MATLAB GUI Application for Digital Image Processing and Remotely-sensed Image Accuracy Assessment

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INFORMASI ARTIKEL	ABSTRAK
	This research demonstrates the application of MATLAB GUI for digital image processing and remotely-sensed image accuracy assessment. Some methods of accuracy assessment for remote sensing images, such as Overall accuracy and Kappa Coefficient are calculated. Following the accuracy assessment, the Correlation Coefficient method was also used in this study to show how efficient the MATLAB GUI is. One of the digital image processing tools, histogram matching, is also utilized in this research. In addition, for remotely sensed images, the composite band tool is also demonstrated in this study. MATLAB GUI is helpful and more convenient to be used and developed in various areas.

1. Introduction

Spatial analysis (which spatial data analysis is one element of it) is the representation of a collection of techniques and models that use the spatial referencing of each case. The spatial analysis describes spatial relationships or spatial interactions between those cases. The results of any analysis will not be the same depending on the spatial distribution and the spatial structure [1]. Spatial data analysis is concerned with that branch of data analysis where the geographical referencing of objects contains important information. In many areas of data collection, especially in some areas of experimental science, the indexes that distinguish different cases can be exchanged without any loss of information.

In Remote Sensing, Spatial Data Analyst is an important part such as image processing and accuracy assessment [2]. To adjust a better image, we need to do some processes and steps in order to achieve this goal. For example, by the meaning in a science field, image processing is processing of images using mathematical operations for which the input is an image, a series of images, the output of image processing may be either an image or a set of characteristics or parameters related to the image. From this processing, we can get any additional information from the to be analyzed. For another issue, such as accuracy assessment which is really crucial and commonly used to assess the classification result.

One of the most widely used platforms for computing in science and engineering is MATLAB. This is a result of the abundance of tools that are already built into the majority of engineering and scientific domains, as well as the implementation's high computing level, which benefits beginners by providing a steep learning curve. Therefore, MATLAB has been commonly used in teaching control system [3], designing supported building of civil engineering [4], and digital image processing [5]. MATLAB provides a Graphical Use Interface (GUI) designer "Guide" that is easy to use and not require any programming experience [6]. It is simple to add components like plots, buttons, and sliders. MATLAB offers a simple approach to create GUIs with components like check boxes, radio buttons, list boxes, pushbuttons, etc. and link them to built-in MATLAB functions.

Therefore, in this research, accuracy assessment and image processing tools are built using MATLAB GUI. This extremely simple GUI will also contain Correlation Coefficient and Composite Band part. Using GUI is easier and more convenient for running the MATLAB functions and getting the results. Since a series of images is used, so it is simpler if we only need to select the image what we want directly from selection box.

2. Methodology

This study aims at utilizing MATLAB GUI for image processing and accuracy assessment as the workflow shown in Figure 1. But first of all, as the beginning step of this research, the display of MATLAB GUI is designed. This step is required to decide how many function files need to be built for the next step. The display of MATLAB GUI is shown as Figure 2.
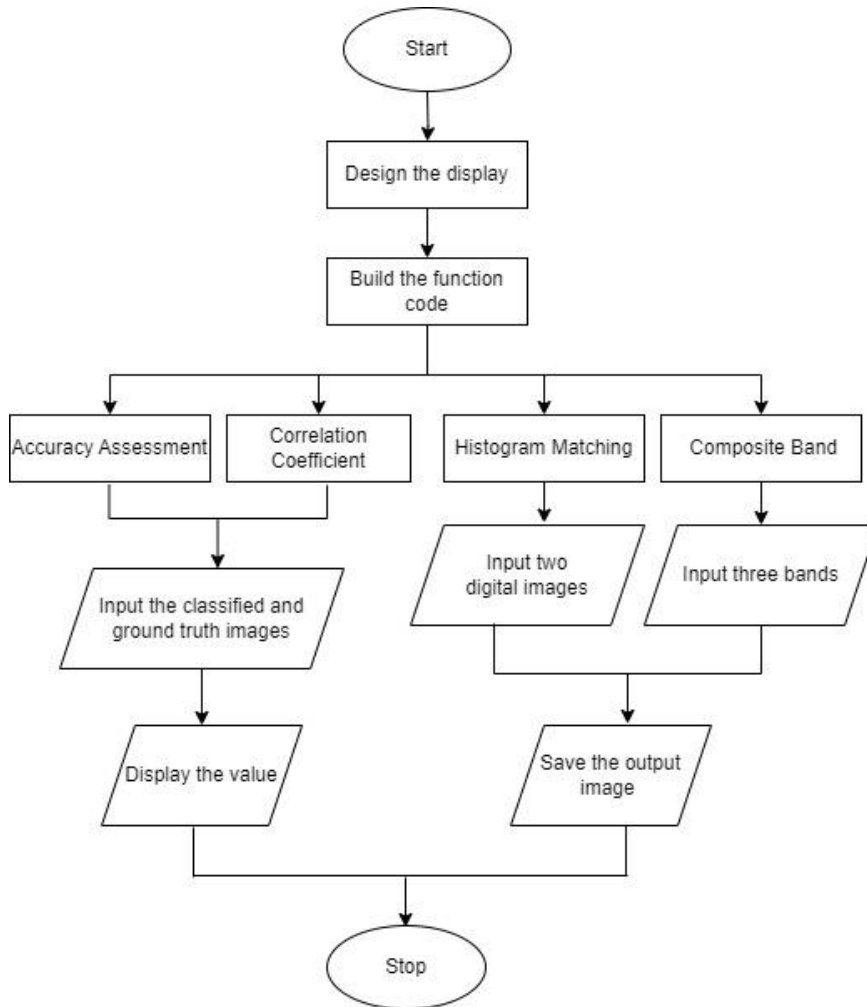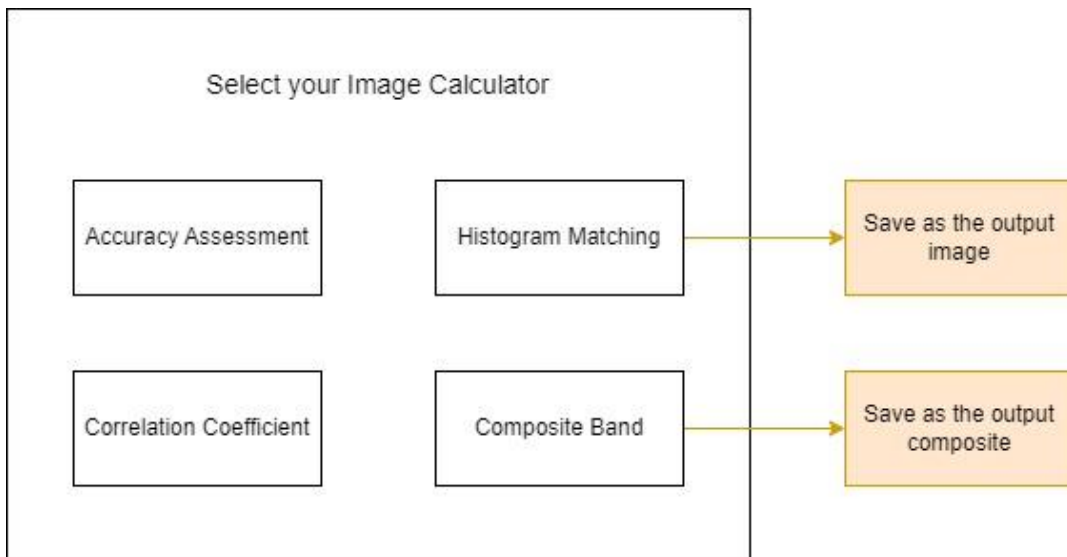

Figure 1. The workflow of this study

Figure 2. The design of MATLAB GUI for processing the remote sensing images

From the design above we can see there are four function files we need for the MATLAB GUI, first is accuracy assessment, correlation coefficient, histogram matching and then composite band. Those four functions will be explained in the following section. For Accuracy Assessment, Correlation Coefficient, and Composite Band, remotely sensed images are used. Especially in Accuracy Assessment and Correlation Coefficient, the classified and ground truth images is used as the input. On the other hand, three bands of remote sensing images are the input in Composite Bands tool. For Histogram Matching, the digital image is the input of the GUI. From the previous step, we decide that the value of Accuracy Assessment and Correlation Coefficient is printed or displayed on the pop-up window. Since the output of Composite Bands and Histogram Matching is the image result so the output will be saved on the device. Accuracy Assessment.

2.1. Accuracy Assessment

For the accuracy assessment function, the Kappa Coefficient and Overall Accuracy are calculated. Kappa Coefficient is a statistical measurement to calculate the agreement between two images, the reference image and the observed image [7]. The range of the Kappa Coefficient value is $0-1$, the closer the value to 1 the better the agreement is. Vice versa, the closer the value to 0 the worse the agreement is.

$$k = (p_o - p_e) / (1 - p_e) \tag{1}$$

where:
p_o = relative observed agreement
p_e = relative reference agreement

On the other hand, the overall classification accuracy is represented by overall accuracy. It is calculated by dividing the total number of pixels that were successfully identified by the total number of pixels that served as references [8]. This measure's limitation is that it does not provide information on how accurately various groups are categorized.

2.2. Correlation Coefficient

In remote sensing, Correlation Coefficient calculates the strength of linear relationship between to remotely sensed data. For quantifying reliability on a categorical scale, Kappa Coefficients are generally used whereas Correlation Coefficients are commonly applied to determine the reliability in interval terms. In order to assess the reliability of ordinal rating scales, both types of coefficients can be used. In this study, the Correlation Coefficient calculated between two images that we can select from the GUI. The higher the *r* the closer relationship between those two images. The value of *r* will be printed out in the message box.

$$r = \frac{n \times \left(\sum(X,Y) - \left(\sum(X) \times \sum(Y)\right)\right)}{\sqrt{\left(n \times \sum(X^2) - \sum(X)^2\right) \times \left(n \times \sum(Y^2) - \sum(Y)^2\right)}} \quad (2)$$

2.3. Histogram Matching

Histogram matching is a process where an image, or higher dimension scalar data is modified such that its histogram matches that of another (reference) image or dataset [9]. In this research, we use the digital image to get the histogram matching. The input images can be chosen by the selection box through the computer device. The calculation by MATLAB is used the imhistmatch (). For this function, the result image will be saved as the result of histogram matching.

2.4. Composite Band

Composite Band is the process of combining 3 bands namely band 4 (red), band 3 (green) and band 2 (blue) to get a multispectral image as one of the images to be sharpened [10]. The function is for compositing three bands and as the input is selecting the band one by one in selection box. For this function the result image will be saved using saveas (gcf,filename).

3. Discussion

Figure 3 shows the display of the MATLAB GUI in this research by running the main code. Then each function contains each tool, Accuracy Assessment, Correlation Coefficient, Composite Landsat Bands, and Histogram Matching.
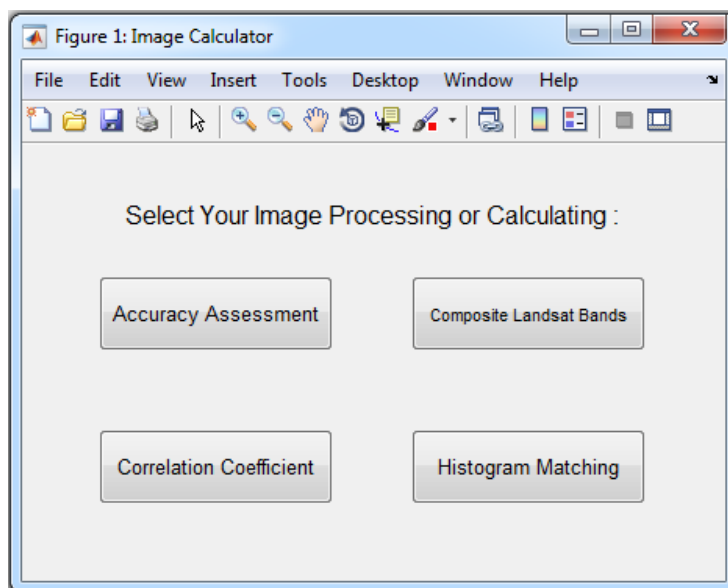
Figure 3. The display of MATLAB GUI

3.1 Accuracy Assessment

Remotely-sensed imageries are used for Accuracy Assessment part in this research. Figure 4 shows the selection box for choosing the ground truth image and Figure 5 shows the selection of classified image. After the images are selected, the Overall Accuracy and Kappa Coefficient are calculated which compared the ground truth and classified images. The value of both accuracies displayed on the pop-up window as shown in Figure 6.
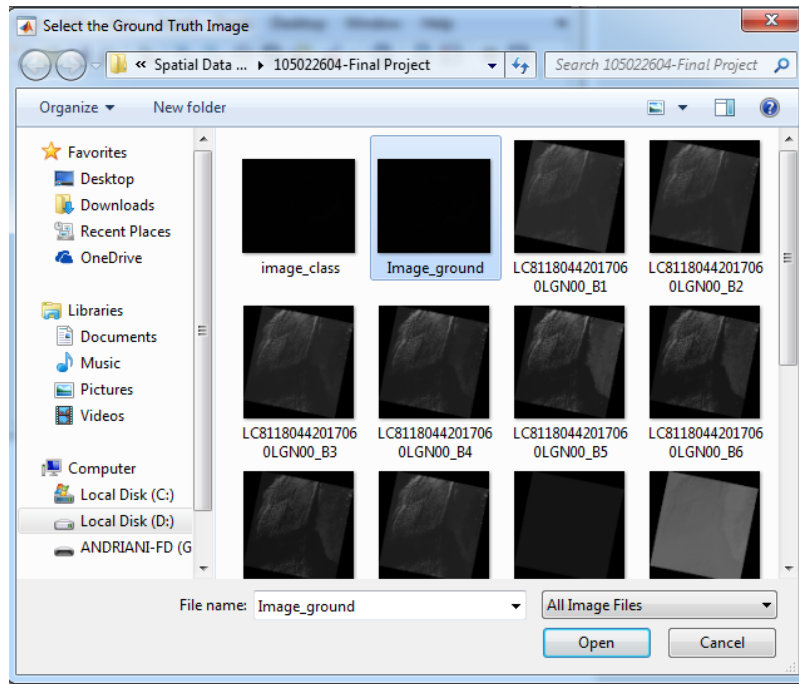
Figure 4. Selecting the reference image

After double-click, or click Open for ground truth image, classified or observed image selection box will appear also. Then we need to double-click on the classified image so the function will calculate the accuracy.
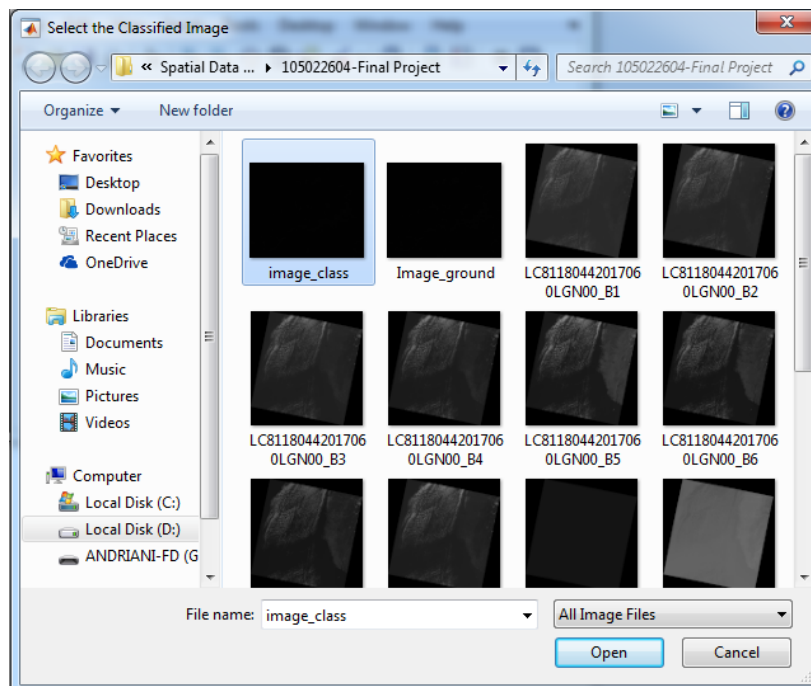

Figure 5. Selecting the observed image

Once the function gets the ground truth and classified images, the function will go through the accuracy part to calculate both values. As the result, both of matrices are printed on the message window as shown in Figure 6.
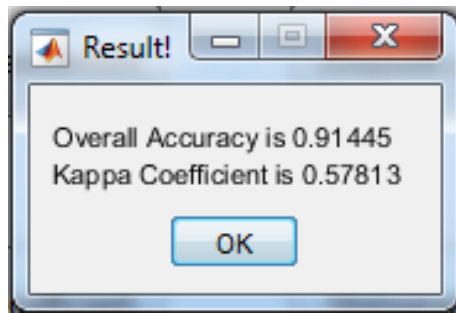
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Figure 6. Accuracy assessment values are printed on the message box

3.2 Correlation Coefficient

The process for Correlation Coefficient is mostly same as Accuracy Assessment above. Firstly, the ground truth image is chosen, then we choose the classified image to calculate the value. When we choose Correlation Coefficient push button, the code will execute the runcorrfunc.m The selection box will appear, and we select two images to be calculated. The result will be printed also in the message box as shown in Figure 7.
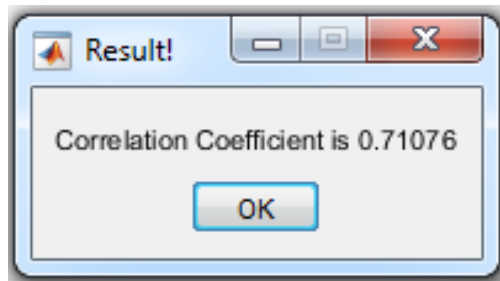

Figure 7. Correlation coefficient value is printed on the message box

3.3 Composite Landsat Bands

Different from two previous tools, Composite Band needs three different remote sensing images. Once we click the Composite Band on the display, the pop-up window will appear as shown in Figure 8. When we choose Composite Bands push button, the code will execute the runcomposite.m. and the message will appear first.
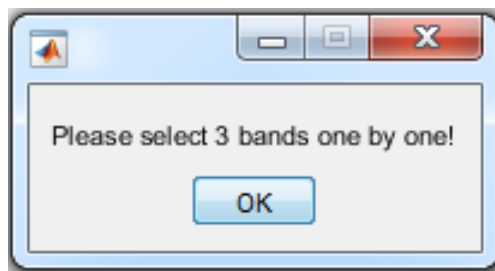

Figure 8. The massage box of composite band

Once we click OK then the selection window will appear as Figure 9. On this step we need to choose band 4, 3, and 2 for Landsat imageries. Figure 9 shows when we choose the first band, which is band 4, the next one is band 3 and the last is Band 2.
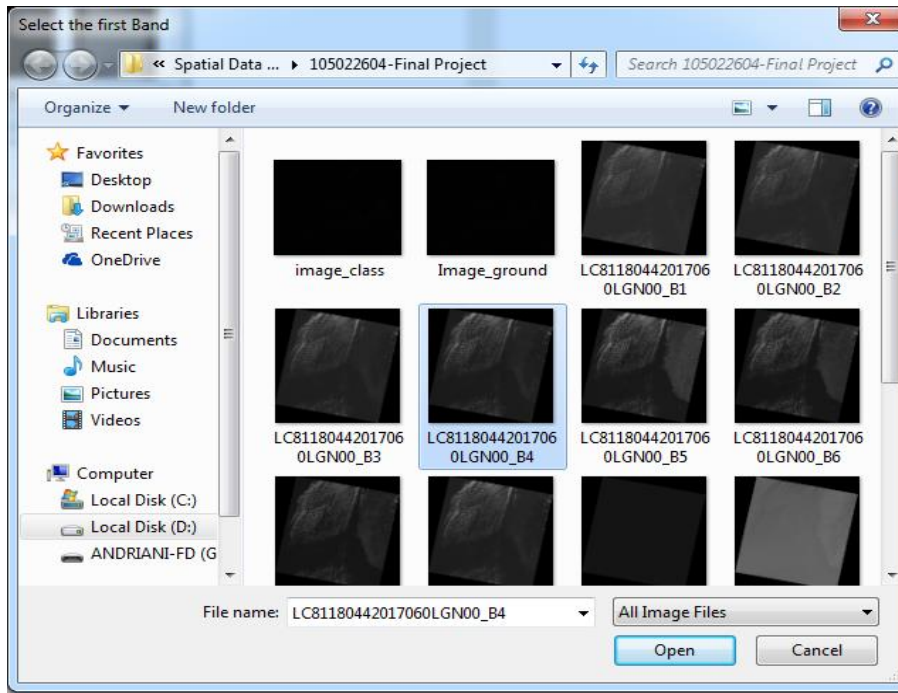
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Figure 9. Selecting the first image

The same action also needed to be done for the next two images, the second and the third one. After the images are chosen, the function of composite bands will be executed and the results will be shown as Figure 10.
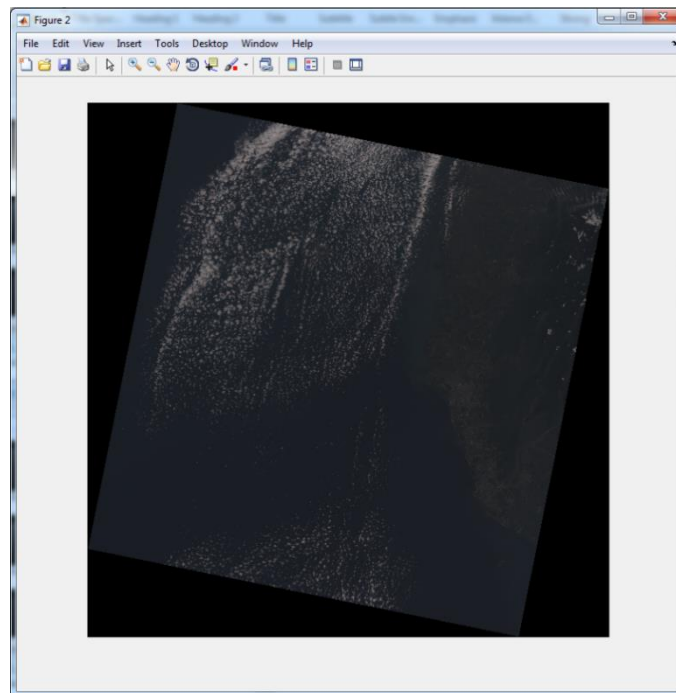

Figure 10. The result of composite bands

Different from Accuracy Assessment and Correlation Coefficient which print the value on the message box, in Composite Band the result image will be saved on the device directory. This step use the saveas() in the function. The saved image will appear on the directory as shown in Figure 11.
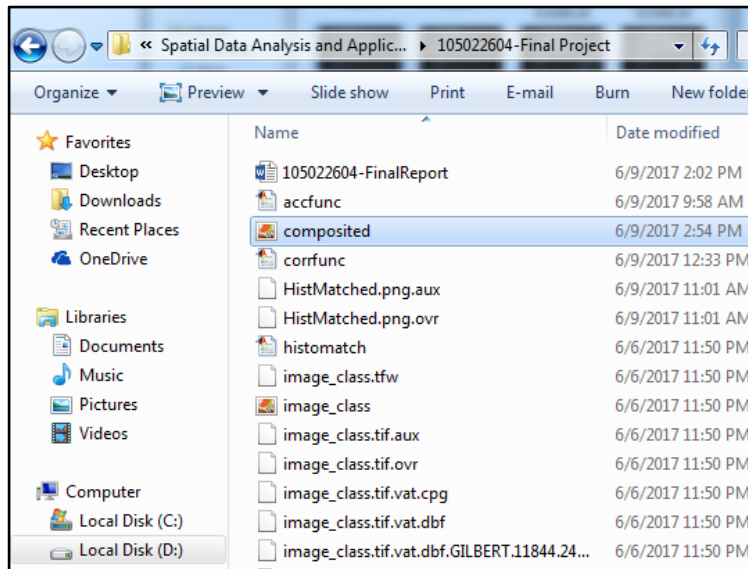
Figure 11. The saved image appears in computer directory

3.4 Histogram Matching

In this research, we define histogram matching as the calibration of an image to match another. Different from three previous tools that use the remotely-sensed images, for histogram matching use the digital images. We can match the adjusted image and a RGB image with the reference image.
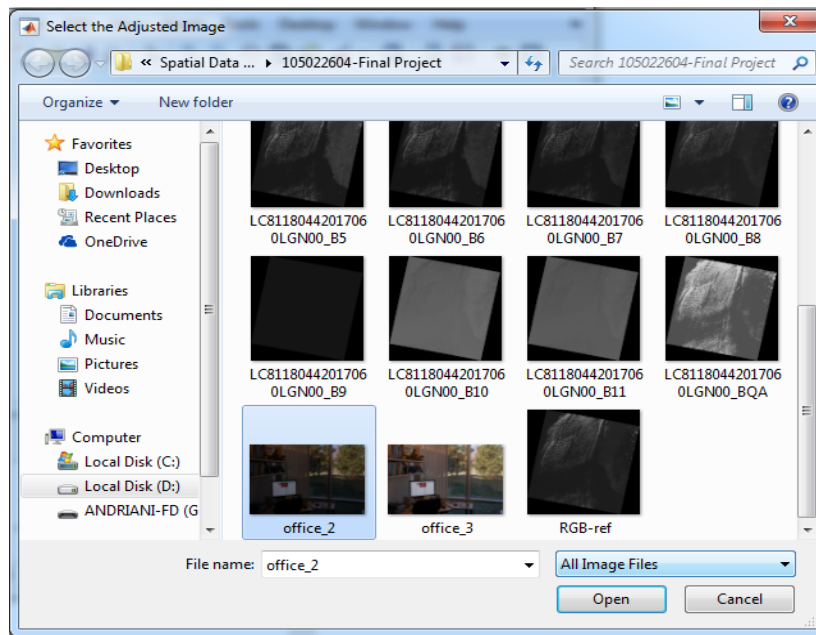

Figure 12. Selecting the first image

Figure 12 shows the selection box of the first image to match the second image. After choosing the images to match each other, the result image will display on the pop-up window as shown in Figure 14. Beside display it, same as Composite Band, the result also saved as an image on the directory.
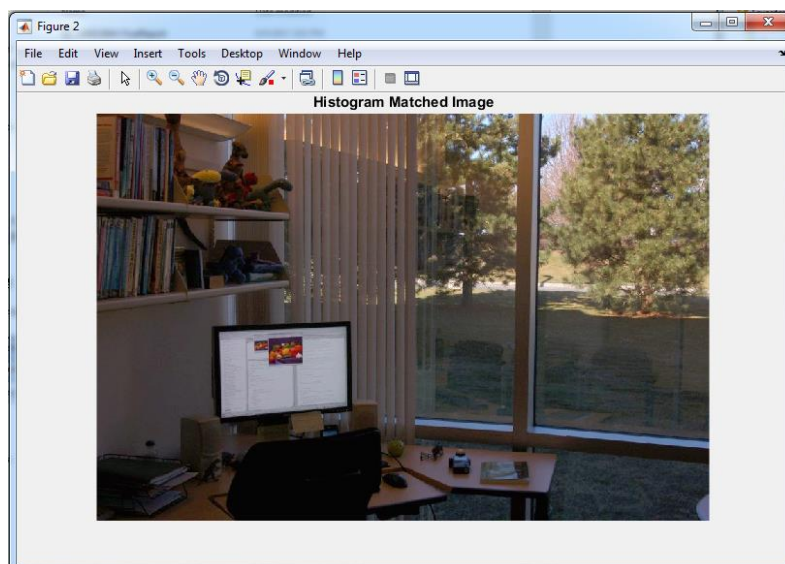
Figure 13. The result of histogram matching

The result shows the matched image of the first and the second images as chosen before. Figure 12 shown the two images, while the first image has less brightness and the second image has more brightness. As the result in Figure 13, the histogram matching helps to get a better image result as the solution of less-brightness problem or another problem for digital images.

4. Conclusion

The research presented demonstrates a GUI tool for digital image processing and remotely-sensed image accuracy assessment using MATLAB. The discussion here aims at showing the users to build and develop image processing in a MATLAB GUI. This solution also helps users be more efficient in utilizing MATLAB robust tools for various subject areas, including image processing and data accuracy assessment. For the next work in the future, the scholar may develop another kind of accuracy assessment matrices or image processing methods using MATLAB GUI such as Root Mean Square Error (RMSE) or Average Difference,

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