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# DEMANDS FOR MODERN SHIPPING AND SURVEILLANCE OF THE ADRIATIC SEA

*ABSTRACT*

*In this work modern navigation and Adriatic control demand characteristics are developed. It correlates the modern navigation characteristics and the Adriatic sea control. The present operating procedures used for sea control are mentioned as well as the new systems and procedures based on new computer and communication technologies (automatic identification systems, GPS, computer networks, Internet/Intranet standards). It discusses unmanned aerial vehicles characteristics according to demands and grading standards for picture/scene interpretation (NIIRS grading scale).*

*KEY WORDS*

*unmanned aerial vehicles, geoinformation system, NIIRS grading scale, sensors, border control, sea lines control, automatic identification systems, GPS, computer networks, Internet/Intranet.*

## 1. INTRODUCTION

The Adriatic Sea is one of the biggest natural resources of the Republic of Croatia, which is also the basis of the development of the tourist industry in the first place, but also the exploitation of the sea and underwater world. Therefore, the Republic of Croatia has to protect this resource with all measures available against any kind of ecological catastrophe, and not allow the same to happen by breaking the safety of shipping and misguidance when it comes to using sea routes. Croatia would, in that case, lose her clean seashore, sea, the underwater world, and her earnings based on tourism which in turn is the basis of the economic growth of the country. Even if no accidents happen, the tankers still pollute the sea by releasing their ballast waters and permanently hinge upon the natural balance of life in the sea. Because of this Croatia in her Constitution, Article No. 3 mentions preserving of nature and the surroundings in which people live as one of the highest treasures and guarantees a healthy environment to each human. On this basis, Croatia has signed an array of international contracts, which are concerned with the protection of the Mediterranean, a part of which is the Adriatic. Because of all the above, in the application of these rules, surveillance and management, a system of unmanned aircraft with their converters in real time has an essential place in the protection of seaways and natural resources of the Adriatic.

## 2. PRESENT STATE OF THE SURVEILLANCE SYSTEM WITH ITS TECHNOLOGY

Inner seawaters, the territorial sea and the protected fishing belt of Croatia are almost the same size as territorial Croatia itself. The space being controlled has the following characteristics: the area of the inner seawaters is 12,461 km$^2$ and the surface of the territorial sea is 19,296 km$^2$, which is altogether 31,750 km$^2$ to control. The protected fishing belt of 25,270 km$^2$ is also added to this. When the area of the inner waters, the territorial sea, and the protected fishing belt are added together, we get 56,964 km$^2$ to control and manage. In this area are 1,242 islands, little islands and rocks, and out of which 66 are populated. The 66 populated islands are populated with approximately 120,000 inhabitants of Croatia. The length of the Croatian border at sea is 948 km. In this seashore area being controlled, together with all of the islands, little islands, and rocks, the length of the shore is 6,278 km, from which the continental length is 1,880 km and the shoreline is 4,398 km. According to the customs in the European Union, the police does the surveillance of the border. To conduct these operations significant material and human resources are needed. According to today's investigation the Republic of Croatia is managing with resources in table 1 [1], to control and supervise approx. 60,000 km$^2$. Since the Croatian border at sea and land is approx. the same length [2] and her complete control with a classic approach would be very expensive, the application of the IBL with modern converters gives an option of efficient and cheap border control according to the European and world standards, considering modern technology and computer communication. To oversee processes in shipping at sea, ecological protection of the Adriatic, possible people trafficking and organized crime with all of the elements for prevention for object and goals which are of interest for Croatia, the depth of reconnaissance demands IBLs with a

**Table 1 - Materials and human resources for coast guard**

| | Ministry of sea, tourism, traffic and development | Ministry of interior | Ministry of defense | Ministry of agriculture, forestry and water economy | Ministry of environment protection, space arrangement and building | Ministry of finance | Ministry of culture | All |
|---|---|---|---|---|---|---|---|---|
| No. of employees | 303 | 248 | ? | 12 | 3 | 20 | ? | |
| Ships | 5 | 5 | 6 | - | - | - | - | 16 |
| Boats | 47 | 33 | - | - | 8 | ? | 1 | 89 |
| Airplanes/<br>helicopters/<br>unmanned aircraft | - | - | 6x<br>4x<br>1x | - | - | - | - | 6<br>4<br>1 |
| Radar system | - | - | Peregrin<br>9x ORMP | - | - | - | - | 9 |

Source: Assessment of state and the solution to manage control and protection at the Adriatic Sea – Working group for preparing suggestions to solve the protection and control at the Adriatic Sea by the government of the Republic of Croatia

reach of 250 km. It can be seen that these material resources are insufficient and unadjusted to please all the needs to control the entire sea area.

## 3. KEY DEMANDS FOR QUALITY OF IMAGE CONVERTERS

Applying the system for quantity judgment of the information potential of an image solves the problem of defining key demands of image converters. The scale was made for 10 basic levels (0-9) [3] and for four basic kinds of converters (converters in the visible part of the spectrum, image radars, infrared and multi-spectrum converters).

This scale was made as a direct adjustment of the NIIRS (National Image Interpretability Rating Scale) standard for quantity judgment of an informational potential of an image [3].

Because of it, here are listed the main advantages when using this system of judging image data. Except for precise definition of the wording related to interpret image data (like detection, recognition, identification, clarity and so on), by using these scales we are enabling the solution to other complex problems:

- Comparing information from different converters; précising demands which the system has to work with to get image data; help with developing new image reconnaissance systems; indication of reliability and accuracy of information extracted from the image material; manipulation with image material in data bases; measuring technical possibilities of the converter and systems to process the image; measuring the reliability and accuracy of the tools, methods of processing the image (interpretation keys) and interpreters itself.

To fit in standards it is necessary to fulfil some demands for converters regarding informational potential of images. Demands regarding quality of the image material for all converters are made with the preposition of vertical reconnaissance from 4000 m. [3]

**Table 2 - Demanded qualities for converters regarding informational potential of images**

| Type of converter | Precision on ground (cm) | Typical objects |
|---|---|---|
| Air-photo | 10 – 20 | Elements on antennas of a ship radar |
| TV | 20 – 40 | A small rescue container |
| IR | 20 – 40 | Tie lines in ports for ships |
| Image radar | 40 – 75 | Boats, small hiding containers |
| Multi-<br>-spectrum | 40 – 75 | A speed boat under a cover net |

An unmanned aircraft should have a device to measure distance and mark a target. To increase the value of the reconnaissance unmanned aircraft, the converting part of the system should be equipped with a device to mark a target and measure distance to a target. The system should also have an option to automatically track the marked target.

In order to analyze the above criteria for converters American standards for decrypting the general content of the image are shown. The analysis for a general content of an image was created out of a need for the users to be able to make and exchange quantity judgments of the informational potential of an image.

In reality of analysis of an image material a term of levels of interpretation is used to show the quality of

**Table 3 - NIIRS levels**

| NIIRS level (resolution) | Typical objects on the picture which can be recognized |
|---|---|
| 0 (—) | It is not possible to get any kind of information from the picture because of poor quality and/or resolution |
| 1 (over 9 m) | Detection of a port of a medium size |
| 2 (4.5 – 9.0 m) | Detection of big ships |
| 3 (2.5 – 4.5 m) | Detection of a large sailboat |
| 4 (1.2 – 2.5 m) | Detection of a mast on a sailboat |
| 5 (0.75 – 1.2 m) | Identification of a type of a sailboat |
| 6 (0.40 – 0.75 m) | Identification of a small boat |
| 7 (0.20 – 0.40 m) | Identification of a out of the boat engine |
| 8 (0.10 – 0.20 m) | Identification of the wipers on the windshield of a boat |
| 9 (<0.10 m) | Detection of the ropes for tying small boats |

information about the observed object. There are four levels of interpretation:

1. Detection – discovering that something is on the picture (for example, something is on the picture of a highland X)
2. Recognition – recognizing, roughly, to which class of targets the observed object belongs, without any finer details (for example, on the highland X is a boat, and it most definitely is not a natural object or a building)
3. Identification – precisely identifying the target within its class of targets (for example, on the position X is a patrol boat X)
4. Description – describing the target according to the characteristics which are of intelligence importance (for example, on the position X there is a ship of type X which is abandoned and damaged)

NIIRS table includes all four types of converters according to its physical basics of operation and technical possibilities. Because of the differences between the converters there frequently comes to differences in the NIIIRS level of image done in the same resolution, but on different converters.

NIIIRS table goes from the image itself and not from the available objects and showings on the field. Because of this there are typical representatives of objects in it, which an expert for image reading (IA) can easily determine even for objects which are not listed in the table.

NIIRS table is based on the mental capacity of a human to give grades from one to ten even for actions and showings, which is not possible to grade objectively. For example, an interpreter can, on the basis of a few already graded referent images determine a relative class of a new image. With this kind of processing almost identical results are given with different interpreters, which confirm the integrity of this kind of an approach [3]. Individual capabilities of interpreters are tested using referent images, and the result is shown on the scale of quality for a subjective grade, SQS. Taking the standard test for an image interpreter assures the level of liability at 93% [3] when it comes to analyzing the image and high comparability of processed images.

## 4. APPLICATION OF NEW INFORMATIONAL TECHNOLOGIES IN THE SYSTEM OF CONTROL AND MANAGEMENT

Everyday use of information and communication technology has completely transformed the way that we manage different resources in space. This transformation in using technology enables a two-way development: in one way expanding and developing new generations of computer run converters and in the other integrating data and systems by mass use of computer technology, especially computer networks. Unmanned aircraft in civil use equipped with new generations of converters have one of the main roles in new technological revolution. As it is known the interest for unmanned aircraft exists from the ancient times, but this dream has been brought to life only with the development of information technology and modern systems that run the new converters.

Today the unmanned aircraft equipped with a modern information technology can be found in military and civilian use. Thanks to the progress of the computer technology systems for positioning and navigation without magnetic fields are in full use. Each aircraft and each ship today have satellite navigation (GPS), and this kind of a satellite receiver for navigation is connected with a computer network and master computer. These complex systems for navigation consist of computers, GPS receivers, different kind of radars, different types of cameras of high resolution, micro spectrometers, accelerometers, navigational and control converters and also converters for temperature and pressure. All of these converters have an interface for connecting directly to their prospective computer (Fig. 1).

Except for these systems, today in traffic and control of borders can also be found an array of auto-

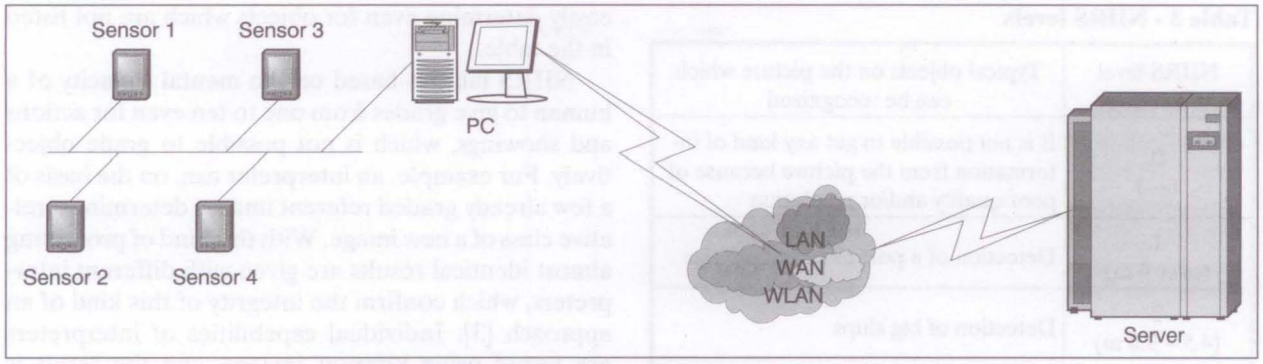


Figure 1 - A network of converters and computers

mated systems for identification and control. In this paper is also mentioned an automated identification system (AIS), a system for long-range identification of ships (LRIS), which are obligatory for ships according to the international conventions.

In communication systems a whole row of systems from satellite receivers for voice and data to complex computer networks, which are using the Internet for accomplishing some of their complex tasks on ships or controlling the ship or just for simple communication with other subjects in traffic system by using E-mail, can be encountered.

The backbone of the entire system is made up out of a computer system based on the intranet-extranet technology. Since each Ministry processes problems characteristic for its line of work it is necessary to ensure specific interfaces because of the interoperability of all of the system, and with the final goal of using the entire system on the national level for unifying the format of the data, protocols, and the way of connecting. By developing the intranet-extranet technology this kind of connecting is completely realistic. So in this system a computer network which would link the institutions of the Government of the Republic of Croatia with the

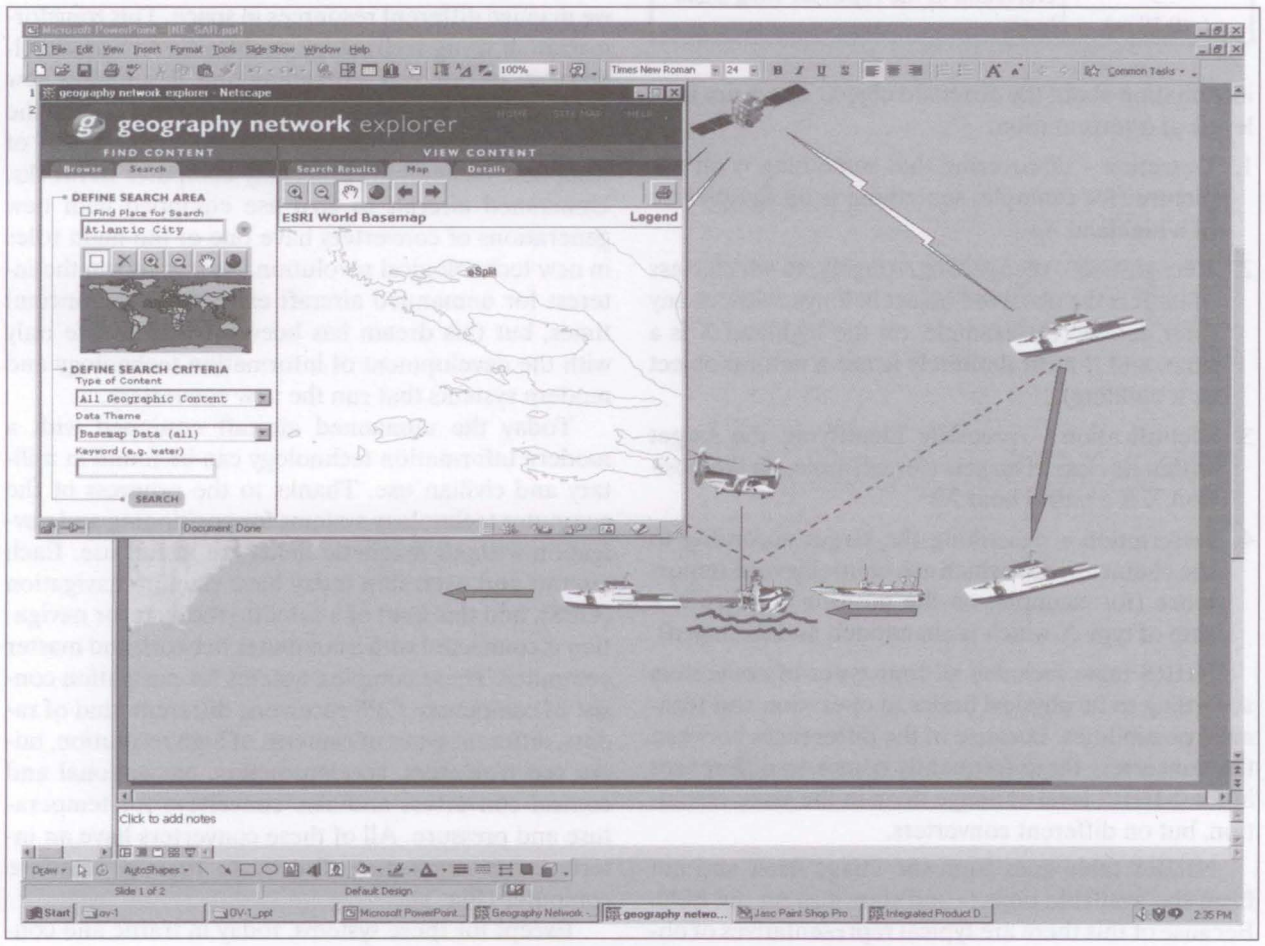


Figure 2 - Presentation of data using Internet Explorer

data, and the operational computer network for managing and controlling the systems for border control and sea ways in the Adriatic is being considered. So, one level is comprised of administrative controlling computer networks while the other one is comprised of computer networks made as an ordering informational system which is a geo-informational system with operational databases, and whose function is a simple visualization of all relevant data, which can be used, by all of the users in this complex process. By use of the geo-informational system as a base system for visualization of data and all other information on different levels, using the intranet technology [4 and 5], each user can see its data organized and shown in space which looks like that space in reality (picture 2). Today's modern geo-informational and information systems [6] are made on the intranet technology so through intranet server and with the help of an ordinary search engine users can go through complex data structures. By this kind of an approach a great deal is saved because no special training is necessary for using the system, and there is almost no official, who is not using the Internet. By this kind of a connection between the systems, by using the intranet technology, a simple coordination and data exchange is enabled between all of the systems which contribute to the control of the Adriatic Sea, no matter whether controlling the border, traffic or ecological protection.

By looking at the world and European trends in development strategy for control of borders and seaways the use of an unmanned aircraft is taking up a special place. The material and human resources, which have to be used, are taken down to the smallest amount possible, which results as an efficient and cheap solution [7].

## 5. CONCLUSION

An approach in the paper is characterized with the distribution of georeferenced data about traffic, possible ecological catastrophes, by using image converters from the unmanned aircraft or other systems, and the distribution of the information to different users by using the Geoinformation system and the Internet. The paper can also be the foundation for a new strategy of development and management in the Republic of Croatia. Also, there is a vision of modern user and converter platform, computer network and converters in the air, sea and land, that enable the spreading of the reality into a virtual one. Such an information dominant way enables faster reacting, alarming, better prevention and a much better protection of the border at the sea. The results of the paper are possible to apply in regulation and control of shipping paths, control of the state border, the ecological protection of the Adriatic Sea as the biggest economic treasure and pearl of the Republic of Croatia.

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*SAŽETAK*

*KARAKTERISTIKE ZAHTJEVA SUVREMENE PLOVIDBE I NADZORA JADRANA*

*U radu su obrađene karakteristike suvremene plovidbe, ekološke zaštite i nadzora Jadranskog mora. Stavljaju se u odnos vrijednosti Jadrana, njegovo ugrožavanje i sustava nadzora i zaštite. Navode se postojeći operativni postupci nadzora i kontrole pomorskog dobra i predlažu postupci i sustavi zasnovani na informacijsko komunikacijskim tehnologijama (automatski identifikacijski sustavi, GPS, računalne mreže, Internet/Intranet standardi). Razlažu se značajke bespilotnih letjelica prema karakteristikama zahtjeva i standardi za ocjenu tumačenja sadržaja slike/scene (NIIRS ljestvica).*

*KLJUČNE RIJEČI*

*Bespilotne letjelice, geoinformacijski sustav, NIIRS ljestvica, pretvornici (senzori), nadzor granice, nadzor plovnih putova, automatski identifikacijski sustavi, GPS, računalne mreže, Internet/Intranet.*

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## ACRONYMS AND ABBREVIATIONS

**AIS** – Automation Identification System
**IBL** – Reconnaissance unmanned aircraft
**NIIRS** – National Image Interpretability Rating Scale
**IA** – Imagery Analyst
**SQS** – Subject Quality Scale
**GPS** – Global Positioning System
**LAN** – Local Area Network
**LRIS** – Long Range Identification System
**WAN** – Wide Area Network
**WLAN** – Wireless Local Area Network