Design & Realization of Interactive Management System for M/V XUELONG

An interactive management information system based on Web GIS

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***Abstract*—M/V XUELONG is the only icebreaker for Chinese polar research now. This paper introduces the design of interactive information platform between XUELONG and domestic, indicates the information supporting functions for ocean sailing in floating ice area based on web GIS, and reveals the statistic data features of XUELONG cruise based on GPS data. Arithmetic for sailing status recognition is given then. Which shows us an information cycle from the mainland to the icebreaker and the return.**

Keywords-M/V XUELONG; information plaform; GPS; data analyse

I. INTRODUCTION

Since 1984, China has carried out the Chinese National Arctic/Antarctic Research Expedition (CHINARE) for 27 years. There're 5 ships involved in these expeditions, including XIANGYANGHONG 10, J121, JIDI, HAIYANG 4 and XUELONG sequentially. Until now M/V XUELONG is the only specialized icebreaker in Chinese bipolar expeditions since 1994, the 11th CHINARE, for her maiden deployment.

During the early expeditions, XUELONG has only satellite telephone connecting with mainland. And email is available in XUELONG since 1999 with ISDN, while it's used intermittently due to the expensive cost. Since 2009, the continuous internet is available in XUELONG with the network upgrade, when the broad area global network (BGAN) is used to replace the ISDN mode with much lower cost and higher traffic bandwidth. Which give us an opportunity to build a full-time interactive information system as in [1].

This paper introduces the construction of "XUELONG Online", a management information system based on Google maps, which was sponsored by Chinese Arctic and Antarctic Administration (CAA). And the functions of "XUELONG Online" are illuminated briefly in this paper. With 2 years GPS data acquired from XUELONG, the spatial features of ocean navigation are analyzed, and a pattern recognition model is given to distinguish the sailing status, such as anchoring, harbor parking, ice breaking and abnormal engine stopping during the sailing in ocean or floating with floating ice. This will contribute to the monitoring and supporting for XUELONG navigation in the future expeditions.

II. CONSTRUCTION OF "XUELONG ONLINE"

A. System Architechure

With the capability of internet surfing, it's possible to get the locations and other public data from XUELONG in real-time. An information system, named after "XUELONG Online", is developed on 2009, which is running automatically 24 hours a day. The system architecture is expressed in figure 1.

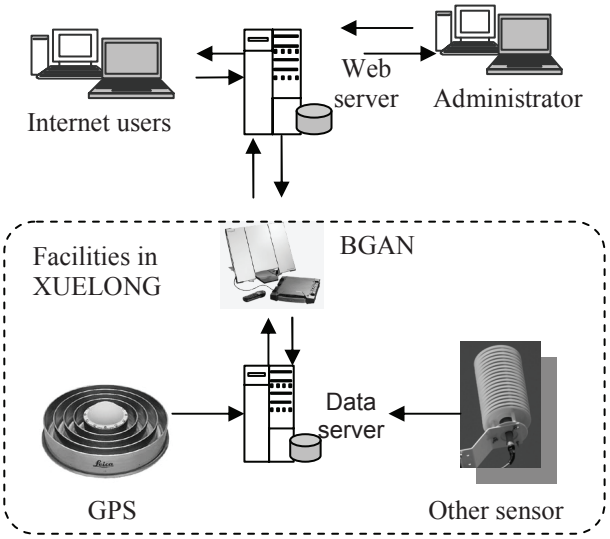

Figure 1. System archietechure of "XUELONG Online".

The facilities in XUELONG comprise of data server, sensors and BGAN. As mentioned before, BGAN is responsible for the internet communication. The sensors are the

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data sources, including GPS data, engine data and meteorological data. The data server is the controlling part for data gathering from sensors and sending back to mainland. The primary facility in mainland is the web server, composing of a database based on Oracle9i and a website based on Google maps as in [2]. The database is responsible for saving the data acquired from XUELONG, and the website presents an access for the internet users. The reason why the Google maps is chosen to develop the website is due to the compatibility of browser/server mode, which makes it accessible for maximum users.

B. System Functions

The "XUELONG Online" as in [3] sets up an information platform between the mainland and the icebreaker. The functions mainly focus on two aspects: getting data from XUELONG and providing convenience for XUELONG navigation. The detailed functions are listed as below:

1) the real-time data view

Currently the real-time data including latitude, longitude, air temperature, air humidity, air pressure, wind speed and wind direction, surface sea water temperature, water depth, engine rotate speed and so on.

2) the planned voyage line view

Before one expedition is carried out, a planned voyage line is presented. The planned navigation nodes can be import to the system in advance. Then the planned voyage line is showed out via the website.

3) historical data query

Until now there're 25 bipolar expeditions having ships. The whole voyage line of each expedition is showed out in the website. But the earlier expeditions only have time and location data in every navigation node.

4) data graph view

Since 2009, the data transferred back to mainland is not only GPS locations and speed, but also the meteorological data and other sensors' data. The graphs of these data are provided when internet users indicate specified time duration.

5) auto replay the real voyage line

The historical voyage lines are composing of many navigation points. With the time sequence, all the points of one line can be showed out one by one.

6) view and query of Antarctic stations

Based on Google maps, the system can overlap any data with spatial locations. So the Antarctic stations are marked on the map and query window is provided to search the designated stations.

7) distance measurement on the map

Using the Google maps API, distance measurement tool is developed simply, which is loaded when the web page is open. Then internet users can measure the distance of one line with arbitrary points on the map.

8) data transfer to the icebreaker

With the data from XUELONG, the people in mainland know the latest status of the icebreaker. What is of benefit to the icebreaker? Daily sea ice maps as in [4] and ocean wave height maps are manually transferred to the ship, which is useful to the sailing voyage especially in floating ice area.

C. System Running Practice

Since September 2009, "XUELONG Online" has been published in the World Wide Web. The website address is http://xuelong.chinare.cn. Until now, there're over 50000 person times who visited this website, which sets up an information platform for monitoring the icebreaker in real-time or nearly real-time. On the other hand, the mainland administrators manually transfer some useful data via this website to the icebreaker including sea ice concentration maps and the ocean wave height maps, which contribute to the navigation of the icebreaker.

III. ANALYZE OF DATA FROM XUELONG

Until now there're two years' data acquired from M/V XUELONG. From which the spatial features in navigation is analyzed as below mainly via GPS data.

A. Sailing Speed,Course data in Whole Expedition

With simple calculation, the average speed, maximum speed, average course change in a fixed period and their standard deviation can be extracted from the database. The detailed data is showed out in table 1.

TABLE I. STATISTIC DATA FROM GPS ON XUELONG IN 27TH CHINARE

Velocity sect	Avg (V)	Std (V)	Avg (vD)	Std (vD)	Max (|vD|)	Count
0	0.11	0.2	0.13	19.37	179.9	116620
1	1.33	0.29	-0.19	23.76	179.9	7807
2	2.41	0.29	-0.16	30	179.9	1951
3	3.45	0.29	0.04	20.2	180	1774
4	4.44	0.29	-0.37	16.59	169.8	1281
5	5.41	0.29	-1.05	12.77	90.1	990
6	6.48	0.28	-0.44	11.05	38.7	986
7	7.49	0.3	0.27	9.67	50.2	1381
8	8.46	0.28	0.08	7.45	45.3	1943
9	9.49	0.28	-0.06	6.39	41.1	2579
10	10.46	0.29	-0.22	6.59	49.8	2295
11	11.48	0.29	-0.17	5.45	45.9	3458
12	12.49	0.28	0.08	4.34	40.3	5405
13	13.54	0.29	-0.03	2.75	35	11436
14	14.49	0.28	-0.02	2.05	29.3	20746
15	15.37	0.28	0.03	1.67	30.1	26711
16	16.23	0.23	0.09	1.29	16.4	4374
17	17.19	0.23	-0.02	1	8.7	344
18	18.18	0.13	0.41	1.14	4.4	47

Here the V means velocity in knots, while vD is the course data change in degree within one minute. Column Avg(V)

means the average velocity from all the data in its velocity sect, Std(V) means the standard deviation of velocity data, Avg(vD) means the average course data, Std(vD) means the standard deviation of course data, Max(|vD|) means the maximum course change in one minute, and Count is the number of records in this velocity sect. All the data records from XUELONG are classified with different velocity. For example, 3 in column V means the statistic data is deriving from all the data records with sailing speed between 3 to 4(not included). From table 1, a figure can be illuminate as below.

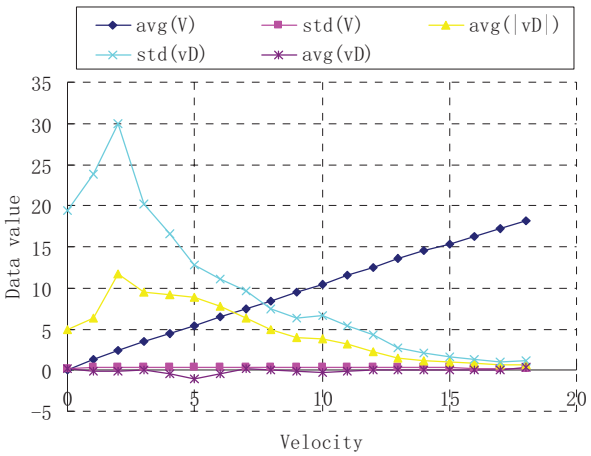

Figure 2. Statistic data graph from GPS on XUELONG.

From table I and figure 2, the normal sailing speed of XUELONG is indicated between 12~16 knot in the whole expedition of 27th CHINARE. With the increasing velocity, the standard deviation of course is decreasing, which means the stability in higher speed is better than that in lower speed.

B. *Statistic Data in Different Sailing Status*

With the artificial judgment, some special sailing periods are selected out for data statistic. Besides normal sailing, the anchoring, harbor parking, ice breaking and abnormal engine stopping features are all analyzed as listed in table II.

TABLE II. STATISTIC DATA OF SPECIAL SAILING FEATURES

Feature	Avg (V) (knot)	Std (V) (knot)	Avg (vD) (°/min)	Std (vD) (°/min)	Max (|vD|) (°/min)
Normal sailing	11.2	0.67	-0.03	1.03	7
Harbor parking	0	0.01	0.01	0.6	11
Anchoring	0.28	0.14	9.65	15	135
Ocean floating	1.18	1.33	-2.11	4.25	18
Ice floating	0.71	0.14	-1.69	2.35	8
Ice breaking	2.61	2.29	-3.24	31.53	180

C. *Sailing Status Recognition with Statistic Data*

With the artificial selected sample period data, the statistic data can be acquired in table II. On the other contrary, with the statistic data listed in table II, a bintree method as figure 3 can be used to find the specified status with threshold criterion from one period sailing data.

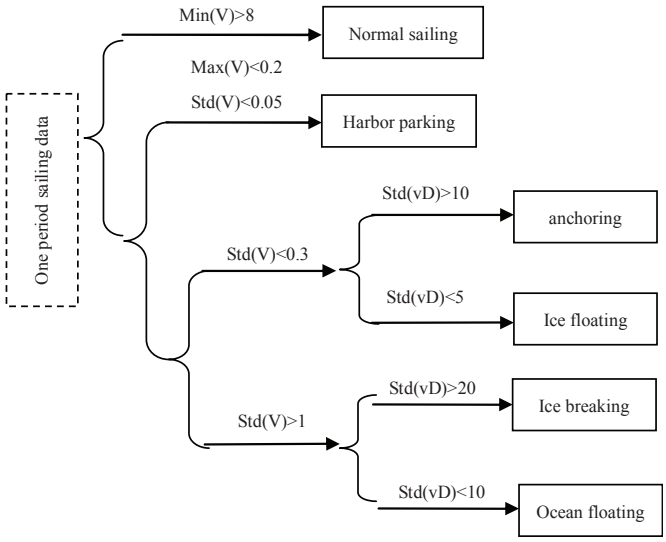

Figure 3. Bintree to recognise the sailing status of XUELONG.

With the bintree method as figure 3, the sailing data in whole expedition of the 27th CHINEARE is tested in hourly period. Finally the sailing data in the whole expedition is processed and the recognition proportion is 91.4%, of which the accuracy is 93.9%.

IV. CONCLUSIONS

With the satellite communication, an interactive information system is set up between the icebreaker M/V XUELONG and the mainland, which greatly contribute to the management of CHINARE.

With the acquired GPS data from XUELONG, the spatial features in different sailing status are analyzed via the statistic data. And it's capable to automatically monitor the real-time sailing status via GPS data in high accurate with a bintree method. Not only the icebreaker XUELONG, but also the other similar huge ocean sailing vessels can be monitored with this method.

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