INFRARED PRINTING AS A STEGANOGRAPHIC PROCESS IN CARTOGRAPHY

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Abstract

Today GPS appliances and devices are a reality in navigation and traffic. Satellite coverage of area is good and reliable. Acceptable price of different GPS appliances makes them affordable to most persons who require them in any possible way. This still doesn't imply that a need for classical maps in navigation has been completely removed. Classically prepared geographical maps for traffic navigation demand a certain graphical preparation. Novelty in graphical industry represents a possibility of steganography protection of prepared documents – in this case infrared protected maps. Paper analyses the possible applications of steganography protection by creation of infrared protected navigation maps for specific needs. Such preparation of maps can, besides protection, also imply new possibilities in communication through map as an object of communication.

Keywords

GPS, Protecting Communications, Mapping, Infrared Protection, Steganography

INTRODUCTION

A Development and organisation of traffic in present circumstances are a consequence of, primarily, developed technical devices and infrastructural possibilities. It could also be expressed vice versa good infrastructural possibilities are a motivation for improvement of technical devices and appliances in qualitative management of traffic, regardless to its category and model. Navigation and regulation of traffic can be analysed from several aspects, but the safety of traffic is certainly the most important factor.

Navigation refers to tracking and controlling object's or vehicle's movement from one spatial point to another. Points are determined by spatial coordinates within a metric space applied to a physical space in which movement takes place [1]. The second important fact in navigation is the environment in which the process of traffic or movement in general occurs. Though the basic prerequisites of navigation are equal to all modes of traffic, still there are certain specificities which differentiate specific modes of traffic.

For instance, sea traffic differs in certain characteristics from inland or air traffic. Term navigation (lat Navigare) in its original meaning is connected to navigation and characteristics of sea traffic where demands for elements of orientation and navigation are different that is more demanding than demands required in inland traffic and inland navigation. This led to a need for terrestrial navigation as scientific sub-discipline. In the process, metric of the applied coordination system for Earth assigns to each physical location a pair of coordinates (latitude -φ, longitude-λ) as measure of distance from the agreed origin positions represented by equator and meridian. Earth as celestial body and environment in which all sorts of traffic occur, is an environment in which people apply, according to their cognitions, the rules of Euclid space.

The second fact, applied metrics, is equally important and submissive to changes. With its shape and relationships in its surroundings Earth imposes some different modes of location, so geographical coordinates are related to sphere geometrics which put Euclid norms to situation of questioning its applicability and value. Navigation can, in such terms, be observed within frames of sphere geometrics – globally and in frames of Euclid geometrics – locally in situation of locally bounded movement from one position to another. In the process, navigation means usage of devices such as navigation geographical maps. Geographic maps are projections of space to a two-dimensional mode with data of position of individual point T (φ, λ), latitude and longitude. The third coordinate, altitude, is important if one tries to analyse position of an object in comparison to a local horizon.

Map is a visual presentation of some area, supported by appropriate symbols, where, when necessary, a relationship between elements of the presented area is underlined. Creation of a map is also connected to the concrete circumstances so it can be important in certain situations. In the present frames of technical possibilities and concrete digitalisation and application of information communication technologies this complete area is going through major changes.

Though it may sound traditional or conservative this paper considers a possibility of making the navigation maps of classic (published) form supported by innovative infrared design technology. Aside from the principle of making the mentioned maps, a pragmatic aspect of the applied geographical maps that is maps required for navigation and traffic in the usual circumstances will be discussed. However, infrared design provides also other possibilities through which traffic, regardless to its form and model can be made safer.

TRAFFIC, NAVIGATION AND OTHER SPECIFIC ATTITUDES…

If traffic is anticipated as the process made of a line of activities which should be realized in order to physically move an object or objects from one position to another, it is necessary to consider various conditions and facts that directly or indirectly determine that same process.

[2] They claim that traffic is a phenomena connected to a complex dynamic behavior according to spatial-temporary standards. This sort of definition tries to emphasis how traffic should be analyzed within frames of traffic and time which defines it, but also the problems derived out of it [3].

Though there are many different definitions, generally traffic can be defined as transportation of people, goods and information from one position to another. If traffic is regarded as change of physical location of objects that are being transferred, then, aside from changing the positions in the process, modus in which that change will be performed should also be considered. If traffic is analyzed from the holistic perspective, then one should consider the following:

- Infrastructure - physical objects and locations in which traffic is performed. This condition enables a classification that allows improvement of traffic conditions in the concrete situations. The basic objects are defined as: roads, railway tracks, airports, ports, commodity terminals, traffic terminals etc.
- Vehicles or objects used in traffic – mostly adjusted to certain class of traffic such as road vehicles, rail vehicles and trains, ships, airplanes etc.
- Associated and required operations – navigation, regulation and signalization of traffic – maps, signs, light signalization, regulation and traffic control etc.
- Time or duration of transport or traffic of goods and people.

However, holistic approach requires also pragmatic consideration of traffic. On the other hand, pragmatic aspects of traffic, besides their relationship with mentioned conditions and determinants, require in the concrete cases also fulfilling additional specific terms (i.e. in transportation of special or specific cargo).

Safety of traffic is undoubtedly the most important aspect of traffic. However, its specificity is usually the consequence of the increased or more intensive need for safety conditions that must be provided during transportation of specific cargo such as dangerous ones.

Traffic as scientific discipline corresponds to other scientific disciplines in a measure in which the basic subject of analysis is connected to instances, processes and subjects through which other sciences and scientific disciplines influence or determine traffic. In such way theory of traffic also embeds basic sciences such as math and physics, but also construction and other applied sciences more or less specific according to its object of research. When several sciences or scientific disciplines correspond in some way, they also share the way they perceive concepts, facts and data of their interest. Strictness of the mutual definition that will consider required specificities is a precondition of qualitative research and deriving the concrete conclusions.

For the purposes of this paper, it is necessary to consider the importance of two sciences: geodesy and cartography. Namely, connection between geodesy and cartography is pragmatic involved in traffic as science. On the basic level of abstraction, one can obviously detect dependence of qualitative traffic of people or goods to the accomplishments and applied scientific facts of these two sciences. More significant elaboration, in sense of insisting on specificities or individual approach goes beyond frames of this paper.

Insisting on spatial temporal frame of traffic demands integral approach, aside from considering specificities, or at least providing the frames in which these specificities will be evaluated. If the spatial component is researched then traffic requires physical surroundings in which it will be realized. On the other side, traffic as organized activity is necessarily connected to the infrastructure and infrastructural possibilities. This connection can be seen in two basic features of traffic: integrity and safety. Temporal component isn't independent that is autonomous. If traffic is process made of line of activities then it has its duration time that is time limitation. Time of duration as indicator or variable determines traffic in a way that it sets or limits range of individual factors which indirectly define traffic as a whole.

In a concrete situation, transportation of the object X from point A to point B in space considers, if not ideal then optimal conditions ensured by space in which transportation will take place. The same conditions are base for determination and calculation of time that is duration of traffic as a concrete process.

Further on, space as determinant of traffic, should be considered as physical and geographical determinant realized through infrastructural possibilities and options which consequently define duration of traffic activities or its temporal component. Temporal conditions, in sense of temporal climate conditions, are also important factor which influence duration of process, so they could be a consequence of spatial terms.

Factor that should be taken into a consideration when defining a concrete form of traffic is obligatory knowledge of sort and nature of materials used in the object that is being transferred or which participates in traffic.

For purpose of this paper it is essential to make a reference to the theory of traffic in three phases [4][5] authored by Boris Kerner. Three phases are, according to this theory, the following:

- Free traffic (F)
- Synchronized traffic (S)
- Traffic in conditions of traffic jam – so-called Wide moving jam (J)

SOMETHING ABOUT … CONCEPT OF NAVIGATION

Concept of navigation in this paper is used in its wider meaning, with priority given to the original definition of navigation. The original meaning of navigation was definition of human capability of orientation in space and

time. Concept is connected to sea or air traffic and capability of human/individual to direct ship or airplane from one spatial position to another. Management skills have been developed as a consequence of need to orientate in space by defining and maintaining the position in the environment in which the navigator operates [6].

As time passed navigation developed to a science of navigating the traffic and it is not exclusively connected to the sea traffic. Influence of other sciences and techniques that is technical means and devices has enabled integration of knowledge and skill in a scientific discipline called navigation. Due to the above mentioned, navigation cannot be classified as solely scientific but also practical-theoretical scientific field. Differentiation within this field specifies today branches such as terrestrial, astronomic, electronic and satellite navigation. As common usage of mentioned forms navigation can be defined as practical navigation.

Navigation as a process which accompanies traffic or transportation of objects during the traffic is necessarily tracked down with specific sorts of devices and appliances. From the beginning of the organised transfer of object – people, goods and information, a need for transfer of all possible modes emerged. This connotes infrastructure, substructure, vehicles and other complementary objects. Some authors describe navigation as a need of an individual to safely return home after certain period of time. In other words, person who knew how to leave should also know how to return [7]. Development of maps necessarily monitors such situations so it is a result of human aspirations to describe space in which one moves in a generally accepted way.

When communication should be organized, within circumstances when characteristics of participants of communication are not well-known, visualization should be approached that is a model that will be acceptable and easily understandable to all. On these basics and described needs cartography was developed. Originally it was defined as an activity of assembling, classifying, and pragmatism, saving and displaying spatial information.

The final display is realized in form of cartographic version. Spatial information refers to every form of information which can, in any possible way, describe object's features along information of its location in space, and sometimes in time. As scientific discipline cartography has been shaped relatively late, in the middle of the 19th Century, mostly as the segment of geography. Only after the need for cartographic projections and inclusion of mathematics developed, conditions for its unquestionable role in geodesy were developed.

Geodesy is a science which usually is treated as applied mathematical discipline. Every geodetic measure ends in cartographic display that makes cartography and geodesy symbolically connected. Development of telecommunications or communications in general and other sciences has led to a need for connecting cartography and geodesy with information sciences. This need has been reflected in defining a complementary information system presently known as GIS.

Application of information telecommunication technologies, computers and proper software has made process of collecting, selecting, analyzing, handling and displaying all forms of geographic information easier. Besides, GIS is defined as information system which can easily be included and integrated in any other business system. Though the possibilities provided by computers simplified the process, the problem of presenting real system in three dimensions remains and causes operative difficulties in navigation and traffic regulations when data try to be displayed in three dimensions.

Cartographic projections actually enable application of mathematical procedures, such as copying the points of curved surface, whether sphere or rotational ellipsoid of Planet Earth and other celestial bodies in level. Application is multiple, but primarily in geodesy and navigation.

Cartographic copies define dependence between coordinates of points on earth ellipsoid and coordinate of their projections in level.

Given projections or planed presentation of bodies is usually referred as map. Map, geographic map or navigation map is basic device in navigation regardless to the traffic mode. Map can have a specific purpose which makes its creation more complex since it should be provided with supplementary data.

Traffic maps are intended to navigation and orientation in traffic so besides position coordinates they also provide a line of symbols which imply through their forms and color the meaning of objects presented on a map.

In time when easy usage of appliances such as GPS (Global Positioning system) for purposes of traffic is simple, discussion on navigation maps may appear minor. GIS is American space global navigation satellite system that provides reliable positioning for all points available, connected to four or more satellites. Time conditions and period of day do not represent a constraint. However, GPS appliances as basic element of satellite-managed navigation are still not available to all since their price is constraining factor. This hasn't removed a need for maps since there is always a possibility of damage in appliance or problems on communication basis in a global sense. Quite contrary, GPS is useful tool in creation of maps and land measurements.

Besides, navigation through GPS appliance is semi-interactive so the navigator is completely adrift to information provided by satellite. Combined with visual control of space navigation is highly safe. However, in every moment a factor of surprise should be considered. Screen of GPS appliance is interactive cartographic projection of navigator's surrounding which, besides certain dynamic features contains all other features of a regular map. It is even inferior to traditional maps in terms of display and symbolic, but not in a way that it hurts traffic's safety.

INFRAREDESIGN® AS NEW POSSIBILITY…

The usual maps applied in road traffic aside from positioning upon two coordinates (latitude and longitude) include data of the third coordinate, altitude, but without

impression of three-dimensionality. Besides, too much data can make map hard to use. Still, some of data should be provided on these maps. Besides, maps become very quickly inaccurate after being printed since the area presented on them is constantly changing. Infrared design as publishing technique is a set of rules which enable a combination of two prints or two pictures, when one of them is visible only under infrared lightning while the other is visible by eye or in a daylight or in an artificial lightning of the usual spectrum.

Infrared design represents certain mode of stenographic technique which protects specific document, or map in this case, from forgery with additional possibilities also available.

Infrared design as printing technique in this sense shouldn't be misplaced with application of appliances based upon infrared rays used in, for example, night surveillance.

Things a human eye can see in normal conditions is just a segment of a spectre which includes radio waves, infrared and ultraviolet X-rays and gamma-rays as forms of electromagnetic emission. Possibility of increasing the visibility with electronic devices represents extremely powerful technique and application of IR segment of spectre when it can be seen. Infrared light has less energy than visible light, relatively bigger wave lengths. Infrared segment of spectre of wave length is of 1 to 15 microns range, or 2-30 times of longer wavelength (and 2-30 times less energy) than the visible light (see Figure 1).

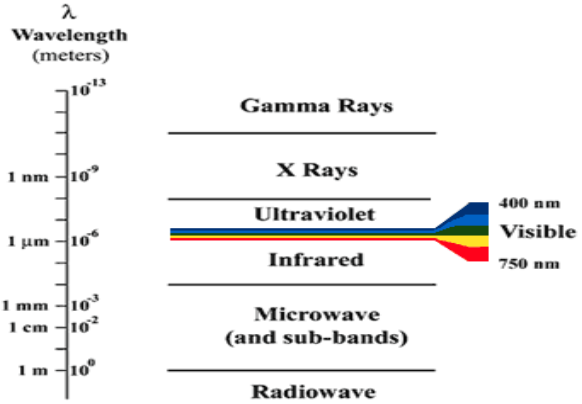

Figure 1: Spectra (Source: http://www.flir.com/cvs /cores/view/?id=51886, 10.I.2012)

Infrared design as printing technique has already been acknowledged in field of protecting personal documents and gilts of all forms and purposes. Since the complete process has been developed on preparation and usage of colours that can react properly on infrared segment of spectrum, the procedure hasn't been constrained only to printing but instead has been applied in arts, in line of works painted by academic painter Nada Žiljak.

Infrared design technique is primarily stenographic, but it doesn't have to remain in that mode exclusively. When printing document or generally printing objects on the same media – which can be anything to which printing film can be applied – two pictures are being deposited of which one picture can be named as protected and the other as a protector. In the process, one picture is visible in a visible part of spectrum and the other could be seen only under the infrared lightning. Pictures can or cannot be semantically connected. Semantic connection emerges when pictures supplement each other with their semantic content that is if they are supplementary or mutually complemented. This helps to distribute information content of certain object into a visible and non-visible that is IR visible part.

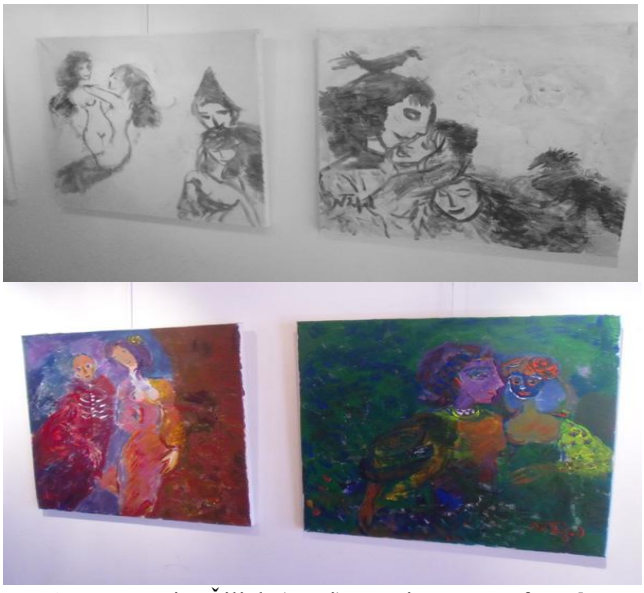

Figure 2: Miss Žiljak (semi)two picture in infraredesign technics

However, a problem of user who can be put in a situation to hold IRD protected document without knowing it still remains. If the purpose is protection of content then the relationships in communication between users will be regulated in a way to inform users about sort and content of message that is facts about protected items, terms of protection and protection from which users will be known facts. Forgery of IRD-prepared documents is possible only if the procedure is completely repeated which decreases the risk of damage.

If the application of IRD doesn't have a stenographic purpose, then possibilities are much bigger and fields of possible application are not restricted. If content of the protector and the protected is put in such a position to make it a complex, by letting the part of redundancy and not insisting on strict complementary, publishing objects can be formed and they will simultaneously carry two pictures on the same position. In what kind of relationship are the protector and the protected object? If the quantity of information carried by the protected – Qi (A), while quantity of information carried by the protector – Qi (B), how big is the complete information or is the relationship $Qi(A)+ Qi(B) \leq Qi(A+B)$ valid if A+B corresponds to the object prepared by infrared design print?(see Figure 2)

Figure 3: Carrier image (400-700 nm) and Hidden image (1000 nm) (source: http://www.ziljak.hr/tiskarstvo/tiskarstvo09/Clanci09web/IvanaZiljak/IvanaZiljak.html

If there is no redundant content then equality is achieved, but in case of any redundancy that is inequality, the true information content of an object is smaller than sum of quantity of information [8]. Study [9] very precisely elaborates thematic of managing the information in IRD field of colours. Paper discusses RedGreenBlue and CyanMagentaYellow. Infrared information is presented through the process printing colours of which cyan (C), magenta (M) and yellow (Y) aren't visible above 750 nm, black as processed colour is visible in the IR segment of spectrum. Eye in natural conditions, through receptors of red (R), green (G) and blue (B), enable a perception of colours which correspond to the printing process combination of CMY [9]. In general this fact is important to know regardless to the area of interest since transfer of documents into a digital form supports transformation from RGB combination to CMY combination, with both of them interesting to cartography.

Why should this approach be interesting to cartography and traffic in general? If one considers the original intention of infrared design technique – protection of printed document, then application in all sorts of traffic that is within frames of integral transportation is possible on every spot that could jeopardize safety of traffic if it is regulated by specific documentation. Personal documents can be protected from forgery and misuse. In the same manner, documents used in traffic of people and goods can be protected in the same way. Travel and transportation documents can include information visible to institutions and person of different control functions.

It has been mentioned that basic assignment of cartography is projection of sphere to a level, when third dimension can be lost if it isn't additionally applied as information in a position marking a certain point. There are also relief maps in which altitude is applied in a proper way but the usage of such maps is constrained due to impractical manipulation.

If navigation, geographical and maps of other purpose are prepared by infrared design technique, then due to specific "two-layer" performance, at least, they could be equipped with data of altitude as the third coordinate. Naturally, the other information can also be prepared and printed in such a mode.[10] There is always a group of information of static character that can be used and presented on map prepared in such a mode. Usually maps carry an adjective of "auto" that suggests its intention in navigation of road traffic. Special interest has been directed to equipping such maps with as much information possible about the area they are presenting. In such a way safety of passengers can be increased in longer and open highways through complementary information of general, touristic and naturally safety importance.

Though it is clear that this procedure can be applied in war conditions, the complete stenography according to this technique isn't possible. Still, it is for a fact that Stalin didn't allow mapping pre-war Soviet Union precisely due to the importance of maps in navigation.

Possibilities provided by infrared design in cartography, and indirectly in geodesy, mathematics and physics are huge.

It is important to mention some other facts of infrared design that are in a way constraining. An object prepared in IRD technique has two-layer structure and a layer visible under IR rays can be seen in gray-black halftone.

When a document is being prepared in a way that colour in it bears a certain semantic meaning that is it contains information of semantic character, that information will get lost. It is a fact that cartography colours represent information so the content of IR part cannot store such information. If that becomes a constraint it can be considered at the very beginning of creating IRD objects. Information on colour if necessary can be prepared in a different way.

CONCLUSIONS

Safety of passengers and goods in present travels, traffic or transportation are an imperative. All technical devices and appliances should necessarily contribute to such safety. All qualitative highways, traffic, communication and telecommunication infrastructure are basis to which more sophisticated appliances are being connected, such as GPS. The assumption is that improvement of such devices and their connecting to automobile industry and vehicle industry will lead to a situation in which GPS will be considered as a standard part of a vehicle. Nevertheless, usage of such appliance bears a certain risk considering the need of interactive relationship between navigator and navigation tool. One could also notice the efforts of mobile operators to provide similar service as part of palette of their services, or the ones provided by web service providers. GPS services can even today be considered as public services from Cloud (Cloud Computing) meaning the same services will be offered by other providers of Cloud services.

Traditional form of maps can go through changes and evolve in form today known as electronic papers, but with the need of traditionally printed maps, regardless to their purpose, possibilities provided by IRD technique offer significantly bigger quantities of information which those maps can carry. At the same time, along with information crucial to safe traffic, other information of touristic and general character can also be displayed.

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