Development and Implementation of Multi-source Remote Sensing Imagery Fusion Based on PCI Geomatica

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Abstract: On the basis of comprehensive analysis and summarization of the image fusion algorithms provided by PCI Geomatica software, deficiencies in image fusion processing functions of this software are put forwarded in this paper. This limitation could be improved by further developing PCI Geomatica on the user's side. Five effective algorithms could be added into PCI Geomatica. In this paper, the detailed description of how to customize and further develop PCI Geomatica by using Microsoft Visual C++ 6.0, PCI SDK Kit and GDB technique is also given. Through this way, the remote sensing imagery fusion functions of PCI Geomatica software can be extended.

Keywords: Multi-source Image Fusion, Remote Sensing, Pixel-level, Feature-level

1.Analysis and Summarization of the Image Fusion Algorithms Provided by PCI Geomatica

With the development of space technology and the consecutive emergence of new kind sensors, large numbers of multi-temporal, multi-platform, multi-band and multi-resolution remote sensing images have been easily acquired. Multi-source remote sensing image data fusion is one of the most efficient techniques to enrich and utilize the remote sensing information of the interested area.

PCI Geomatica is the software product of PCI company, Canada. It has been put into wide use in remote sensing image processing, photogrammetry, GIS spatial analysis and professional cartography. Several fusion functions are provided by PCI Geomatica, and the models are IHS Cylinder transform, IHS Hexcone transform and the Brovey transform. Through these functions, the output RGB color image can be created by fusing an input RGB color or pseudocolor image with an input black-and-white intensity image. Nevertheless, the fusion functions provided by PCI Geomatica are all based on the pixel-level processing, and different method has its own limitation. For example, IHS data fusion model can cause the spectral information mixture among the image bands. Although the "ImageLock Data Fusion" algorithm can automatically register and then fuse the multi-sensor and multi-resolution images while keeping the independence of each band's spectral information, the fusion result depends largely on the precision of the automatic registration.

From what has been mentioned above, we can see that though some image fusion functions with specific characteristics have been provided by PCI Geomatica, they are all based on pixel-level processing, and the algorithms based on feature-level are not offered. How to customize and extend the image fusion functions of PCI Geomatica according to the user's needs are discussed in this paper.

2.Customization Methods Provided by PCI Geomatica

The methods to customize PCI Geomatica can be concluded as follows.

The first method is using EASI[+] language and the Author application module. EASI[+] language has the similar syntax to C or Fortran programming language. It has complete operations including variable operation, expression, control, cycle, input, output, character string operation, file operation and special operation to PCI internal data format, PCIDSK. Further more, all application programmes in EASI/PACE can be invoked. Author can provide a visualizable

development environment, driven by events and similar to the one in Visual C++ and Visual Basic. The codes responding to each event are developed in EASI[+] language. However, the main limition to customize PCI Geomatica in this way is that Author module must be purchased additionally if only the PCI Fundamentals version is purchased and the developed functions cannot work independently without the Author running environment's support.

The second method is using the visualizable flow interface, PCI Modeler, provided by PCI Geomatica. The user can self-define the operation by using the models in the model library. But this development mode is restricted by the limited number of the arithmetic models in the model library.

The third method is using the PCI SDK development kit, together with Visual C++, Visual Basic or Java Script etc. In this pattern, the Class Library and the function library of the common development tools, such as Visual C++ and Visual Basic etc can be fully taken advantage of. The defect is that except for invoking the functions in PCI SDK development kit, the existed function modules in EASI/PACE cannot be invoked.

After considering the features of each customization method, the third method, using the function library with GDB technique is adopted in this paper. GDB technique is used in directly reading and writing more than 100 types of data formats including raster data formats, vector data formats and other formats. By using this technique, the processed data can be quickly and directly accessed without the format conversion. Functions developed in this way can even work well without the support of the Author module. It can provide the friendly user interface and be integrated into PCI Geomatica seamlessly.

3.Customizing PCI Geomatica on Image Fusion Functions

3.1 Extended Fusion Functions

In this paper five fusion algorithms based on pixel-level processing, which are IHS Triangle transform, Linear transform, Linear&Multiplication

transform, PCA transform and Color Fidelity Fast transform, are extended in PCI Geomatica.

The reason for extending these five algorithms is listed as follows. IHS transform models of PCI Geomatica would be integrated if the IHS Triangle transform is added into the software. Experiments show that there has not too much difference among three IHS fusion models, thus the user can freely choose any algorithm of them in the actual applications. This can unquestionably enhance the flexibility of PCI Geomatica. Linear transform is the most intuitionistic image fusion method, and it can keep the spectral information of the original images. The weight of each image can be obtained by calculating the correlation coefficient between two images. Linear&Multiplication transform can greatly increase the contrast in image detailed parts. PCA transform can process the images with more than three multi-spectral bands. Although it causes the loss of some physical features, it can effectively improve the spatial resolution of the multi-spectral images. Aiming at general fusion algorithms can bring some color changes in the result image, Color Fidelity Fast transform can maximumly keep the spectral information of the original image at the same time has the very quick computing speed and bring the sharpened result.

3.2 Customizing the Interface

In order to integrate the developed functions into PCI Geomatica seamlessly, the extended function modules are integrated into PCI Xpace.
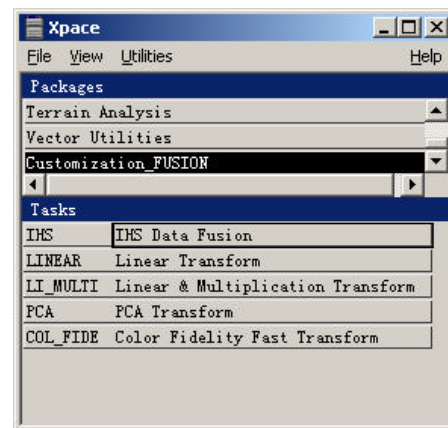

Fig. 1. Referring Customized Modules by Viewing *Package*

When Xpace is running, the customized modules can be referred by viewing *Application*, *Package*, *Common Tasks* or *All Tasks* on the View menu. For example, when the customized modules are referred by viewing *Package* in Xpace, the interface will look like the picture depicted in figure 1.

Scroll the upper window of Xpace to the bottom, the "Customization_FUSION" button will appear. Click the "Customization_FUSION" button, the extended five function modules will be displayed in the task column, the lower part of the Xpace window. Codes of this part of work can be developed by editing the "Xpace.dat" file, located in the PCI Geomatica installation directory.

Click the module name region, the left part in the task column, a dialog will pop up. Take the PCA Transform as an example. See the figure 2.

Click the "Run" button, another dialog will pop up (depicted in figure 3).

According to the prompt on the dialog, click the "Select" button to browse and choose the relevant input images from the Fie Selection Dialog, then click the "OK" button to finish the PCA Transform operation.

3.3 Development and Implementation of the Fusion Algorithms

The interface and algorithm of each fusion function are developed in Visual C++, together with the PCI Software Development Kit, SDK, including the GDB function library. The processed data is accessed quickly and directly without the data format conversion. The "exe" executable file is generated in the compiling environment of Visual C++, and then integrated into PCI Geomatcia by modifying the relevant interface file of PCI Geomatcia.

4.Conclusions

On the basis of comprehensive analysis and summarization of the image fusion algorithms provided by PCI Geomatica software, the customized developing scheme to PCI Geomatica on the user's

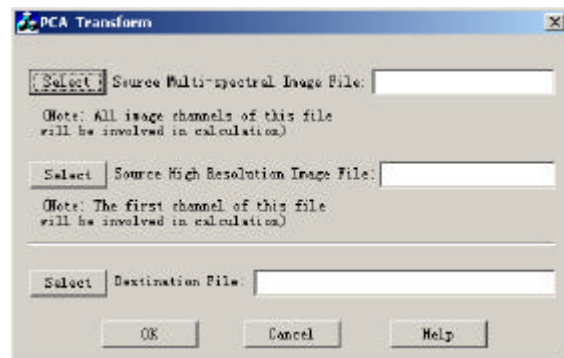**Fig. 2. Run the PCA Transform Module**

Fig. 3. The Interface of the PCA Transform Module

side is put forwarded in this paper. By virtue of the powerful existed functions of the large-scale commercial software, the user's various requirements can be met by customizing and further developing the software.

Furthermore, the feature-level image fusion model, such as the fusion algorithm based on wavelet theory could be added into PCI Geomatica. All these work could perfect and enhance the multi-source image fusion functions of PCI Geomatica, and the accuracy and reliability of remote sensing imagery information extraction and the application fields of remote sensing imagery can be also enhanced and extended.

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