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CHEAP AND IMMERSIVE VIRTUAL REALITY: APPLICATION IN CARTOGRAPHY

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Carto4edu

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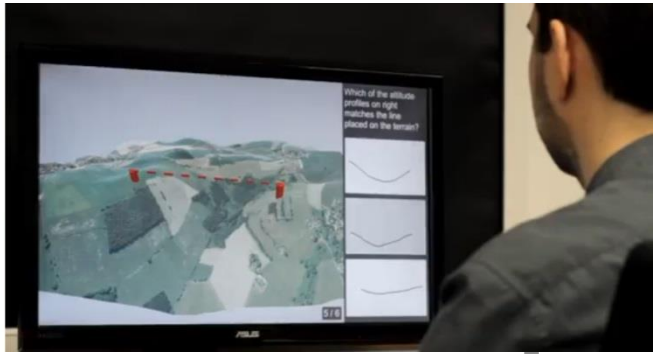
Outline

- Introduction and motivation
- Low-cost virtual reality
  - Comparison of devices
- Virtual environment
  - „Carthoreality“
- Pilot user study
  - Description
  - Results
- Discussion and conclusions



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Cart4edu

- Part of the project: „**Influence of cartographic visualization methods on the success of solving practical and educational spatial tasks**“
  - March 2016 – December 2018
  - Interdisciplinary research
    - Faculty of Science – Department of Geography
    - Faculty of Arts – Department of Psychology
    - Faculty of Education – Department of Geography
    - Faculty of Informatics – Department of Computer Graphics and Design

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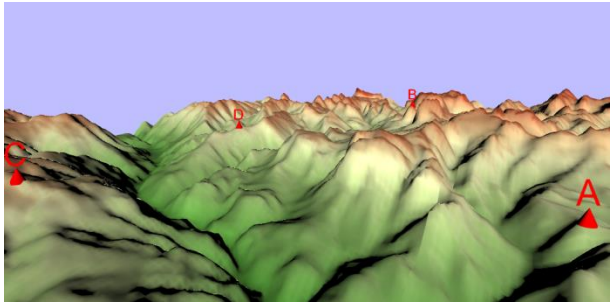
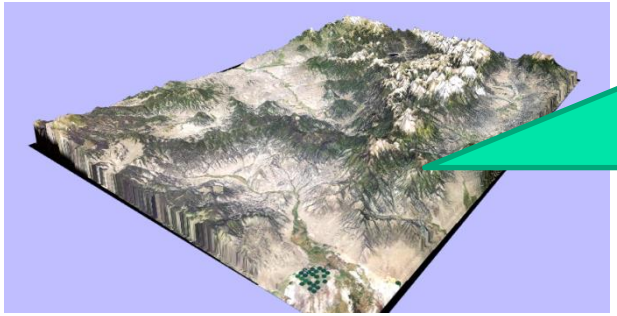
Interactive 3D Visualizations and Virtual Environments



Herman & Stachoň (2016)



Herman & Stachoň (2018)

Level of realism

Stachoň et al. (2018)

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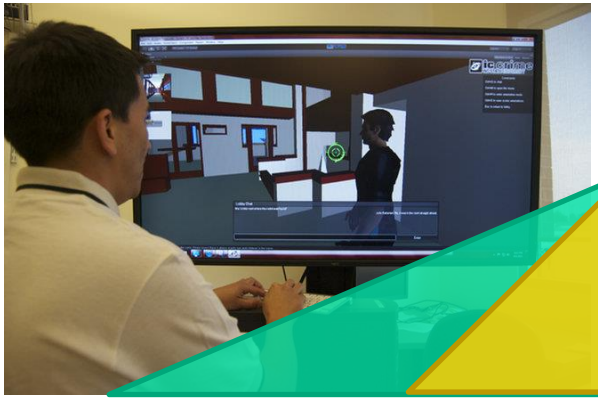
Technologies for Virtual Reality



Price

Level of immersion

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Is it feasible to provide immersive, but cheap virtual reality?

Google said YES

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Low-cost Virtual Reality

- synergy of three components: smartphone, software, and headset
- 2014 – Google Cardboard
- 2015 – Samsung Gear VR
- main disadvantage of all „cheap“ device is absence of tracking and motion sensors

CHEAP — NOT SO CHEAP

	Low-end	Mid-range	High-end
Integrated IMU	No	Some	Yes
Tracking and motion sensor	No	No	Yes
Adjustable optics	Some	Yes	Yes
Integrated LCD display	No	No	Yes
Processing unit	Smartphone	Smartphone	PC
External energy source	No	Some	Yes
Input	Button on headset, or none	Included	Included
Price	$5 – $30	$30 – $100	$300 – $600
Examples	Google Cardboard Splaks 3D VR, Homido VR	BoboVR Z4	Oculus Rift HMD

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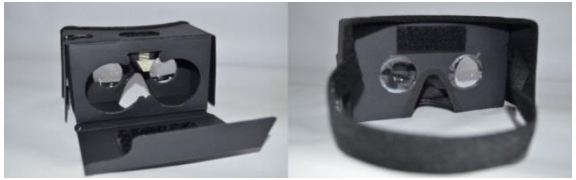
Comparison

Google Cardboard
Splaks 3D VR



- similar to original Google Cardboard
- smartphone is fixed inside by suction cups
- one button for interaction with display

Homido VR

- made from plastic
- buttons to adjust focal length of lenses and eye width
- absence of a button for interaction with display

BoboVR Z4

- both button types as a previous device
- 3.5mm jack input for integrated earphones
- volume control

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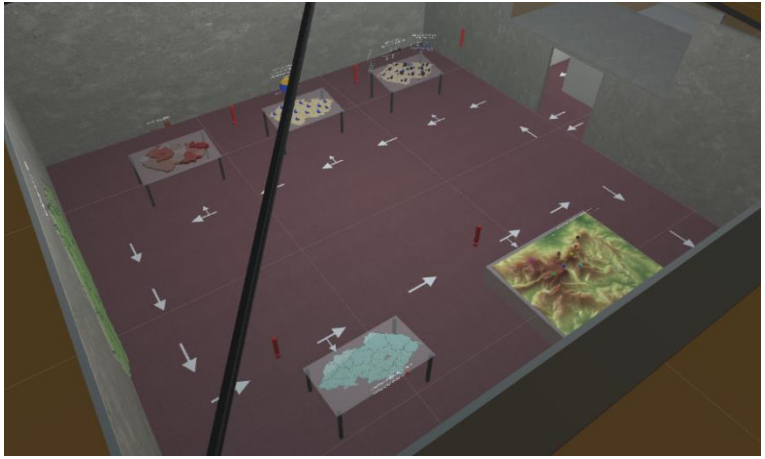
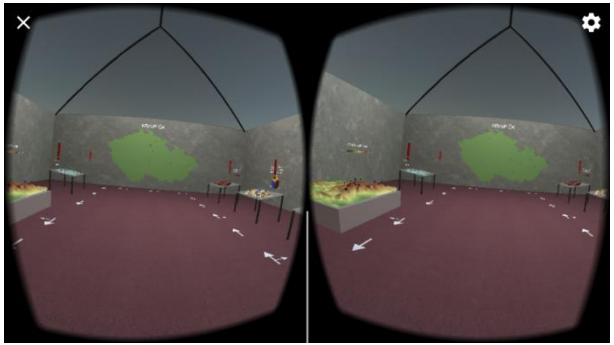
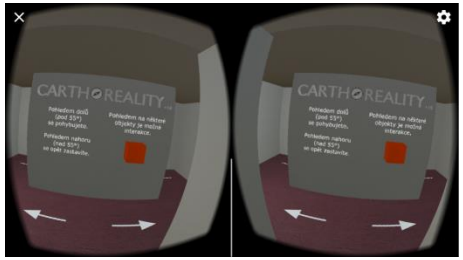
Carthoreality

- is virtual map room, that enables the user to go through, view different 3D maps and solve some tasks with these maps
- was created in Blender with plug-in BlenderGIS, and Unity engine connected with Android Studio
- works on the Android platform (versions 7.0, 7.1 or 8.0)
- is browsed by users by tilting the headset
  - down – activates walking
  - up – stops the movement
- user can also look around
- selected elements are interactive
  - when user look at them







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Carthoreality – maps and tasks

1) 3D diagram map (simple proportional symbols)
2) diagram map with extruded pie charts
3) prism map
4) overview map of the regions of the Czech Republic
5) dot map
6) terrain of selected area

maps are sorted in the order in which the user walks around when the suggested direction is delivered

- 14 tasks (questions); examples:
- map n. 1
  - In which region or regions is wood logging the most intensive?
- map. n. 2
  - Which region has the smallest share of the secondary sector?
- map n. 3
  - Which region has the highest population?
- map n. 5
  - Which regions registered the least immigrants?
- map. n. 6
  - What is the altitude of “Svorová hora”?

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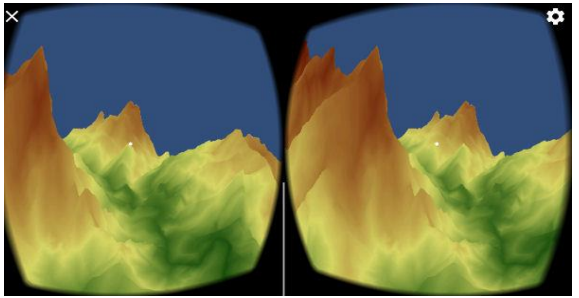
User experiment

- Exploratory research – very simple pilot study
- Within-subject design
- 5 participants (3 females and 2 males, aged between 20 and 51 years)
- Three steps
  - User test all three compared devices and selected the best one
  - Work with „Carthoreality“
  - Questionnaire related to five „I“ factors of provided VR



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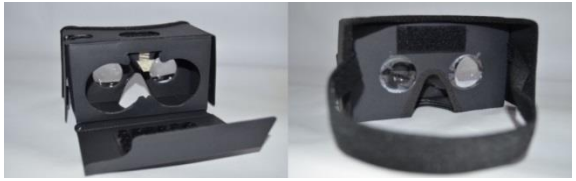
Results – comparison of devices

Its paper construction caused considerable discomfort, because the weight of the smartphone in this headset caused that it not holds on the head.
There is also a problem with significant light transmission on the display.



Google Cardboard
Splaks 3D VR

There is also a problem with light transmission.

Homido VR

BoboVR Z4

Ranked as the best by all participants.

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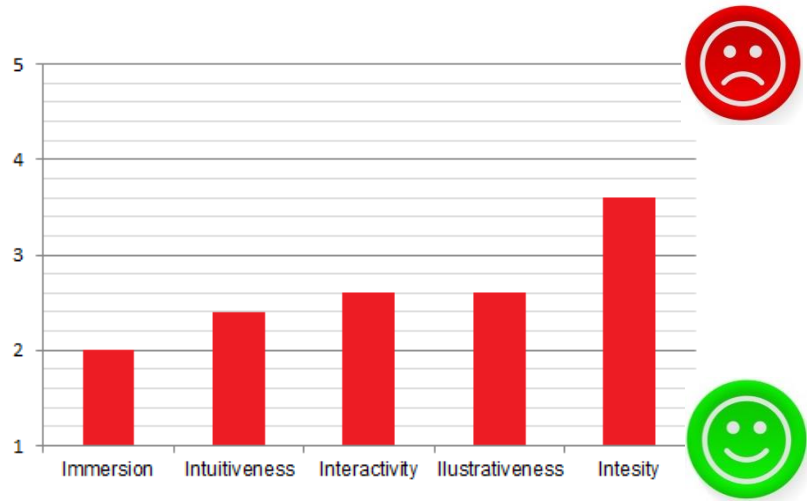
Results – virtual environment

- Carthoreality - functionality
  - Comments were related to the speed of movement or the angle required for “activating” walking
  - Interactive indicator of view (gaze) is missing, when users are working with smaller interactive objects
  - All participants who completed the experiment answered the questions correctly
  - Speed of user responses (efficiency) of individual tasks had not been evaluated due to the low number of participants

- Five „I“ factors of VR



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Main Identified Problem of Low-cost Devices

- Only 4 participants completely passed the virtual environment, since the 5th was sick during testing and was unable to continue.
- Some kind of nausea („cybersickness“) during the wearing of headsets and disorientation after removing the headset have occurred for all 5 participants.
- This reaction could have been due to longer exposure to the virtual environment (length of stay in the environment was around 13 minutes) or absence of IMU (Inertial Measuring Unit).

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Conclusions and Future Work

- Cheap headsets are not well suited to long-term use.
- These negative experiences can lead the unexperienced users to think they can not handle VR in general.
- Problem is the performance of different processing units (smartphones) used in these low-cost headsets.

- In order to create virtual environments, also open source or freely available technologies, can be used. Implementation of the Carthoreality in the Blender and Unity confirms these conclusion.
- Carthoreality can be further developed and optimized.

  add functionality to capture answers to questions directly in the virtual environment

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Sources and links

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- **https://youtu.be/4Mny2VyYD-E**

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THANK YOU FOR YOUR ATTENTION!

QUESTIONS…

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