Research Article

Monitoring and Mathematical Model Analysis of Dynamic Changes in Land Resources Based on SAR Sensor Image

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The monitoring and analysis of dynamic changes in land resources can detect the changes of land aimed at a single-band or multiband remote sensing image of multiple phases in a given region or target with image processing methods and can also extract the change information and realize remote sensing monitoring through the comprehensive analysis of multiphase remote sensing images. Synthetic aperture radar (SAR) image change monitoring technology, with the advantages of high resolution, high precision, real-time service, and rapid imaging, can achieve qualitative or quantitative analysis of targets and is gradually widely used in quarterly monitoring, emergency monitoring, postbatch verification, law-enforcement inspection and land inspection, and other remote sensing data acquisitions and analyses. Therefore, on the basis of summarizing the research results of previous research works, this paper expounded the current situation and significance of the researches on the monitoring and analysis of dynamic changes in land resources; elaborated the development background, current situation, and future challenges of SAR sensor data; introduced the methods and principles of band setting, polarization mode, geometric correction, and image filtering; proposed the status target identification of land resources; explored the dynamic information discovery of land resources; conducted the dynamic change monitoring of land resources based on SAR sensor data; analyzed the basis and characteristics of SAR sensor data; performed the generalization and optimization of land resource information; demonstrated the dynamic change analysis of land resources based on SAR sensor data; compared the acceptance ability and accuracy of SAR sensor data; and discussed the discovery and extraction of dynamic information of land resources. The results show that the SAR sensor data can monitor the characteristics of scattering points in land resource observation scenes and can obtain the change information of ground object by distance component and band component, so that the SAR system can make two-dimensional imaging of land resources directly in front of the receiving platform. Thus, the SAR data obtained by multisystem parameters shows great application potential in land resource monitoring, which provides the possibility of decoupling to remove land resources and surface roughness and thus provides possible solutions for land resource analysis in complex environment. The results of this paper provide a reference for the follow-up studies on the monitoring and analysis of dynamic changes in land resources based on SAR sensor data.

1. Introduction

Over time, the utilization of land resources will also change. The dynamic information of land resource changes is mainly including the land type, specific location, related quantity, and other relevant data, and this information is necessary to grasp some content in a timely manner, which is conducive to the rational and sustainable development of land resources [1]. The monitoring and analysis of dynamic change of land resources refer to the single-band or multiband remote sensing images of multiple phases given in the same region or the same target, and the use of image processing methods to detect the change of land and materials in the area can be used, and the change information can be extracted through the comprehensive analysis of multiphase remote sensing images to realize a comprehensive technology of remote sensing monitoring [2]. The SAR sensor data takes into account image pixels and texture characteristics, two values are combined with the results of different methods of homologous SAR, and the final dynamic change results of land resources are obtained by multisource SAR variation map fusion. Whether it is in civilian use, such as climate

and natural changes, vegetation, and forest changes, or in the military, such as strategic and tactical target change monitoring, strike effect monitoring has a wide range of applications [3]. In the new land survey technology and remote sensing technology with its rapid, punctual, and accurate extraction of relevant land use change information, land survey with dynamic monitoring has been widely used, and the scientific management of related land resources and rational and effective use are of great significance [4].

Synthetic aperture radar (SAR) image change monitoring technology refers to the use of SAR images from different periods in the same region to obtain information on changes in the target of the ground and further achieves qualitative or quantitative analysis of the target [5]. The SAR sensor data has the ability to penetrate clouds and fog all day; all-weather, fast imaging has obvious advantages; can be applied to quarterly monitoring, emergency monitoring, post-approval verification, law enforcement inspection and land inspection, and other remote sensing data acquisition; and increasingly gets a high degree of attention [6]. The use of SAR sensor data to obtain reliable dynamic changes in land resources requires the establishment of an effective separation of land resources and surface roughness contribution model. The monitoring and analysis of dynamic changes in land resources are characterized by some features, texture features, line features, wavelet features, etc., commonly used in SAR images. With the increasingly abundant SAR sensor data acquisition, the SAR sensor data obtained by multisystem parameters shows great application potential in land resource inversion, which provides the possibility of coupling to remove land resources and surface roughness, thus providing a possible solution for the inversion of land resources in complex environments [7]. However, the technology is prone to phase aliasing in large deformation areas, and according to the existing phase, a solution algorithm can not restore the deformation, resulting in SAR deformation monitoring gradient which is limited, and can not obtain accurate deformation information [8].

Based on the summary and analysis of previous research results, this paper expounded the current situation and significance of the researches on the monitoring and analysis of dynamic changes in land resources; elaborated the development background, current situation, and future challenges of SAR sensor data; introduced the methods and principles of band setting, polarization mode, geometric correction, and image filtering; proposed the status target identification of land resources; explored the dynamic information discovery of land resources; conducted the dynamic change monitoring of land resources based on SAR sensor data; analyzed the basis and characteristics of SAR sensor data; performed the generalization and optimization of land resource information; demonstrated the dynamic change analysis of land resources based on SAR sensor data; compared the acceptance ability and accuracy of SAR sensor data; and discussed the discovery and extraction of dynamic information of land resources. The detailed chapters are arranged as follows: Section 2 introduces the methods and principles of band setting, polarization mode, geometric correction, and image filtering; Section 3 conducts the dynamic change monitoring of land resources based on SAR sensor data; Section 4 demonstrates the dynamic change analysis of land resources based on SAR sensor data; Section 5 discusses the acceptance ability and accuracy of SAR sensor data and the discovery and extraction of dynamic information of land resources; Section 6 is conclusion.

2. Methods and Principles

2.1. Band Setting and Polarization Mode. The distance direction and orientation of the forward-looking single-base SAR are not orthogonal or near orthogonal, the distance line and the band line cannot be in the rectangle or near the rectangle to divide the observed scene, and the intersection of the same isothermal line and band line is not unique, which means that the scattering characteristics of these area scattering points cannot be obtained according to the distance component and band component, thus obtaining the fact that the single-base SAR cannot achieve two-dimensional imaging [9].

Time function and probability integration method are the classical theoretical models for studying the dynamic change of land resources, which have been applied in a large number of practical applications, and their equations can be expressed as

$$A(x) = \frac{a_x - b_x}{c(x) - d(x)}. \tag{1}$$

In the formula, $A(x)$ in the formula is the final change value of the surface point; a_x is the transient change value of the surface point in time x; b_x is the deformation gradient of adjacent cell x; $c(x)$ and $d(x)$ are the deformation values and edge lengths of the cell x, respectively.

Because in a real scene, the perspective of the observed object is simulated by the SAR emulator, there are multiple transformation relationships with the real scene. Therefore, the one-dimensional optimization problem in the match function becomes an optimization problem:

$$B(x) = \frac{|x_i - x_j|}{(e_x + f_x) - [g(x) + h(x)]}. \tag{2}$$

In the formula, $B(x)$ is the two-dimensional conversion vector of the image during registration; x_i is the width of the building; x_j is the length of the building; e_x is the incident angle; f_x is the azimuth; $g(x)$ is the resolution; $h(x)$ is the distance resolution.

For even distribution, the criteria for classification at all levels are the equidistant distance evenly between the maximum and minimum values. In general, all images can be balanced by histograms, so that the distribution function meets even distribution:

$$C(x) = \frac{A(x)}{B(x) + 1} \lim_{n \to \infty} \sum_{i=1}^{n} \frac{k(x) - l(x)}{m(x) + o(x)}. \tag{3}$$

In the formula, $C(x)$ is the grayscale of the point where the image is located in a particular class, which varies with

the change of the class; $k(x)$ is the target change; $l(x)$ for the incident angle of the SAR sensor; $o(x)$ for the energy contributed to the ground scattering echo.

The isometric and band lines of the dual-base SAR system constitute approximate orthogonal segmentation of the forward observation scene, and the same isometric and band lines have only unique intersections, which means that the scattering characteristics of scattering points in the observation scene can be obtained using distance components and band components, thus demonstrating that the forward-looking dual-base SAR system can perform two-dimensional imaging of the front scene of the receiving platform. Because the receiver's beam direction of exposure and its track direction in one direction, so the receiver motion so that the echo in the slow time domain to produce a stable band, almost no band spread wide.

2.2. Geometric Correction and Image Filtering. The backward scattering information of bare surface radar is jointly affected by the parameters of land resources and radar system. Therefore, the use of SAR sensor data to obtain reliable dynamic changes in land resources requires the establishment of an effective separation of land resources and surface roughness contribution model. With the increasingly rich SAR sensor data acquisition, the SAR sensor data obtained by multisystem parameters shows great application potential in land resource inversion, which provides the possibility of decoupling to remove land resources and surface roughness and thus provides a possible solution for the inversion of land resources in complex environments [10].

A remote sensing image is assumed as a collection of pixels $X = \{x_1, x_2, \cdots x_n\}$, the dynamic change monitoring method of land resources based on SAR sensor data is to make similar measurements of the grayscale characteristics of each pixel in the differential image and the cluster center obtained in real time and constantly iterate on the target function until the convergence condition is reached, and the fuzzy classification results of the image data are obtained; the target function is represented as follows:

$$D(x) = \frac{1}{t} \int_{i=1}^{n} \left[\frac{q_x}{\sqrt{p(x)}} - \frac{s_x}{\sqrt{r(x)}} \right]. \qquad (4)$$

In the formula, $D(x)$ is the x-th pixel in the equation belongs to the first class; $p(x)$ is the cluster center of the x-th class; q_x is the local probability marked at x-th class; $r(x)$ is the neighborhood system of pixels in s-th class position; t is the weighted index of fuzzy membership.

In higher resolution images, dynamic changes in land resources are usually represented by sleek curves with a certain width and basic constant, so the monitoring operator function of dynamic changes in land resources in SAR images is defined as

$$E(x) = \frac{\alpha + \beta - 1}{\alpha\beta} \left[\frac{v(x) - w(x)}{y(x) - z(x)} \right]. \qquad (5)$$

In the formula, $E(x)$ depends on the size of the contrast

between the land and the surrounding background; $v(x)$ is determined by the uniformity of the grayscale values of the land pixels, $w(x)$ and $y(x)$ are the mean and standard deviation of the category x data; $z(x)$ is the area of the shadow area where the building or ground target does not return energy; α is one-way scattering from the front wall; β is a single scattering returned from the roof of a building.

According to the analysis method of dual-base SAR ad lance resolution based on spatial fuzzy function, it is learned that the ad directional resolution of dual-base SAR can be expressed as

$$F(x) = \frac{1}{\gamma + 1} \sqrt{\frac{G_x - H_x}{I_x - J_x}}. \qquad (6)$$

In the formula, $F(x)$ is synthetic aperture time; G_x and H_x are the speed and direction of the transmitter's flight angle around the target point, respectively; I_x and J_x are the receiver's angular speed and direction around the target point, respectively; γ is the unit vector of target point.

In order to remove the effect of surface roughness on land resource inversion, multifrequency, multiangle, and multipolar SAR sensor data are used in land resource inversion research in different environments. The basic principle of this method is that radar backward scattering information with different frequencies, different incident angles, and different polarization methods has different degrees of sensitivity to land resource parameters, and SAR sensor data obtained by different system parameters can effectively characterize land resource parameters affecting radar backward scattering information, so as to achieve reliable inversion of land resources. On the side of the building that deviates from the SAR sensor, part of the ground is obscured by the building, creating a black shadow area.

3. Monitoring of Dynamic Changes in Land Resources Based on SAR Sensor Data

3.1. Status Target Identification. The main differences between SAR sensor data and traditional optical data are as follows: first, nonvisible light—imaging is not time-limited; second, active remote sensing—the image is actually the ground object reflection and scattering imaging radar emission electromagnetic wave echo intensity combination information; image characteristics and optical data are very different. Therefore, the application of SAR sensor data not only is influenced by surface roughness, dielectric characteristics, geometry, and other factors but also changes due to the different basic settings of sensors, which directly affect the effective determination of land cover and land use status. The dielectric characteristics are related to the chemical properties and observation frequencies of the composition of the target substance, and the larger the dielectric constant, the stronger the echo intensity [11]. The error of SAR sensor data is caused by the difference of imaging spectrum and imaging method, and the physical significance of the backward scattering of various types of earth objects and image recognition has its own unique laws. Surface roughness is

directly related to wavelengths, different types of exposed soil, etc., with weak backscatter or mirror reflection, no echo signal, and dark areas on the image. The characteristics are obvious due to the strong reflection or mirror reflection of microwaves by buildings and linear man-made objects, and the different angles of microwave incident produce geometric deformation of the composition. Figure 1 shows the monitoring and analysis framework of dynamic changes in land resources based on SAR sensor data.

The postclassification comparison method is to classify remote sensing images of different phases independently and then compare and analyze the results of classification, detect the change information of the object of interest, and provide the information of the type of change. If the category label for the corresponding pixel is the same, the pixel is considered unchanged; otherwise, it is considered to have changed, because different time phase images are classified independently. However, many scholars have compared and analyzed the principles and application results of these methods and found that the results obtained by different change monitoring methods are very conflicting, and even there is a conflict between the conclusions supported by quantitative accuracy estimation, which occurs because the data, environment, and purpose of the application are different, and the results are not comparable to a large extent. This shows that there is no optimal change monitoring method in the general sense, and the choice of change monitoring method depends on the analyst's understanding of the method, the processing skills of remote sensing data, the characteristics of the data used, and the specific situation of the study area. The SAR imaging mechanism is different from multispectral remote sensing images, so the general image change monitoring method is directly used for SAR image processing, which may not be able to achieve the ideal effect.

The extraction algorithm of the dynamic change characteristics of land resources is based on the fact that on any kind of the SAR sensor data image, the target of interest always has edges or corners, and this part of the image mostly shows the characteristics of strong reflection, which is easier to determine. Texture feature is important and difficult to describe in the dynamic image processing of land resources, and it is customary to refer to the local irregular and macroregular characteristics in the image as texture feature [12]. From the experience of perception, it can be seen that roughness and direction are the two main characteristics used to distinguish texture, most of the texture algorithms are established in the specific use of statistical analysis methods, and the spatial grayscale layer symbiosis matrix is a commonly used statistical method. In low-resolution images, urban areas are due to the existence of a large number of residential areas, commercial areas, and strong reflectors, so that the dynamic change of land resources as a large area of bright areas and energy is large, and in these, bright areas will appear in the regular grayscale changes, so that the uniformity of the region is worse than other areas. Thus, on higher-resolution SAR images, the interior of the built-up area contains bright spots caused by buildings, interspersed with black land, shadows, and light gray patches caused by rough vegetation.

3.2. Dynamic Information Discovery.

Horizontal roof surfaces can generally be considered smooth, with strong reflections, and because the SAR sensor receives very few echoes, it appears black on the image. For tilted roofs facing a radar observation direction, the energy returned by its mirror reflection is easy to be received by radar, and the corresponding high grayscale value is shown on the SAR image. If a land type is missing, it is easy to misclassify it into other categories, resulting in the boundaries between the categories of land objects not properly divided, affecting the classification results. When the building wall faces the direction of the radar wave, the two-sided and three-sided angle reflection formed by the wall and the ground in the building area will also produce strong echoes, forming bright lines and bright spots on the image. The dynamic information discoveries of land resources based on SAR sensor data are shown in Figure 2. When using the traditional classification method classification, not only the built-up area category participates in the learning process of classification, but also the other types of land objects exist in the study area. When radar waves enter narrow streets, there are multiple scatterings between the walls and the ground of the building, rough surface scattering occurs on the lawns between buildings, and scattering waves scatter into the walls of buildings to form anisotropic secondary scattering, which is relatively weak.

The SAR sensor data takes into account image pixels and texture characteristics, two values are combined with the results of different methods of homologous SAR, and the final dynamic change results of land resources are obtained by multisource SAR variation map fusion. The integrity of low-resolution variation area, high-resolution change area edge structure information, and building area change information are reflected in the final change result, and the accuracy of change monitoring is significantly improved. Considering the image pixel characteristics and the dynamic change of land resources combined with mathematical morphological filtering and postprocessing, low-resolution SAR images can get the change graph quickly, and the change area is more complete inside, and the edge structure information is rich. Small gaps caused by speckle noise decrease within large areas of land resources, but data spots increase outside large areas [13]. This is due to the random distribution of coherent spot noise, which is reduced by pixel fusion in large-scale variation areas, while in small-scale variation areas, noise data complement each other and expand the range of influence. Especially in building areas, reflective structures similar to the two-sided angle are bright on the image, and change images extracted from texture features can have pseudochange information near the area.

Phase decomposition is required before the average calculation can be performed using the observation phase sequence within the subimage set. First of all, one scene image is selected as the main image inside the subimage set, and the other is interfered with the main image as the subordinate image. If the dynamic change of land resources is slow, the time domain one-dimensional phase is entangled directly to each SAR sensor data candidate point without the need for phase decomposition in a two-dimensional space. Phase-by-point tangle processing is done, and neighborhood
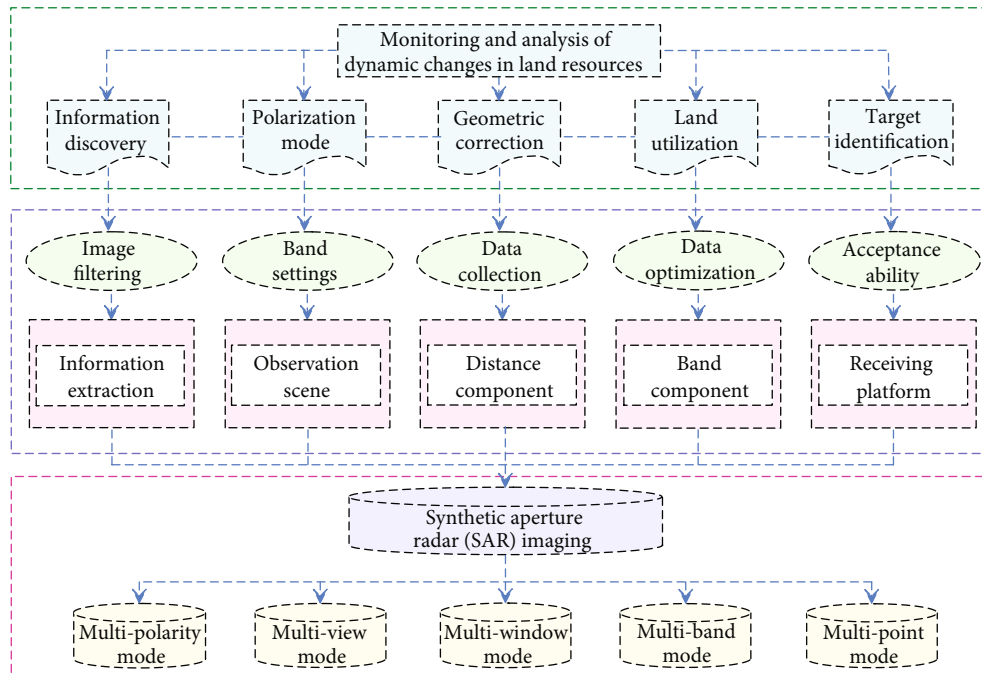
FIGURE 1: Monitoring and analysis framework of dynamic changes in land resources based on SAR sensor data.
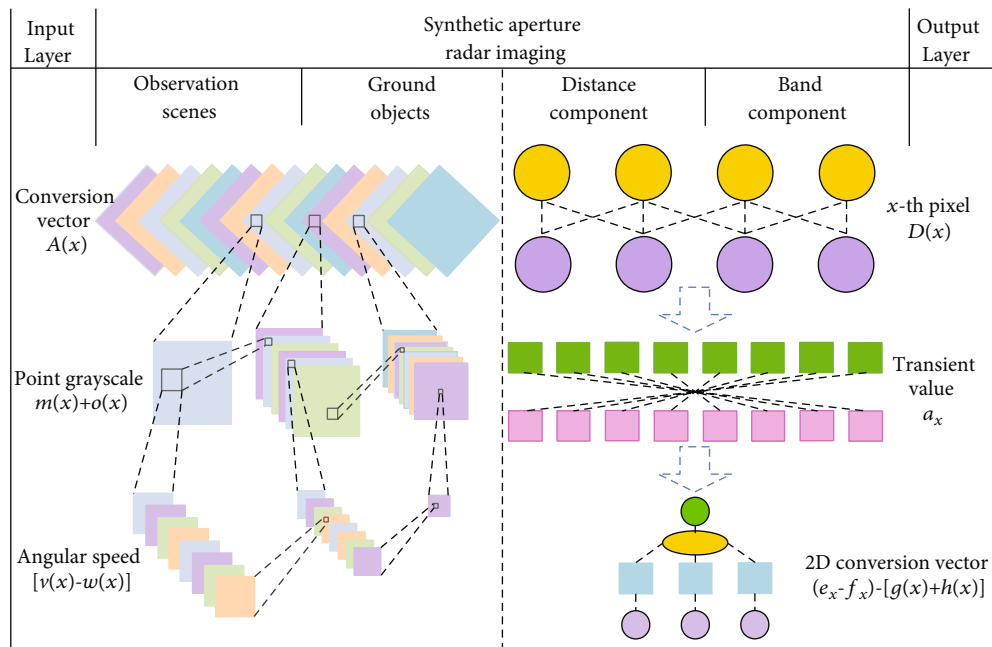

FIGURE 2: Dynamic information discoveries of land resources based on SAR sensor data.

differences are calculated to eliminate partially isolated deformation anomaly point targets [14]. However, there are great differences between ground-based SAR equipment and on-board SAR sensors in the algorithm and spatial relations of radar image imaging, system working mode, and the characteristics of the acquired radar image itself, so the time series star-borne SAR technology can not be directly used for the analysis and processing of ground-based SAR image sequence. The so-called stable point target of ground-based SAR can only be stable for a relatively short period of time, and it is more seriously affected by the meteorological disturbance of periodic fluctuations under the long sequence. Due to the difference between beam width and radiation geometry field of view, different from the on-board SAR image, there are a large number of false models in the ground-based SAR image.

4. Dynamic Change Analysis of Land Resources Based on SAR Sensor Data

4.1. Basis and Characteristics of SAR Sensor Data. At present, remote sensing technology with remote sensing digital terrain model as its core and spatial analysis as its prominent features provides new technical means for monitoring and analyzing the dynamic changes of land resources, such as using remote sensing images for the determination of airport construction and land resource range. In SAR imagery, typical urban structures are affected by overlay, secondary scattering, and shadow effects, which are related to the slope geometry of radar sensors [15]. This method first uses a machine learning method to detect building changes in high-resolution optical remote sensing images and then uses high-resolution synthetic aperture radar images to perform building height inversion and extract the height of new buildings. It focuses on the analysis of the image scattering characteristics of buildings in high-resolution SAR images, multiple reflections, and shadow effects, and on this basis, the algorithm of locating and estimating the height of buildings in SAR images based on spatial data is expounded. With the advance of the work surface, the maximum sinking point moves forward, the surface sinking volume is also increasing, while the left deformation gradient of the maximum sinking value is becoming larger and more stable, the right deformation gradient is smaller overall, but the influence range is expanding, further explaining that the surface deformation gradient changes with the progress of mining (Figure 3).

The SAR image change monitoring is to study the changes between the same scene images at different time periods. Image changes mainly detect changes in radiation values and local textures. These changes may be caused by the real changes in the image scene, or by changes in irradiation angle, atmospheric conditions, sensor accuracy, and ground humidity, and an important application of image data obtained from airborne and on-board SAR is change monitoring. The basic premise of using SAR image data for change monitoring is that changes caused by random factors are divided from changes in radiation values or local textures caused by changes in the observation scene target itself. On the on-board SAR image, the built-up area exhibits similar image features, but due to the low spatial resolution, smaller buildings have smaller bright spots, some of which are only bright spots [16]. These random factors refer to atmospheric conditions, projection angle and angle of view, soil moisture, season, weather, tides, etc. As for the relationship between image magnitude and land distribution, $[k(x) - l(x)]$ is the difference between the target change and incident angle of the SAR sensor; $[c(x) - d(x)]$ refers to the relationship between deformation values and edge lengths of the cell; $[y(x) + z(x)]$ gives the mean and standard deviation of the category data (Figure 4). Some variation monitoring methods are premised on the assumption that the area of change caused by it is quite small; that is, changes in the surface will lead to changes in the intensity of the SAR image, and changes in the intensity of the image caused by changes in the surface will be much greater than changes caused by other factors.

The main source of SAR sensor data is the offset between the image in adverse to the center frequency of the echo signal band and the offset of the ground frequency at distance due to the difference in incident angle, which is the geometric decoy source of interference processing. Before the fine registration of the dynamic change of land resources, the filtering treatment of frequency domain, i.e., prefiltering, is needed to remove the geometric factors. Prefiltering is usually done in adverse direction and distance direction, respectively. The dynamic change analysis of land resources of medium and low-resolution optical remote sensing and passive microwave remote sensing is characterized by large scale, long-term sequence, multispectral, and high time resolution. However, for the application field of high-cold mountain land remote sensing at regional and basin scale, the optical land remote sensing product with high spatial resolution is not mature enough. In general, if the spectrum offset is too large, adverbial filtering should be carried out before registration, which can improve the accuracy of registration, while distance filtering must be carried out between the main form images after registration. The specific process of orientation and distance forward filtering is similar, starting with frequency domain analysis of the main image in and out of direction and then filtering out the nonoverlapping parts of the spectrum of the two through the band-pass filter.

4.2. Generalization and Optimization of Land Information. Because background and other changes even exceed the target in size and quantity, a large number of false alarms will be generated, reducing the performance of the monitoring system. In monitoring techniques, man-made targets are often modeled as tight areas with different spectral information than the background. When the background characteristics and targets are similar, the false alarm rate will be greatly increased, making the performance of the monitoring system very poor. The SAR image change monitoring technology based on clustering analysis can first cluster the prechange image and classify the pixel value of the original image. The simulation results show that the method can effectively distinguish the target or area of change from other changes in the background and can eliminate the influence of sensor position on it (Figure 5). If the distance is calculated for each point of each class in the image and then its threshold is selected based on a priori information and false alarm rate indicators, the area of change in the image can be initially calibrated and a binary graph can be generated based on the criteria for change and nonchange. Typically, remote sensing images have systematic background differences and, though not obvious, are important sources of false alarm rates. If there is a change within the class, a new value appears, the pixels within the class become a mixture, and their value distribution becomes wide, and the distance between these points is much larger than the background.

Figure 6 shows the distribution frequencies of land information values in geometric correction and image filtering. The monitoring and analysis of dynamic changes in land resources are characterized by some features, texture features, line features, wavelet features, etc., commonly used
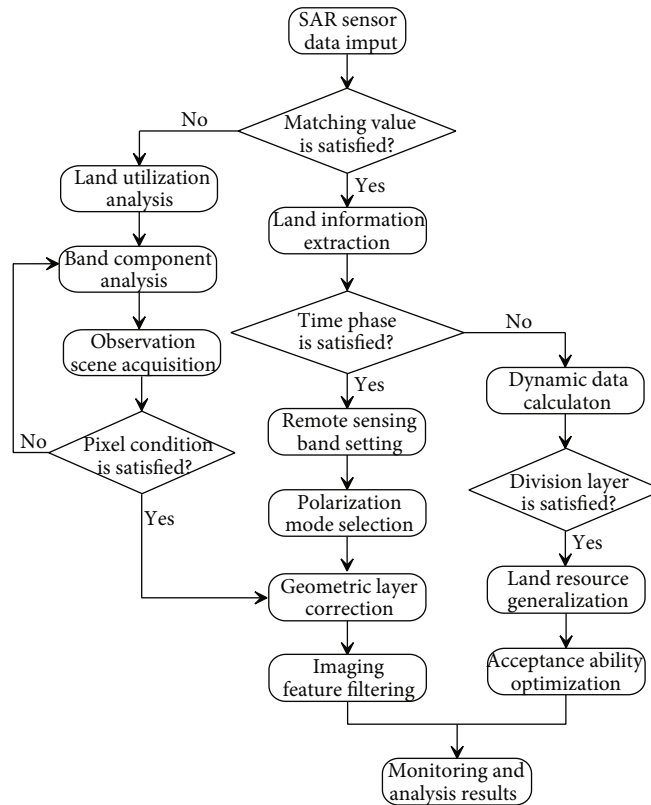
FIGURE 3: Flowchart of dynamic change analysis of land resources based on SAR sensor data.
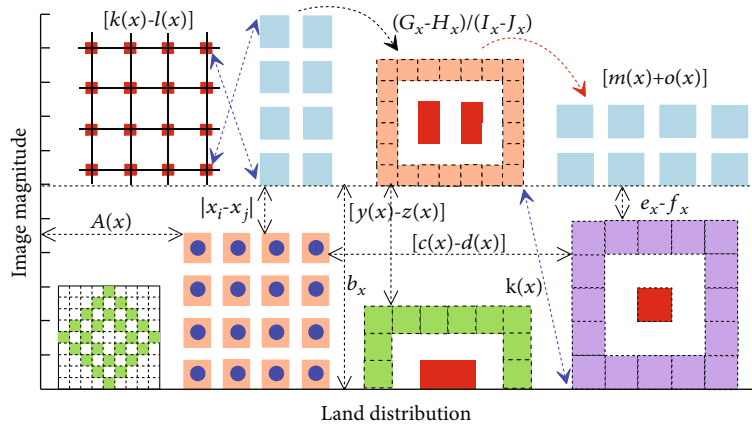

FIGURE 4: Basis and characteristic of SAR sensor data in dynamic change analysis of land resources.

in SAR images. Because SAR data have multiplier coherent spot noise, these features are better noise resistant than traditional pixel-based analysis. The disadvantage of wavelet method is that high frequency information in the dynamic change frequency domain of land resources is still part of the image, so the method of denoising in the frequency domain often loses the main information of the image. In addition, the frequency domain-based approach requires the conversion of the image of the airspace to the frequency domain processing, and then from the frequency domain to the airspace, the calculation is more complex [17]. The main

advantage of the method based on statistical distribution is that it is better to detect the edge region of the dynamic change of land resources, because the difference of local statistics between the two-phase images at the edge is more obvious. Most methods based on statistical distribution do not consider pixel values, so the monitoring effect of homogenous region of SAR image is poor, because the statistical distribution difference of homogenous region is small. In the land resource dynamic change monitoring task, the registration work of image preprocessing is very important to the result of change monitoring. If the registration is not

SAR system of multi-polarity mode

(a)

SAR system of multi-view mode

(b)

SAR system of multi-operating mode
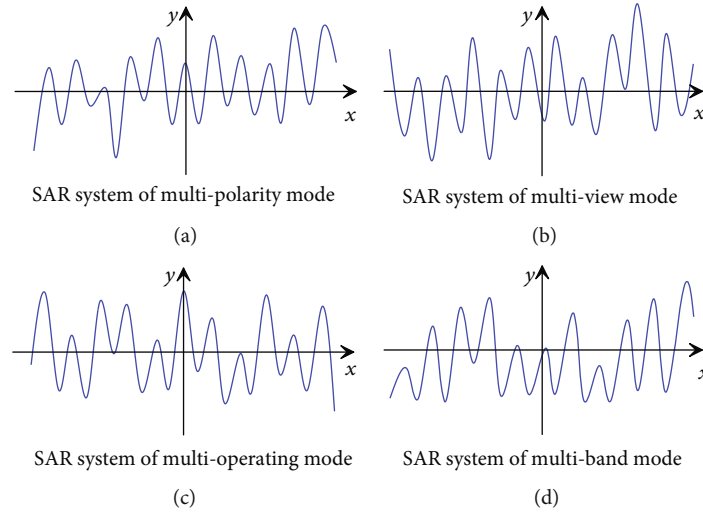
(c)

SAR system of multi-band mode

(d)

FIGURE 5: Generalization and optimization of land information based on SAR sensor data with multipolarity (a), multiview (b), multioperating (c), and multiband (d) modes.
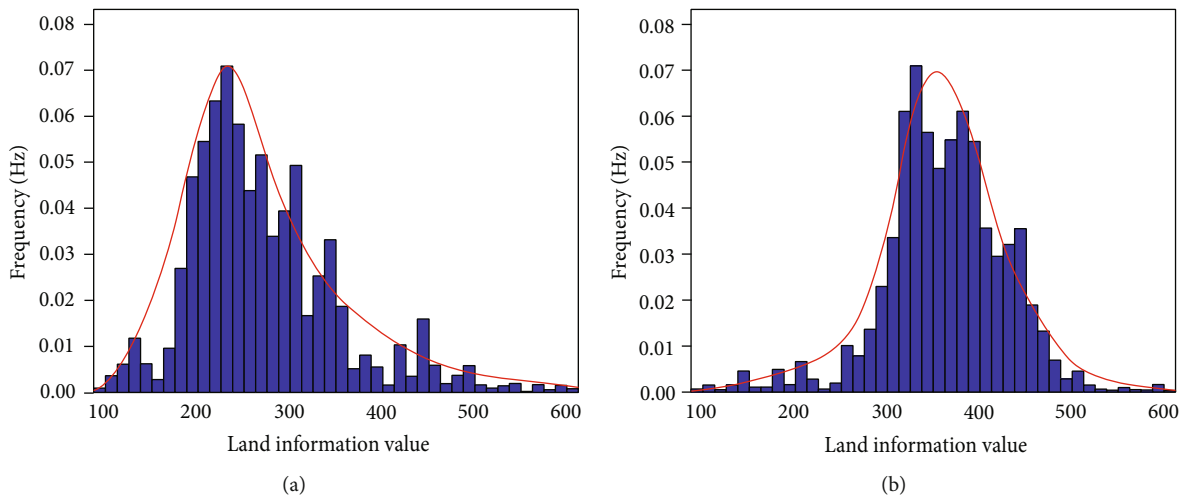

(a)

(b)

FIGURE 6: Distribution frequencies of land information values in geometric correction (a) and image filtering (b).

accurate, it will bring a lot of error to the change monitoring, so the advantages of line characteristics can reduce the error caused by registration change monitoring.

The SAR date is active remote sensing, subject to hardware technology; in the actual polarization SAR system, polarization radar emits pulsed partial polarization wave. In the process of interaction between electromagnetic waves and land resources, due to the dynamic changes of land resources, dielectric constant, direction, shape, position, and other factors, partial polarization phenomenon will also occur again, so that the polarization state of the echo changes. Especially because of the change of the shape, distribution, and movement of land resources, the way and degree of this polarization also change with time and place [18]. Compared with the polar SAR system, the advantage of polarization SAR technology lies in the ability to obtain more comprehensive electromagnetic wave polarization scattering characteristics of land resource targets and greatly

improve the ability to obtain various information on land resource targets. The SAR sensor imaging captures the process of scattering signals backward from a target similar to the scattering of visible light on the surface of an object. After the electromagnetic wave emitted by the radar antenna is acted by the target land resource, only a part of the signal reflecting the target's backward scattering characteristics is returned and received by the radar antenna and in the process of polarization SAR imaging. The land resource target exhibits different backward scattering characteristics to the incident electromagnetic waves in different polarization states, which is called polarization scattering mechanism.

5. Discussions

5.1. Acceptance Ability and Accuracy Increase of SAR Sensor Data. The SAR sensor data by generating a set of different scale images from differential images and using adaptive

method in the clustering process, through the guidance between the coarse scales to the fine scale, enhances the robustness and detail retention of speckled noise and improves the overall accuracy of monitoring. It is a new attempt to reduce speckle noise interference while keeping the details as much as possible in SAR image change monitoring. However, the classical model still regards the SAR image as a smooth image, which is equivalent to the effect of the assumption that the clustering center in the algorithm is constant in SAR image change monitoring, and cannot effectively handle the slow change in the local area, which is very detrimental to maintaining the details of the image [19]. With the increase of the number of filters, the detail information is gradually missing, but the regional consistency is better and the noise interference is getting weaker and weaker. From the point of view of image segmentation, the result of getting better regional consistency and maintaining more detail is the effectiveness of the method. Then combined with the different characteristics of various scale images in detail and noise resistance, by selecting a certain number of different scale images for processing, multiscale information can be fused into the algorithm, and how to use this multiscale information rationally will be a key to the algorithm. The dynamic monitoring rates of five typical scenes of land resources based on SAR sensor data are shown in Figure 7.

Band, multipolarity, multiview, and multioperating mode earth observation can fully quantitatively analyze the radar scattering characteristics of ground targets, while the improvement of spatial resolution and time resolution is beneficial to the resolution of time-related and small area changes. In addition, it is also an important research topic to ensure the stability of SAR system parameters and the high quality of images. The SAR images have overhead inversion, shadow, space, and time correlation and noise caused by various reasons, which makes data processing very difficult, and the efficiency and quality of data processing are directly related to the actual application of SAR. Compared with other methods of monitoring the dynamic changes of land resources, the SAR can provide not only high-resolution images and topographical data of regions but also high-resolution seismic and seismic deformations, which is beyond the reach of other methods. Combined with signal processing, image processing, pattern recognition, spatial geodesy, digital photography, and engineering mathematics, the key technologies such as high-precision automatic registration, deleveling effect, quality improvement of interference phase decomposition, and precise correction of pitch or ground distance data have been studied and made significant progress, making the application of SAR simpler and more convenient and gradually becoming a practical method for surface deformation monitoring [20].

Dynamic changes in land resources are dark in low-resolution SAR images and bright colors in high-resolution optical images, and it is obviously pointless to compare them directly or features. However, the SAR imagery and optical imagery are different ways of describing the same scene, and it is from the electromagnetic characteristics of the target imaging, and optical image is the target of the spectral
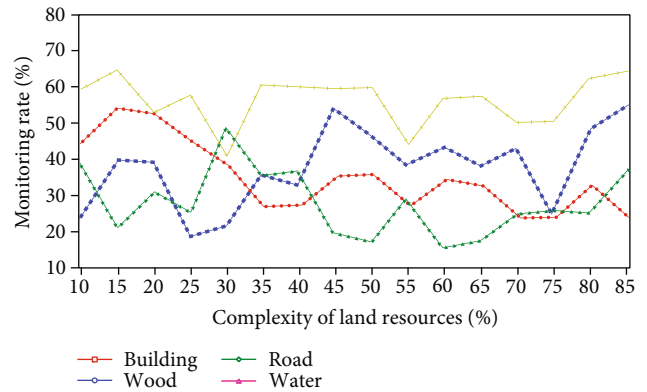

FIGURE 7: Dynamic monitoring rates of five typical scenes of land resources based on SAR sensor data.

characteristics of imaging; there is a certain degree of transformation between the two to communicate each other's types of objects. The monitoring and analysis of dynamic changes in land resources based on SAR sensor data map the two-time feature pair to a common feature space, which makes them directly comparable. The multiresolution land resource dynamic change monitoring framework combines the feature learning based on a depth structure with the feature change analysis method based on mapping learning to achieve efficient change monitoring of multisource and multiresolution remote sensing images. Although radar image and optical imaging mechanism are different, they image the target from electromagnetic and spectral characteristics, respectively, but there are different ways of portraying the same scene, and based on the learning of mapping neural networks to establish a mapping relationship between the two, so it is comparable in the feature space.

5.2. Discovery and Extraction of Dynamic Information on Land Resources. The dynamic change monitoring of land resources is the key to data update, considering that in the actual process of urban reconstruction and expansion where it is often a part of the land changes, a linear characteristic of the change monitoring method is proposed. When extracting land networks from the SAR sensor data, because the model uses segmented continuous curves to approximate the actual smooth land curves, land network data is usually described in a vector data structure [21]. The location of land is determined by the same series of coordinates; the points represented by coordinates are sampled by smooth land curve intervals (Figure 8). Therefore, in the change monitoring, the single land feature in SAR sensor data is used as the change monitoring unit, which matches the segment between the two coordinate points in the land feature and the land segment of fusion monitoring in remote sensing image, and determines whether the original data should be corrected or new land features added. This change information is integrated into the SAR sensor database, the land in the land layer is corrected, and the land that is extracted by the remote sensing image fusion is considered new land and added to the land layer.
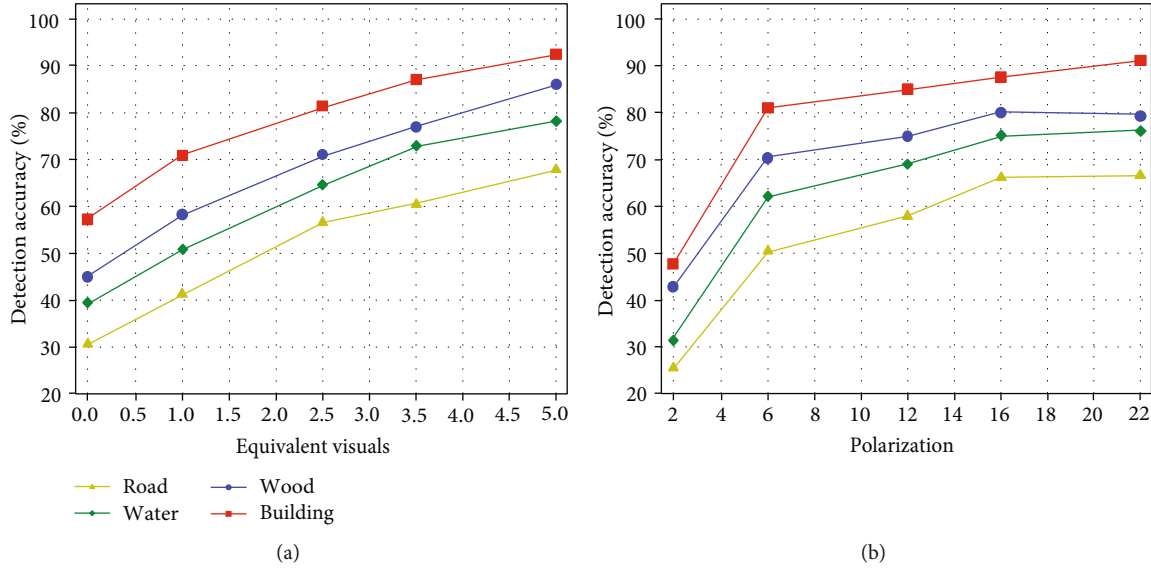
Figure 8: Relationships between detection accuracy and equivalent visuals (a) and polarizations (b) in five typical scenes of land resources based on SAR sensor data.

The purpose of a decimal transformation of tiles detected by dynamic changes in land resources is to change the multiplier noise in the image into added noise. Due to the coherent imaging mechanism of SAR images, there is a co-coherent spot noise of multiplier in the image, which is usually unevenly distributed. The decimal transformation operation of the slice can effectively suppress the coherent spot noise and transform the multiplier model into the added model on the one hand and compress the dynamic range of the grayscale of the image on the other hand, so as to reduce the influence of the pixels with large grayscale values in the image [22]. Clustering hypothesis means that dynamic changes in land resources belonging to the same cluster are likely to have the same markers, under which the decision boundaries of the classifier should, as far as possible, pass through the areas of the data domain and away from the denser areas in the data domain, avoiding dividing samples of the same class into two categories in the decision interface, which reveals the overall characteristics of the decision function. In the study algorithm of monitoring the dynamic change of land resources based on clustering hypothesis, the main function of unlabeled samples is to help identify sparse and dense areas of data distribution in sample space and then to guide the semisupervisory learning algorithm to adjust the decision boundaries learned using marked samples so that they can pass as sparsely as possible through the sparse areas in the data domain.

The SAR images reflect the information reflected by ground objects on radar beams, mainly grayscale images formed by the backward scattering information of ground objects to radar emission signals. Scattering index is called backward scattering coefficient; the factors affecting backward scattering coefficient are divided into two main categories: first, the operating parameters of radar system, such as working wavelength, incident angle, and polarization mode. Because the water surface fluctuates so much, it can cause a

very large backward scattering coefficient, or even a reflective signal that is too strong, and the radar receiver is oversaturated, which can render very bright areas in the SAR image. For example, some classifiers tend to obtain the highest overall accuracy of all categories, while the category of interest may be only one of the smaller categories, and the overall accuracy of the best does not guarantee the best accuracy of the category of interest. Threshold segmentation is a simple and effective method of image segmentation, which is recognized as the same type of object within the same threshold range. The threshold segmentation method is simple to calculate and very efficient, but the noise resistance is weak.

6. Conclusions

This paper conducted the dynamic change monitoring of land resources based on SAR sensor data, analyzed the basis and characteristics of SAR sensor data, performed the generalization and optimization of land resource information, demonstrated the dynamic change analysis of land resources based on SAR sensor data, compared the acceptance ability and accuracy of SAR sensor data, and discussed the discovery and extraction of dynamic information of land resources. It is a new attempt to reduce speckle noise interference while keeping the details as much as possible in SAR image change monitoring. Band, multipolarity, multiview, and multioperating mode earth observation can fully quantitatively analyze the radar scattering characteristics of ground targets, while the improvement of spatial resolution and time resolution is beneficial to the resolution of time-related and small area changes. The disadvantage of wavelet method is that high frequency information in the dynamic change frequency domain of land resources is still part of the image, so the method of denoising in the frequency domain often loses the main information of the image. In the change

monitoring, the single land feature in SAR sensor data is used as the change monitoring unit, which matches the segment between the two coordinate points in the land feature and the land segment of fusion monitoring in remote sensing image, and determines whether the original data should be corrected or new land features added. The results show that the SAR sensor data can monitor the characteristics of scattering points in land resource observation scenes and can obtain the change information of ground object by distance component and band component, so that the SAR system can make two-dimensional imaging of land resources directly in front of the receiving platform. Thus, the SAR data obtained by multisystem parameters shows great application potential in land resource monitoring, which provides the possibility of decoupling to remove land resources and surface roughness and thus provides possible solutions for land resource analysis in complex environment. The results of this paper provide a reference for the follow-up studies on the monitoring and analysis of dynamic changes in land resources based on SAR sensor data.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] M. Habibi, M. R. Sahebi, Y. Maghsoudi, and S. Ghayourmanesh, "Classification of polarimetric SAR data based on object-based multiple classifiers for urban land-cover," *Journal of the Indian Society of Remote Sensing*, vol. 44, no. 6, pp. 855–863, 2016.

[2] W. Lin, X. Liao, J. Deng, and Y. Liu, "Land cover classification of RADARSAT-2 SAR data using convolutional neural network," *Wuhan University Journal of Natural Sciences*, vol. 21, no. 2, pp. 151–158, 2016.

[3] A. Najafi and M. Hasanlou, "Land cover changes detection in polarimetric SAR data using algebra, similarity, and distance based methods," *Engineering Journal of Geospatial Information Technology*, vol. 6, no. 2, pp. 143–163, 2018.

[4] P. Iervolino, R. Guida, D. Riccio, and R. Rea, "A novel multispectral, panchromatic and SAR data fusion for land classification," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 12, no. 10, pp. 3966–3979, 2019.

[5] V. N. Fikriyah, "Mapping land cover based on time series synthetic aperture radar (SAR) data in Klaten, Indonesia," *Journal of Geography of Tropical Environments*, vol. 3, no. 2, pp. 12–21, 2020.

[6] M. Ohki and M. Shimada, "Large-area land use and land cover classification with quad, compact, and dual polarization SAR data by PALSAR-2," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 56, no. 9, pp. 5550–5557, 2018.

[7] P. Gonnuru and S. Kumar, "PsInSAR based land subsidence estimation of Burgan oil field using TerraSAR-X data," *Remote Sensing Applications: Society and Environment*, vol. 9, pp. 17–25, 2018.

[8] M. M. M. Pai, V. Mehrotra, U. Verma, and R. M. Pai, "Improved semantic segmentation of water bodies and land in SAR images using generative adversarial networks," *International Journal of Semantic Computing*, vol. 14, no. 1, pp. 55–69, 2020.

[9] G. Liu, J. Fan, F. Zhao, and K. Mao, "Monitoring elevation change of glaciers on Geladandong Mountain using TanDEM-X SAR interferometry," *Journal of Mountain Science*, vol. 14, no. 5, pp. 859–869, 2017.

[10] S. Yan, K. Shi, Y. Li, J. Liu, and H. Zhao, "Integration of satellite remote sensing data in underground coal fire detection: a case study of the Fukang region, Xinjiang, China," *Frontiers in Earth Science*, vol. 14, no. 1, pp. 1–12, 2020.

[11] B. Pradhan, S. Abdullahi, and Y. Seddighi, "Detection of urban environments using advanced land observing satellite phased array type L-band synthetic aperture radar data through different classification techniques," *Journal of Applied Remote Sensing*, vol. 10, no. 3, pp. 036029–36029, 2016.

[12] V. N. Mishra, R. Prasad, P. Kumar, D. K. Gupta, and P. K. Srivastava, "Dual-polarimetric C-band SAR data for land use/land cover classification by incorporating textural information," *Environmental Earth Sciences*, vol. 76, no. 1, p. 26, 2017.

[13] J. R. M. Florez and I. A. L. Salcedo, "Land cover classification at three different levels of detail from optical and radar sentinel SAR data: a case study in Cundinamarca (Colombia)," *Dyna*, vol. 87, no. 215, pp. 136–145, 2020.

[14] R. Nasirzadehdizaji, D. E. Akyuz, and Z. Cakir, "Flood mapping and permanent water bodies change detection using sentinel SAR data," *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. 4218, pp. 797–801, 2019.

[15] S. Mastrorosa, M. Crosetto, L. Congedo, and M. Munafò, "Land consumption monitoring: an innovative method integrating SAR and optical data," *Environmental Monitoring and Assessment*, vol. 190, no. 10, p. 588, 2018.

[16] C. Sukawattanavijit, J. Chen, and H. Zhang, "GA-SVM algorithm for improving land-cover classification using SAR and optical remote sensing data," *IEEE Geoscience and Remote Sensing Letters*, vol. 14, no. 3, pp. 284–288, 2017.

[17] J. Reiche, C. M. Souzax, D. H. Hoekman, J. Verbesselt, H. Persaud, and M. Herold, "Feature level fusion of multitemporal ALOS PALSAR and landsat data for mapping and monitoring of tropical deforestation and forest degradation," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 6, no. 5, pp. 2159–2173, 2013.

[18] K. Balasubramani, "Physical resources assessment in a semiarid watershed: an integrated methodology for sustainable land use planning," *ISPRS Journal of Photogrammetry and Remote Sensing*, vol. 142, pp. 358–379, 2018.

[19] M. Besoya, H. Govil, and P. Bhaumik, "A review on surface deformation evaluation using multitemporal SAR interferometry techniques," *Spatial Information Research*, vol. 29, no. 3, pp. 267–280, 2021.

[20] G. Duan, H. Gong, H. Liu, Y. Zhang, B. Chen, and K. Lei, "Monitoring and analysis of land subsidence along Beijing-Tianjin inter-city railway," *Journal of the Indian Society of Remote Sensing*, vol. 44, no. 6, pp. 915–931, 2016.

[21] Q. Meng, X. Wen, L. Yuan, and H. Xu, "Factorization-based active contour for water-land SAR image segmentation via the fusion of features," *IEEE Access*, vol. 7, pp. 40347–40358, 2019.

[22] A. G. Koppad, Syeda Sarfin, and A. K. Das, "A study on land-use and landcover classification using microwave data in Joida taluk of Uttara Kannada district, Karnataka," *Journal of Applied and Natural Science*, vol. 12, no. 1, pp. 9–12, 2020.