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FLOODED AREAS DETECTION TECHNIQUE USING CROSS NORMALIZATION METHOD

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Abstract- The problem of detection of flooded areas from multitemporal SAR images is addressed here. Different image processing methods for synthetic Aperture Radar (SAR) images have been presented in order to identify flooded areas after a flood event. Multitemporal image analysis methods are applied to a pair of SAR images, acquired on the same area at different times. SAR calibration is a very complex and sensitive problem; some errors may persist after calibration that interferes with subsequent steps in the data fusion and visualization process. "Cross-calibration/normalization," method is proposed to solve this problem. This, in turn, facilitates image enhancement and the numerical comparison of different images with data fusion and visualization processes. The proposed processing chain includes filtering, histogram truncation, and equalization steps applied in an adaptive way to the images. Fast-ready flooded maps have been generated by an RGB composition that is able to enhance the changes occurred. Pre-flood and post-flood images are combined into a color image to better identify the flooded areas in comparison with permanent water and other classes. "Fast-ready flood map," are very quickly and automatically generated without user interaction to support the authorities in providing first aid to the population.
Keywords – Flood detection, image enhancement, multitemporal synthetic aperture radar (SAR) imagery, RGB composition, Cross-calibration/normalization.

1. INTRODUCTION

Several countries experience fatalities, injuries, property damage, economic and social disruption resulting from natural disasters such as earthquakes, hurricanes, floods, volcanic eruptions. The interest in monitoring weather events is continuously increasing because of the numerous disasters occurred in the recent years in many countries. Radar images are typically best data for flood detection. Several studies demonstrated that Synthetic Aperture Radar (SAR) systems represent powerful tools for flood mapping because SAR can observe the Earth's surface during daytime and nighttime and even in cloudy conditions. The approach proposed here allows examining the affected areas to assess the damages, for providing first aid to the population and to plan for rescue operation. Multitemporal SAR images are very useful source of information for large amount of applications, especially for change detection and monitoring.

Timely and accurate change detection of Earth's surface features is important for understanding relationships and interactions between human and natural phenomena. Detecting the changes in the images of the same scene taken at different times has interested researchers to a large number of applications.

Synthetic Aperture Radar (SAR) sensors are optimally suited for providing reliable information on extensive floods, which provides the information even under rainy or at least cloudy conditions. Flood information is needed as quickly as possible to provide an overview of the situation and to improve the crisis management and response activities. For the purpose of flood risk and flood damage assessment, other flood related parameters than flooded area such as inundation depth and flood duration are required. Since these parameters cannot be derived directly from satellite data, additional information has to be included.

Multitemporal SAR data from the same area at different times are particularly useful for investigating damage. The changes exhibited by an image pair can be identified to generate an overall understanding of the phenomenon, which in turn can help relevant authorities to provide first aid and other assistance to the general population. Unlike in damage assessments and disaster prevention using satellite data, a very rapid response is mandatory in emergency situations.

Here a novel image preprocessing chain is proposed together with methods of data fusion and rendering for multitemporal images. The pre-event and post-event images are combined into a color composite image to better indicate the changes, integrating different information sources into a single display. This is referred to as the "fast-ready flood map". This is a flood picture generated automatically and very rapidly without any user interaction for use by the authorities.

The proposed preprocessing techniques, followed by the color image generation process, make it possible to obtain better and more easily understandable visual results than the original images. Thus, an extremely precise calibration or the cross-normalization of multitemporal images is required to facilitate the subsequent processing steps.

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Change detection based on ratioing requires much data preparation including data calibration. In most cases, multitemporal analysis has proven superior to single data approaches. Multitemporal analysis is only possible if the pair of images is radiometrically and spatially accurately registered. Thus an extremely precise calibration or the cross normalization of multitemporal images is required to facilitate the subsequent processing steps.
An important process used with SAR images is noise reduction. The filtering step reduces granularity due to the speckle noise present in SAR images and enables to obtain better results in subsequent steps. Different filters have been proposed, including the Lee, Frost, Enhanced Lee Frost filters and SRAD (Speckle Reducing Anisotropic Diffusion) filter.

2. DESIGN OF PROPOSED SYSTEM

The different processing steps involved in the generation of the flood maps. The overview for the proposed system is shown in Fig.1.,
The proposed preprocessing chain, followed by the color image generation process, makes it possible to obtain better and more easily understandable visual results than the original images, for a successive photo interpretation analysis aimed at identifying the changes that have occurred in the pair of images. The proposed self-normalization procedure can be used for image analysis or classification purposes, as well as during the training or modeling phases, and can be performed using more than two images. Images acquired in different acquisition modes from Cosmo/SkyMed satellites have been used for the experiments.

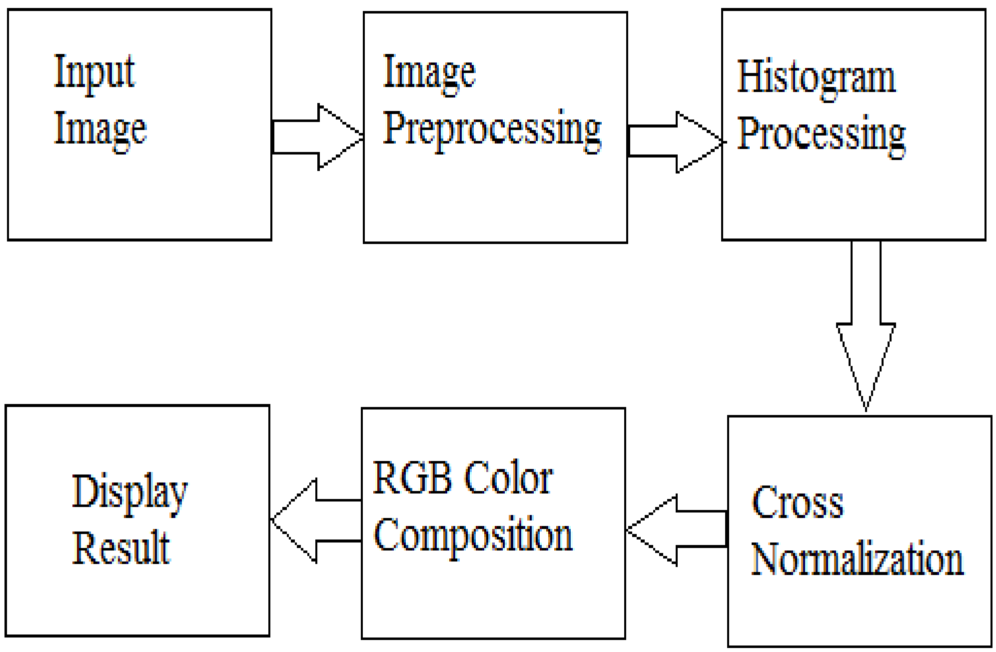

Fig.1. Overview of proposed system

RGB composition can be used to enhance regions of interest and as a preprocessing step intended to aid in identification, as in which the combination is based on textural features of images. RGB composition is used as a preliminary step in the change detection process to map flooded areas along with rivers. The color composite technique used with radar imagery relies upon basic principles related to surface roughness or smoothness and changes in the backscattering signal intensity of the surface conditions.
This method is unique because it involves an automatic adaptive self-normalization procedure that works with various sensor settings, because it makes calibration unnecessary, and because it works even when calibration errors exist. Thus, it is possible to use this method with different SAR sensors, imaging modalities, and spatial resolutions; no adjustments are necessary.
The proposed method includes several sequential steps used to generate fast-ready flooded maps: filtering, histogram clipping and equalization, and finally, the linkage of the inputs with RGB channels.

3. METHODOLOGY

The different processing steps and methodologies involved in the generation of the flood maps are shown in fig.2.,

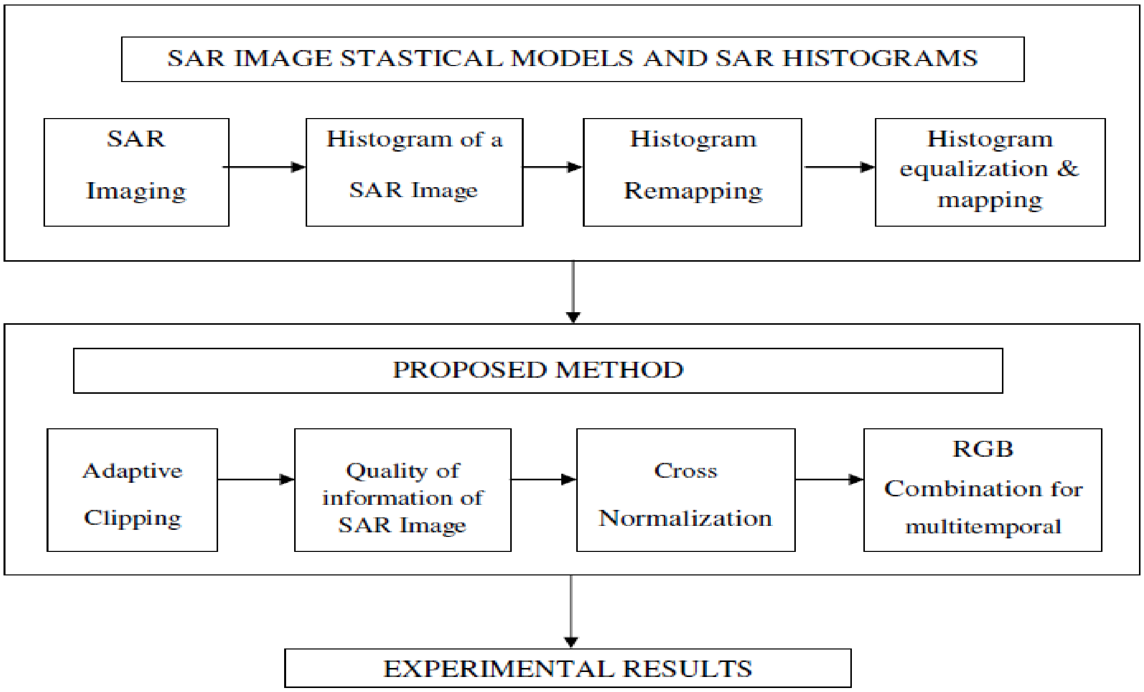

Fig.2. Proposed system

- SAR Imaging

Synthetic-Aperture Radar (SAR) is a form of radar whose defining characteristic is its use of relative motion, between an antenna and its target region, to provide distinctive long term coherent-signal variations that will be exploited to obtain finer spatial resolution than is possible with conventional beam-scanning means. SAR images have wide applications in remote sensing and mapping of the surfaces of both the Earth and other planets.

- Filtering

Speckle noise is a granular noise that inherently exists in and degrades the quality of the SAR images. It is caused by coherent processing of backscattered signals from multiple distributed targets. Filtering will helpful to remove the speckle noise present in the images. Several methods are used to eliminate the speckle noise, based upon different mathematical models of the phenomenon.

a) Multiple-look processing
Averaging out the speckle noise by taking several "looks" at a target in a single radar sweep.
b) Adaptive filters
Adaptive speckle filtering is better at preserving edges and detail in high-texture areas.
c) Non-adaptive filters
Non-adaptive filtering is simpler to implement, and requires less computational power. There are two forms of non-adaptive speckle filtering: one based on the mean and one based upon the median.
d) Speckle Reducing Anisotropic Diffusion (SRAD) method relies on the Instantaneous
Coefficient of Variation (ICOV) edge detector as a controller of diffusion rate near edges of regional structures. SRAD filtering approach has been used here.

-SRAD filter

SRAD can preserve edges even enhance edges; however this character or function highly depends on the precision of edge detecting. If the edge is not detected, the edge will not be enhanced and even smoothed. And if the noise is detected as edges, the noise will not be smoothed and even enhanced. So the performance of SRAD is sensitive to the selection of threshold value. Speckle noise is the grainy salt-and-pepper pattern present in radar imagery caused by the interaction of out-of-phase waves with a target. SRAD method relies on the Instantaneous Coefficient of Variation (ICOV) edge detector as a controller of diffusion rate near edges of regional structures.

- Histogram of SAR image

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance.

- Histogram remapping

The first step common to all histogram remapping techniques is the transformation of the pixel intensity values of the given image via the rank transform. The rank transform is basically a histogram equalization procedure which renders the histogram of the given image in such a way that the resulting histogram approximates the uniform distribution. Here, each pixel value in an N dimensional image I(x, y) is replaced with the index (or rank) R the pixel would correspond to if the image pixels were ordered in an ascending manner. For example, the most negative pixel value is assigned a ranking of 1 while the most positive value is assigned a ranking of N. the only difference is in the way the new, mapped pixel intensity values are computed and in the domain they are mapped to.

- Histogram Equalization and Matching

Histogram equalization is used to equally distribute the number of pixels between grey levels. This method usually increases the global contrast of many images. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values. The method is useful in images with backgrounds and foregrounds that are both bright or both dark.

- Adaptive clipping

Adaptive clipping is used to clip the signals which exceed the threshold region present in the peak region at histogram of SAR images. The adaptive clipping threshold value is selected by fixing the same percentile value for all data takes. All gray levels higher than this value are saturated via a clipping process. For two images at times t1 and t2, respectively, even if the two thresholds are different, the percentile values are the same.

- Entropy of the SAR image

This Shannon entropy measure quantifies the expected value of the information contained in a message and indicates the average information content of the random variable. To measure the uncertainty associated with the random variable corresponding to the image and evaluate the performance of the proposed method, we use the entropy measure.

- Cross-Calibration/Image Normalization

During Cross-Calibration/Image Normalization, the equalization process is helpful because it allows us to match all of the temporal channels to a unique, uniform, reference model, normalizing the different histogram distributions of the images. The aim is to match every processed image to the uniformly distributed image as well as possible by avoiding information loss and obtaining similar dynamics for all of the images. The metrics used to determine the quality of the processed images are entropy measures and goodness-of-fit tests.

- RGB composition of the multitemporal SAR image

When the temporal pair of images will be preprocessed, the images can be used to create the RGB composition. A multitemporal sequence of images will be combined, so that different colors identify flooded, dried, no-flooded areas and permanent water.RGB composition will used as a preliminary step before a change detection process which will helpful to map flooded areas along rivers. The color composite technique will use with radar imagery relies upon basic principles related to surface roughness or smoothness and changes in the backscattering signal intensity of the surface conditions. A rough surface will have a high radar backscatter coefficient value and will therefore tend to be bright, whereas a smooth surface will tend to be dark because of its low backscatter coefficient value resulting from a rather specular reflection response. Thus, changes in surface conditions will result in changes in colors from basic red (R), green (G), blue (B) to a resulting combination (yellow, cyan, and magenta).

4. CONCLUSION

This paper presents a overview of the proposed technique of Detection of flooded area using multitemporal SAR images. Here, cross normalization of the multitemporal images can be used for the identification of flooded areas gives a novel method to identify flooded area independent of acquisition parameters. The RGB composition will make it easier to identify the changes that have been occurred between the two acquisition dates. This paper provides an efficient way of identifying the flood affected areas.

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