# SEPARATION OF BUILT-UP AREAS USING POLARIZATION ORIENTATION FROM POLARIMETRIC SAR IMAGES

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## 1. INTRODUCTION

Polarimetric decomposition and classification are important applications for polarimetric synthetic aperture radar (POLSAR) images. Among many methods developed so far, entropy-anisotropy-alpha classification [1] and three component decomposition [2] are most popular. In an urban area analysis, it is found that the polarimetric analysis has a problem to identify built-up areas. With the three component decomposition technique, built-up areas are assigned to a strong volume scattering target. In order to extract built-up areas, the method based on polarimetric correlation coefficient in both linear and circular polarizations was proposed and its performance was demonstrated using X-band airborne POLSAR data [3]. When this method is applied to L-band POLSAR data from ALOS PALSAR, extraction of built-up areas is insufficient. In this paper, polarization orientation angle shifts are investigated to separate built-up areas.

## 2. THEORY

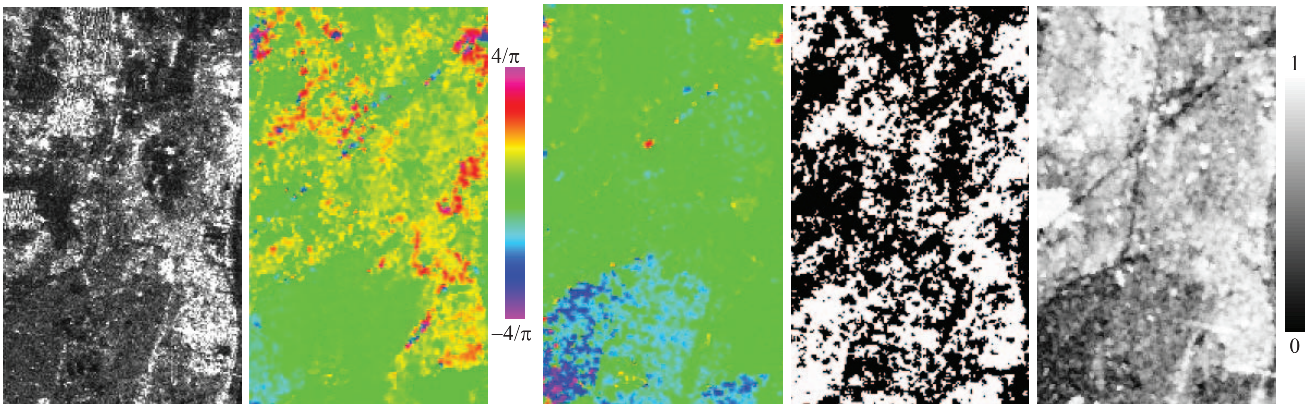
As a polarimetric feature of built-up areas in POLSAR images, the polarization orientation angle shift is known and is given from the scattering model [4].

$$\tan\theta = \frac{-\tan\alpha}{\cos\phi} \tag{1}$$

where $\alpha$ is the wall or street orientation angle, and $\phi$ is the radar incidence angle. From POLSAR data, it is calculated by the circular polarization method [5].

$$\theta = \mathrm{Arg}\left(-\left\langle O_{\mathrm{RR}} O_{\mathrm{LL}}^{*} \right\rangle\right) / 4 \tag{2}$$

where $O$ is the observed backscatter, R and L are the right and the left circular polarization, respectively. It is expected that level ground surface would have always around zero polarization orientation angle independently of the radar illumination direction. If more than two POLSAR images with different look direction (two opposite directions are excluded.) are available, separation of built-up areas and the level ground surface would be possible.




(a) (b) (c) (d) (e)

Fig. 1 Part of the results. (a) HH image from the descending orbit, (b) Polarization orientation angles from the ascending orbit, (c) Polarization orientation angles from the descending orbit, (d) Separated built-up area (white) and the level ground surface (black) by the proposed method and (e) Correlation coefficient of RR and LL polarizations from the descending orbit.

## 3. RESULTS

Two ALOS PALSAR images of the Atsugi area, Japan from ascending and descending orbits were used. Firstly, two polarization orientation angle images were generated using (2). Next, the two images were ortho-rectified, map-projected and registered. To separate built-up areas and the level ground surface, a certain criterion $c$ was applied to the polarization orientation angle from ascending orbit $\theta_a$ and that from descending orbit $\theta_d$.

- Built-up area: $|\theta_a|>c$ or $|\theta_d|>c$.
- Level ground surface: $|\theta_a|\leq c$ and $|\theta_d|\leq c$.

Part of the results is shown in Fig. 1. The comparison of an optical image and map (not shown here due to copyright) with the result by proposed method (Fig. 1(d)) and the correlation coefficient in the circular polarizations (Fig. 1(e)) indicates better performance of the proposed method than using only the correlation coefficient in the circular polarizations at L-band.

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