SEGMENTATION OF LAKES FROM THE LOCAL BACKGROUND ON THE SURFACE OF TITAN USING CASSINI SAR IMAGES

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1. INTRODUCTION

The lakes of Titan, the largest satellite of Saturn, are bodies of liquid hydrocarbon that have been detected by the Cassini space probe, and had been suspected long before by the Voyager 1 and 2. The large ones are known as seas and the small ones as lakes. Synthetic Aperture Radar (SAR) images of Titan's surface reveal quasi-circular to complex shape lakes which vary from <10 to more than 100,000 km². Lake-like features are separated into 3 classes; dark lakes, granular lakes, and bright lakes. Dark lakes are interpreted as liquid filled while bright lakes are interpreted as empty basins. Granular lakes are inferred as transitional between dark and bright lake features. The morphology of lakes on Titan span the range of observed morphologies on Earth [1]-[3].

Cassini carries a multimode Ku-band (13.78 GHz, λ =2.17 cm) radar instrument designed to probe the surface of Titan and that of other targets in the Saturn system in four operating modes: imaging, altimetry, scatterometry, and radiometry. The Synthetic Aperture Radar (SAR) mode is used at altitudes under ~4000 km, resulting in spatial resolution ranging from ~350 m to >1 km. Images are acquired either left or right of nadir using 2–7 looks. A swath 120–450 km wide is created from 5 antenna beams. SAR coverage is dependent on spacecraft range and orbital geometry. Radar backscatter variations in SAR images can be interpreted in terms of variations of surface slope, near-surface roughness, or near-surface dielectric properties. The images obtained using SAR revealed that Titan has very complex surface [4]-[5].

The evidence that SAR-dark lakes are liquids is summarized because their morphology and relationship with fluvial features give strong evidence that the lakes are, or recently were, filled with liquids. The anomalously low radar backscatter (at times, the lowest the radar can see) implies that these areas are extremely smooth at the scale of 2.17 centimeters and, further, that very little or no energy is

backscattered from the lake volume itself. The presence of liquids at the polar regions is consistent with atmospheric and climatological models. The lakes' radiometric brightnesses, higher by several degrees than the surrounding terrain, are consistent with the high emissivity expected for a smooth surface with the low dielectric constant (1.7–1.9) of liquid ethane-methane solutions. However, it can be argued that the liquids hypothesis has yet to be tested conclusively [6].

The framework of this study is focused on automatic fast recognition of dark lake interest for Cassini SAR images. The intended goal is to label regions in an image as fast as possible, into two classes (dark lake and the local background). First, a filtering technique is applied to obtain the restored image. Then, a method of unsupervised segmentation is used. The Otsu's method which is based on the optimum threshold of histogram is used here.

2. FILTERING

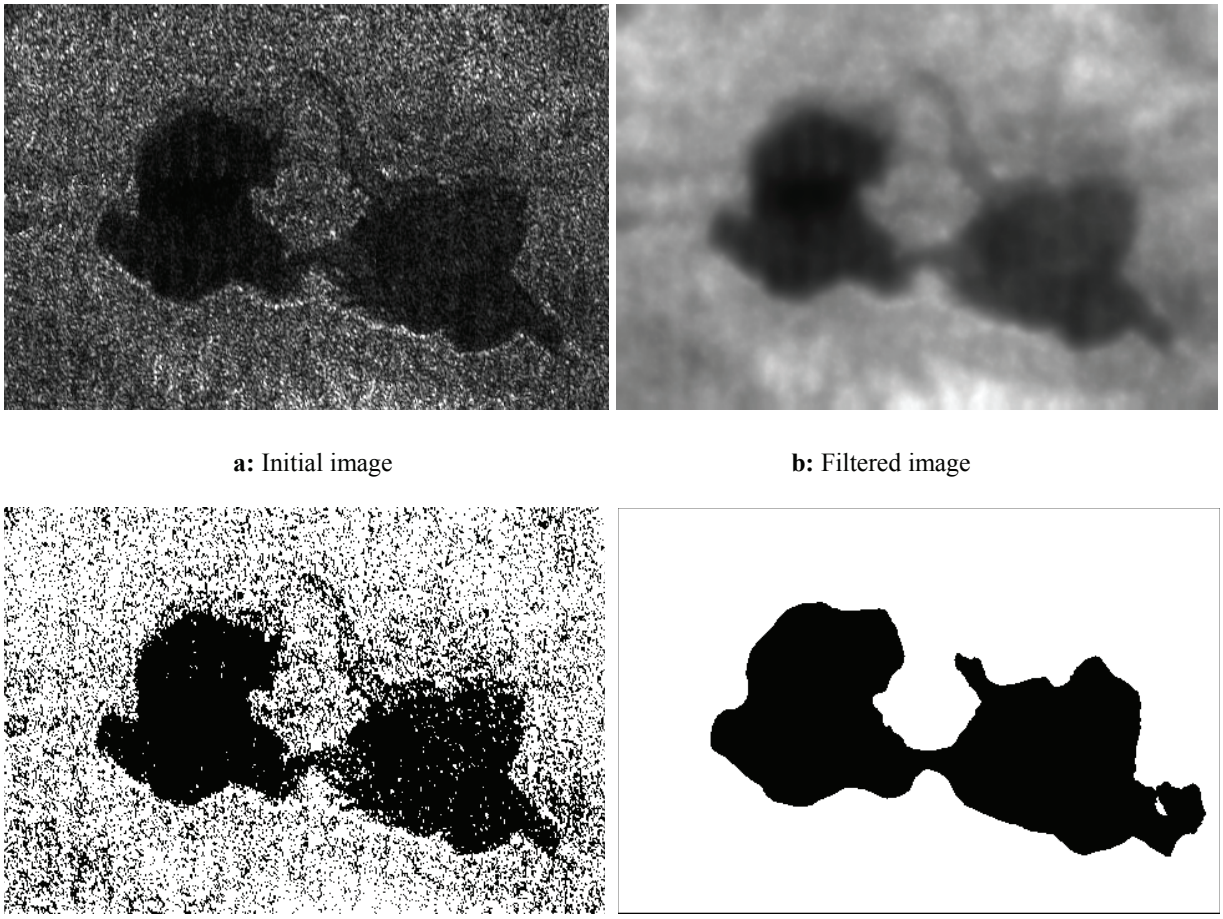
A filtering technique is applied to obtain the restored image. One of the major problems hampering the derivation of meaningful texture information from SAR imagery is the speckle noise. It overlays "real" structures and causes gray value variations even in homogeneous parts of the image. Our method is based on probabilistic methods and regards an image as a random element drawn from a prespecified set of possible images. The TSPR (Total Sum Preserving Regularization) filter used here is based on a membrane model Markov random field approximation with a Gaussian conditional probability density function optimized by a synchronous local iterative method. The final form of despeckling gives a sum-preserving regularization for the pixel values of the image. The TSPR method preserves the mean values of local homogeneous regions and decreases the standard deviation up to six times [7].

3. UNSUPERVISED SEGMENTATION

The unsupervised segmentation classifies the image automatically using a certain criterion. The despeckle filter can be used as intermediate stage for the extraction of meaningful regions that correspond to structural units in the scene or distinguish objects of interest [8]. The Otsu's method

detects the optimum threshold of histogram and separates the image in two regions of interest (two labels). Black is the label of dark lakes and white the label of the local background [9].

We begin with the Cassini SAR image of kissing lakes (PIA08740) which has dimensions 484x326 in pixel size and after using the despeckling filter TSPR we apply the segmentation method. We can see the results in figure 1.



a: Initial image **b:** Filtered image

c: Segmented image without filtering **d:** Segmented image after filtering

Figure 1: The image of kissing lakes (PIA08740)

4. CONCLUSIONS

The despeckling filter TSPR as a first stage gives a new restored image which can be easily segmented with an unsupervised or supervised method.

5. REFERENCES

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