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DIGITIZATION OF STAR MAPS ON THE EXAMPLE OF TWO MAPS FROM KOTLARIĆ'S "*NEW STAR FINDER*"

Abstract. *The New Star Finder* by Stjepo Kotlarić, evaluated by both local and foreign experts as exceptional work in the field of astronomical navigation, has undergone several editions and has long been the main and the only star finder (or star identifier) used by our navy, naval schools, and sailors in general. In this paper we present, on the example of the two stellar maps from the second edition of Kotlarić's *New Star Finder*, the proposal process of digitization of a star maps. That process include, in addition to standard step of scanning and removal of deformation of scanned material, a vectorization of scanned maps using the software package AutoCAD and Raster Design 2010. Idea is to give the proposal process of digitization of any stellar maps in order to store the existing data as well as leave the possibility of their further updates.
Keywords: astronomical navigation, star finder (identifier), digitization, vectorization, digitization and global ethics

Introduction

In the fifth book of the Homer's Odyssey, Calypso, the heavenly goddess, advises Odysseus to follow the stars as he sailed away from her island [1]. This is the one of the oldest written testimonies about navigating using the stars and heavenly bodies. Since Homer's time to the era of GPS, star navigation, so called celestial or astronomical navigation, has gradually developed. In this work, however, we will not talk about its long history, but about the digitization of a handbook, so called *Star Finder* or *Star Identifier,* which is, with the *Nautical Almanac*, one of the basic manuals for classical celestial navigation.

The best-known Star Finder in our region is Dr. Stjepo Kotlarić's *The New Star Finder* (*Novi identifikator zvijezda*), published for the first time in 1965. It was published by the Hydrographic Institute of the Yugoslav Navy, in order to: "*...[help] the seamen of our naval and commercial fleets...*" [2]. On its importance wrote Anton Botrić, Dušan Stajić, W.A. Scott and others...[1]. Until 1991, this was the only Star Finder ever published on the territory of the former Yugoslavia, written in one of the official languages of SFRY[2].

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1 Anton Botrić, Značenje i prednost Kotlarićeva novog indentifikatora zvijezda u praksi astronomske navigacije, Društvo za proučavanje i unapređenje pomorstva Jugoslavije, Zadar 1967; Dušan Stajić, Astronomska navigacija, Beograd 2005; W.A. Scott, A Yugoslav Star Finder, Journal of Navigation (1958), Volume 11, Issue 04

2 Some web pages today state that the Kotlarić's *Novi identifikator zvijezda* from 1977 was written in *Croatian,* for example: <http://openlibrary.org/books/OL4505368M/Novi_identifikator_zvijezda> (6 May 2011) or the browser of the library funds of the Hydrographic Institute of Croatia:

Today, when Hydrographic Institute of the Yugoslav Navy no longer exists, and when, in this era of GPS, studying the demanding astronomical navigation might even seem like a waste of time[3], there's a question of whether or not there is a need to digitize such publications, such as a star finder? Since the publications of the Hydrographic Institute of the Yugoslav Navy are the part of the heritage of the former Yugoslavia, cultural and historical importance of their digitization is clear. But there is a question whether their digitization entails another, for example scientific significance? Our answer is YES. For example, if we consider the fact that astronomical navigation is still studied at some naval schools, the availability of digital literature for pedagogical and scientific work has numerous advantages, among others, from the point of view of efficiency and practicality. Also, modern electronic and radio equipment, such as a GPS system, are subject to failures or abuse in certain circumstances, so it might be useful to have an alternative. Lastly, digitized material can be used and adapted to the requirements of different scientific disciplines.

The digitization of the second edition of The New Star Finder by Dr. Stjepo Kotlarić

In 1977 the Hydrographic Institute of the Yugoslav Navy (Hidrografski institut Jugoslovenske ratne mornarice), celebrating the thirtieth anniversary of the publication of Dr. Stjepo Kotlarić's scientific work, published the second edition of his *New Star Finder*. It represents, in the words of Dr. Kotlarić himself, a special publication which contains a planchette made of transparent plastic with a marked hemisphere (Figure 1), as well as 18 pairs of stellar maps of certain cartographic projection. The left (red) map of each pair shows the stars of the Western, and the right (black) one the stars of the Eastern hemisphere. Each circle of stellar map represents the celestial meridian of observers, and has a diameter of 195 mm. The maps contain the positions of 182 brighter stars: 54 whose coordinates were published in the local nautical almanac, 22 from American, British, Norwegian and Italian almanacs, and 97 in a special list of stars at the end of the American Nautical Almanac.

The second edition of Kotlarić's *New Star Finder* brings a lot of information and data, which are used for various analysis and calculations. Their good digitization assumes a careful approach, and therefore we used the suggested standards of digitization published in several different papers, mainly in the journal *Review of the National Center for Digitization* [3, 4, 5], but, due to the specific nature of the subject given, we didn't find fully adequate example.

In order to avoid the use of licensed software and make the process of digitization, among other things, financially affordable, free software was used wherever possible, for example: for scanning program called *FreeKapture,* and for image processing programs *GIMP Image Editor* and *Inkscape Vector Graphic Editor*. This way, in part, we wanted to avoid the pessimistic view that Bertrand Lavendrine showed in his book "*A Guide to the Preventive Conservation of Photograph Collections*", that digitization, as a financially demanding process, is questionable in this time of economic crises [6]. Unfortunately, as adequate free software couldn't be found at the time, licensed programs *AutoCAD 2010* and *Raster Design 2010* were used for vectorization of the cartographic material.

<http://www.hhi.hr/staticpages/index/knjpretrazi> (6 May 2011). According to the Article 246 of the *Constitution of SFRY* from 1974, Croatian was one of the official languages of the state and its institutions.

3 U.S. Naval in the late 20th century from its curriculum threw a course on astronomical navigation, considered to be one of its more demanding courses (Celestial Navigation, *Wikipedia* (last modified 07. april 2011) <http://en.wikipedia.org/wiki/Celestial_navigation> (6 May 2011))

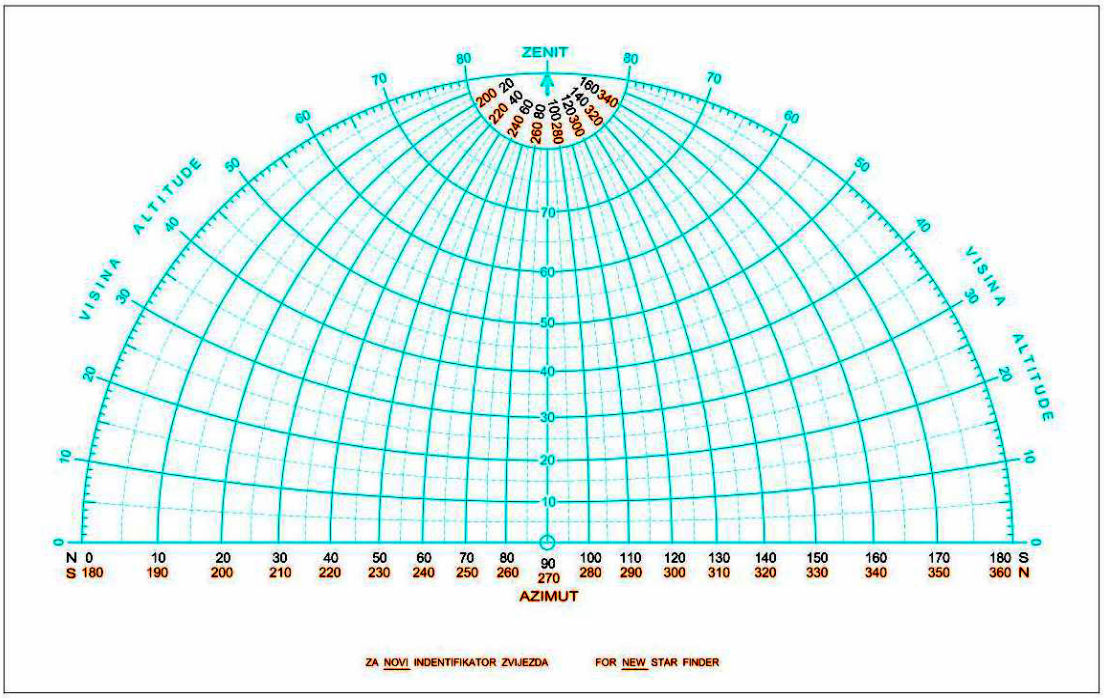

Figure 1: *Planchette made of transparent plastic after vectorization*

Respecting the concept of global ethics in digitization [7] and *Law of copyright and related rights* [8], HTML presentation was created for nonprofit educational use (Figure 2). Our plan is to, after obtaining the necessary rights, make the digitized material publically available on the Internet, and link it to the relevant online databases, for example: http://adsabs.harvard.edu/abs, http://openlibrary.org/, http://www.ncd.matf.bg.ac.rs/, etc.

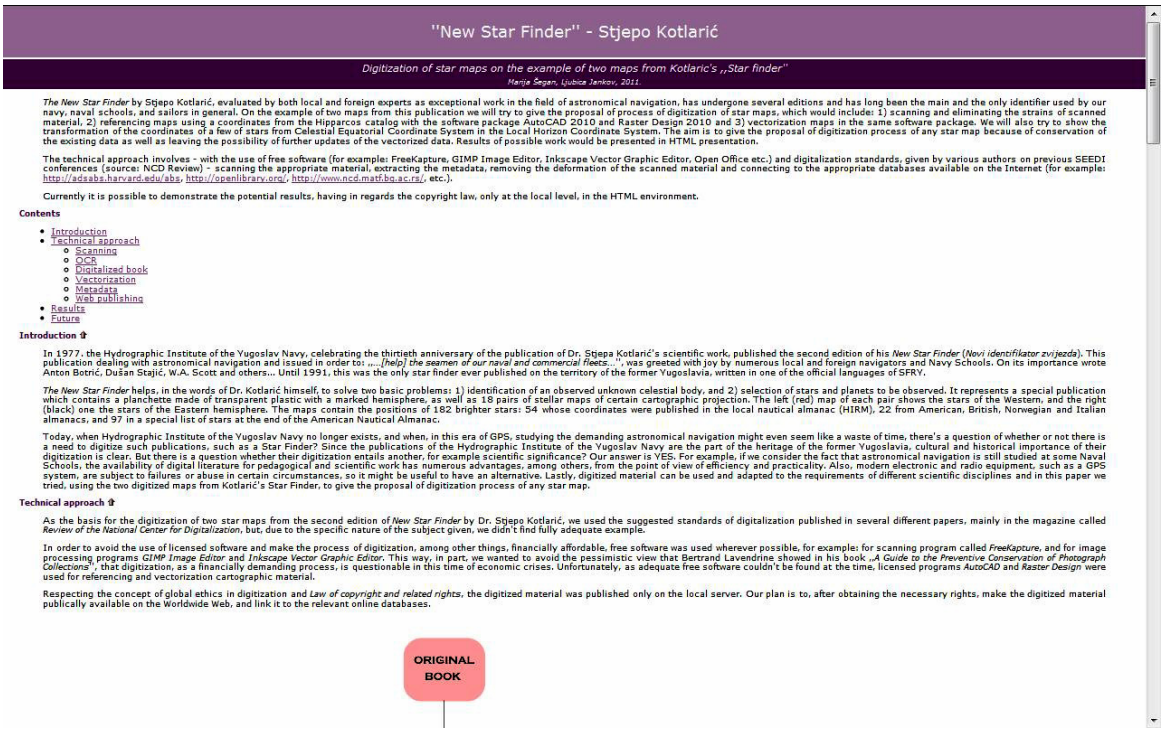

Figure 2: *The HTML presentation*

More about vectorization as a special step of digitization

Kotlarić's stellar maps came down to us in their analog, paper form. Scanning and converting them into the so-called raster images[4] was just the first step of their digitization. Since the idea was to preserve, in the best possible form, all the information that one map bears, next natural step was vectorization.

Today, the field of application of vectorization is great, and most commonly found in industry, civil engineering, geodesy, architecture, automotive industry, etc. For instance, in textile industry, vectorization and processing of images help in reconstruction of folk costumes, and one of the examples of its omnipresence is decoration of tombstones using a special program to make a desired drawing[5]. However, vectorization of maps puts this method on a great test. As maps and their contents are very specific and precise, and copying them from paper into vector form is a demanding and complex operation, use of various commercial programs does not yield wanted results. In these cases automatic vectorization is out of question; they require the method which demands high precision, in other words, manual vectorization, most commonly using various CAD/CAM tools. The advantage of this method is that most users are already skilled with these programs; the drawback, however, is that the software in question is not free, but licensed. Therefore, in the case of vectorization of Kotlarić's stellar maps, the use of the licensed program package AutoCAD 2010 and Raster Design 2010 was economically justifiable.

The proposition of digitalization in this paper regards digitalization of two maps from the 2nd edition of Kotlarić's *New Star Finder*, specifically, one of the Eastern and one of the Western hemispheres. Steps in the process of digitalization of these data were the gathering of analog (paper) maps, their scanning and elimination of deformations, as well as their vectorization. A scanned map (raster image) (Figure 3) serves as a foundation over which a new vector image is drawn, using the tools of the aforementioned program package. Before the vectorization itself, the raster image has to be referenced; that is, geometrically corrected to approach theoretical values. For this to be achieved or, in other words, for the raster image to be at theoretical coordinates (thus making the dimensions of raster image theoretical, or identical to the analog image) need to be transformed. As our major aim in this paper is to present the possibilities and applications of efficient vectorization, we did not take up the time-consuming processes of transformation and referencing. We used the scaling of the scanned image instead. This made it possible for the scanned map to be of the same dimensions as the analog one. As the final vectorized map in .dwg format contains numerous pieces of information, such as the names and sizes of stars, these bits of information are grouped according to their content. One of the ways to achieve this is the use of layers and blocks (Figure 4). Each of these objects can be placed in a tagged layer with a different label, and assigned certain types of lines, widths, colors, etc. Layers are very suitable to work with, providing clarity of drawing and print.

4 Raster image is an image represented by the values of the amplitudes of brightness (or color) of the smallest image element, pixel, and vector image is an image represented by mathematical description (most commonly Bézier curves). Even though there are high quality methods of compression for raster images, they obviously take up more space than the vector ones, and are also harder to process.

5 <http://www.unze.ba/am/pzi/2010/vektorizacija_rasterske_Benisa_Mujezinovic/ocr.html> (26 November 2011)

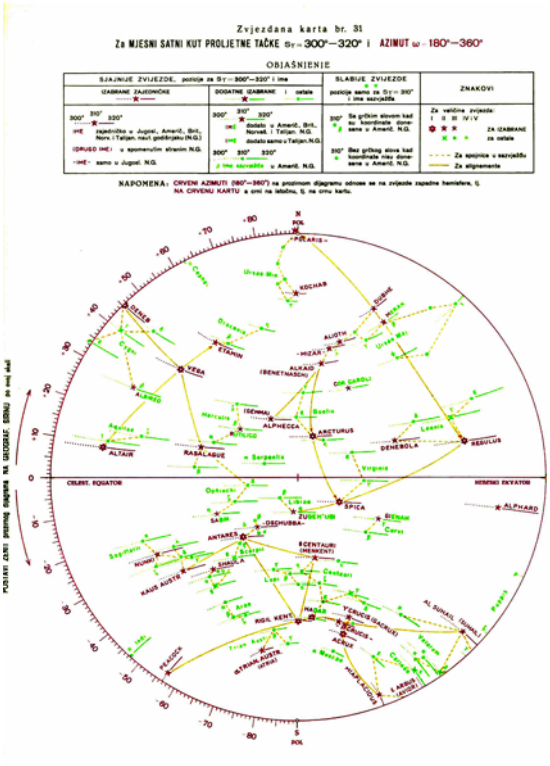

Figure 3: *Raster image (scanned star map)*

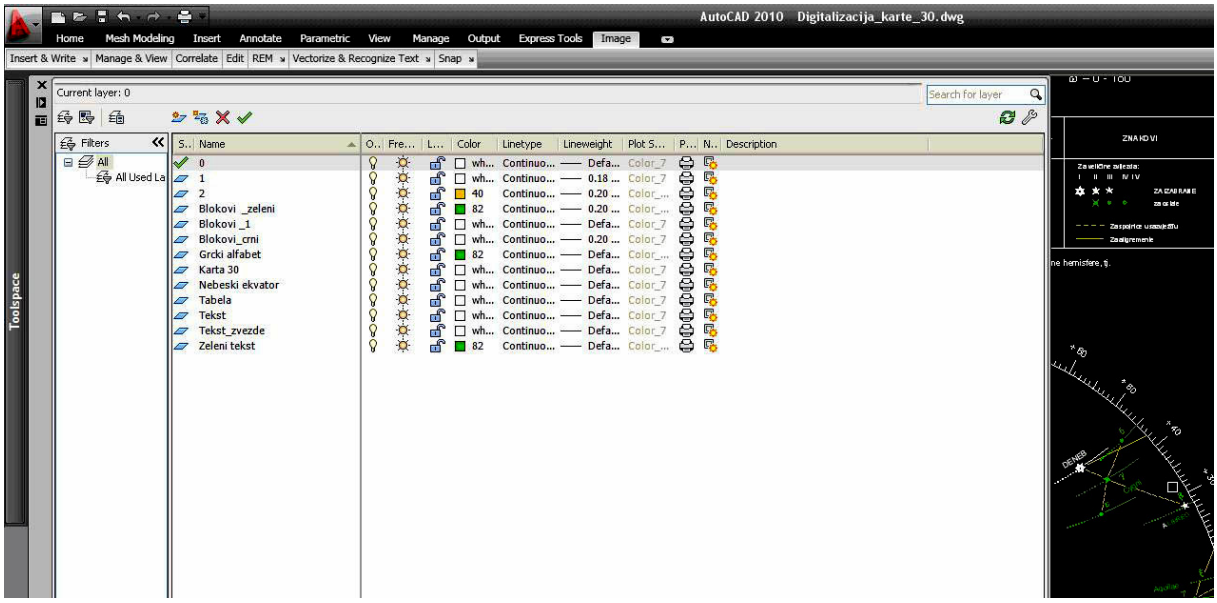

Figure 4: *Vectorization - Creating layers in program AutoCAD 2010*

Bearing in mind the value of these analog data being vectorized not only for preservation, but also for further updating, these stellar maps are vectorized with great care to add suitable documentation to each star from the raster image. Not only does this enable good clarity and quick search of objects on the drawing (Figure 5), it also makes it possible to edit this documentation at a later date and link it to up-to-date stellar maps (one of the most commonly known being the Hipparcos Catalogue).

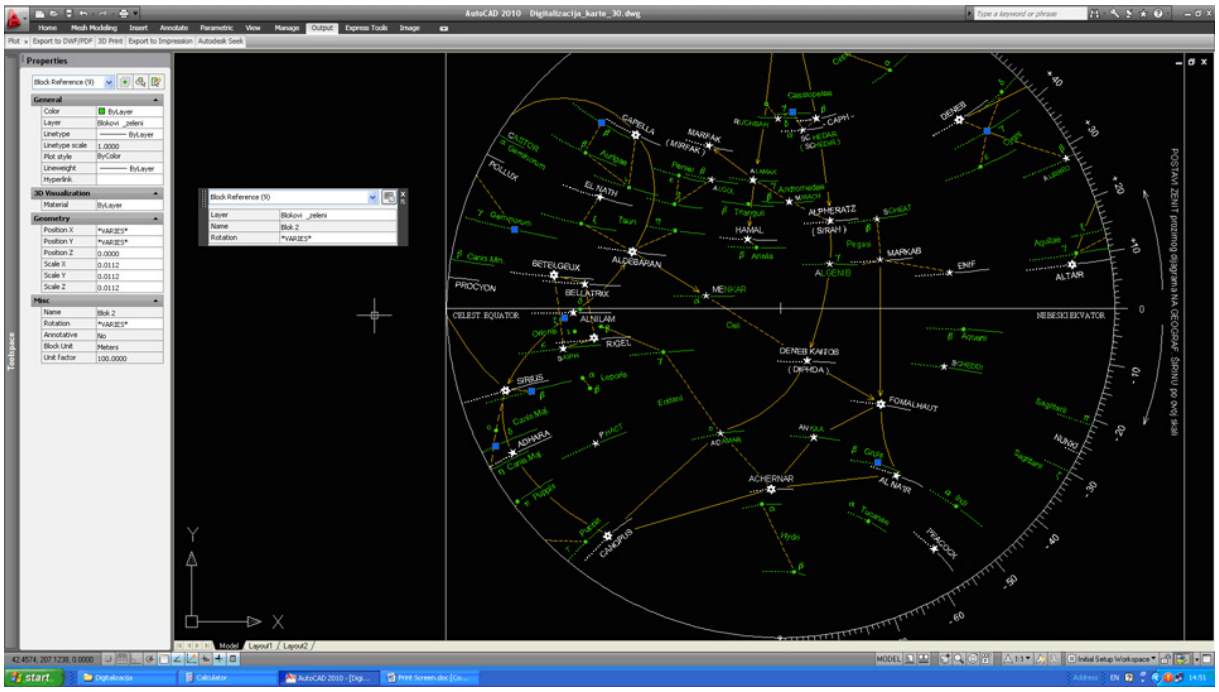

Figure 5: *Vectorization – Automatic selection of the blocks in program AutoCAD 2010*

Conclusion

Our proposal of the digitization of the star maps is only a working draft. But compared to the national and world contributions in this field, it proved to be functional, efficient, economical and user friendly. It includes the description of digitized material, as well as appropriate digital documents (star maps, photographs, metadata). Our next goal is to find the suitable free software for referencing and vectorization of cartographic materials. We also intend to concentrate on the question of transformation of stellar coordinates from one coordinate system into another (for example, from the sky coordinate system given in Kotlarić, into location, horizon, and other coordinate systems). Finally, our aim is also to use the vectorized data and create suitable informational systems.

Literature

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