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Measurement of spectral reflectance of map image

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Abstract:

Military topographic maps (DTMs) require legibility under diverse lighting conditions, including low lighting and night environments. Vehicle´s and aircraft´s cabins utilize light sources for map reading that must comply with specific standards: no driver/pilot dazzling and no infrared emission. Consequently, designing legends for military maps, including DTMs, necessitates considering legibility under standardized illumination.

Standardized map content (e.g., DTM Portrayal Catalogue) defines the content, nevertheless, colour variations within printing standards (DGIWG, 2022) allow for optimized legibility. However, there are two main problems. Firstly, if it is possible to verify the legibility of given colour variant in all lighting conditions, and secondly, objectification the determination of this legibility.

Researchers from the University of Defence involved in the project "Evaluation of the useful properties of DTMs created according to the DPS DTM standard" attempted to objectively assess the readability of the DTM content under different lighting conditions using the spectral reflectance of the map image. The spectral reflectance of the map image was measured for two colour variants.

The USB4000-VIS-NIR spectrometer was used to provide the objective measurement of the reflectance of the map image under the illumination of defined spectrum, which measured the intensity of light reflection in given spectrum from map image under the daylight conditions (daylight) and when using red or green-blue light emitted by LEDs. To ensure stable lighting conditions, repeatability of measurements and accurate localization of the map image in the test fields, a portable coordintatograph Haag-Streit was used, which was adapted to fix the spectrometer sensor, which detects optical radiation in the 380–950 nm range, as well as to fix the LED light sources.

Map reflectivity was evaluated across the light spectrum relevant to military standards: aircraft cabin lighting standards for military aviation and general technical specifications for tactical lighting in military vehicles for ground forces. Daylight readability was also considered.

A calibration basis for the spectral reflectance measurements was created containing all the colours and their shades used, including the permissible variations according to (DGIWG, 2022) that are used in the creation of the DTM. On this basis, the difference in the reflectance intensity of the base and overprint ink in the given variants, i.e. the colour contrast, was also evaluated. Based on the evaluation, the variant that maximises this contrast was recommended. The table (Table 1) shows examples of the measured values for the base and overprint colours. Variants of the base colour for forest areas (Green355-31, Green346-31) and overprint colours for contours and transportation ways fills (DkBrown1815), hydrology (Cyan) and aerial obstacles (Blue072) were used.

The legibility of the overprint elements against the background was evaluated in the colour space defined by the CIE 1976 and CIE 1931 methods. In particular, colour contrast was evaluated as the difference in the colour of the background and drawing elements using the Weber-Fechner Law. The contrast values are given in the last column of the table. Results indicate Green346-31 as the preferred base colour for forest areas under all lighting conditions. However, further investigation into other polygon fill colours, particularly for settlements and water areas, is necessary to determine the optimal colour variant.

In the next part of the research, real spaces depicted on the DTM will be verified so that they contain different landscape types and have different graphic fillings. This testing will take place during 2024.

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Table 1 Measured values for base and drawing colours in the calibration base

Base Colour				Overprint Colour				Weber-Fechner´s low - Contrast
Colour designation	Reflection intensity in the RGB spectrum [count]			Colour designation	Reflection intensity in the RGB spectrum [count]			
	R - Red	G -Green	B -Blue		R - Red	G -Green	B -Blue	
Daylight								
Green355-31	30300	21500	7100	Black	5400	3200	2200	5,15
				Dk-Brown1815	22900	5600	2800	1,25
				Cyan	8900	17000	11300	0,60
				Blue072	11500	8700	7200	1,46
Green346-31	35900	24100	9300	Black	5400	3200	2200	6,06
				Dk-Brown1815	22900	5600	2800	1,58
				Cyan	8900	17000	11300	0,84
				Blue072	11500	8700	7200	1,82
Red Light								
Green355-31	38600	0	0	Black	7100	0	0	4,44
				Dk-Brown1815	26900	0	0	0,43
				Cyan	10700	0	0	2,61
				Blue072	13600	0	0	1,84
Green346-31	43900	0	0	Black	7100	0	0	5,18
				Dk-Brown1815	26900	0	0	0,63
				Cyan	10700	0	0	3,10
				Blue072	13600	0	0	2,23
Blue-Green light								
Green355-31	0	39600	8400	Black	0	5600	2800	5,90
				Dk-Brown1815	0	8400	2800	3,66
				Cyan	0	33600	14200	0,16
				Blue072	0	15200	8100	1,53
Green346-31	0	43900	12100	Black	0	5600	2800	6,69
				Dk-Brown1815	0	8400	2800	4,20
				Cyan	0	33600	14200	0,29
				Blue072	0	15200	8100	1,82

References

DGIWG (2022). *DGIWG 131 Printing Colours for Defence Geospatial Products* (1.0 ed.). DGIWG. Retrieved 9 2023, from https://dgiwg.org/documents/dgiwg-standards?set=131

DGIWG (2023). *DGIWG 252-2 Defence Topographic map for 1:50,000 Scale (DTM50), Data Product Specification (DPS) - Portrayl Catalogue (PC)* (1.1 ed.). Defence Geospatial Informatin Working Group. Retrieved 9 2023, from https://dgiwg.org/documents/dgiwg-standards?set=252

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