PALSAR SCANSAR SCANSAR
Interferometry

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Introduction

• L-band PALSAR strip mode with 70km swath can effectively achieve the deformation mapping even for the vegetation covered area. (Chuetsu-oki, Noto, Solomon, Iwo, Hawaii, etc.)

• PALSAR SCANSAR with 350km swath is more effective than the repetitive observations of the STRIP mode for global land observation. SCANSAR SCANSAR interferometry (SSI) is also important tool for the earth observation.

• Azimuth signal spectrum is the dispersive and transmission beam synchronization is mandatory for the SSI.

• PALSAR activation timing is controlled by 1 sec as the normal operation. This has been limiting the SSI for long time.

• Here, we conducted the experimental activation of the PALSAR for SSI performance evaluation. The target area was Africa (Sahara desert and Tanzania) and Amazon.

• We introduce the results of the first PALSAR SSI.
The Advanced Land Observation Satellite - ALOS

PALSAR
L-band (23.6 cm)
Synthetic Aperture Radar Polarimetry
Dual Polarization
SCANSAR

Launch: 24 Jan. 2006
PALSAR SCANSAR

WB1 : Bw 14 MHz, 5 SCANs, 3 looks ~ 7 looks, 120 Mbps

WB2 : Bw 28 MHz, 5 SCANs, 1~ 3 looks, 240 MHz
Timing block diagram (1)

Timing allocation block diagram
SSI condition

2D spectrum (range and azimuth) should be the same.

Assumption
10 % allowance for azimuth spectrum

\[ \Delta T_s < 0.1 T_s \sim 0.014 \text{ s.} \sim 90 \text{m} \]

Where, 1st scan, \( T_s \sim 0.2 \text{ s} \)

Corresponding position allowance is 90m

Power spectrum of the SCANSAR in azimuth (spectrum diversity).
Expression for the ground target point ($r_p$)

\[ f_d = \frac{f_{PRF}}{nn} i \left( -\frac{nn}{2} \leq i < \frac{nn}{2} \right) \]

\[ f_d = \frac{2}{\lambda} \left( v_s - v_p \right) \cdot \frac{r_p - r_s}{\|r_p - r_s\|} \]

\[ z = F(r_p) \]

\[ \frac{x_p^2}{R_a^2} + \frac{y_p^2}{R_a^2} + \frac{z_p^2}{R_b^2} = 1 \quad (i.f. \ z = 0) \]

$f_d$: Doppler frequency

$f_{PRF}$: Pulse repetition frequency

$nn$: burst numbers

$r_p$: position vector of the pixel

$r_s$: position vector of the satellite

$z$: height of the target

$F()$: function giving the height

$v_s$: satellite velocity

$v_p$: target point velocity

$i$: azimuth address
InSAR processing Routine (SPECAN)

Master

- Telemetry: Doppler Model
- Range compression
- Curvature
- SPECAN (Azimuth)

Slave

- Telemetry: Doppler Model
- Range compression
- Curvature
- SPECAN (Azimuth)

Doppler model: \( f_D = a_0 + a_1 \cdot r + a_2 \cdot r^2 \)

Co-registration

\[ e^{j\varphi} = \frac{\langle a \cdot b^* \rangle}{\sqrt{\langle a \cdot a^* \rangle \cdot \langle b \cdot b^* \rangle}} \]

output

summing(box car)
n-look processing

Bp correction
Terrain correction

\[ r_g' = a + b \cdot r_g + c \cdot a_z \]
\[ a_z' = d + e \cdot r_g + f \cdot a_z \]
Sample result of the InSAR products output from the Browse InSAR processor (SPECAN) : Functionality test
Results of Browse-InSAR (2006/8/2-2006/5/2)
(Specan processing@SIGMA-SAR)
Results from FBS DinSAR: 2006/8/2-2006/5/2: Bp=80m
(Correlation processing@SIGMA-SAR)
Operational constraints and achievement for PALSAR SSI

1) Normal operation
   • T1 is 1s unit. (Even same latitude is set for the first transmission, 7km dislocates at maximum)
   • prf is tabulated every 100 m height.

   \[
   \text{SSI could be done by chance (But, never realized the SSI)}
   \]

2) Special operation
   • Specify the followings
     Latitude of argument
     Five prfs

   [Note: Latitude of augment from GPS is biased (0.993km).]

   \[
   \text{SSI can be done.}
   \]
SCANSAR SCANSAR InSAR experiments
Duration April 2 - April 17 2008
Sites: Sahara, Tanzania, Amazon
Mode WB1 and WB2

<table>
<thead>
<tr>
<th>Master</th>
<th>Slave</th>
<th>Mode</th>
<th>Result</th>
<th>Area</th>
<th>Bp</th>
<th>BS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/2</td>
<td>2/16</td>
<td>WB1</td>
<td>NG</td>
<td>Different location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/5</td>
<td>2/19</td>
<td>WB1</td>
<td>NG</td>
<td>Different location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/9</td>
<td>2/23</td>
<td>WB2</td>
<td>NG</td>
<td>Differs in prf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/10</td>
<td>2/24</td>
<td>WB1</td>
<td>OK</td>
<td></td>
<td>228m</td>
<td>80%</td>
</tr>
<tr>
<td>4/13</td>
<td>2/27</td>
<td>WB1</td>
<td>NG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/14</td>
<td>2/28</td>
<td>WB1</td>
<td>NG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/15</td>
<td>2/29</td>
<td>WB1</td>
<td>NG</td>
<td>Differs in prf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/17</td>
<td>3/2</td>
<td>WB1</td>
<td>OK</td>
<td></td>
<td>168m</td>
<td>50%</td>
</tr>
<tr>
<td>4/14</td>
<td>2/28</td>
<td>WB2</td>
<td>NG</td>
<td>Large Bp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SCANSAR parameters: Beam synchronization

\[ \Delta p_j = \frac{L_0_j}{L_j} \]

<table>
<thead>
<tr>
<th>No</th>
<th>Pulses</th>
<th>PRF</th>
<th>Duration(s)</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>247</td>
<td>1692.0</td>
<td>0.146</td>
<td>0.993</td>
</tr>
<tr>
<td>2</td>
<td>356</td>
<td>2369.7</td>
<td>0.150</td>
<td>1.02</td>
</tr>
<tr>
<td>3</td>
<td>274</td>
<td>1715.2</td>
<td>0.160</td>
<td>1.09</td>
</tr>
<tr>
<td>4</td>
<td>355</td>
<td>2159.8</td>
<td>0.164</td>
<td>1.15</td>
</tr>
<tr>
<td>5</td>
<td>327</td>
<td>1915.7</td>
<td>0.171</td>
<td>1.16</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>0.791</td>
<td>5.38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case</th>
<th>Master</th>
<th>Slave</th>
<th>Bp</th>
<th>Δp</th>
<th>Lo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20080410</td>
<td>20080224</td>
<td>228m</td>
<td>0.8</td>
<td>800m</td>
</tr>
<tr>
<td>2</td>
<td>20080417</td>
<td>20080302</td>
<td>168m</td>
<td>0.5</td>
<td>1500m</td>
</tr>
</tbody>
</table>
Location of the test paths
Amplitude

April 10 - Feb. 24

Bp=200m
BeamS~80%

Tanzania

350km
Flat earth corrected fringe
Deformation (cancelled for the low frequency)
RSP325
Sahara
2008/4/17-
2008/3/2
Bp=\sim 100m
BeamS=\sim 50\%
Conclusions

PALSAR SCANSAR SCANSAR SCANSAR Interferometry has been examined and succeeded by conducting the beam synchronization with the previous images.

The parameters are the PRFs and augment of latitude for the first scan.

Two examples out of 9 examples show that 80% and even 50% of the beam synchronization can produce the SSI over the dense forest and desert of Africa.

It promises that PALSAR can provide the SCANSAR SCANSAR SCANSAR Interferometry for wide range of the target, i.e., earthquake, Antarctica, Greenland monitoring.

Further research
Correction of the SCAN-SCAN phase offset
Correction of the atmospheric error and orbital errors.
Improvement of the processing speed
Trial for Full aperture type processing