



MASARYK  
UNIVERSITY  
Czech Republic

# TOUCH INTERACTION WITH 3D GEOGRAPHICAL VISUALIZATION ON WEB

## SELECTED TECHNOLOGICAL AND USER ISSUES

Lukáš Herman,  
Zdeněk Stachoň, Radim Stuchlík, Jiří Hladík, Petr Kubíček

Department of Geography, Faculty of Science, Masaryk University Brno  
(Czech Republic)



## Introduction

- 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
  - Main research questions of this project:
    - how different methods of visualization and user interfaces (UI) affects the way of solving spatial tasks by individual person or by group of people
    - and how they affect the efficiency of processing and interpretation of spatial information and learning

## Research question

- Are different technologies ready for visualization and interactive control of 3D data?
- Are there universal gestures for controlling 3D virtual geographic environment?
- What are the available metrics for gesture measurements and how they differ on the level of individual users?

Rotate



Pinch



Press



Pan



Tap



Swipe



	<i>Supported gestures</i>							
	Tap	Double tap	Press	Pan / swipe	Rotate	Pinch / Zoom	Drag	More Fingers
Hammer.js	x	x	x	x	x	x	x	
jGestures	x			x	x	x		x
jQuery doubletap	x	x		x				
jQuery.pep.js							x	
Mootools Mobile			x	x		x		
Quo.js	x	x	x	x	x	x	x	x
thumbs.js								
Touchable	x	x	x					
Touchy			x	x	x	x	x	

# Web Technologies for 3D Visualization

- Testing of selected technologies for 3D rendering
  - SceneJS, Three.js, XML3D, X3DOM, SpiderGL
- Gesture on screen → type of movement in virtual space**

- Pan, pinch/zoom gestures



- SpiderGL

- Lenovo tablet with Windows 8.1



device (OS, version)	web browser	library	gesture					
			tap	doub. tap	press	pan	rotate	pinch / zoom
Smartphone Leagoo Elite 5 Android 5.1	Google Chrome 50.0	SceneJS		III	I	I	I, III	III
		Three.js				I	III	III
		XML3D				I	I, II, III	III
	Opera 36.2	X3DOM		III			I	III
		SceneJS		III			I	III
		Three.js					I	III
Smartphone Lenovo S750, Android 4.2	Mozilla Firefox 34.0	X3DOM				I	I, II, III	III
		XML3D				I	III	III
		X3DOM		III			I	III
Tablet Lenovo, Windows 8.1	Internet Explorer 11	SceneJS						
		Three.js						
		XML3D						
Notebook with touch screen, Windows 10	Google Chrome 51.0	X3DOM		IV				
		SceneJS					I	III
		Three.js					I	III
		XML3D					I	III
Desktop with touch screen, Windows 8.1 Pro	Mozilla Firefox 47.0	X3DOM		IV				
		SceneJS					I	III
		Three.js			II		I	III
		XML3D					III	I

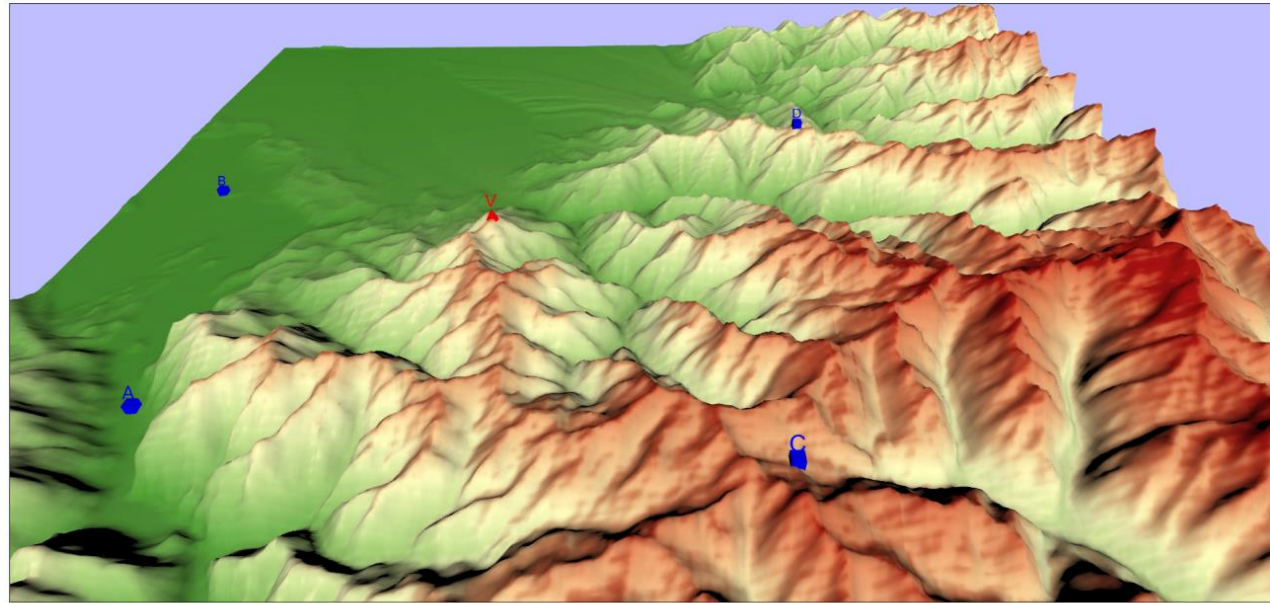
I rotation of 3D model  
 II shift of 3D model  
 III zoom in / zoom out  
 IV set center of rotation

## Usability testing

- 6 participants
- 2 tasks, with same instructions: „Determine which of the four cubes (A – B – C - D) are visible from the top of mountain marked with red cone“
- LCD monitor Acer FT240HQL (diagonal 60 cm)
- Own experimental testing tool
  - based on HTML, PHP, JavaScript, **X3DOM** and **Hammer.js**
  - speed of user performance (efficiency), answers and their correctness (effectiveness), movement in virtual space and used gestures on touch screen were recorded.
- Stimuli = digital terrain models from SRTM (Shuttle Radar Topography Mission)

## 3D scenes

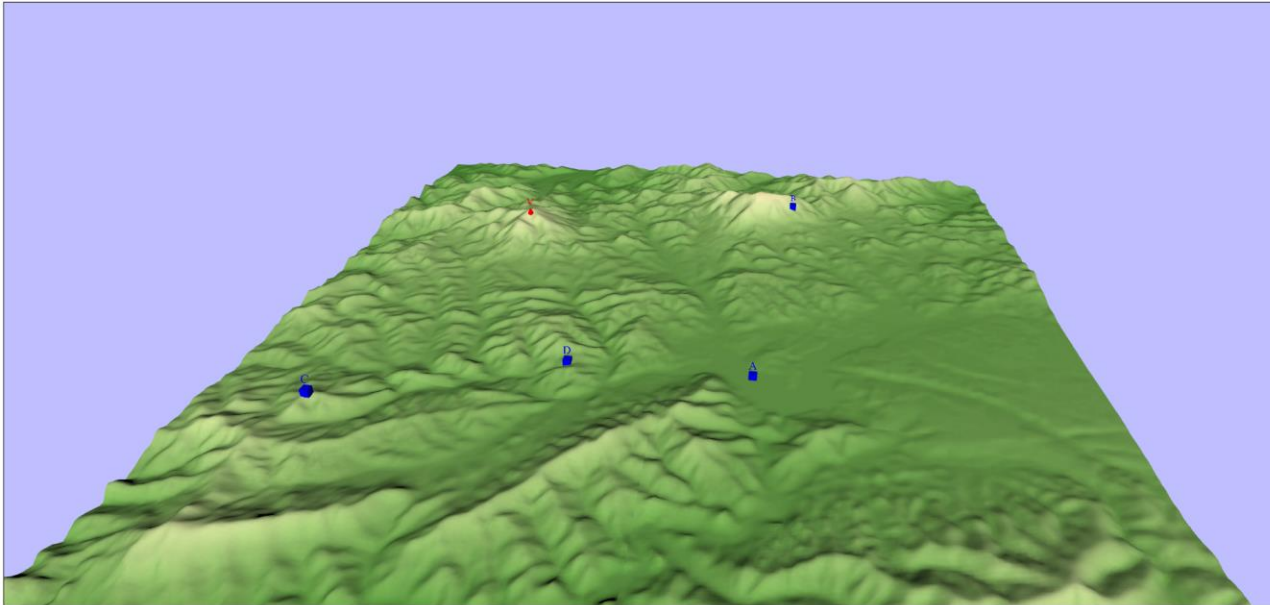
### Task 1



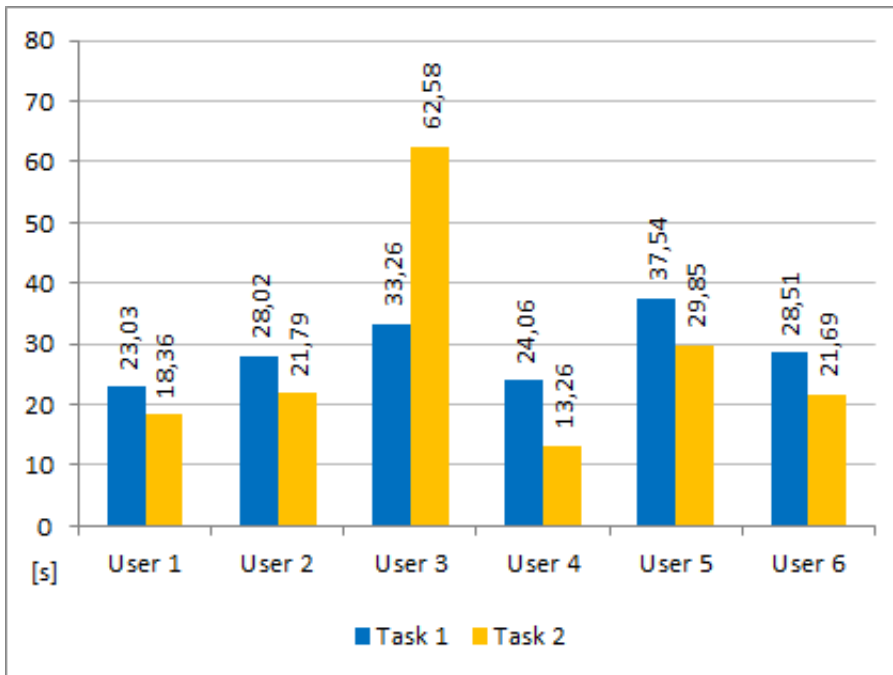
Určete, které ze čtyř krychlí jsou viditelné z vrcholu označeného červeným kuželem.

— — — —

### Task 2



# Results



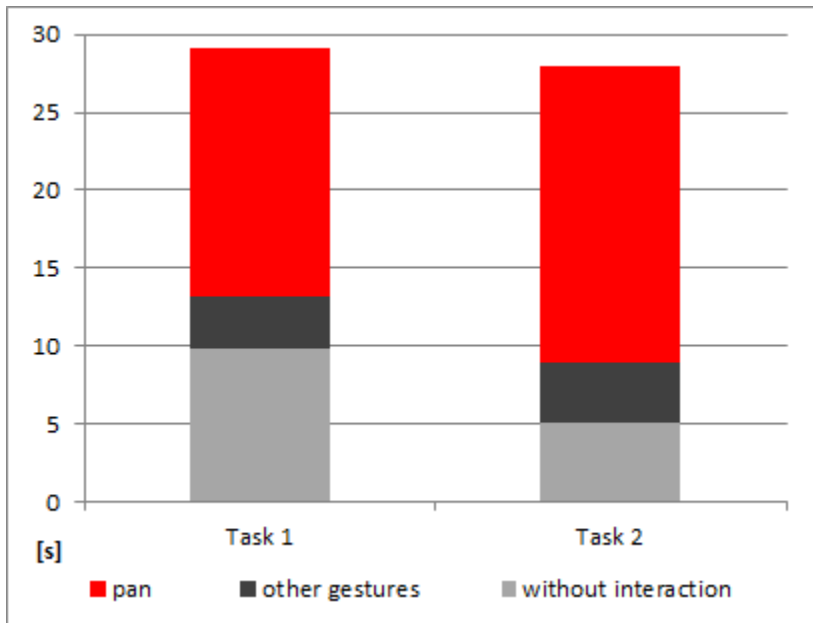
The speed of task performance (in seconds) for individual users

User	Task 1		Task 2	
	dist.	speed	dist.	speed
	[km]	[km/s]	[km]	[km/s]
1	378.67	16.44	251.26	13.69
2	653.82	23.33	179.84	8.25
3	534.95	16.08	1037.50	16.58
4	522.50	21.72	191.93	14.47
5	1290.43	34.37	352.82	11.82
6	298.79	10,48	665.48	30.68

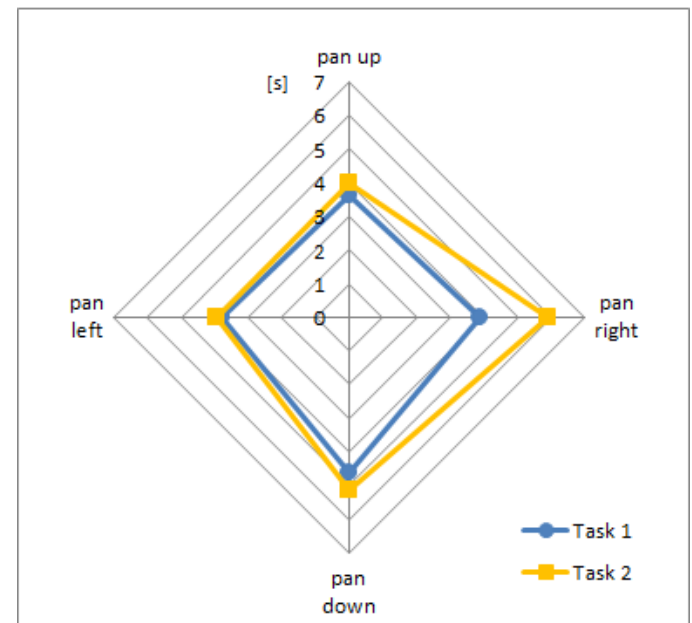
Virtual distances and speeds of individual users in task 1 and 2



# Results



Average time (in seconds) spent by interaction through gestures



Average time (in seconds) spent by interaction through pan gesture (divided by direction)

## Conclusions

- Work in progress, but...
  - Pan is a gesture with a relatively good support across used devices. Zooming is also relatively well supported. Support for other gestures is significantly smaller and differ between devices.
  - It is evident that the most commonly used gesture (pan) is also supported in most of the 3D libraries.
  - Our results suggest that the most significant differences can be found among individual participants. This fact may be affected by participant's spatial abilities and previous experience with interacting with 3D visualization. We can expect a more significant difference among users of various age groups, education, professional background etc.



# QUESTIONS?

# THANK YOU FOR YOUR ATTENTION!

Lukáš Herman ([herman.lu@mail.muni.cz](mailto:herman.lu@mail.muni.cz)),  
Zdeněk Stachoň ([14463@sci.muni.cz](mailto:14463@sci.muni.cz)), Radim Stuchlík ([radim.stuchlik@mail.muni.cz](mailto:radim.stuchlik@mail.muni.cz)),  
Jiří Hladík ([hladikjiri@mail.muni.cz](mailto:hladikjiri@mail.muni.cz)), Petr Kubíček ([kubicek@geogr.muni.cz](mailto:kubicek@geogr.muni.cz)),

