, Digital cameras, etc.
- The significance of LUTs is that they can be used to quickly and easily transform the appearance of an image.

# 4. DELIVERABLES:

https://drive.google.com/drive/folders/1r-cxpIplX1TSQa2wZuRNg97TuK3XMAa8?usp=sharing

# 5. conclusion:

- DNs are integers that represent the brightness of a pixel in an image. The higher the DN, the brighter the pixel. DNs are typically stored in 8-bit or 16-bit integers.
- Linear stretching is a technique that can be used to improve the contrast of an image, but it can also can reduce the clarity of images.
- There are many different LUTs available, each with its own unique effect.