DOCUMENT

Instruction of OpenSARShip

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Version	**1.0**
Date	**23rd March 2017**
Distribution	**Open**
Source	**http://opensar.sjtu.edu.cn/.**

Contents

Instruction of OpenSARShip

OpenSARShip is organized in different folders which corresponding to different scenes of images. In each folder, there contains four subfolders providing four formats of ship chips, one Ship.xml, one Metedata.xml, and one ReadMe.pdf. Figure 1 gives an example of the content for a specific image.

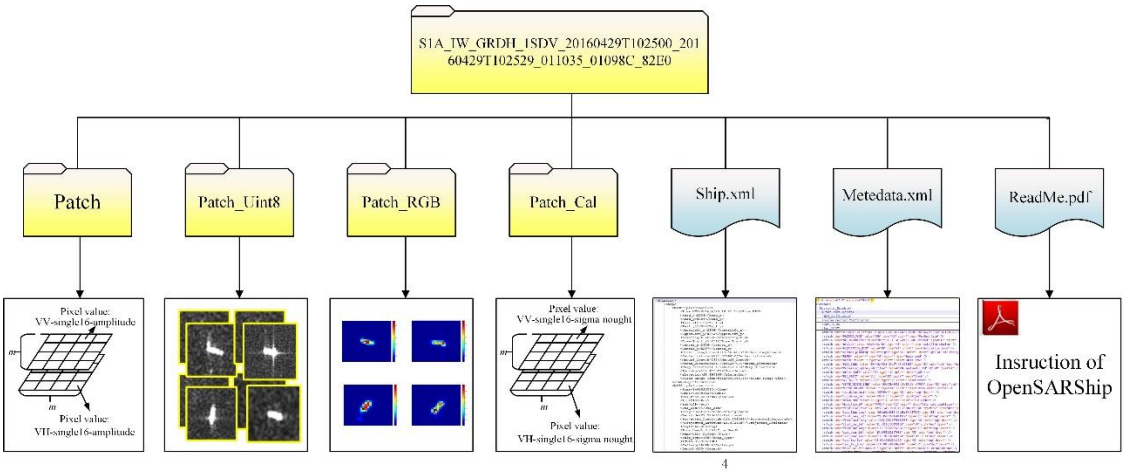

Figure 1. Organization of OpenSARShip

1. Introduction of ship chip

For each Sentinel-1 SAR image, four subfolders provide four formats of ship chips: original data, calibrated data, visualized data in pseudo-color, and visualized data in grey scale, respectively, so as to satisfy different requirements of users. Ship chips are named by pixel coordinates for the convenience of retrieval.

1.1 Size of ship chip

The determination of the chip size is illustrated in Figure 2， where A(x_1, y_1) and B(x_2, y_2) represent the pixel coordinate of ship head and ship tail (with 180 degree ambiguity), and point O indicates the center of the ship. Then we calculate the value of $|x_1 - x_2|$ and $|y_1 - y_2|$, respectively, and choose the larger value multiplied by 2 to get d. Finally, taking point O as the center of chip, we get a square chip with the length of $2d$.

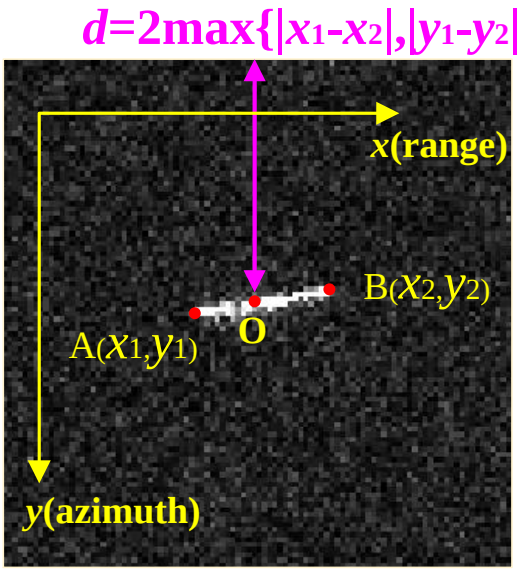

Figure 2. The size of the ship chip

1.2 Patch

For Patch folder, filenames can be identified with the following code: NNN_xHHH_yVVV.tif, where NNN indicates the ship type (cargo, tanker, fishing, et al.) reported by AIS, HHH is the pixel coordinate in x-axis, and VVV is the pixel coordinate in y-axis.

OpenSARShip database contains two modes of products, the first one is Sentienl-1 interferometric wide (IW) ground range detected (GRD) product, the other one is Sentienl-1 interferometric wide (IW) single look complex (SLC) product.

1.2.1 GRD

The original data format (stored in single-precision values) of GRD ship chip is illustrated in Figure 3. Via inputting the ship chip in MATLAB, we get a $m \times m \times 2$ dimension matrix, in which $(x, y, 1)$ indicates the pixel amplitude value of VH channel, and $(x, y, 2)$ indicates the pixel amplitude value of VV channel.

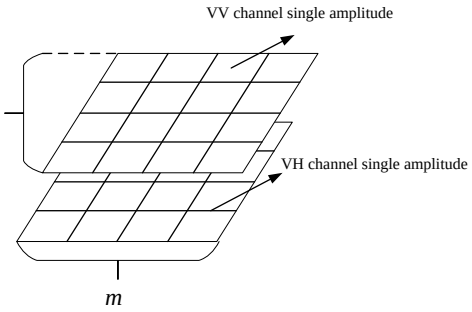

Figure 3. Data format of GRD ship chip

1.2.2 SLC

The original data format (stored in single-precision values) of SLC ship chip is illustrated in Figure 4. Via inputting the ship chip in MATLAB, we get a $m \times m \times 4$ dimension matrix, in which $(x, y, 1)$ indicates the real part value of pixel for VH channel, $(x, y, 2)$ indicates the imaginary part value of pixel for VH channel, $(x, y, 3)$ indicates the real part value of pixel for VV channel, and $(x, y, 4)$ indicates the imaginary part value of pixel for VV channel.

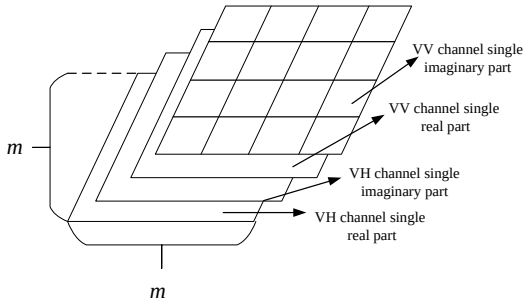

Figure 4. Data format of SLC ship chip

1.3 Patch_Cal

For Patch_Cal folder, filenames can be identified with the following code:
NNN_xHHH_yVVV.tif, where NNN indicates the ship type (cargo, tanker, fishing, et al.) reported by AIS, HHH is the pixel coordinate in x-axis, and VVV is the pixel coordinate in y-axis.

We apply SNAP3.0 Toolbox to get radiometric calibrated product. The radiometric calibrated data format of ship chip is illustrated in Figure 5. Via inputting the ship chip in MATLAB, we get a $m \times m \times 2$ dimension matrix, in which $(x, y, 1)$ indicates the

pixel normalized radar cross section (NRCS) value σ_0 of VH channel, and $(x, y, 2)$ indicates the pixel NRCS value σ_0 of VV channel.

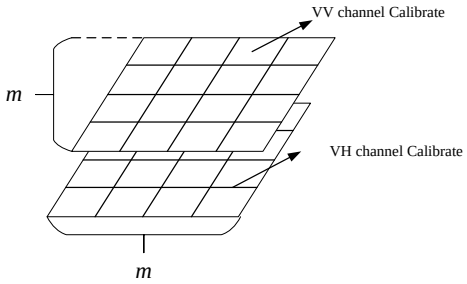

Figure 5. Data format of calibrated ship chip

1.4 Patch_RGB

For Patch_RGB folder, filenames can be identified with the following code: NNN_xHHH_yVVV_pp.png, where NNN indicates the ship type (cargo, tanker, fishing, et al.) reported by AIS, HHH is the pixel coordinate in x-axis, VVV is the pixel coordinate in y-axis, and pp indicates the polarization (vh/vv) of ship chip.

Based on the calibrated ship chip, we employ MATLAB ColorMap (jet) to visualize ship chip with Pseudo color. As shown in Figure 6, for each ship chip, the RGB visualized ship chip are provided with VH and VV channel, respectively.

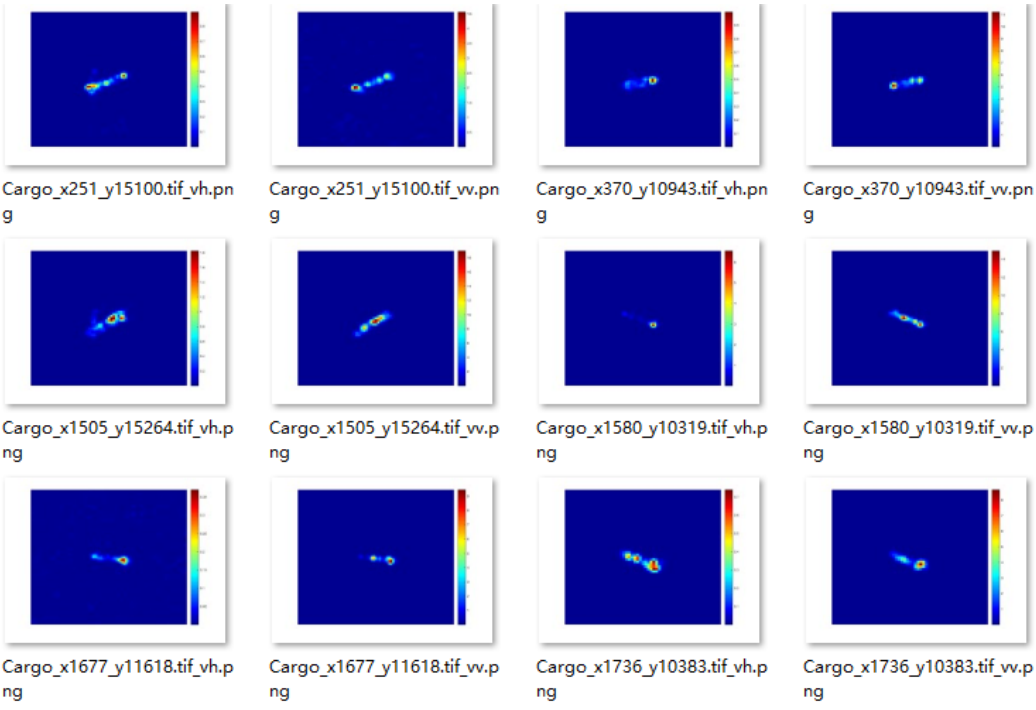

Figure 6. Data format for RGB ship chip

1.5 Patch_Uint8

For Patch_Uint8 folder, filenames can be identified with the following code: Visual_NNN_xHHH_yVVV_pp.png, where NNN indicates the ship type (cargo, tanker, fishing, et al.) reported by AIS, HHH is the pixel coordinate in x-axis, VVV is the pixel coordinate in y-axis, and pp indicates the polarization (vh/vv) of ship chip.

Based on the original ship chip, we apply image enhanced by MATLAB programming to visualize ship chip with 0-255 grey scale (stored in unsigned 8-bit (1-byte) integers). As shown in Figure 7, for each ship chip, the grey scale visualized ship chip are provided with VH and VV channel, respectively.

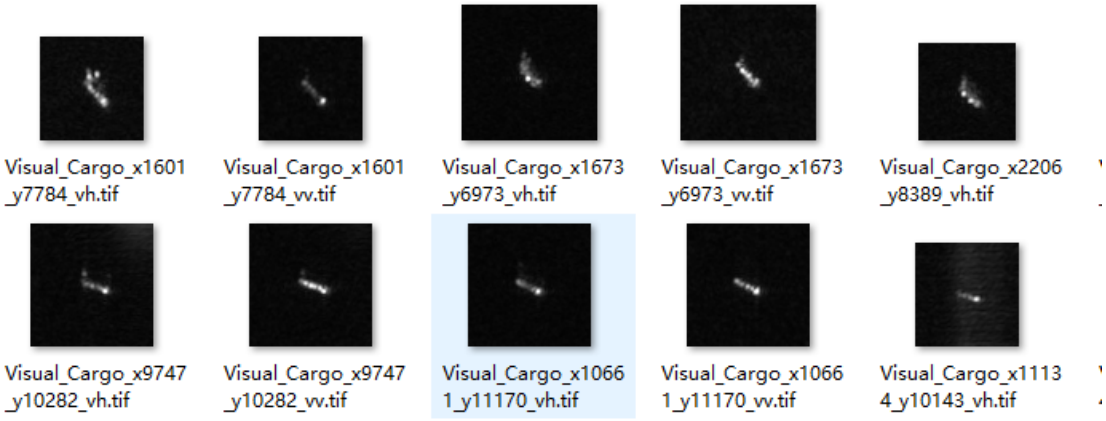

Figure 7. Data format of Uint8 ship chip

2. Introduction of Ship.xml

As shown in Figure 8, the detailed information of each ship chip containing AIS messages, SAR ship signatures, and elaborated messages provided by MarineTraffic Website, are listed in a XML file named ship.xml. Via the pixel coordinates shown in the filename of each chip, users can retrieve the corresponding information in the Ship.xml file.

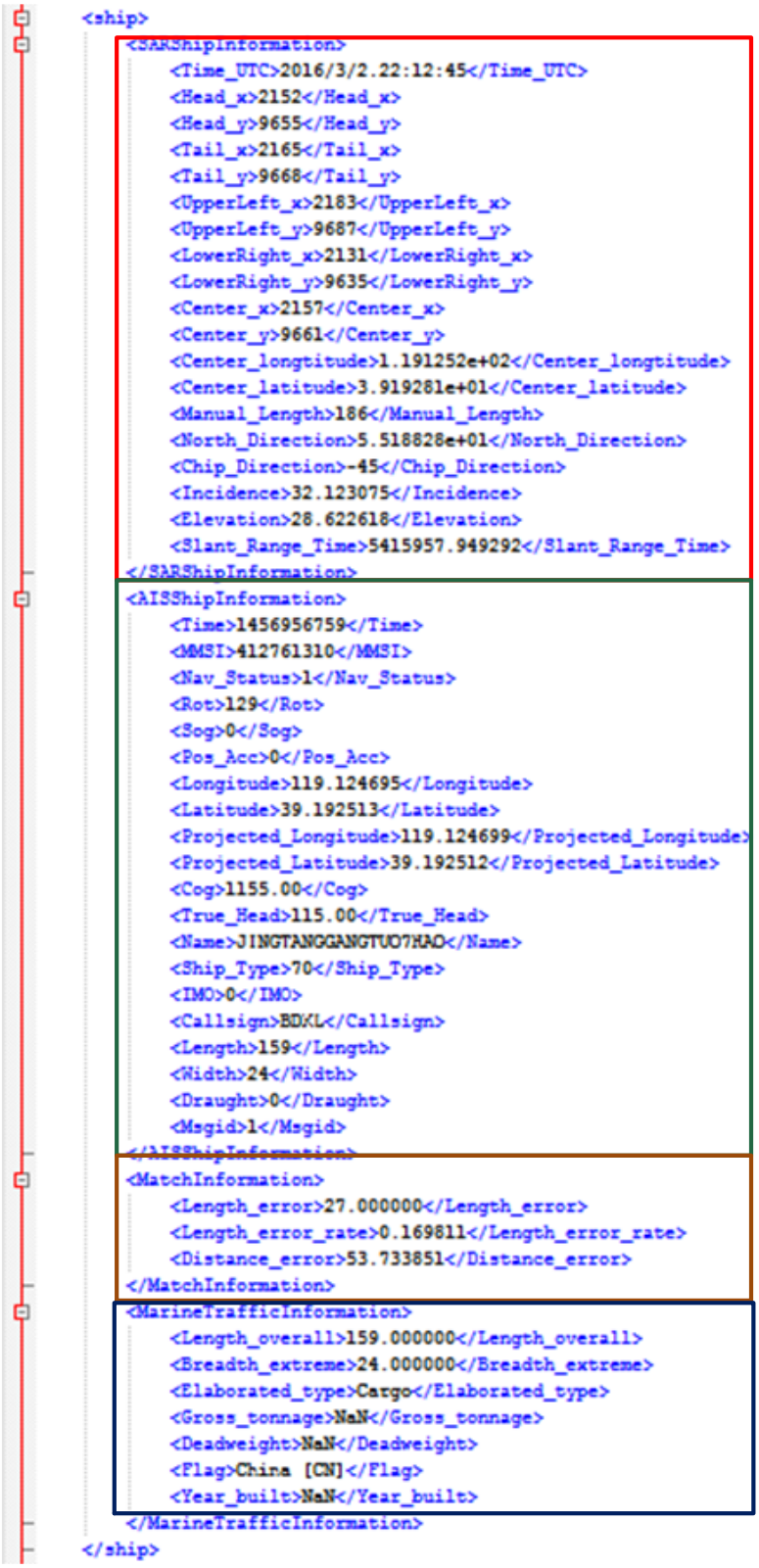

Figure 8. Detailed information of each ship chip

The detailed information of each item provided in Ship.xml is clarified in Table 1. Some specific AIS information is further illustrated in appendix.

Table 1. Detailed information of each ship chip

SAR information		
Name	Explanation	Unit
Time_UTC	SAR acquisition time	--
Head_x	Pixel coordinate of ship head (with 180 degree ambiguity)	--
Head_y	Pixel coordinate of ship head (with 180 degree ambiguity)	--
Tail_x	Pixel coordinate of ship tail (with 180 degree ambiguity)	--
Tail_y	Pixel coordinate of ship tail (with 180 degree ambiguity)	--
UpperLeft_x	Pixel coordinate of the upper left point of chip	--
UpperLeft_y	Pixel coordinate of the upper left point of chip	--
LowerRight_x	Pixel coordinate of the lower right point of chip	--
LowerRight_y	Pixel coordinate of the lower right point of chip	--
Center_x	Pixel coordinate of ship center	--
Center_y	Pixel coordinate of ship center	--
Center_longitude	Longitude of ship center	degree
Center_latitude	Latitude of ship center	degree
Manual_Length	Ship length measured manually	m
North_Direction	Ship direction respect to north (clockwise, from 0 to 360)	degree
Chip_Direction	Ship direction respect to azimuth (clockwise, from 0 to 180, and -180-0)	degree
Incidence	Incidence angle of ship center	degree
Elevation	Elevation angle of ship center	degree
Slant_Range_Time	Slant range time of ship center	s
AIS information		
Time	AIS time stamp	--
MMSI	MMSI of ship	--
Nav_Status	Navigation status (further detailed in appendix)	--
Rot	Rotation rate	degree
Sog	Speed of ground	10*knot
Pos_Acc	Accuracy	--
Longitude	Longitude of ship reported by AIS	degree
Latitude	Latitude of ship reported by AIS	degree
Projected_Longitude	Longitude of ship by AIS-projected	degree
Projected_Latitude	Latitude of ship by AIS-projected	degree
Cog	Course of ground	10*degree
True_Head	Ship head direction	degree
Name	Name of the ship	--
Ship_Type	Ship type (further detailed in appendix)	--
IMO	IMO of ship	--
Callsign	Callsign	--
Length	Length reported by AIS	m
Width	Width reported by AIS	m
Draught	Draught	10*m
Msgid	AIS code (meaningless)	--
Match information		
Length_error	Length error between matched SAR and AIS	m
Length_error_rate	Length error between matched SAR and AIS divided by AIS length	--
Distance_error	distance error between matched SAR and AIS	m
MarineTraffic information		

Length_overall	Ship length	m
Breadth_extreme	Ship breadth	m
Elaborated_type	Ship type	--
Gross_tonnage	Ship weight	t
Deadweight	Ship dead weight	t
Flag	Nationality of the ship	--
Year_built	Ship built year	--

3. Introduction of Metedata.xml

Besides, a XML file of the original SAR image name Metedata.xml is also provided. This Metedata.xml is contained in the product which can be downloaded from Sentinel Scientific Data hub.

Appendix

A. The specific explanation of Nav_Status code (Table 2)

Table 2. Specific explanation of Nav_Status code

Code	Explanation
0	Under Way
1	At Anchor
2	Not Under Command
3	Restricted Maneuverability
4	Constrained by her draught
5	Moored
6	Aground
7	Engaged in Fishing
8	Under Way Sailing

B. The specific explanation of Ship type code (Table 3)

Table 3. Specific explanation of ship type code

Code	Explanation
20	Wing in ground (WIG), all ships of this type
21	Wing in ground (WIG), Hazardous category A
22	Wing in ground (WIG), Hazardous category B
23	Wing in ground (WIG), Hazardous category C

24	Wing in ground (WIG), Hazardous category D
25	Wing in ground (WIG), Reserved for future use
26	Wing in ground (WIG), Reserved for future use
27	Wing in ground (WIG), Reserved for future use
28	Wing in ground (WIG), Reserved for future use
29	Wing in ground (WIG), Reserved for future use
30	Fishing
31	Towing
32	Towing: length exceeds 200m or breadth exceeds 25m
33	Dredging or underwater ops
34	Diving ops
35	Military Ops
36	Sailing
37	Pleasure Craft
38	Reserved
39	Reserved
40	High speed craft (HSC), all ships of this type
41	High speed craft (HSC), Hazardous category A
42	High speed craft (HSC), Hazardous category B
43	High speed craft (HSC), Hazardous category C
44	High speed craft (HSC), Hazardous category D
45	High speed craft (HSC), Reserved for future use
46	High speed craft (HSC), Reserved for future use
47	High speed craft (HSC), Reserved for future use
48	High speed craft (HSC), Reserved for future use
49	High speed craft (HSC), No additional information
50	Pilot Vessel
51	Search and Rescue vessel
52	Tug
53	Port Tender
54	Anti-pollution equipment
55	Law Enforcement

56	Spare - Local Vessel
57	Spare - Local Vessel
58	Medical Transport
59	Ship according to RR Resolution No. 18
60	Passenger, all ships of this type
61	Passenger, Hazardous category A
62	Passenger, Hazardous category B
63	Passenger, Hazardous category C
64	Passenger, Hazardous category D
65	Passenger, Reserved for future use
66	Passenger, Reserved for future use
67	Passenger, Reserved for future use
68	Passenger, Reserved for future use
69	Passenger, No additional information
70	Cargo, all ships of this type
71	Cargo, Hazardous category A
72	Cargo, Hazardous category B
73	Cargo, Hazardous category C
74	Cargo, Hazardous category D
75	Cargo, Reserved for future use
76	Cargo, Reserved for future use
77	Cargo, Reserved for future use
78	Cargo, Reserved for future use
79	Cargo, No additional information
80	Tanker, all ships of this type
81	Tanker, Hazardous category A
82	Tanker, Hazardous category B
83	Tanker, Hazardous category C
84	Tanker, Hazardous category D
85	Tanker, Reserved for future use
86	Tanker, Reserved for future use
87	Tanker, Reserved for future use

88	Tanker, Reserved for future use
89	Tanker, No additional information
90	Other Type, all ships of this type
91	Other Type, Hazardous category A
92	Other Type, Hazardous category B
93	Other Type, Hazardous category C
94	Other Type, Hazardous category D
95	Other Type, Reserved for future use
96	Other Type, Reserved for future use
97	Other Type, Reserved for future use
98	Other Type, Reserved for future use
99	Other Type, No additional information