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AIS MONITORING OF DANUBE DELTA AND DANUBE-BLACK SEA NAVIGATION ROUTE

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Abstract: *The paper presents a method to monitoring the Danube Delta navigation traffic routes and offshore side of Black Sea. The method refers to AIS (Automatic Identification System) monitoring. All ships transmit there references via AIS to shore AIS receivers which upload them on an internet server. To have access at this information, the user must have installed on his PC a monitoring software and must be connected to the internet. All information are being displayed over an electronic chart.*

1. AIS RECEIVER

A high performance AIS receiver capable of receiving AIS information from ships equipped with AIS transmitters. The AIS receiver must be easy to install necessitating only the coupling of a VHF antenna and a personal computer. The AIS receiver must be compatible with any ECDIS system capable of processing AIS NMEA 0183 phrases. The equipment should be conforming to IEC954/EN60954 and ITU1371-1, IEC61993, IEC 61162-2.
The information processed and received should include:
*Name of vessel
*Call sign
*Type of vessel
*Destination
*Speed (SOG)
*Course (COG)
*Heading
*Position
*Navigational status
*Rate of turn
*Vessel dimensions
*MMSI number

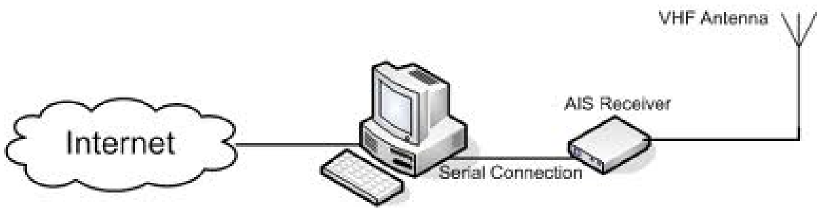

Figure.1

2. TECHNICAL SPECIFICATION

Dual Channel VHF receiver designed to receive and decode transmissions from ships equipped with Class A transceivers.

2.1 Electrical specifications

Power: 9 - 15 Volts DC
Consumption: <1.5W

2.2 Communications

Baud/s: 38400
Format: ITU/ NMEA 0183
Output message: VDM

2.3 Receptor

Frequency: AIS1 161.975 MHz
AIS2 162.025 MHz, dual channel, simultaneous reception
Channel spacing: 25 KHz
Gain: -116dBm
Demodulation: GMSK
Baud rate: 9600
Impedance: 50 ohms
Physical dimensions: Length: 115mm, Width: 75mm,
Height: 28mm
Weight: 400g
Connectors: BNC antenna
Output port: 9 pin D serial socket

3. APPLICATION FUNCTIONALITY

System should be comprised of a unique server component and mobile instances. The server component should have the following characteristics:
The AIS server is a unique software component with the function of routing messages among clients connected to the network. The server is responsible for establishing and maintaining the connection with the mobile AIS systems defined under it. The AIS messages should be decoded and transmitted in a compressed form from the mobile systems to the central server. The transmission should be possible over any media including internet in a secure mode.
The transmission of data from a mobile AIS system to the central server should be made in real-time selectively through Ethernet, GPRS, 3G or CDMA. The time interval at which ship dynamic data are communicated should be in the frame of 2 to 10 seconds. Between the mobile AIS systems and the central AIS will be circulated data processed locally on the base station in such a manner that a 9kbps channel could be used.
The mobile system should be able to function both standalone and client-server;
The mobile system should be operable and accessible in any point of the globe through commercial communications;
The system should be able to display on a digital map ship positions and the information transmitted by their AIS transponder;
Between several mobile consoles of the system the following interactions should be possible:

- secure chat message exchange;
- display of tactical drawing visible to all the members of the mobile units network in real time;
- the display of ships should be superimposed over a digital map that should be loadable from local and public sources;
- the console will have a multilingual user interface (Romanian, English, French, German and Spanish);
- the console should be able to load and display drawings external to the system geographically referenced and scalable;
- the data received from the ships should be saved in a database;
- the database should allow for the following reporting mechanisms: MMSI display, MMSI historical display of successive positions for the duration of the monitoring action;
- highlighting of a monitored MMSI within certain geographical boundaries, reports regarding ship traffic relative to certain AIS sensors, ship type reports;

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[1] Savo G. Glisic, *Advanced Wireless Communications, 4G Cognitive and Cooperative Broadband Technology*, *second edition,* University of Oulu, Finland
[2] Jairo Gutierrez, *Business Data Communications and Networking,* University of Auckland, New Zealand
[3] Richard P. Hodges, *Underwater Acoustics. Analysis, Design and Performance of Sonar*
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THE MATHEMATICAL MODEL TO DETERMINE THE UNDERWATER EXPLOSIONS DIRECTION AND DISTANCE

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Abstract: *This report presents the triangulation of the underwater explosion source.*
The analysis is based on the time-delay measurement the underwater acoustic wave, deriving the range and the direction to the underwater source of explosion. The mathematical model is simulated for different values of the time-delay at three sensors. It was built a practical demonstrator, which gave the possibility to verify in real environment the mathematical model.

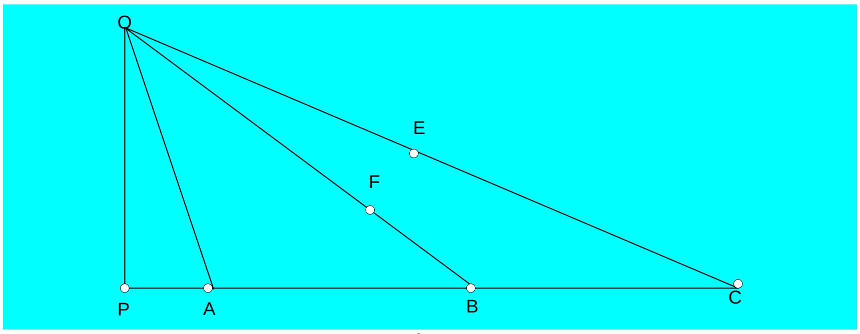

Fig. 1

The hydro-acoustic sensors are placed in the A, B, C points, at d_o range; the event take place in O point. We trace a perpendicular in P point.

OA=OF=OE and represents the range covered by the wave from t_0, moment when the event took place and t_1, moment when the signal was received from A point. The wave will cover the range FB in the time T_B, which is $T_B=t_2-t_1$, where t_2 is the time when the wave came in the B point, so $FB=T_B*v$, where v is the speed of wave in the water, speed known either from the hydro-acoustic prognosis or approximated at 1450m/s.

The wave will cover the range EC in the time T_C, which is $T_C=t_3-t_1$, where t_3 is the time when the wave came in the point C, so $EC=T_C*v$.

We can write the following relations:

$(OP)^2=(OA)^2-(PA)^2$

$(OP)^2=(OF+FB)^2-(AB+PA)^2$

$(OP)^2=(OE+EC)^2-(AB+BC+PA)^2$

The unknown of the system are: OP, OA, PA.

Knowing the sides, in OPA triangle, sin A=OP/OA.

So the range and the direction are determinates. We observe that if the event is in the left of the hydro-acoustic sensors line, the wave came firstly in point C.

In this case:

$(OP)^2=(OC)^2-(PC)^2$

$(OP)^2=(OF+FB)^2-(CB+PC)^2$

$(OP)^2=(OE+EC)^2-(CB+BC+PC)^2$

The unknown of the system are: OP, OC, PC.

Knowing the sides, in OPC triangle, sin C=OP/OC.

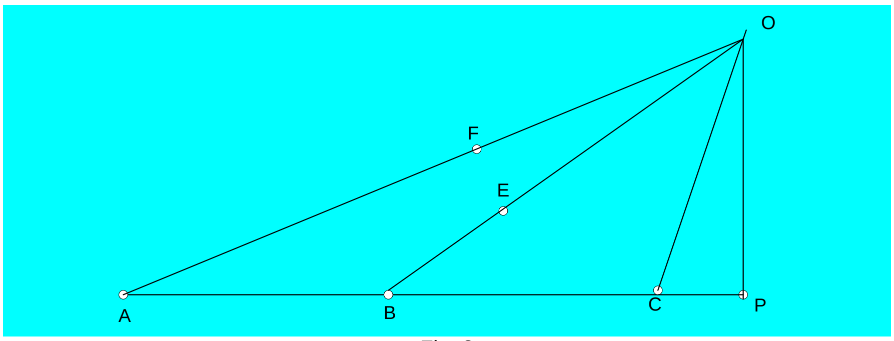

Fig. 2

The resolution of the system is simple:

$(OP)^2=(OA)^2-(PA)^2$
$(OP)^2=(OF+FB)^2-(AB+PA)^2$
$(OP)^2=(OE+EC)^2-(AB+BC+PA)^2$

We decompose,

$OP^2=OA^2-PA^2$
$OP^2=OF^2+2*OF*FB+FB^2-AB^2-2*AB*PA-PA^2$

Considering AB=BC of known value, we would analyze the minimum value for AB

$OP^2=OE^2+2*OE*EC+EC^2-4*AB^2-4*AB*PA-PA^2$

Replacing in the last two equations:

$OA^2-\underline{PA^2}=OF^2+2*OF*FB+FB^2-AB^2-2*AB*PA-\underline{PA^2}$

$OA^2-\underline{PA^2}=OE^2+2*OE*EC+EC^2-4*AB^2-4*AB*PA-\underline{PA^2}$

Or:

$OA^2=OF^2+2*OF*FB+FB^2-AB^2-2*AB*PA$
$OA^2=OE^2+2*OE*EC+EC^2-4*AB^2-4*AB*PA$

But OA=OF=OE, so:

$OA^2=OA^2+2*OA*FB+FB^2-AB^2-2*AB*PA$
$OA^2=OA^2+2*OA*EC+EC^2-4*AB^2-4*AB*PA$

The unknown of the system are OP, OA, PA. By simplification the system became:

$2*OA*FB+FB^2-AB^2-2*AB*PA=0$
$2*OA*EC+EC^2-4*AB^2-4*AB*PA=0$

Result PA:

$$PA=\frac{FB^2+2\cdot OA\cdot FB-AB^2}{2\cdot AB}$$

$$OA=\frac{2FB^2+2AB^2-EC^2}{2\cdot EC-4\cdot FB}$$

Where AB is the range between the sensors, B=T_B*v, EC=T_C*v, with $T_B=t_2-t_1$ and $T_C=t_3-t_1$, t_1 is the time when the signal was received by the sensor from the A point, t_2 is the time when the wave came in the B point, t_3 is the time when the wave came in the C point. The results of the simulation are presented down.

INITIAL DATA TRIANGULATION PROGRAM

No.	X	y	z	v	d	t0	t1	t2	t1-t0	t2-t0
Event at the left										
1	20	-24	31.241	1400	2	0.0223	0.0234	0.0245	0.0011	0.0022
2	35	-30	46.0977	1400	2	0.0329	0.0338	0.0348	0.0009	0.0019
3	60	-41	72.6705	1400	2	0.0519	0.0527	0.0535	0.0008	0.0016
4	95	-52	108.301	1400	2	0.0773	0.0780	0.0787	0.0006	0.0014
5	450	-132	468.961	1400	2	0.3349	0.3353	0.3357	0.0004	0.0008
6	1200	-450	1281.6	1400	5	0.9154	0.9166	0.9179	0.0012	0.0025
7	2400	-870	2552.82	1400	5	1.8234	1.8246	1.8258	0.0012	0.0024
8	5000	-2400	5546.17	1400	5	3.9615	3.9630	3.9646	0.0015	0.0030
9	12400	-6000	13775.3	1400	10	9.8395	9.8426	9.8457	0.0031	0.0062
10	25000	-12000	27730.8	1400	10	19.807	19.810	19.813	0.0030	0.0061
Event at the right										
No.	X	y	z	v	d	t0	t1	t2	t1-t0	t2-t0
11	20	24	31.241	1400	2	0.0223	0.0212	0.0202	0.0010	0.0021
12	35	30	46.0977	1400	2	0.0329	0.0320	0.0311	0.0008	0.0017
13	60	41	72.6705	1400	2	0.0519	0.0511	0.0503	0.0007	0.0015
14	95	52	108.301	1400	2	0.0773	0.0766	0.0760	0.0006	0.0013
15	450	132	468.961	1400	2	0.3349	0.3345	0.3341	0.0003	0.0007
16	1200	450	1281.6	1400	5	0.9154	0.9141	0.9129	0.0012	0.0024
17	2400	870	2552.82	1400	5	1.8234	1.8222	1.8210	0.0012	0.0024
18	5000	2400	5546.17	1400	5	3.9615	3.9600	3.9584	0.0015	0.0030
19	12400	6000	13775.3	1400	10	9.8395	9.8364	9.8333	0.0031	0.0062

20	25000	12000	27730.8	1400	10	19.807	19.804	19.801	0.0030	0.0061

Table 1

References

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