HYDROPOWER PLANTS ON LOWER SAVA RIVER – SYSTEM FOR DETECTING NAVIGATION AND DRIFT-WOOD BASED ON COLOR SPACE ELIMINATION

Aleš ŠTRICELJ

POVZETEK

V članku je predstavljena metoda zaznavanja predmetov na vodi s pomočjo izločanja barvnih območij . Izraz barvno območje predstavlja kompleksen nabor barvnih spektrov, značilnih za določeno opazovano področje. Metoda detektiranja predmetov na vodi predstavlja vpeljavo različnih metod obdelave slike na vodi in je tako prilagojen barvnemu spektru vode. Metoda razpoznavanja, predstavljena v članku, uvaja faze pred-procesiranja slike, določitev barvnega območja primernega za tak sistem, definiranje barvnega odmika z evklidovo razdaljo ter uvaja postopek erodiranja nad sliko. Zasnova takšnega sistema nam omogoča robustno ter zanesljivo detekcijo predmetov na vodi, hkrati pa nam daje primerljive rezultate s sistemi, ki bazirajo predvsem na optimizaciji kontrasta slike ter detekciji robov.

ABSTRACT

This article presents a method of detecting objects on water surface using color elimination based on image eroding with morphological variable. Term color area represents a complex enlistment of color spectra distinctive for a specific observed area. System of detecting object on water surface presents initiation of different methods of processing image on water surface and is so adapted to colorful water spectrum.

The method of recognition which is introduced in this article, initiates phases of image pre-processing, determining color area, suitable for this kind of system and defining color deviation with Euclidean distance. It also initiates procedure of eroding on the image.
Plan of that kind of system enables robust and efficient detection of objects on water surface and gives as comparable results with systems that base above all on optimization of image contrast and edge detection.

1. INTRODUCTION

Detecting objects on water surface, especially detecting navigation and drift-wood is a problem, which has not been researched enough nowadays. That is why there are still a lot of possibilities for introducing various systems for water detection in this field. Navigation through riverbeds in the vicinity of power objects is problematic not only because of direct threatening of participating person but it is also seriously dangerous for power object itself and can have different working consequences. These consequences vary from negligible ones

to those that can seriously endanger working of power object for a certain time and safety of the person involved. In the surrounding of a power object, for example hydroelectric power station, is a defined area in which any kind of river navigation is prohibited. In these restricted areas or in the accumulation pool areas some sport activities like boating, rafting, swimming, driving with motorboats and others are happening. Those can be a grave problem in case that a person or an object is swept away towards the hydroelectric power station. If we could perceive that kind of objects we would be able to adequately alarm the crew in guidance center, which would be able to suitably decide. This article also presents the idea of drift-wood detection, which like navigation, can present a serious problem for working of hydroelectric power station. Drift-wood is a relatively grave problem in hydroelectric station area, especially in times of increased river flow because it demands regular cleaning of entrance grids on turbine flows and removing of drift-wood from the barriers. In the process of cleaning we have to lower the power of electrical generator sets, sometimes even stop them which mean diminution of power or even a temporary working cutout. Momentary non-working or working on lowered powers means a great financial loss in that time. Problem of filling turbine flows in case of open barriers and decanting is transmitted on all of the hydroelectric stations in a chain. In time of normal working drift-wood gathers in the accumulation pool before hydroelectric station and it has to be removed from the water every now and then. However, in time of high waters it could come to a problem of greater drift-wood like tree trunks or car tires. Reasons for that kind of drift-wood are mostly abundant rainfall through the year, storms and snow in winter, which breaks tree branches along rivers. Because of the rainfall the water level rises and high water sweeps away trees, branches and other waste. Source of other drift-wood like pieces of plastic, car tires and metal is mostly men, who interfere in the nature itself with unofficial garbage dumps. In all those cases we could warn on approaching objects with detection of objects in water and in this way prevent possible additional damage.

2. POSSIBILITIES OF THE METHOD USAGE EXPANSION

The method of detection objects on water surface using color is composed of more image segmentation complexes. Each complex represents a concluded integrity and can be used for different purposes and in different fields. Regarding to system complexness we will give just few usage possibilities in this chapter and a way how to modify detection of objects on water surface with color elimination for use in other fields.

2.1 Expansion possibilities

As we have briefly said in the introduction chapter this method works firstly on defining color area. Based on defining this area, we can transform this method and define color area for specific use. Application itself can then be used in many fields. Detecting based on color elimination enables us to as our base choose any element, object in the image that we would like to eliminate from the rest. In general the method enables us to set color area which presents a redundant part in specific image and we want to eliminate it. In this case we get a

rough image of object we want to eliminate from the image. Further on the method enables us to eliminate all redundant elements that do not present suitable result from the image. Because definition of color area and shape and size of morphological variable are experimentally defined, they define optional spectrum of usage and method expansion possibilities. Next we will show some cases of method usage.

2.2 Some cases of method usege

- *Detecting navigation in river and see areas:*

Field of detecting navigation (Figure 1) can be a serious problem in areas where navigation is prohibited for example in areas with energetic objects like hydroelectric power object and in areas with riverbed barrages. The method is designed that regarding to chosen image base enables detecting objects on water surface. As base color area it uses shades of blue which have to be experimentally defined. In phase of segmentation we also experimentally define thresholding value of individual pixel, which later on enables us successful detecting of object on water surface. Figures that show us some cases of method usage are marked with letters which mean: A – original, basic image, B – a display of edge detection above original image, C – a display of scaled image after defining color deviation, D – converting C into grey image, E – an image of values, that deviate from certain border, F – an image after eroding process, G – a display of mask of chosen pixels above basic image, H – a display of edge detection above gained image of chosen pixels.

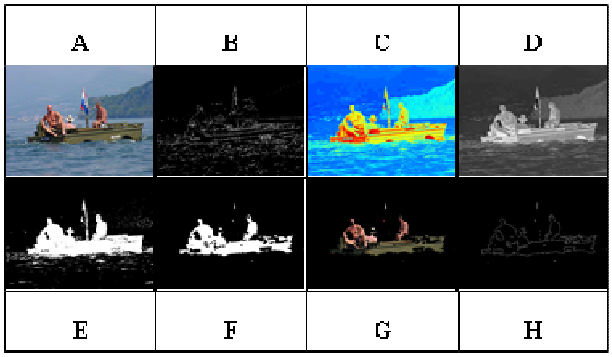

Figure 1: A display of detecting navigation

- *Detecting swimmers, drowned people and people in danger on water surface:*

One of the main working fields of the method for detecting objects on water surface with color elimination is certainly detecting dangers on water surface. Detecting people or animals that could be in danger on water surface in times of floods, high waters, rains or various natural water disasters can in these cases be a solution or can help personnel that works in rescuing procedure.

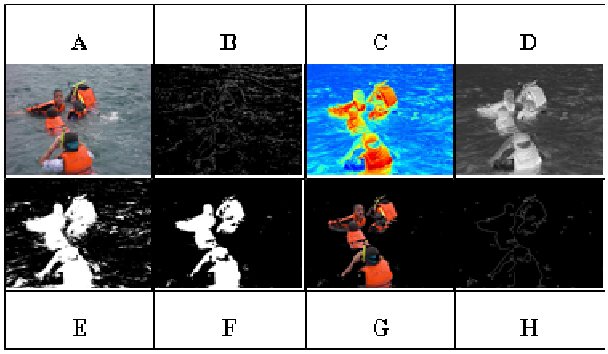

Figure 2: A display of detecting swimmers, drowned people

- *Drift-wood detection in river and see areas:*

Drift-wood detection is a field to which we have not devoted a lot of attention so far. Problematic is topical especially in energetic object areas like hydroelectric power stations because masses of drift-wood in front of the object cause cutout of working process and that presents a great financial loss for object's owners. With the method presented in this article we can successfully detect drift-wood on surfaces like rivers, sees, beaches and banks. Regarding to the usage place: rivers, sees, banks or beaches, we firstly have to experimentally define color spectrum of the area where we want to perform detection. We also have to suitably set the border, thresholding value for individual pixel that still suits our demands.

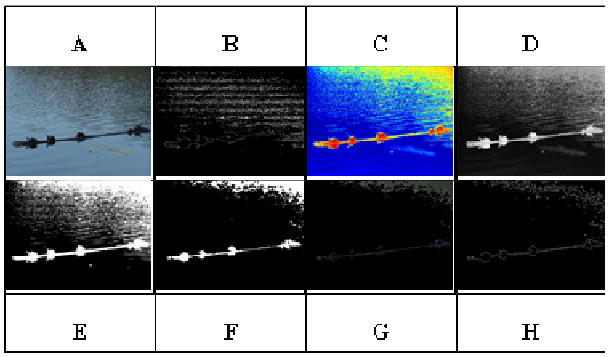

Figure 3: A display of drift detection

- *Detection of air vehicles:*

With the method of detecting objects based on color elimination we can also easily detect air vehicles like planes, helicopters, hang-gliders, skydivers etc. In some air areas there are air corridors within which it is strictly prohibited to perform any kind of sport recreation (hang-gliding, skydiving). In its last phase the method suggests edge detection. Based on that in the phase of distinguishing air vehicles we could easily determine elements that do not fit in a

certain corridor and on the basis of that recognition we could suitably take steps in forbidding flying.

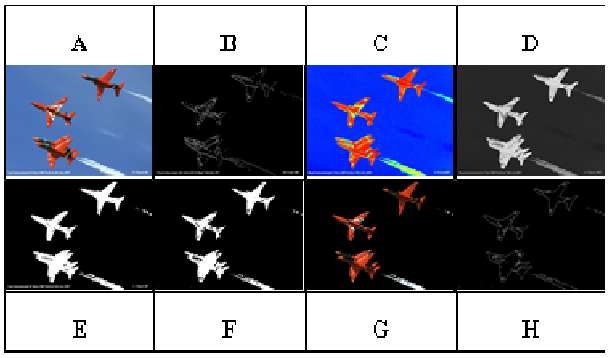

Figure 4: A display of detecting air vehicles

3. SYSTEM FOR DETECTING NAVIGATION AND DRIFT-WOOD BASED ON COLOR SPACE ELIMINATION

A system that would enable us detection of objects on water can be also used on other fields, if used by the method introduced in this article (see chapter 2). The method of detecting objects on water surface first of all needs appropriate selective image material on which the whole detecting system will work. Idea of detecting objects on water surface presented in this article, uses a shade of blue color for its base, which has been, according to given image base (see chapter 5) the best choice for further detecting. For successful working of the method in the very beginning we have to carry out image pre-processing and define suitable size of individual image and choose proper ones for further use from a number. Further the method defines color area, which is specific for a fixed field of system working. Because all further steps of detection then refer to correct definition of color area with this method we can in the very beginning define field or options of detection system working (see chapter 2) which uses this method. In case of using this method in any of the other fields we have to use different color parameters and define basic color area, which we will successfully eliminate in further procedure. Moreover the method defines color deviation with help of Euclidean distance. Regarding to entering demands, parameters and edge conditions (see chapter 4) which are required by method itself a defined image is processed according to individual picture element – "pixel". In this way the method examines color composition of particular pixel and memorizes color values of three basic colors: red, green and blue. That is how we get RGB ("Red Green Blue") values for each individual element and use them in defining color deviation. After the procedure of defining color deviation with Euclidean distance we get a chart of values of individual pixel. That is followed by transformation of an image in grey color area. Then the method anticipates a definition of thresholding border. Similarly as in defining color area we also experimentally define thresholding border according to the field of method usage and it depends on level of necessity of eliminating

defined color area of specific image. All values of individual pixels that do not satisfy border criteria and do not fall into specific color area are eliminated from further processing and are considered as useless. Next is creating a morphological variable with which we can later on in the procedure of eroding specific color segments easily detect elements in the image that actually present objects for detection. Form, length and direction of the morphological variable itself are experimentally defined to at the most satisfy edge conditions which are set by detection method. After the eroding procedure comes a review of pixels that satisfied edge conditions above the base image. Above the original image we get a created mask that contains elements of color area defined in the beginning. With elimination of this area we extract an object we wanted to detect from original image. To prove effectiveness of the method in the end we perform edge detection over image and compare it with detection over the original image. The method of detecting objects on water surface with help of color areas presented in this article definitely gives us favorable, reliable and useful results as some of the other methods. Results of method usage and comparison with other methods are mentioned at the end of the article (see chapter 6).

4. EDGE CONDITIONS AND ENTERING DEMANDS

Method of detecting objects on water surface with color elimination firstly presents a demand, as it is evident from its name, for eliminating color areas from the image. Color area is defined according to the field and purpose of method usage which enables use of this method in many fields. In the article, one of the entering demands is elimination of object from water surface. The next entering demand for successfully method working is defining size of images used in this method. Image size and format are limited to image format JPEG and size 800x600 pixels. In the method itself it is possible to adjust optional size of entering images and kind of formats but we have circumscribed in process of detecting objects on water surface with color elimination on already mentioned image format and size because of easier interpretation of final results and method performing. Next demand is edge condition and it is in the method of defining values that individual pixel can take in chart of color values of individual pixel. Values that specific pixel can take in this table are between 0 and 443. For the purpose of easier thresholding border determination and result interpretation we limited the highest possible value of specific pixel on 225. All other pixel values that exceed these values are equaled with value 225. Edge condition of limiting value of individual pixel was limited on value 225 because all values that individual pixel take above this value in case of our method mean suitable result. In case that anyhow some random pixel or a number of pixels takes value above 225 and we adapt it as value 225 then presents a suitable value for elimination from color area and this color area is suitably eliminated from further detecting in eroding phase.

5. IMAGE BASE

From the very beginning this method needs a suitable amount of image material above which we can perform the whole detection system. The idea of detecting objects on water surface presented in this article uses a shade of blue color for its foundation and at the same time there is also majority of image that express sports activities on water like boating, rafting, swimming, driving motorboats and others. In image base (figure 5) are also images in which we can see people's activities on water surface like swimming or rescuing people from water.

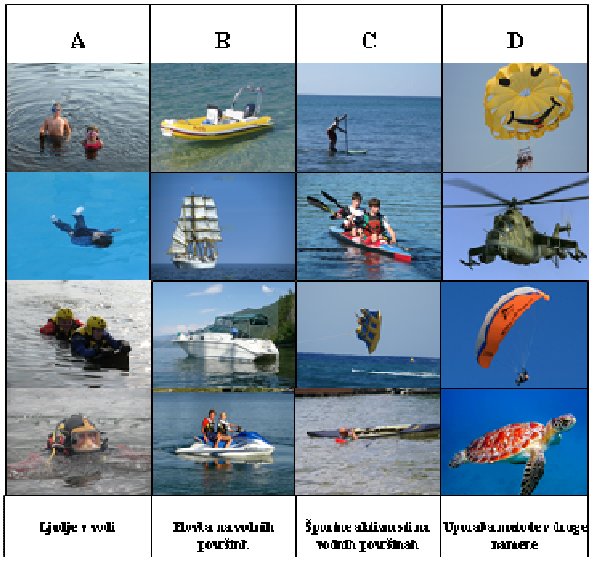

Figure 5: A display of some images from the base that illustrate problematic from this article

Column A – people in water, column B – navigation on water surface, column C – sport activities on water surface, column D – use of the method for some other purposes

Because we can use this method also in other purposes (see chapter 2) image base includes a lot of other image examples from which we can by using method for detecting object based on color elimination successfully eliminate given objects.

6. RESULTS OF METHOD USAGE

An example of successful usage of detection objects on water surface using color elimination has been presented in this article through process from pre-processing of individual image to procedures, phases that this method introduces for successful object detection. In this part we are going to present some other results that, based on suitable engagement led us to the result we set ourselves as an entering demand. At the same time we compare all the results with Sobel edge detection above the basic image because of showing

improved results of edge detection above basic image with the method presented in this article. Images are presented in intermediate phases and are marked with letters which mean: A – original, basic image, B – a display of edge detection above original image, C – a display of scaled image after defining color deviation, D – converting C into grey image, E – an image of values, that deviate from certain border, F – an image after eroding process, G – a display of mask of chosen pixels above basic image, H – a display of edge detection above gained image of chosen pixels. Result examples:

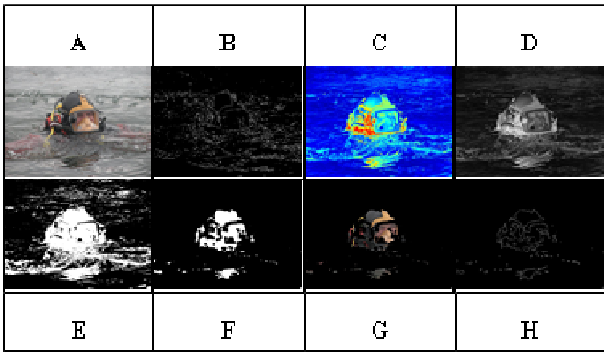

Figure 6: A display of results for diver's image

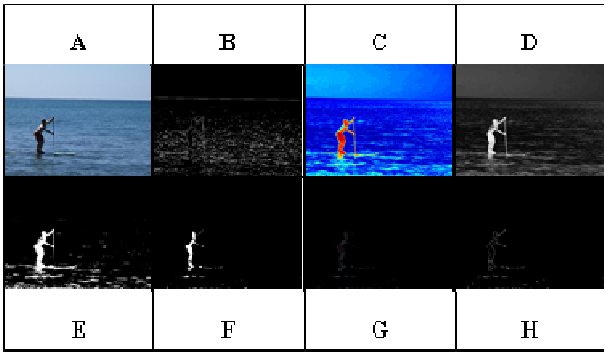

Figure 7: A display of results for surfer's image

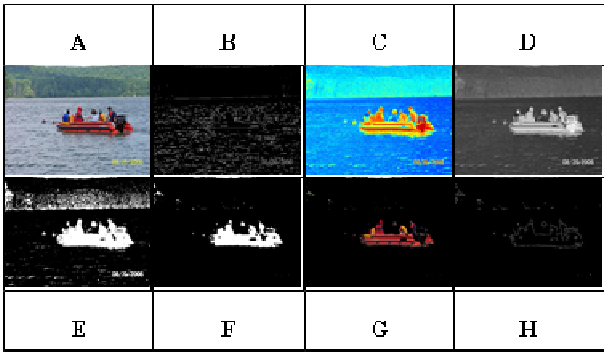

Figure 8: A display of results for rescuing boat image

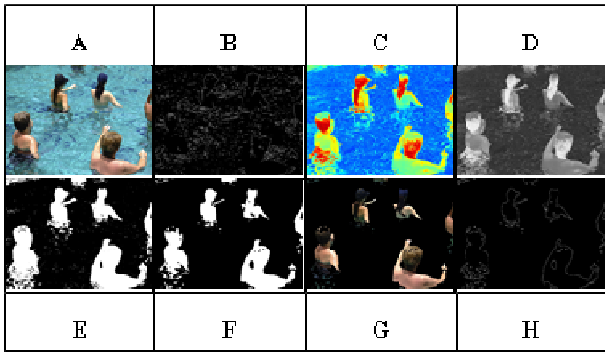

Figure 9: A display of results for image of people in water

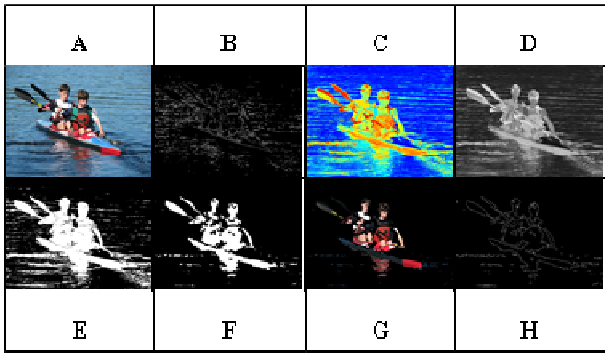

Figure 10: A display of results for canoeist image

7. CONCLUSION

In this article the method, system of detecting navigation and drift-wood based on color space elimination is presented. System presented in this article enables us detection of navigation and drift-wood on water surface which reduces possibilities of potential risks and other problems, which can later on seriously affect the operation of hydropower plants.

8. SOURCES, LITERATURE

[1] Strokovni članek: ERK08: Povezovanje hidroelektrarn na spodnji Savi; Aleš Štricelj univ.dipl.inž.tel.
[2] Strokovni članek: ERK09: Hidroelektrarne na spodnji Savi – možnosti vpeljave storitev na povezanem sistemu hidroelektrarn na spodnji Savi; Aleš Štricelj univ.dipl.inž.tel.
[3] Strokovni članek: ERK10: Vpeljava sistema za detekcijo plovbe ter plavja na območju hidroelektrarn na spodnji Savi; Aleš Štricelj univ.dipl.inž.tel.

[4] Stefan U. Thiel1, Ron J. Wiltshire1, Lance J. Davies: Automated object recognition of blue-green algae for measuring water quality – A preliminary study; Water Research, Volume 29, Issue 10, 1995
[5] Zhao-Yi Wei, Dah-Jye Lee, David Jilk, Robert Schoenberger: Motion Projection for Floating Object Detection; Advances in Visual computing, Third international Symposium, Lake Tahoe, NV, USA 2007
[6] L. Guan, Ed. Multimedia Image and Video Processing. Boca Raton: CRC Press LCC, New York, 2001.

ADDRESS OF THE AUTHOR

Aleš Štricelj, univ.dipl.inž.tel.

Termoelektrarna Brestanica d.o.o.
Cesta prvih borcev 18, 8280 Brestanica, Slovenija

Tel: + 386 7 48 16 240 Fax: + 386 7 492 22 62
Elektronska pošta: ales.stricelj@teb.si