Conversion and Visualization of Remote Sensing Image Data in CAD

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Abstract. In this paper, a process visualization model for remote sensing image classification algorithms is constructed to analyze the current processing characteristics of process visualization in remote sensing application systems. The usability of the model is verified in a remote sensing application system with a remote sensing image classification algorithm based on support vector machines as an example. Given the characteristics of remote sensing applications that require high visualization process and a large amount of data processing, the basic process of an image classification algorithm for remote sensing applications is summarized by analyzing the basic process of existing image classification algorithms in remote sensing applications, taking into account the characteristics of process visualization. Based on the existing process of remote sensing image classification algorithm, a process visualization model is proposed. The model takes a goal-based process acts as the basic elements of the model, provides visualization functions and interfaces for human-computer interaction through a human-computer interaction selector, and uses a template knowledge base to save processing data and realize the description of customized processes. The model has little impact on the efficiency and accuracy of the support vector machine-based remote sensing image classification algorithm during the process of process visualization and customization. Finally, the application of the model to integrate business processing of earth observation can address the problem of process customization visualization for remote sensing applications to some extent.

Keywords: 3D CAD; remote sensing imagery; vector machines; visualization
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1 INTRODUCTION

With the widespread application and rapid development of remote sensing data, the amount of civilian remote sensing data is increasing year by year, and various remote sensing application systems and platforms have also emerged. During the period of the Twelfth Five-Year Plan, the application of domestic high-resolution earth satellites will be further enhanced and the amount of remote sensing data will also increase at a geometric rate [1]. At the same time, the remote sensing data processing system will also develop along the direction of high-speed, efficient, and convenient process processing. While the technology of remote sensing data processing platform is becoming more mature, Mhangara *et al.* showed that remote sensing data processing platform has been widely used in national departments such as environmental protection, transportation, and land [2]. As a platform system about remote sensing information, it faces different demands from different industries and different users, therefore, it is a key issue of today's research to concisely express the data processing content with a visualization scheme, effectively unify the production mode of remote sensing data, simplify the data processing steps and improve the operation efficiency. Wagner *et al.* specifically meet the specific needs of remote sensing application system platform, process, and visualization processing will have broad application prospects [3]. AutoCAD has a powerful drawing function and vector graphics data editing and processing function, widely used in the design and urban planning, etc., with a wide range of user groups, including a large number of mapping workers. In recent years, with the rapid development of remote sensing image technology, a large number of high-quality remote sensing image maps can be obtained in a short time, and then provide spatial location information services [4]. It can be seen that AutoCAD and remote sensing technology have their advantages and applications, and we often need to combine them in practical applications. Mukarugwiro *et al.* proposed that it need to superimpose some map images expressing the geographic location of the project on the AutoCAD drawing for auxiliary use, such as to understand the geographic location or terrain of a project [5]. On the other hand, to better provide spatial location information services, we often need to convert remote sensing image data into vector graphics data, to better use the GIS, then you can use AutoCAD to factorize based on remote sensing image maps [6]. In this case, AutoCAD can be used to perform factorization based on remote sensing image maps. Therefore, if AutoCAD and rs can be combined, they can complement each other, expand their respective application areas, and improve data processing efficiency. In recent years, Jinya *et al.* have done a lot of fruitful research on the conversion of CAD and GIS data, but these studies have certain limitations, and rarely involve the conversion of RS image data to CAD [7]. At present, the remote sensing product control and production platform applied to a variety of satellite data types, for the distributed storage and production of remote sensing data, has the characteristics of integrated processing of multi-source remote sensing data, large data processing throughput, high algorithm accuracy, and clear requirements for visualization [8]. Although the current remote sensing application system has improved the working and storage efficiency per unit time to a great extent, the system is oriented to various user groups and massive remote sensing data, and in the face of different types and requirements of products and massive user orders, how to effectively communicate the data and configuration between each subsystem, increase, and realize the construction, organization and virtual display of the remote sensing image landscape as a whole. James *et al.* pointed that the reusability of the strong system configuration makes the real visualization, automation, standardization, and traceability operation of the product production more and more prominent [9]. Remote sensing image classification is a common data processing method to automatically identify different surface features or objects by analyzing the data of remote sensing image pixels, which is widely used in different fields of various industries such as natural disaster identification, feature detection, road traffic condition analysis, environmental monitoring, etc. The data in the remote sensing image classification algorithm also undergo pre-processing, geometric correction, cloud detection, etc. The data in the classification algorithm are analyzed by the data processing module [10]. Degerickx *et al.* pointed that the main embodiment of the visualization of the process lies in the design of the idea [11]. This idea, similar to the visual programming language manifestation, but the difference is that the purpose of the visual programming language through direct and rapid components to achieve efficiency, and the object is program editors, while the process visualization in this paper compiled language as a remote sensing data analysis and visualization [12]. The application descriptive language, on the other hand, completes the reorganization of the standardized, standardized and engineering remote sensing algorithm model, realizes the information reuse and technical reuse of the remote sensing algorithm model in the remote sensing application system, and provides a more flexible, convenient and easy-to-use operating environment for the program users.

In the remote sensing field, which often needs to deal with a large amount of data, a stable, engineering-oriented language-like driver platform is needed to enhance the visualization process of customization, expand the reusability of software, and improve the stability and ease of use of the system. At the same time, as the industrialization of remote sensing application technology and the ability of large-scale engineering services are increasingly improved, the advantages of visualization, scalability, and reusability have also been highly valued and studied by scholars at home and abroad.

2 BASIC THEORY OF REMOTE SENSING IMAGE DATA CONVERSION PROCESS AND VISUALIZATION

2.1 Basic Processes and Methods of Remote Sensing Image Data Conversion

Process visualization focuses on the interrelationships and trends between data and data, data and algorithms, and data and processes in workflows. Depending on the different objects, it may lead to different manifestations and implementation methods of process visualization. Only according to the different characteristics of different objects can be the appropriate models and process visualization methods be effectively summarized. Concerning the process characteristics of remote sensing data (mainly remote sensing images) processing, this chapter systematically introduces the basic theories of process visualization and existing mature technologies, and makes a brief introduction and feature extraction of the basic process of remote sensing data processing. The majority of what we commonly refer to as remote sensing data is made up of remotely sensed images. A remotely sensed image (a remote sensing image) is an image that describes a feature in digital form. There are many types of images. Visually, images are divided into visible images and invisible images. From the visual point of view, images are divided into visible images and invisible images, and from the point of view. Images can be divided into analog images and digital images by the degree of light and darkness and the continuity of spatial coordinates. Analog images, also called optical images, are visible images, and the spatial coordinates and the degree of light and darkness of the analog image are continuously changed. The analog image can be converted to a digital image by aid conversion. Digital image refers to the computer to store, process and use the image, the spatial coordinates of the digital image and the degree of light and dark are not continuous, it is several points with certain values arranged in rows and columns of a two-dimensional matrix, because it only exists in digital form, so only to grayscale or color values displayed or printed out to be seen. As shown in Figure 1, the intensity of electromagnetic radiation detected by the remote sensing sensor determines the size of the brightness value of the remote sensing image, and the detection element converts the electromagnetic wave incident to the remote sensing sensor into an electrical energy signal, and then after the household JD conversion, the absolute radiation brightness value R. To facilitate the application, R can be converted into the relative value v that can represent the radiation brightness of the object.

2.2 The Need for Flow-Through Data Transformation for Remote Sensing Image Classification Algorithms

Many of the current remote sensing applications for remote sensing images require the use of multicultural remote sensing image classification algorithms, and the continuous innovation of remote sensing application requirements also promotes the continuous improvement and perfection of multicultural remote sensing image classification algorithms.

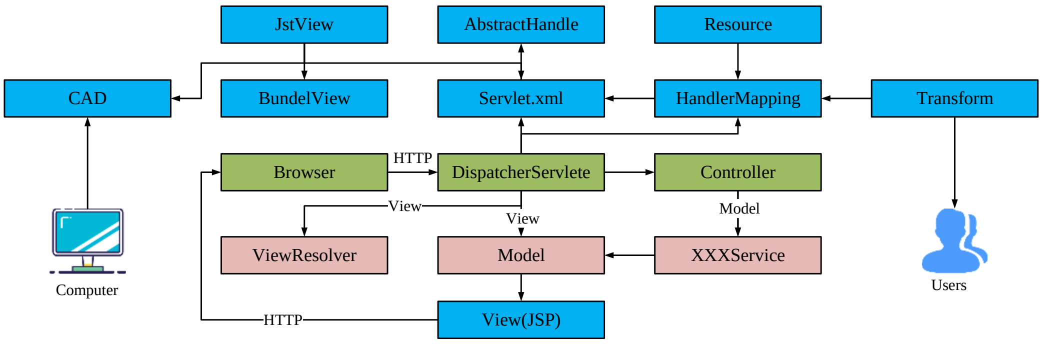

Figure 1: Remote sensing charts data processing flow chart.

Modern remote sensing imaging technology makes remote sensing images have the characteristics of three high (high spatial resolution, high spectral resolution, high temporal resolution) and three multi (multi-platform, multi-sensor, multi-angle), in which there is a large amount of spatial position information, and the multicultural remote sensing image classification algorithm should use this information comprehensively to accurately detect the specific area of change and the type of change, even by analyzing the spatial position information. Regional features around the area of change to predict the likely factors for change to occur. Among the existing remote sensing multicultural images remote sensing image classification algorithms, the main process in almost all of them based on image algebraic operations is to obtain the difference images by comparing the multicultural remote sensing images. However, after obtaining the difference image, it is necessary to classify it to separate the changing area from the overall background, and the currently common practice is to adopt the applanation method. The appendix value method is a pre-set threshold value to distinguish whether the difference image has changed or not, and if the difference image exceeds this threshold value, it is considered to have changed, otherwise, no change has occurred. The threshold method is an intuitive and simple way to monitor the change information, but it is very difficult to set a threshold, and it is impossible to use a constant threshold to identify the detection results in all cases; also, some are very sensitive to the change of 0 value, and if the 0 value is changed, it may lead to a large change in the detection results. The image classification algorithm based on the change vector, region segmentation, and wavelet transform is to analyze the distribution pattern of remote sensing image spectral space and extract the changing information in the image using a more accurate classification method, thus improving the accuracy and robustness. Complex algorithms will inevitably result in a decrease in detection efficiency. As shown in Figure 2, the remotely sensed images to be processed are usually large, so both accuracy and detection efficiency have to be taken into account.

2.3 A process Framework for Data Transformation of Remotely Sensed Image Classification Algorithms

Visualization, essentially a method of converting data information into a graphic image is a mapping of data structures concerning images. It encompasses not only the data itself but mainly the interconnections between the data. Currently, visualization techniques can be divided into four main categories: scientific computational visualization, information visualization, data visualization, and knowledge visualization, while process visualization is an emerging field among knowledge visualization.

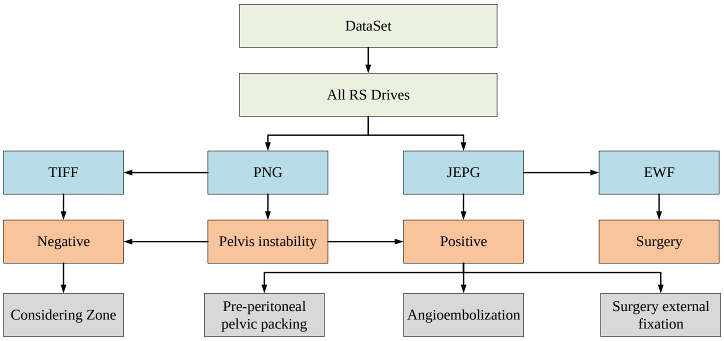

Figure 2: Remote sensing image data conversion process.

Most of the visualization techniques are used in scientific research to simulate some complex environment or data relationships, which is more obvious or easier to abstract the model of the content itself. Currently, the focus of visualization research is on finding effective representations of large amounts of multi-dimensional data, not only to reflect the connection between data and content but also to show the characteristics of high-dimensional correspondence in the lowest possible dimensional space. It is this ability to simplify and clarify complex data relationships that can fundamentally help us to refine abstract relationships and understand the relationship between data and attributes. Process Visualization currently exists mainly in application areas. To put it simply, the basic goal of process visualization is to visualize, analyze, and study the various modules in a system according to the system's operation flow. However, the current process visualization research is by no means satisfied with just simple module sorting and visualization of each module, its main development trend is to study the potential connections under the working framework of the whole system, and search for a reasonable and abstract process visualization model based on this basis. In this context, the author's view of process visualization is that it is a knowledge-based visualization of an image built based on process-based work, focusing on research that emphasizes the interrelationships between data and data, data, and algorithms, data, and processes, and the implied trends.

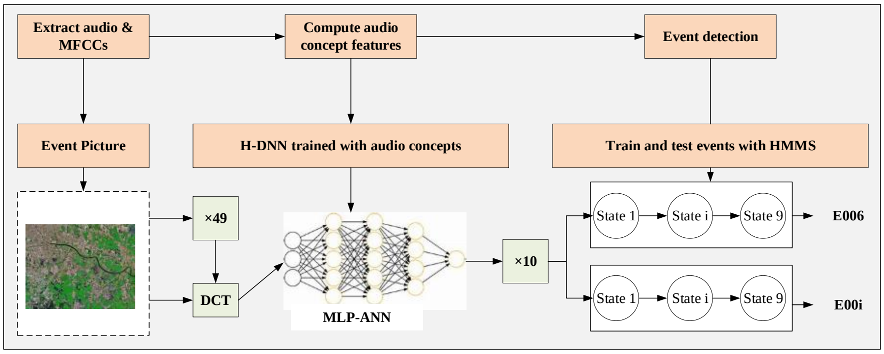

Figure 3: Remote sensing image flow framework based on a machine learning algorithm.

In this paper, processes are mainly referred to as business processes in application-based system activities. A business process is a series of processing processes that a system performs to satisfy user needs or goals pursued by users. Among these processes, the various modules that must be undergone must contain clear task allocation relationships, consistent purpose, and logically sound j formations. As shown in Figure 3, its essence is to abstract and extract the modules of the system following the running order, the number of runs, the frequency of use, and other basic data in the process, and according to their correspondence, the formation of low-dimensional space-based (generally two-dimensional or three-dimensional space) visualization information. In this paper, the process of process customization for remote sensing data (image-based) in remote sensing classification product algorithms will be investigated and presented in a programming language like format.

3 DATA TRANSFORMATION PROCESS VISUALIZATION MODEL FOR 3D CAD REMOTE SENSING IMAGE CLASSIFICATION ALGORITHMS

3.1 Remote Sensing Image Data Transformation Process Visualization Model Construction

Once the guidelines for model construction are defined, the knowledge base of templates created, and the responsibilities of the selector are determined, it is possible to build a visual model of the process for a remotely sensed image classification algorithm. The flow is the order in which things are executed. In a computer system, the order of execution is generally accomplished by the relaying of messages between modules. Prisoner of this, the necessary elements for a universal process model are two kinds of basic elements and support elements. The basic elements are the components of the flowchart and the nodes we often refer to it. Although the supporting elements cannot be reflected in the flowchart. They are the necessary links connecting the basic elements in the model.

Based on the basic process model, a process processing objective is added to it. A process processing goal is an estimate of the desired outcome based on the information from the internal inputs of the system while executing a module or function. This processing goal includes not only the expected data relationships or process content but also the required operational data to achieve the goal and the logical relationship between the goal and other related goals in the system process. If the goal can be decomposed, it also includes information about the multiple branch goals related to the goal. Corresponding logical relationships are generated according to the different goal levels. The required information for all sub-objectives is mainly taken from the number template knowledge base.

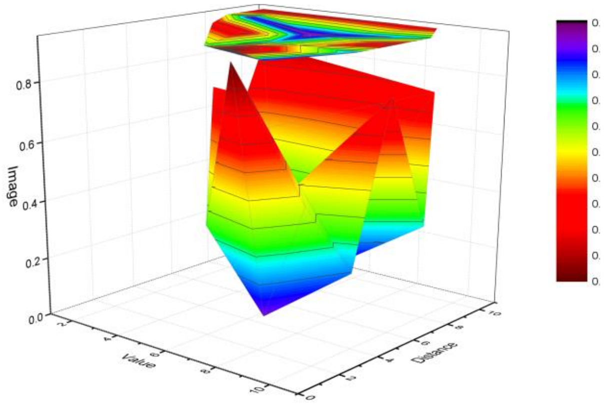

Figure 4: CAD remote sensing image visualization effect.

To build a process visualization model, it is first necessary to establish a process template knowledge database (PTKB), which is used to store the behavioral target templates, template data and provide data support for selectors needed in process view design. The selector is a kind of control module for judging the direction of process behavior, and its main selection method is user selection through a visual interface. At the same time, the selector can also generate a new process template according to the user's choice, to enrich or update the template knowledge base for the next visual selection. As shown in Figure 4, each module in the process constitutes a node on the process view, and the selector is located at the intersection of the node connections with corresponding relationships, the execution of the process depends on the message through the selector, and the operation of the user for process control is actually to control the flow of the message through the selector.

3.2 Remote Sensing Image Data Transformation Process Visualization Model Construction

Geospatial Data Abstraction Library (GDAL) is an open-source raster spatial data conversion library under the X/MIT license, with open-source, cross-platform, simple, efficient features, can read, write, convert, a process most of the major raster data file formats, including Arc/Info GDAL uses a single abstract data model that conforms to the OpenGIS underlying data model standard to parse the data formats it supports, consisting of datasets, coordinate systems, affine teleconferencing, geodesic transformations, geodesics, geodesics, and other common remote sensing image data formats. The GDAL library is open source, we need to compile the source code before we can use it. Before compiling, configure the GDAL source code file, correct errors in the source code, and additional support as needed, such as Proj, GeoTiff, etc. In this article, we need to add GeoTiff's support. After compilation, create a bin folder which contains the core GDAL file in the form of a DLL, and perform substantive operations on this file by placing it in a location accessible to the program; create include and lib folders which will also be used for development, add paths to both in the development environment, and add the static library files required by GDAL.

As shown in Figure 5, AutoCAD does not support most of the remote sensing image data formats, so remote sensing images cannot be inserted directly into the display. The raster image data formats that can be directly inserted into AutoCAD include TIFF, BMP, GIF, JPG, etc. GeoTiff is a Tiff file format that contains geographic information, and GDAL supports the reading, writing, and creation of GeoTiff format files. In this paper, by using GDAL's raster space data read conversion function, the original remote sensing image data of many formats supported by GDAL can be read, then use GDAL's CreateCopy method to write and create Tiff format raster image, to convert the original remote sensing image to the GeoTiff raster image data format supported by AutoCAD. Get a raster map that can be inserted directly into AutoCAD.

3.3 Remote Sensing Image Data Transformation Process Visualization Model Construction

AutoCAD's secondary development programming language and tools include AutoLISP, ADS, VisualLISP, VBA and ObjectARX development package, etc. ObjectARX has the advantages of rich functions, high code execution efficiency, and fast running speed in many secondary development tools of AutoCAD. The application is a service program, and AutoCAD calls the ARX program module through the acrxEntryPoint() function. ARX applications typically consist of an initializer and a user-defined command function. To visualize the converted raster maps in Auto-CAD, this paper combines MFC with ObjectARX for secondary development in AutoCAD. Before converting the remote sensing image data, GDAL reads the spatial position information of the original remote sensing image and can insert it into AutoCAD according to the projection coordinates of the original map image to realize geographic visualization.

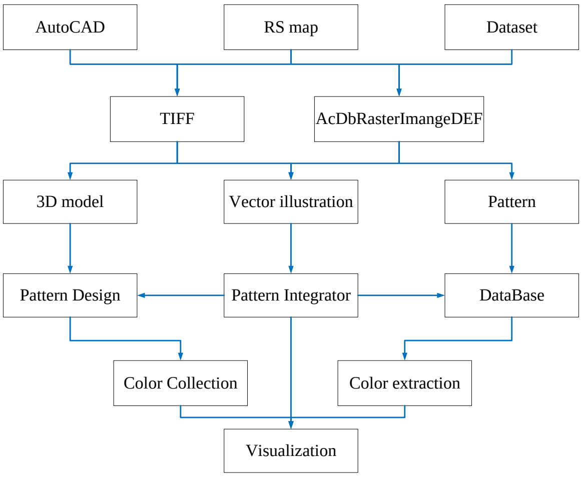

Figure 5: Process of inserting remote sensing image data into CAD after conversion.

The specific solution is to read the projection coordinates of the upper left corner of the image map by GDAL while opening the original remote sensing image data, and then read 6 affine transformation coefficients, image height, and width, and use these parameters to calculate the projection coordinates of the lower right corner of the image by the affine transformation formula. The affine transformation formula describes the mapping of the coordinates of the mapped image point to the geo-referenced space, and the formula is as follows.

$$X = \frac{GT(0) + X \times GT(1)}{Y \times GT(2)} \tag{1}$$

$$Y = \frac{GT(3) + X \times GT(4)}{Y \times GT(5)} \tag{2}$$

GT(0) and GT(3) are the coordinates of the upper left corner projection of the image map, GT(1) and GT (5) are the pixel width and height respectively, the coefficients of GT(2) and GT(4) are 0, Xpixel and Ypixel are the image height and width respectively. ObjectARX development processing raster image reference needs to call acISMobj17.dec module, in the initialization program to load it, with to unload it. This article refers to the raster image file path to create an image definition object, add it to the AutoCAD database dictionary, and then create an image entity object, associate it with the image definition object, added to the model space or drawing space, then create an image definition object reactor, and finally use the previously saved spatial position data set to insert the base point and crop rectangle, manipulate the transformed map image according to projection The coordinates are inserted into AutoCAD, and the map is finally visualized.

In this paper, we loaded the ARX application based on GDAL, converted the original remote sensing image to TIFF format raster image, and inserted it into AutoCAD according to the projected coordinates, the effect is shown in Figure 6. Comparing and analyzing geographic features and display effects of the two maps, we can see that a better image data conversion is achieved, and accurate map visualization is carried out concerning the projection coordinates.

Figure 6: Schematic representation of remote sensing image maps before and after data conversion.

3.4 CAD Remote Sensing Image Data Conversion Algorithm Process Visualization Implementation

The purpose of scientific research is a better application, therefore, the examination of the process visualization model of remote sensing image classification algorithms in practical applications is one of the essential aspects. This study introduces the application of the process visualization model of the remote sensing image classification algorithm mentioned above in real algorithms and projects. It also briefly describes the performance of the model in the application of the model in specific projects. Compared with the traditional classifier, SVM performs better in the case of small training samples. Of course, in the case of a small number of training samples, a small increase in the number of samples can speed up the classification efficiency of SVM. Therefore, the SVM-based image classification algorithm is generally suitable for training environments with a high dimensional number and low sample size.

The accuracy index of this image classification algorithm is calculated based on the equal number of training samples and test samples selected uniformly from the images in the sample extraction target. The number of selected samples is listed in Figure 7.

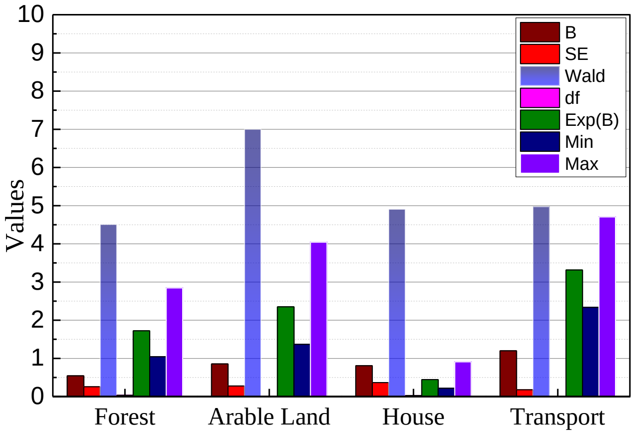

Figure 7: Sample description.

This paper designs and implements a multi-platform display and flexible organization of scene models for a specific area of the garden landscape construction and virtual display system, using Oculus Rift as a device for virtual experience, to achieve an immersion remote sensing image scene display, and uses the university library garden area as a case study, and specifically builds a corresponding garden landscape, and carries out the Multi-faceted virtual display. As shown in Figure 8, we need to consider the ornamental characteristics, ecological functions and aesthetic art and other characteristics of the landscape vegetation, a complete remote sensing image landscape system needs to achieve the scientific and technical unity of the landscape, with basic geographic data and thematic element data as support, to form a three-dimensional simulation of the overall art effect diagnosis and interpretation of the landscape platform. For the new demand of remote sensing image landscape construction and virtual display system, through the data organization, 3D modeling and scene rendering as well as a virtual display, the conceptual model of the landscape system based on OSG graphics rendering engine and parametric modeling is proposed.

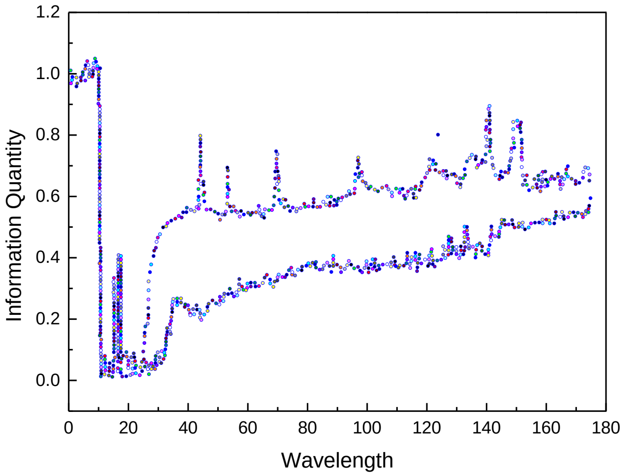

Figure 8: Influence of color distribution of remote sensing images on data conversion.

The immersion virtual display of a remotely sensed image scene in a virtual reality device is the process of re-drawing an organized remotely sensed image scene in a virtual reality helmet display device, especially for virtual reality immersion display devices, because it is an immersion virtual display of the scene through a binocular lens, so it usually requires a secondary rendering or copy rendering of the scene texture to achieve binocular scene Simultaneous display. For scene rendering, texture repainting rendering is a key step, and for different rendering engines. As shown in Figure 9, in the virtual reality display module of this paper, the second rendering method is applied for the texture redrawing of the scene.

As shown in Figure 10, oculus supports the calculation of device pose to predict the texture drawing delay, to improve the overall stability of the scene in the helmet display device, through a specific function to obtain the helmet pose and frame drawing time, the information is passed to the texture eye pose array RenderPose, the next frame texture prediction processing. After texture rendering, the module calls functions to destroy the mirror textures built during the rendering process, swap texture buffers and corresponding process objects to prevent memory overflow and other errors.

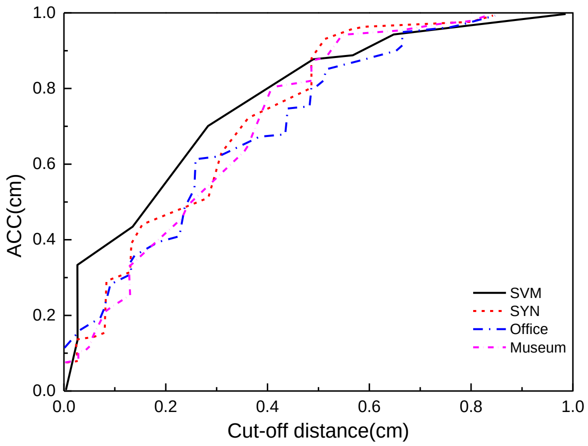

Figure 9: Final model integrity assessment.

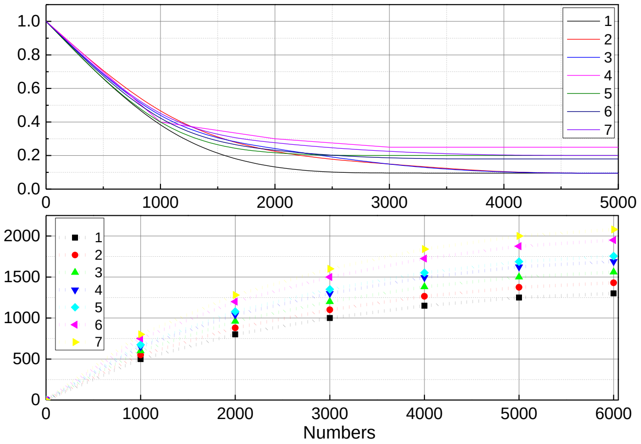

Figure 10: Effect of the number of iterations of the remote sensing image data transformation model on the visualization results.

4 CONCLUSION

This paper provides a detailed description of the techniques related to process visualization and remote sensing image classification algorithms, analyzes and compares existing visualization techniques, and proposes a method for process visualization of remote sensing image classification algorithms based on the general characteristics of a variety of remote sensing image classification algorithms. This paper provides a brief introduction to the basic techniques and concepts of remote sensing image classification algorithms, a brief overview of the process visualization techniques, and well a brief introduction to the visualization evaluation techniques. This paper provides a detailed description of the basic processes of several existing commonly used image classification algorithms, including remote sensing image classification processes based on statistical analysis, SVM-based remote sensing image classification processes, and remote sensing image classification processes based on multi-source data fusion. Based on the functional similarity and consistency of these processes, a set of general remote sensing image classification algorithm process is summarized, which covers a series of steps from the pre-processing of remote sensing images, sample selection and training of classification targets, feature extraction and selection of classification targets, specific classification discriminating process, and finally the evaluation of the results and accuracy of the classification algorithm.

In general, this paper completes the complete research process of concept-method-model-application, takes the features of remote sensing image classification algorithms as a starting point, completes a more systematic study of the theory of process visualization, and draws specific conclusions. Given time and effort, the authors' current research on process visualization for remote sensing image classification algorithms has been described in detail in this paper. In this paper, there are still shortcomings in some details of the process visualization method, and in the future work and learning will continue to develop more in-depth research from the following aspects, to further study the functions and processes in the business process visualization modeling method, as well as to enrich and develop the degree of adaptation of the visualization modeling method to variability, and to expand the use of this modeling method.

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