International Cartographic Association
Association Cartographique Internationale

# Multivariate Mapping techniques and Immersive Virtual Environments

Ondřej Kvarda [a,*], Zdeněk Stachoň [a,b]

[a] *Dept. of Geography, Masaryk University. Ondřej Kvarda – kvarda.ondrej@mail.muni.cz, Zdeněk Stachoň – 14463@mail.muni.cz.*
[b] *Dept. of Information and Library Sciences, Masaryk University*

* Corresponding author

**Keywords:** 3D cartography, virtual reality, thematic cartography, multivariate map symbols

**Abstract:**

Multivariate mapping methods encode multiple data variables using multiple cartographic visual variables. These can be represented (but are not limited to) by several well-known and used methods such as bi- or multivariate choropleth maps which use colour or texture as their distinguishing variable, ray-glyph/polygonal-glyph, stick-figures (sometimes also called trees), spoke glyph, Chernoff faces, data jack, chart map (pie, bar, stack, radar, etc.), or simple bi- or multivariate point symbol (e.g. geometric) (Slocum et al., 2005). The point symbols can change their dimensions (or dimension of their parts), form, or prominent attributes (in the case of Chernoff faces) to represent these values and can be represented as either 2D or 3D objects.

These methods have been, in most cases, used solely in non-immersive mediums that do not allow for any form of advanced user interaction, true 3D visualisation, or user movement along all three axes of the 3D space. Thus, their suitability for use in for example immersive virtual environment (iVE) was not yet thoroughly examined. The fitness of each aforementioned method, and even their overall usability, may vary when comparing the "traditional" use and the use in iVE. The ability to move freely along all three axes of the 3D space (surging, strafing, elevating) while simultaneously being able to tilt one's head (rolling, pitching, yawing), and in the process change the perspective through which we assess the scene (for example lowering the users view to the vertical base level of the symbols to assess and compare their heights), can influence the way we perceive, compare, and discern certain objects from one another and can therefore lead to different methods being more preferable to employ in iVE than in traditional cases.

The aim of the "study in progress" is to address the shortcomings in this regard and analyse the usability and suitability of different 3D multivariate symbol methods in an immersive virtual environment solely in the context of the user's perception. This is done through 1. Initial research of existing scientific papers concerning this area of interest (although after preliminary research their numbers seem to be close to none). 2. Conversion, design, and construction of said symbols (Chernoff faces, charts, spoke glyphs, etc.) into 3D (model example can be seen in Figure 1.). 3. Creation of iVE with map tasks focused on work with 3D multivariate symbols (preliminary example can be seen in Figure 2.). An example of such task would be finding a symbol with a highest/lowest value of a certain variable or finding a particular symbol with given values (shown to the user as an example) across different 3D multivariate mapping methods. 4. An experiment using an HMD (head-mounted display) with several tasks aimed to determine the suitability of certain 3D multivariate mapping methods (participants' interactions in the virtual environment will be logged). 5. And a final analysis of the output data along with the consequent conclusions and recommendations on which point multivariate mapping methods should be considered when visualising the data in iVEs (or possible modifications of said methods for iVEs).

The study is still under development, but the preliminary results are expected to be available at the beginning of September.

Abstracts of the International Cartographic Association, 5, 2022.
European Cartographic Conference – EuroCarto 2022, 19–21 September 2022, TU Wien, Vienna, Austria.
https://doi.org/10.5194/ica-abs-5-99-2022 | © Author(s) 2022. CC BY 4.0 License.

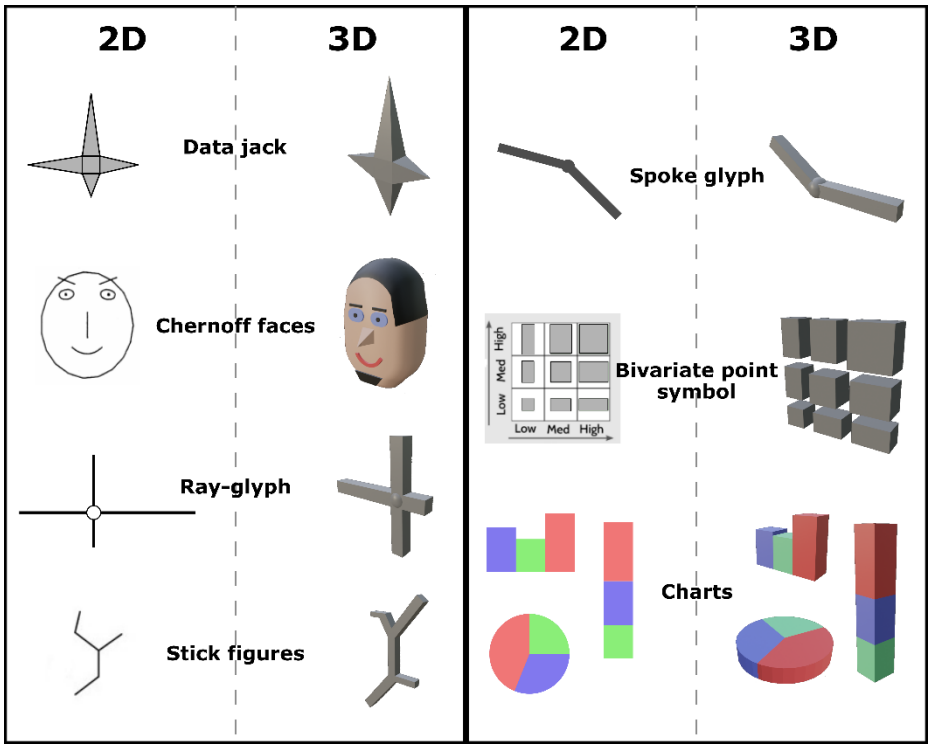


Figure 1. A model example of different 2D multivariate symbols and possible 3D equivalents.

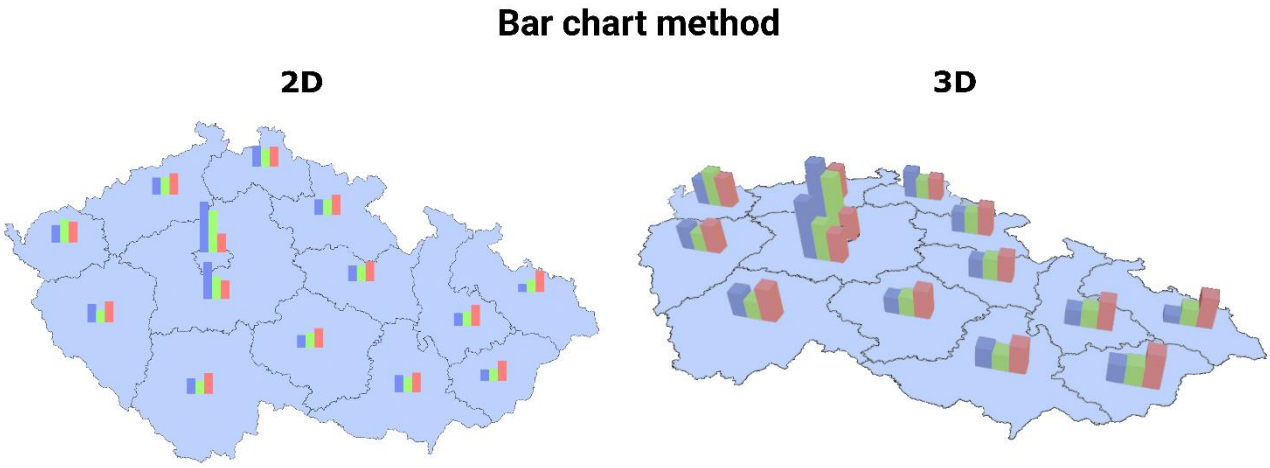


Figure 2. Example of a bar chart method converted from 2D (left) into 3D (right).

**Acknowledgements**

The contribution was supported by the project entitled “Geographical research on dynamics of natural and societal spatial processes” (MUNI/A/1570/2020).

**References**

Slocum, T., McMaster, R. B., Kessler, F. C, Howard, H. H., 2005. Thematic Cartography and Geographic Visualization. 2nd ed. Pearson Prentice Hall, Upper Saddle River, New Jersey, 518 s


https://doi.org/10.5194/ica-abs-5-99-2022 | © Author(s) 2022. CC BY 4.0 License.