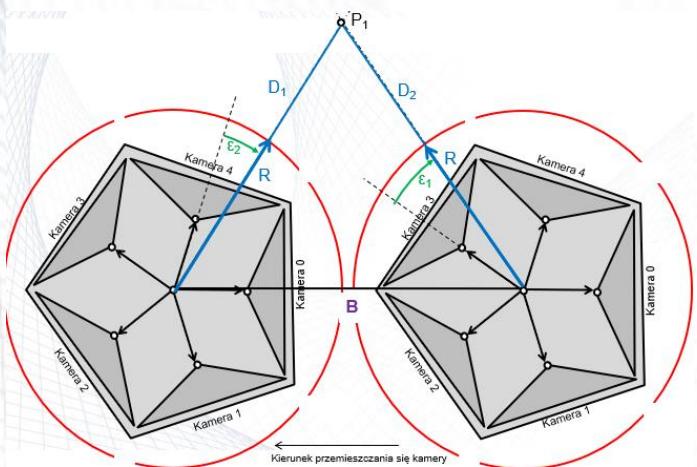


Immersive photogrammetry



Karol Kwiatek, PhD

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14th June 2021

Plan of the lecture

1. Introduction
2. Immersive camera
3. Immersive photogrammetry
4. Errors of immersive panoramas
5. Immersive mobile mapping system
6. Applications of immersive mobile mapping system
7. Applications to MMS
8. News from MMS



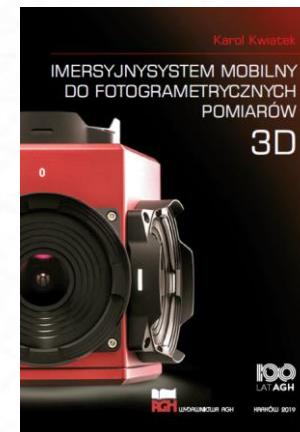
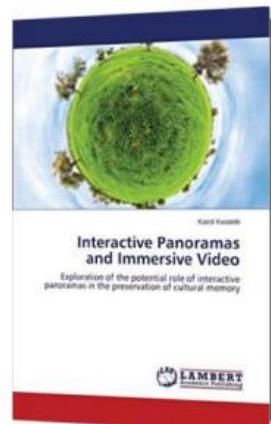
www.kwiatek.krakow.pl



Karol Kwiatek, PhD, PhM

Graduated from AGH in Krakow, Dresden University of Technology (Germany) and Plymouth University (UK)

- academic teacher;
- created an award winning sole trader;
- Microentrepreneur of the Year 2006;
- finalist of Innovator of Malopolska 2007;
- winner of Dragon's Den in UK;
- current work related to Industry 4.0.



<https://scholar.google.com/citations?user=M0YdQCEAAAAJ>

1. Introduction

- a) History of panoramas
- b) History of cinematographic panoramas
- c) Immersion
- d) The beginning of the concept of immersive photogrammetry



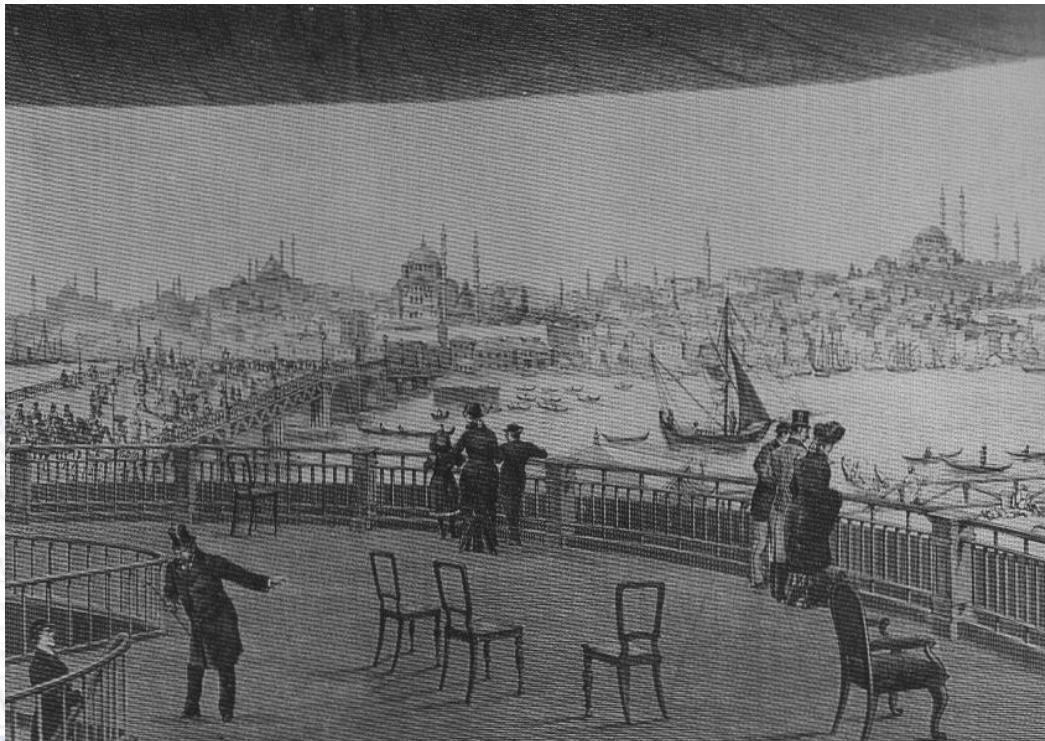
2007



2017

History of panoramas

- A term was created for a 360° image view that was applied to artistic works painted on the internal face of large scale cylinders
- **Robert Barker** (1739-1806) patented his invention in **1787**



History of panoramas

Cylindrical panorama

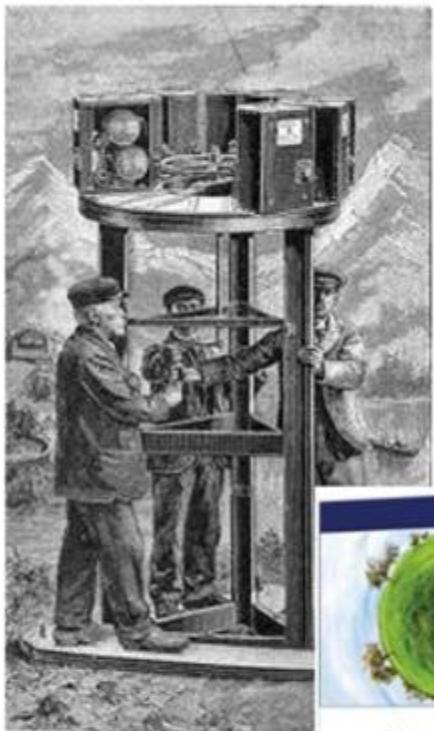


Spherical panorama

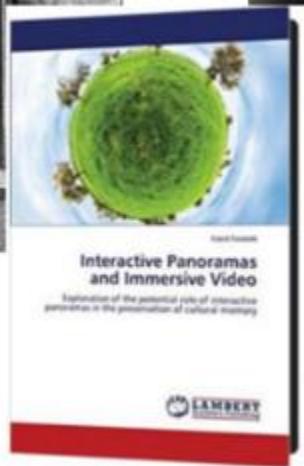


Panoramic image

History of panoramas



1900



(Kwiatek 2015)



<https://www.youtube.com/watch?v=7HLtF49Wrmg>

Panoramic video

History of panoramas

Prehistoric cave paintings



How to present distant locations or past events?

Baroque ceiling panoramas



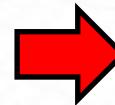
How to maximise the realism and create the illusion of depicted places?



Painted panoramas

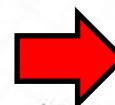


Photographic panoramas



Rotundas

Cinematographic panoramas



'Digital rotundas'
and panoramic viewers

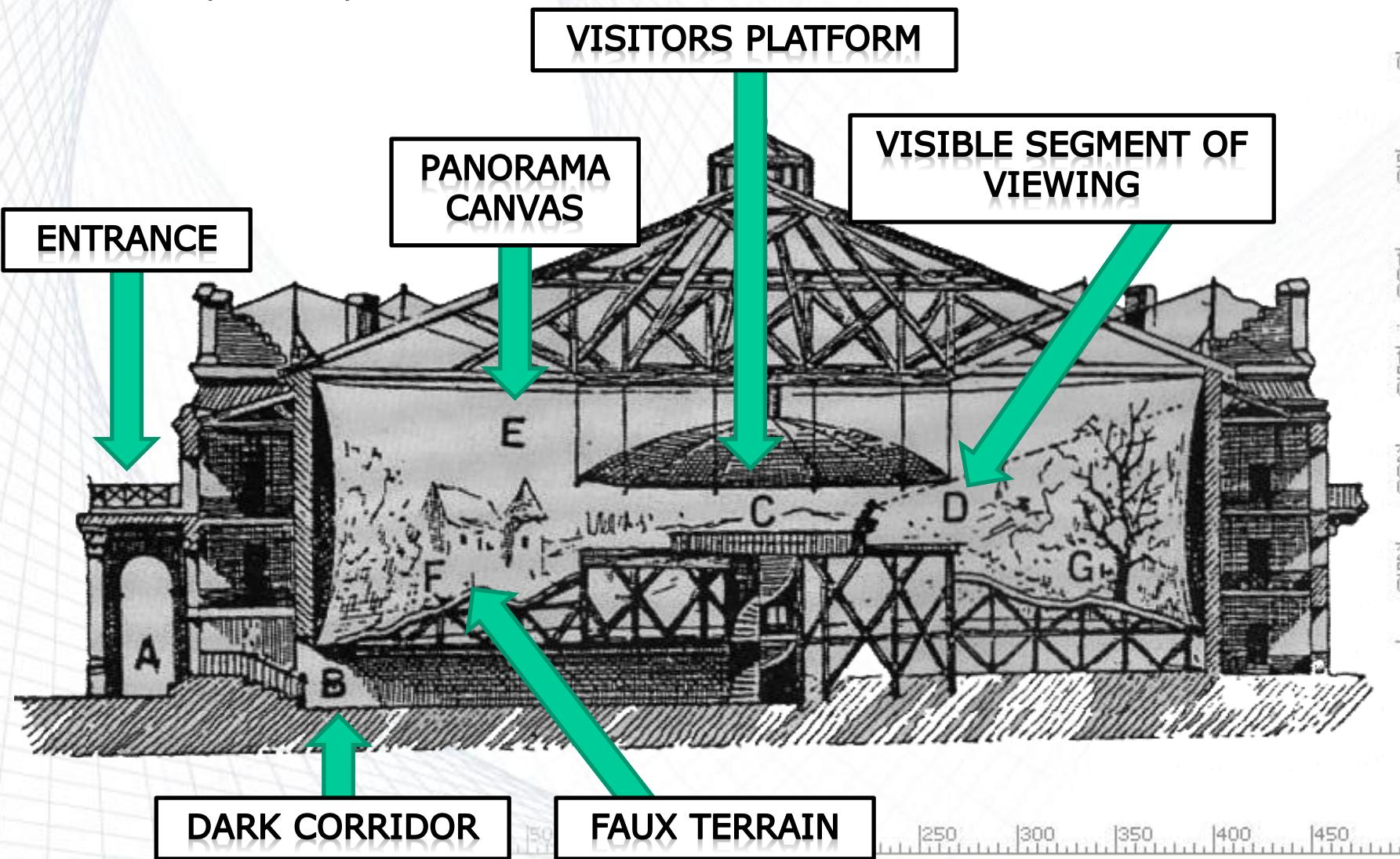


Digital panoramas

50 100 150 200 250 300 350 400 450

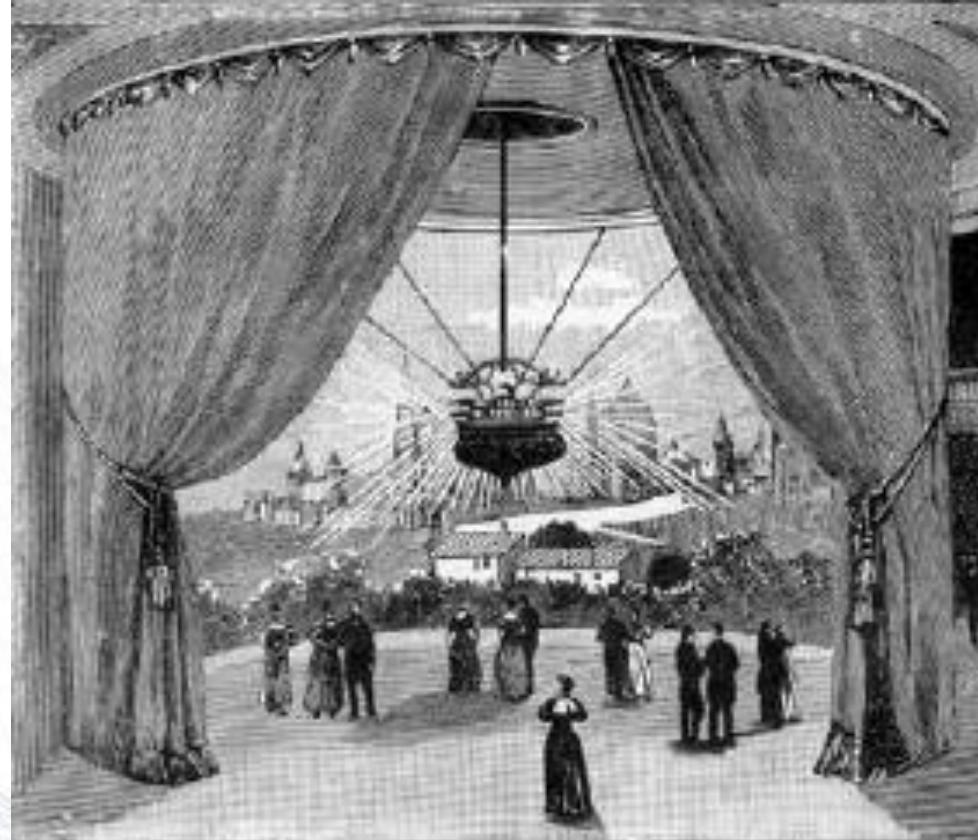
History of panoramas

Rotunda and painted panorama



History of cinematographic panoramas

16 slides
were switched
simultaneously, creating
the illusion of movement
for the viewers.



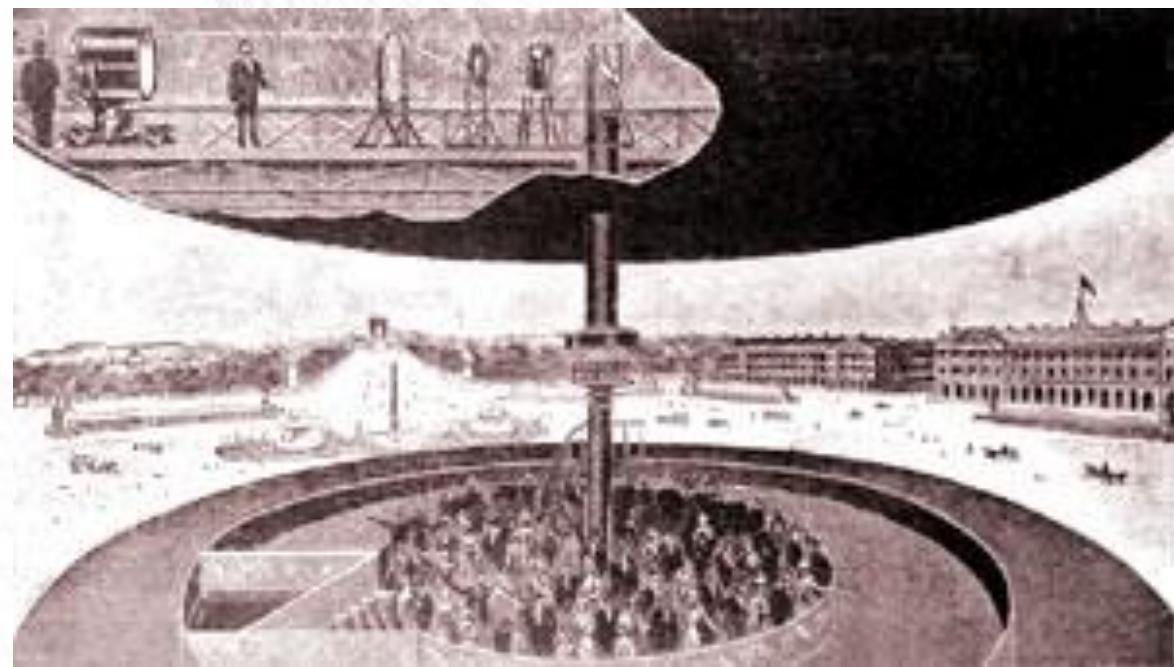
Stereopticon (1894)

Charles Chase – Chicago

History of cinematographic panoramas

Screen:
21 metres in
circumference and six
metres high

360 degree
panoramic projector
which used 70mm
film



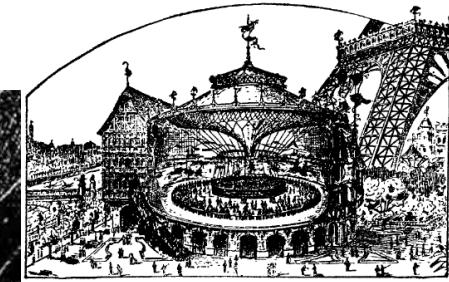
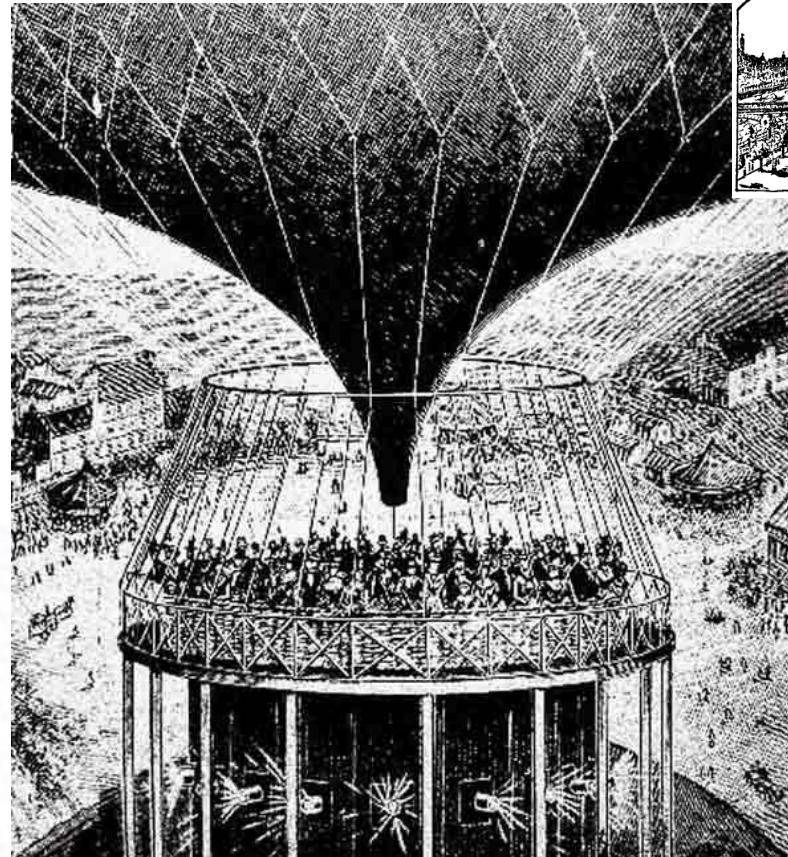
Photorama (1900)

Auguste and Louis Lumière - Paris

History of cinematographic panoramas



Ten synchronised cameras arranged in a circle filmed a balloon ascent from the balloon basket



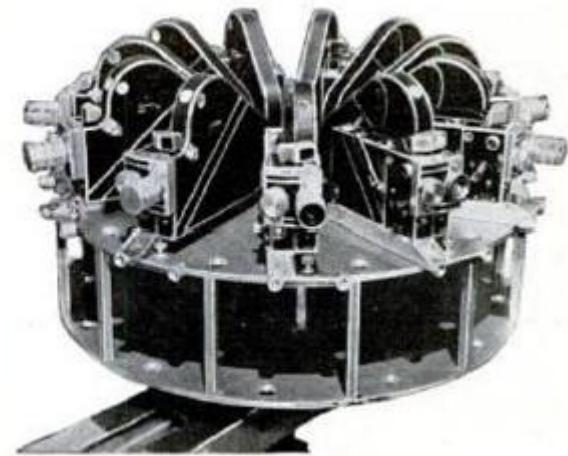
Cinéorama (1900)

Raoul Grimoin-Sanson- Paris

History of cinematographic panoramas



11 synchronised cameras arranged in a circle



Circarama (mid 1950s)

Walt Disney's engineers

History of cinematographic panoramas

2x11 synchronised cameras arranged in a circle



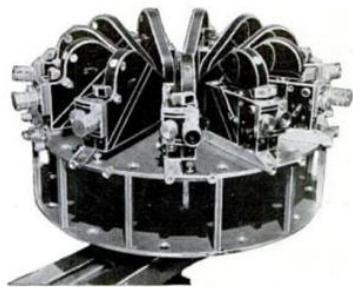
Moscow

Circular Kinopanorama (late 1950s)

Immersion



Circarama, 1956

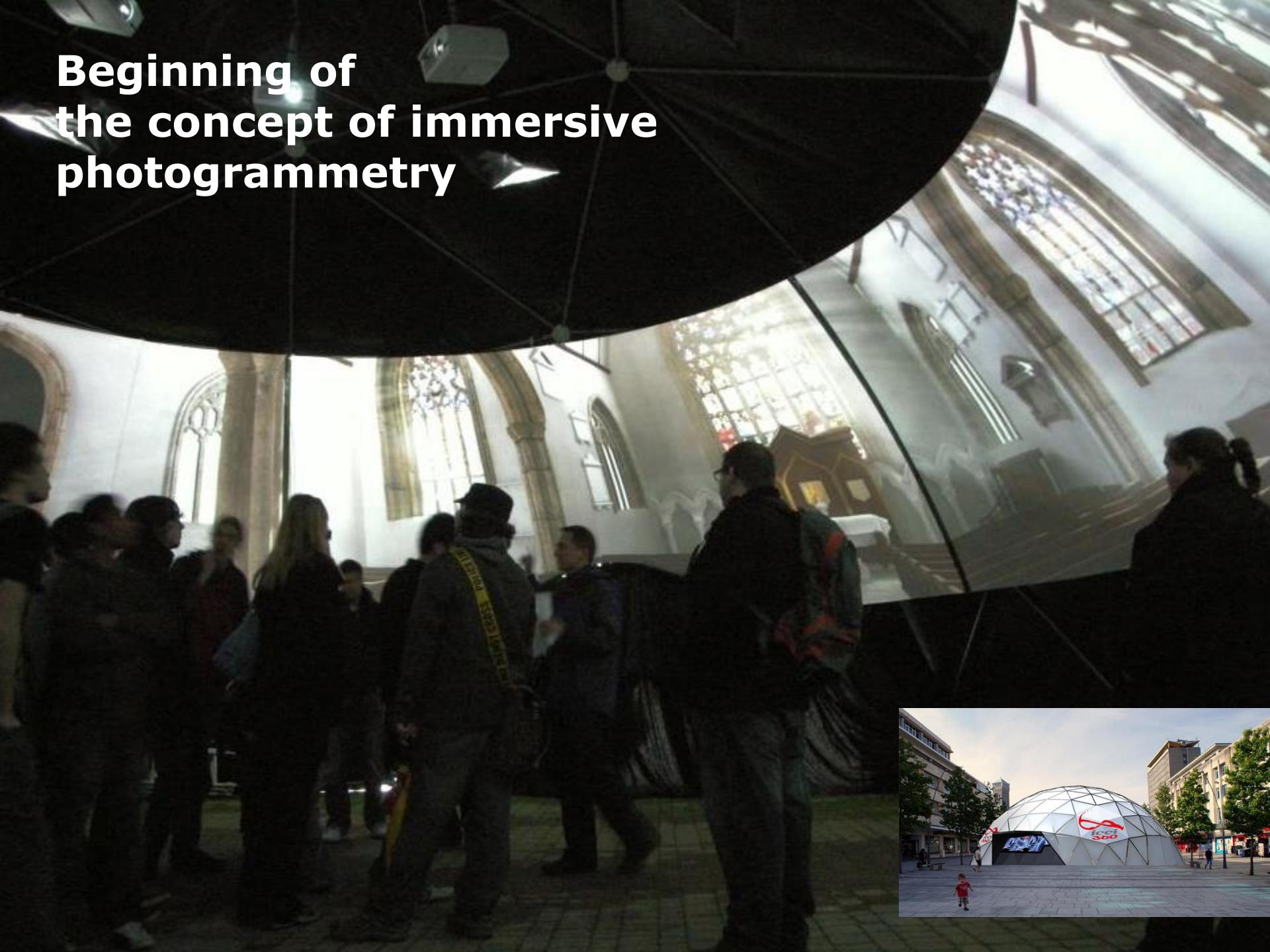


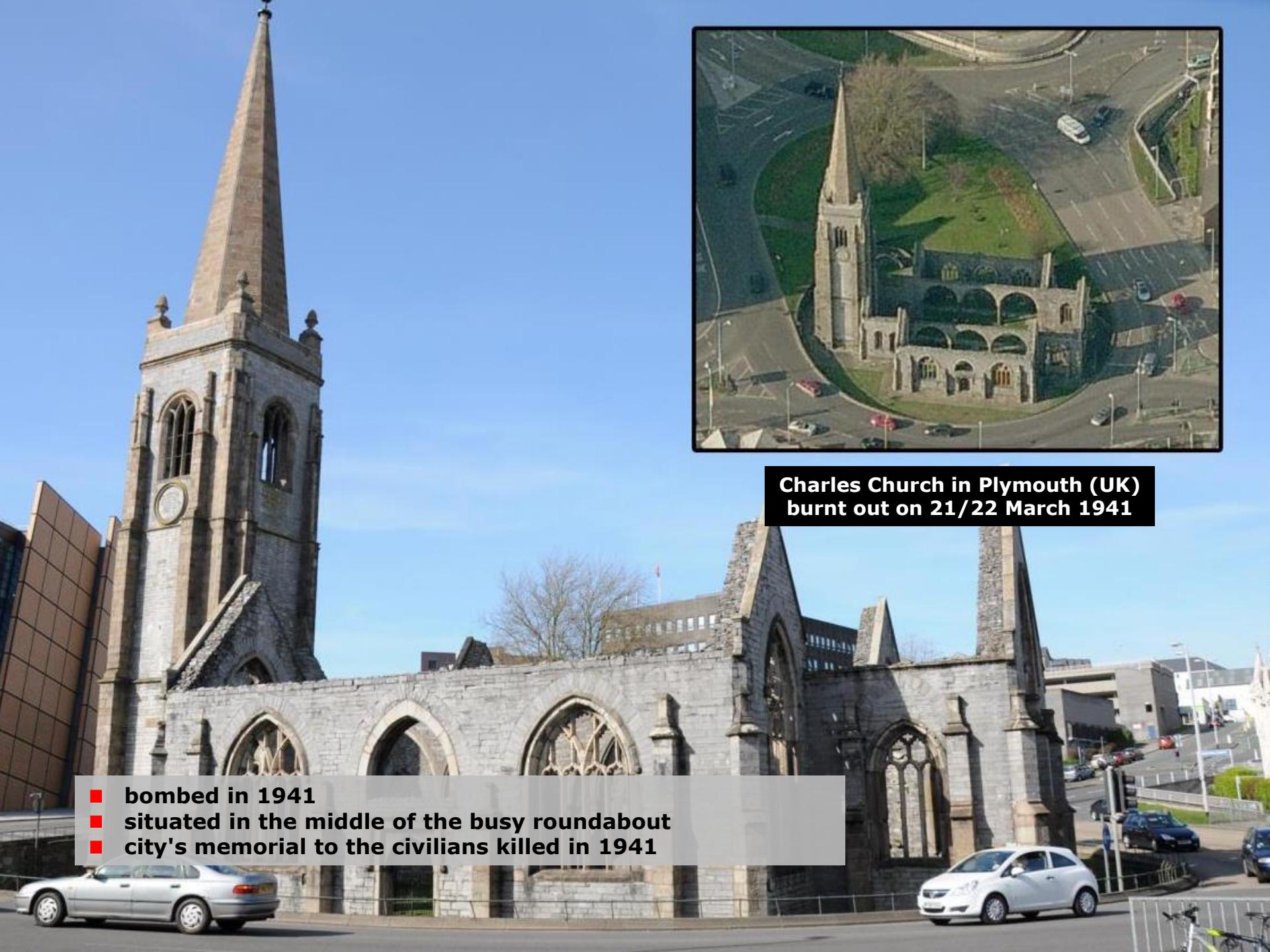
Intellectual stimulation of the state of the consciousness of the viewer or spectator who is placed in the middle of the shown events and has the opportunity to interact with the displayed objects

Grau, 2003

EXPO 2012

Beginning of the concept of immersive photogrammetry





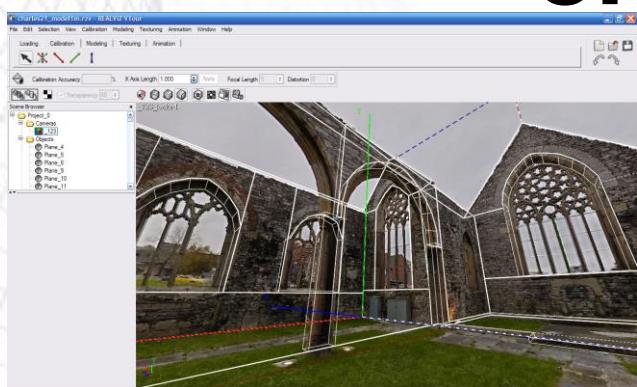
**Charles Church in Plymouth (UK)
burnt out on 21/22 March 1941**

- bombed in 1941
- situated in the middle of the busy roundabout
- city's memorial to the civilians killed in 1941



CHARLES CHURCH
PLYMOUTH, UK
PHD RESEARCH PROJECT

Computer 3D reconstruction of Charles Church



Historical images



0
100
200
300



CHARLES CHURCH
PLYMOUTH, UK
PHD RESEARCH PROJECT

Computer 3D reconstruction of Charles Church

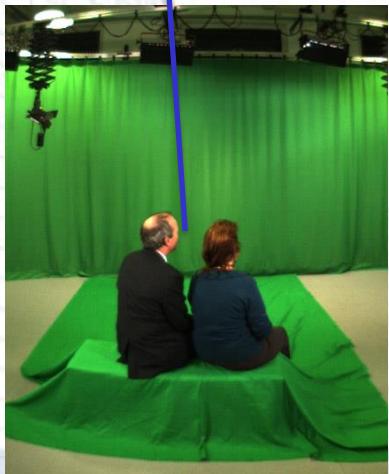


Front

Back

360°

Reconstruction of the wedding in a computer reconstructed Charles Church



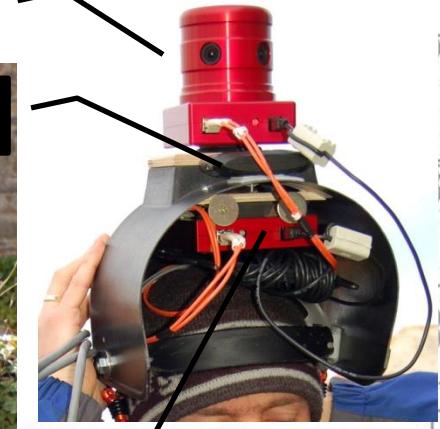
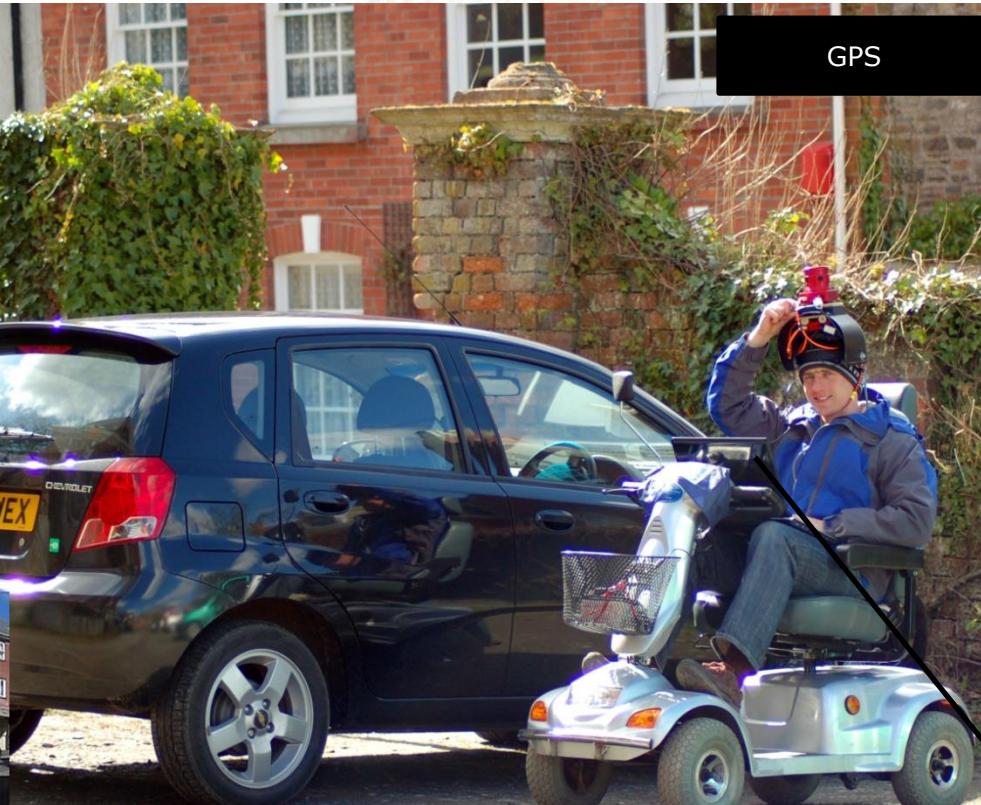
360° filming



„Discover Krakow” displayed during Immersive Film Festival



- First trials of MMS with Ladybug2
- Recorded using a motorised wheelchair



Count 0 100 200 300 400 500



2. Immersive camera

- a) Immersive panorama
- b) Immersive camera
- c) Geometry of immersive camera
- d) Generation of immersive panorama

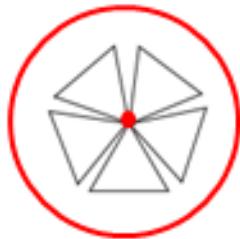


- Multi-camera omnidirectional vision systems capture space more **efficiently and effectively** than individual vision sensors
- Panoramas and video panoramas recorded by omnidirectional vision systems serve primarily as a visual base for laser scanning data (e.g. (np. Leica Pegasus, Topcon IP-S3) – they are **expensive**
- One way to **reduce their cost** is not to use an active scanning system but to use **panoramic images**

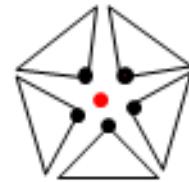
- Doing so simplifies the mobile system but can have **negative consequences on the accuracy** and completeness of the developed products
- Most often, not just separate frame images are used, but "imperfect" spherical panoramas are created, which in this presentation are called **immersive panoramas**
- The frame images are projected onto the **surface of the sphere** and **displayed as spherical panoramas** with a common perspective center
- It causes creation of **errors on these panoramas**, which affect the accuracy of photogrammetric studies

Spherical panorama vs immersive panorama

One common perspective centre



Multiple perspective centres



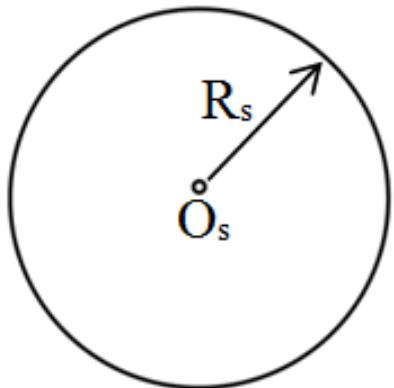
Spherical panorama

Immersive panorama

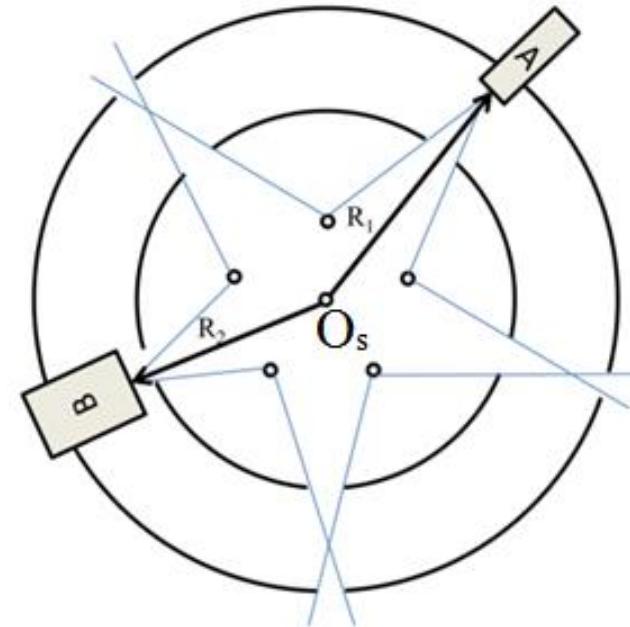
Immersive panorama - omnidirectional image, acquired with the use of various sensors, giving a "flawed" spherical panorama due to the offset of the perspective centres of the frame images.

(Kwiatek, Tokarczyk 2018)

Immersive panorama



Spherical panorama



Immersive panorama
- the necessity of choosing radius R

(Kwiatek, Tokarczyk 2018)

In the immersive panorama it is important to assume a certain radius for the sphere to be created (R), for which the object points lying on the sphere are not affected by the eccentricity.

Immersive panorama



Necessary to choose R

Immersive cameras



a)



b)

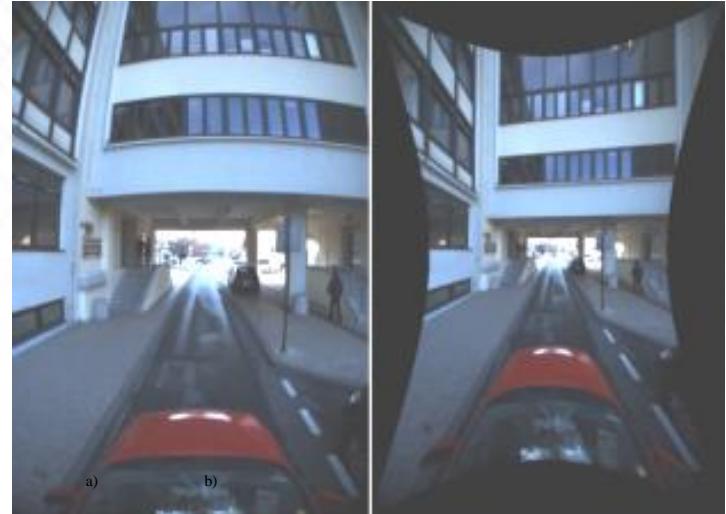


c)



d)

- Immersive cameras:
- a) Ladybug® 2;
 - b) Ladybug® 3;
 - c) Ladybug® 5
 - d) Ladybug® 5+



a)

b)

Images generated by Ladybug frame cameras:
a) raw image;
b) rectified image.

(Flir 2019)

Immersive cameras



Features of immersive cameras:

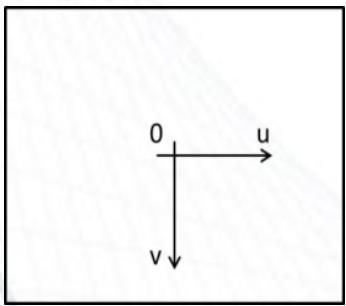
- shift of perspective centres of frame cameras
- video recording
- selectable radius R



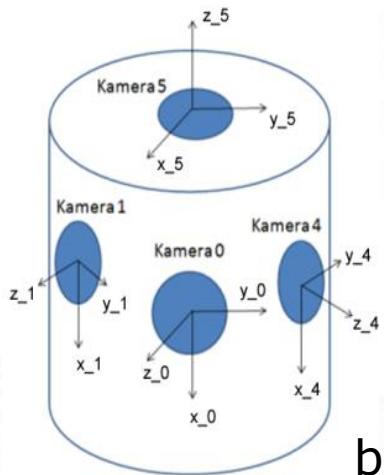
Immersive camera - a digital camera that captures 360° video that is recorded from frame cameras with individual projection centers

(Kwiatek, Tokarczyk 2018)

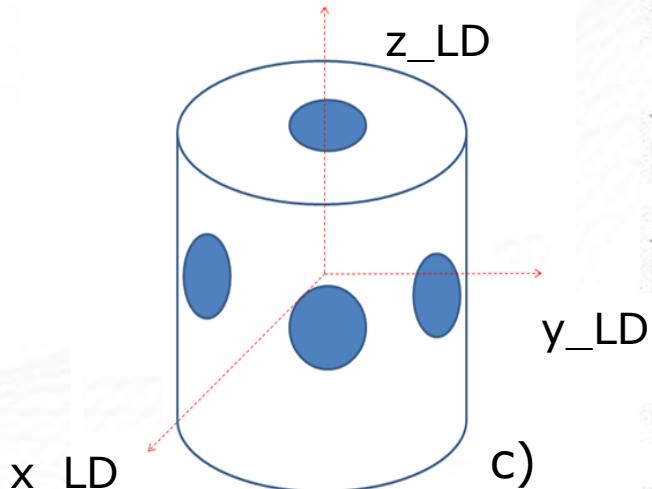
Geometry of immersive camera



a)



b)



c)

Coordinate systems in Ladybug cameras:

- a) 2D coordinate system of frame camera;
- b) 3D coordinate system of frame camera;
- c) 3D coordinate system of immersive camera

Immersive panoramas
are generated.

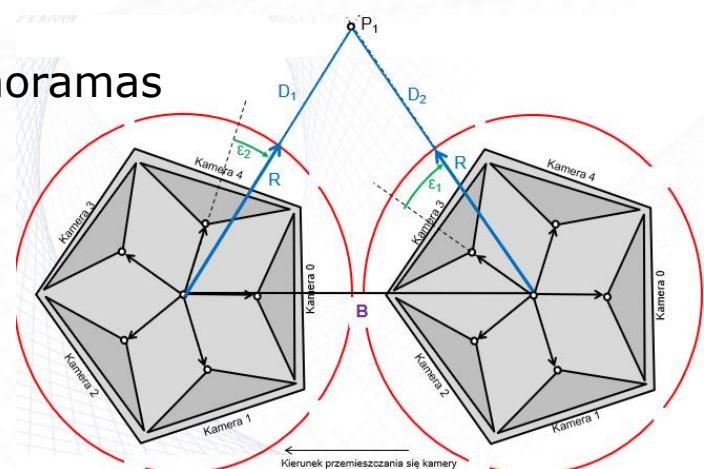
Generation of immersive panorama



1. Rectification of each raw image registered by a frame camera for the influence of lens distortion.
2. Transformation of the imaging coordinates of the rectified image to the 3D coordinate system of the individual camera.
3. Transformation of the coordinates in the 3D coordinate system of the individual frame camera into the coordinate system of the whole camera; the sphere radius (R) is then set.

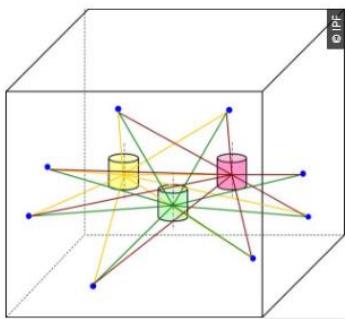
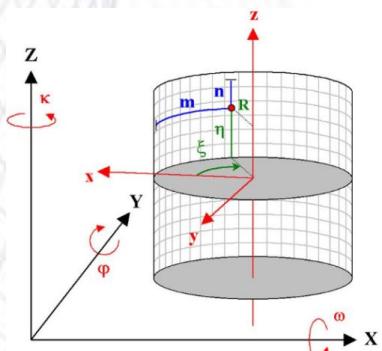
3. Immersive photogrammetry

- a) Panoramic and spherical photogrammetry
- b) Measurements from spherical panoramas
- c) Immersive model
- d) Spherical vs immersive model
- e) Measurements from immersive panoramas
- f) Immersive photogrammetry



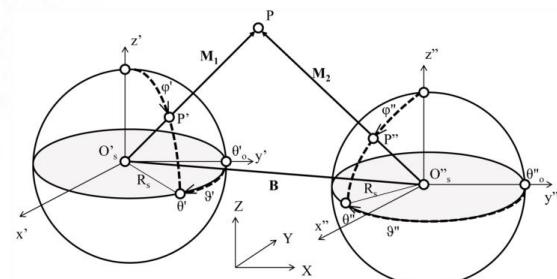
Panoramic and spherical photogrammetry

Panoramic photogrammetry



(Schneider i Maas 2003, Schneider i Maas 2004, Parian i Gruen 2004)

Spherical photogrammetry

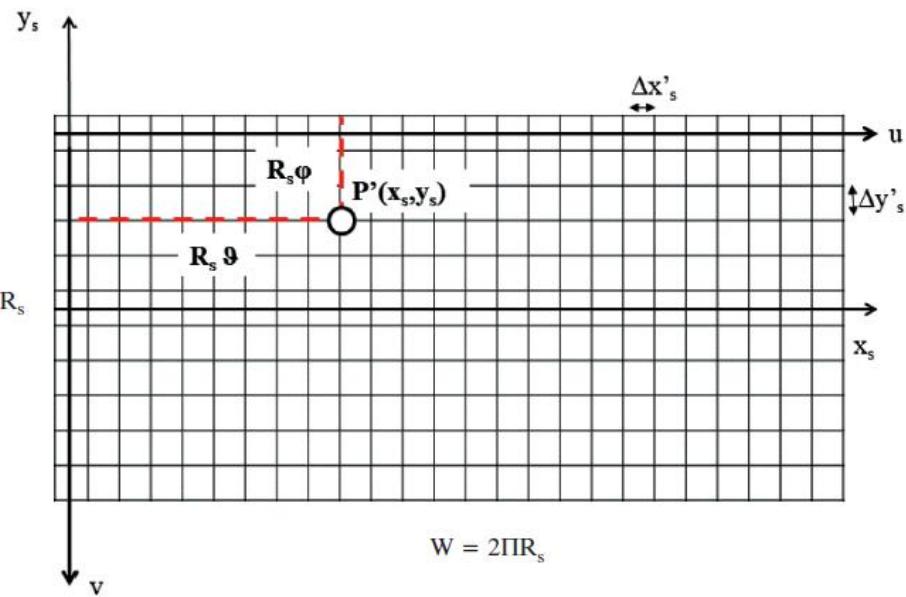
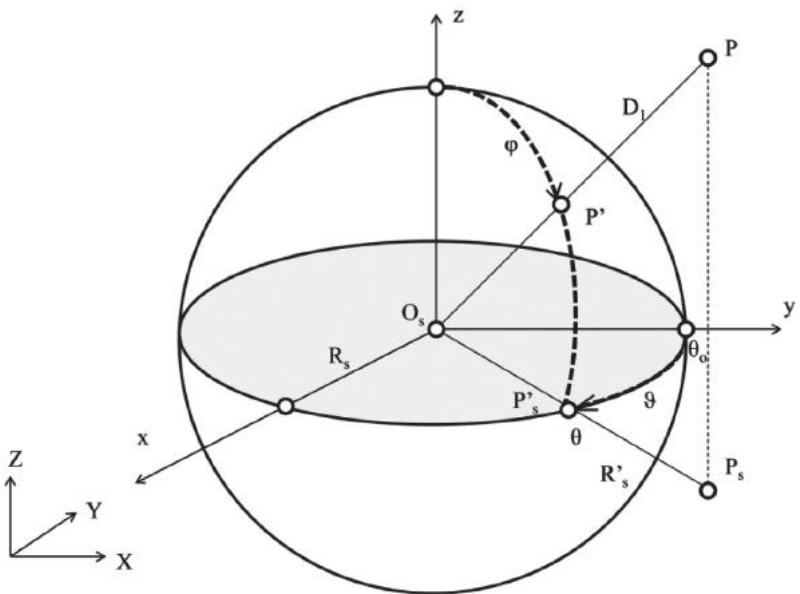


(Fangi 2006, Fangi 2007, Fangi i Nardinochi 2013, Fangi 2017)



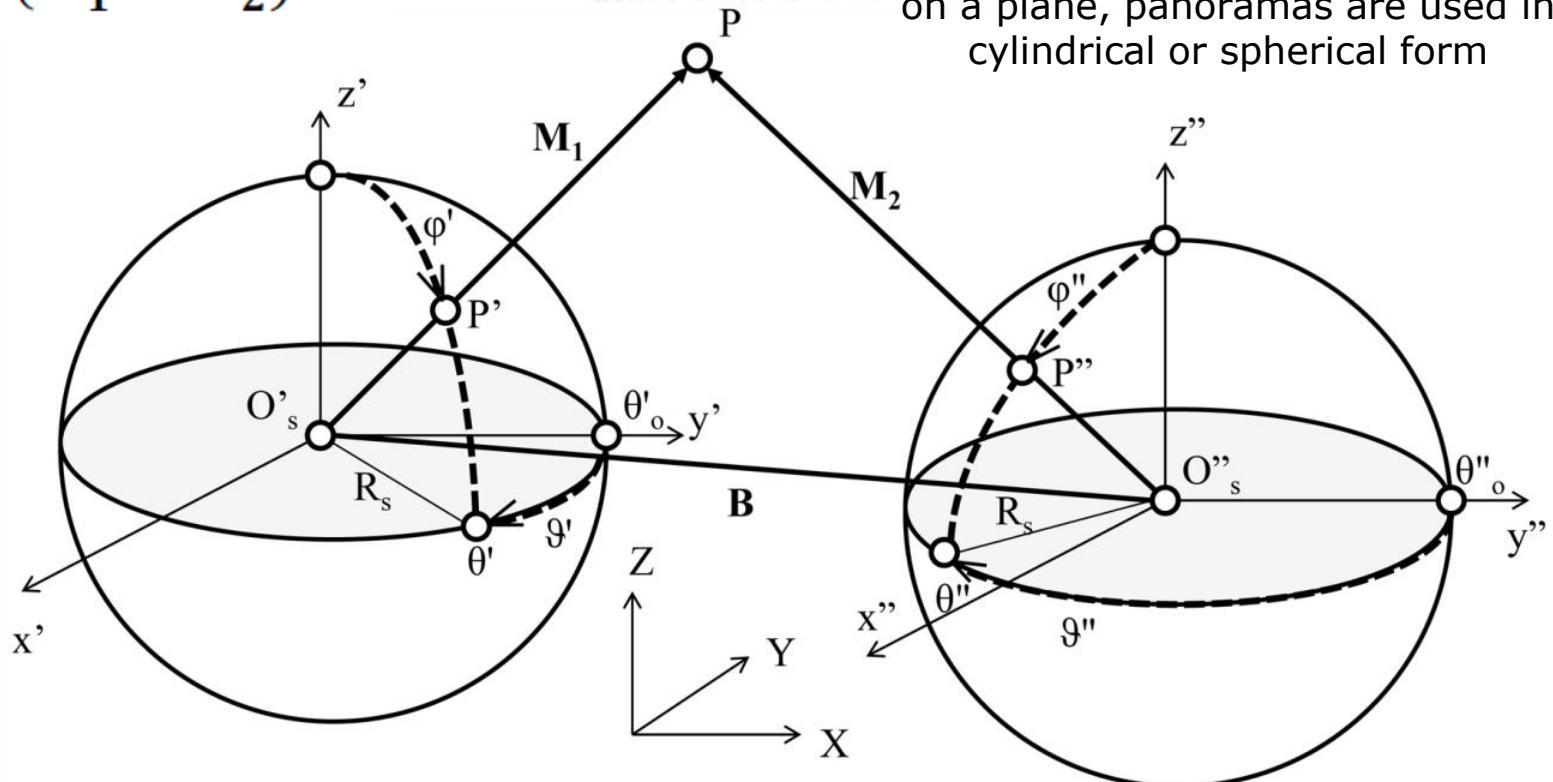
Panoramic and spherical photogrammetry

- In spherical photogrammetry, it is fundamental to know **two angular values** (ϑ and φ) and the **length of the sphere radius** (R_s), which is calculated from the circumference of the spherical panorama.
- Measurement using spherical panoramas can be compared to measuring directions with **a theodolite**, where two angles are also measured: horizontal and vertical (or zenith).



Measurements from spherical panoramas

$$\mathbf{B} \cdot (\mathbf{M}_1 \times \mathbf{M}_2) = 0$$



Panoramic/spherical photogrammetry is a branch of close-range photogrammetry in which instead of images that are a central projection on a plane, panoramas are used in cylindrical or spherical form

(Fangi 2006)

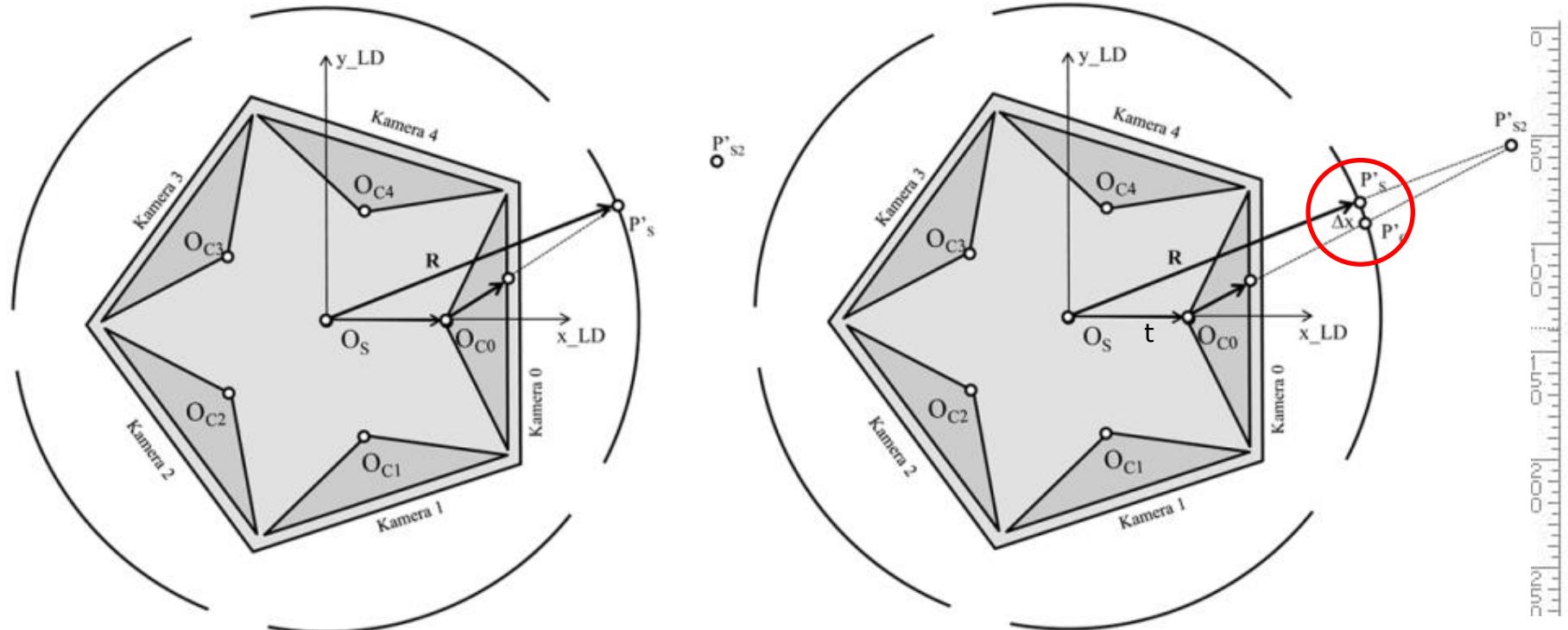
(Fangi 2007)

(Fangi, Nardinocchi 2013)

(Fangi, Piermattei, Wahbeh 2013)

Complanarity of two rays coming from two spherical panoramas

Immersive model



radius R is equal to the distance to P'_S

(Kwiatek, Tokarczyk 2018)
(Kwiatek 2020)

parallax error (Δx) on immersive
panorama
caused by the application
of spherical model

$$\Delta x = \frac{(D - R) \cdot t \cdot \sin \varepsilon}{D}$$

$$\Delta y = \frac{(D - R) \cdot t \cdot \sin \xi}{D}$$

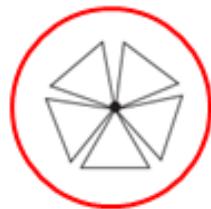
The largest parallax errors are for large values of R and small values of D

Spherical vs immersive model

Spherical model	Immersive model
<ul style="list-style-type: none">• one perspective centre• there are programs for working with spherical panoramas• the distance to the photographed object does not have to be known• imaging errors concern mainly places where spherical images are merged or created	<ul style="list-style-type: none">• shift of the perspective centres of frame cameras to one common perspective centre• lack of software for handling immersive panoramas taking into account the shift of frame cameras• knowledge of distance to the object helps to create immersive panoramas and to eliminate panorama errors• imaging errors of spherical model are the essence of this model

Immersive photogrammetry

Radius of the sphere should correspond to the **average distances** to objects placed around the imaging camera, but in practice it is difficult to select a single value of R to all the objects placed around it.



Model sferyczny

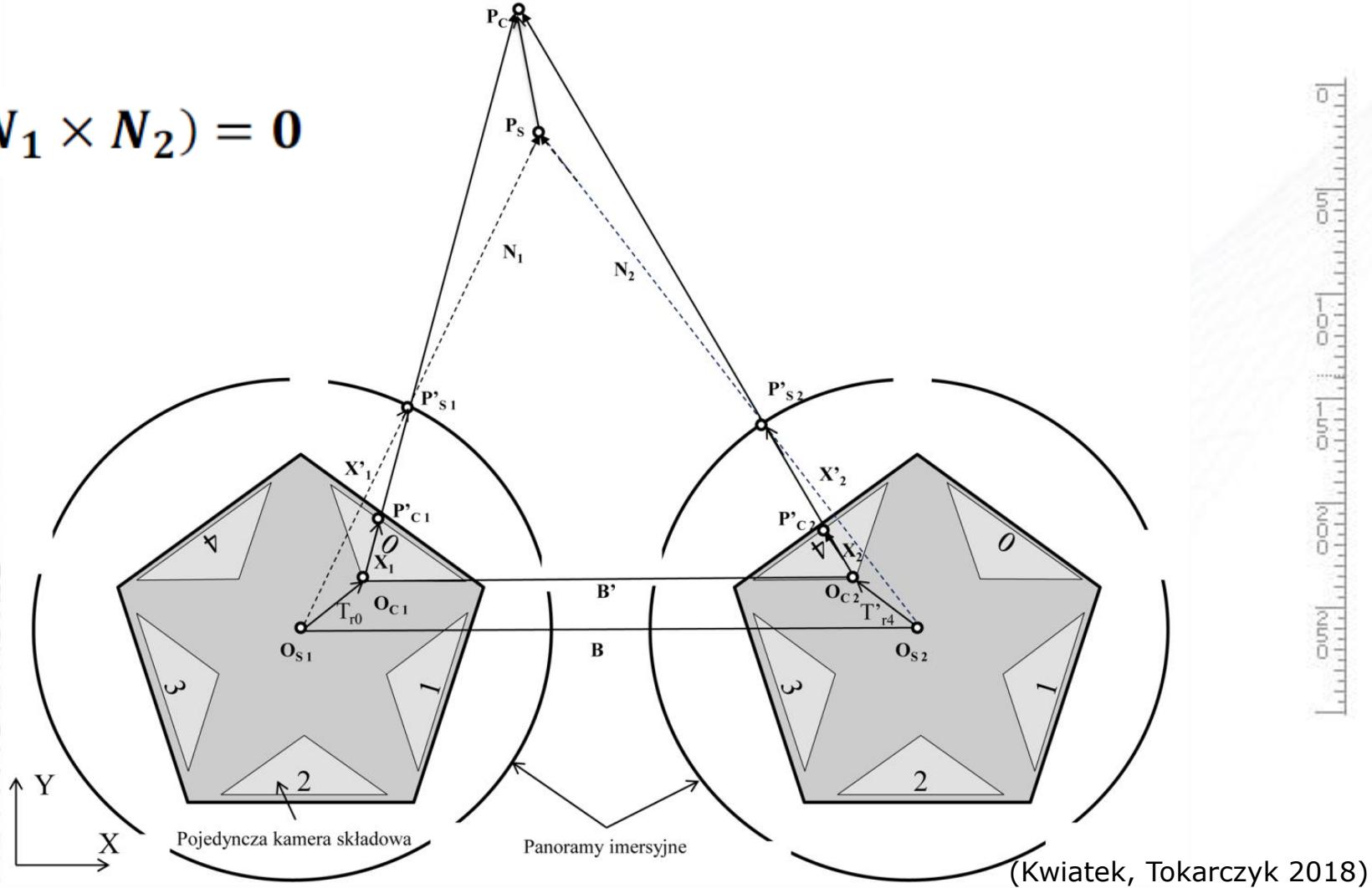


Model imersyjny

(Kwiatek, Tokarczyk 2018)
(Kwiatek 2020)

Measurements from immersive panoramas

$$B \cdot (N_1 \times N_2) = 0$$



(Kwiatek, Tokarczyk 2018)

Complanarity of two rays coming from immersive panoramas (shift of perspective centers are taken into account)

Measurements from immersive panoramas

The use of immersive model requires:

- identification of frame camera for which each point was measured
- knowledge about orientation of frame camera according to global coordinate system
- knowledge about shifts of all frame cameras

In order to make all the process easier – **immersive panoras** are generated.

It becomes useful to analyse the impact of differences between the spherical model and the imersive model

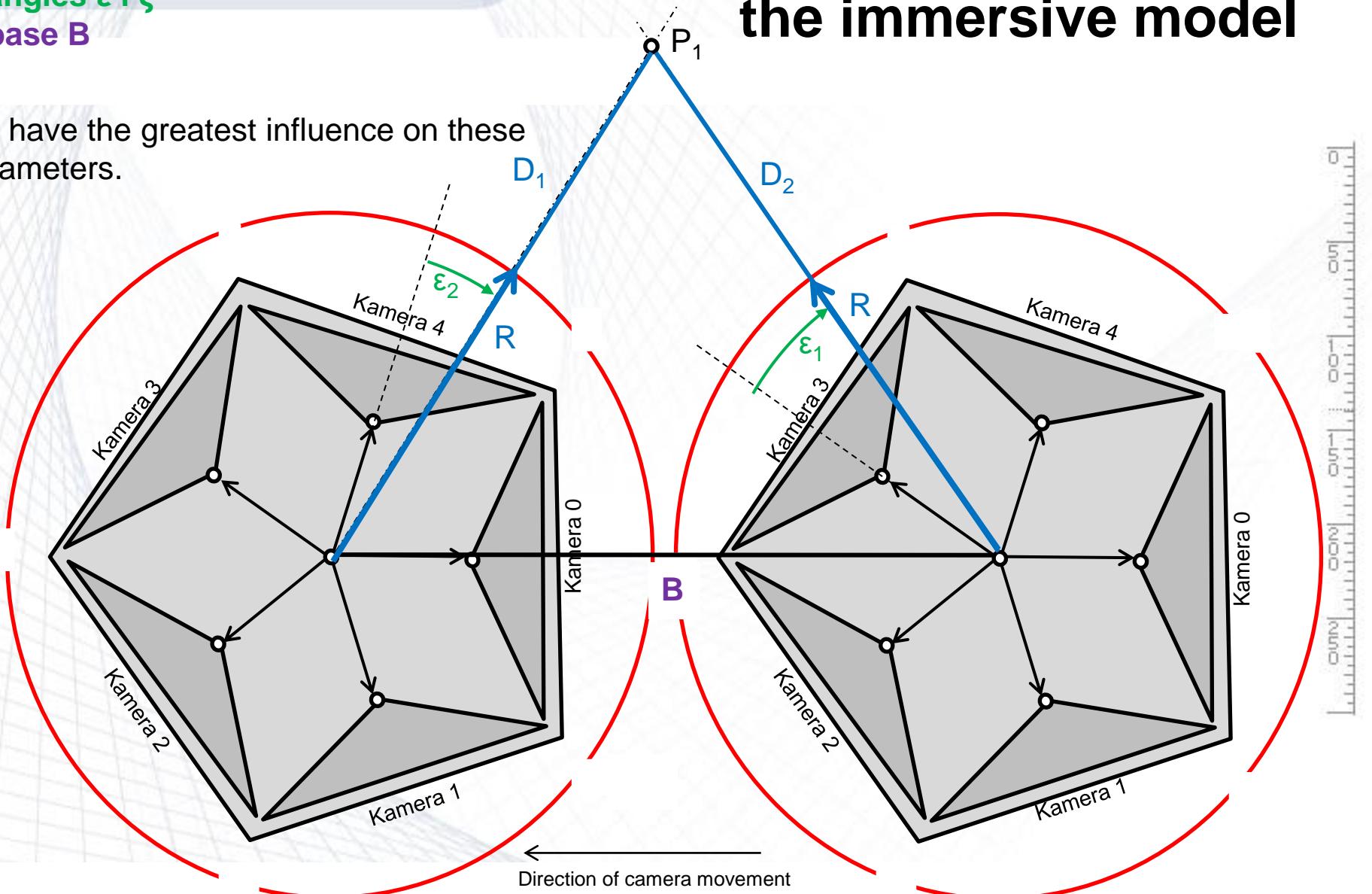
- determination of **factors** influencing generation of spherical and immersive panoramas
- determination of **errors** in photogrammetric measurements using immersive imaging in a spherical model

Accuracy depends mainly on:

- ❖ **choise of R and D**
- ❖ **angles ϵ i ξ**
- ❖ **base B**

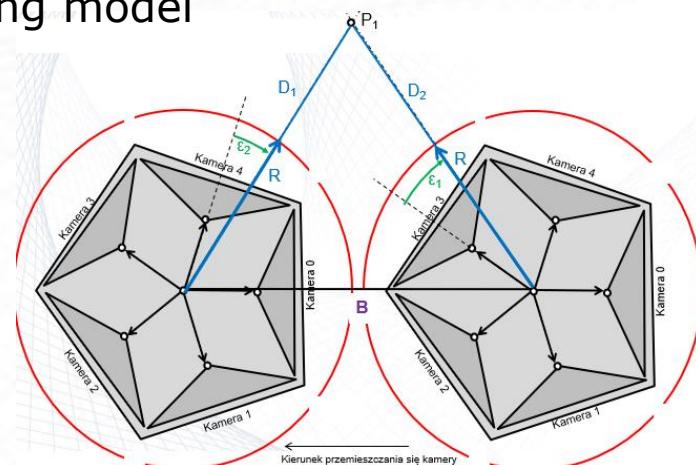
Geometric accuracy of the immersive model

We have the greatest influence on these parameters.

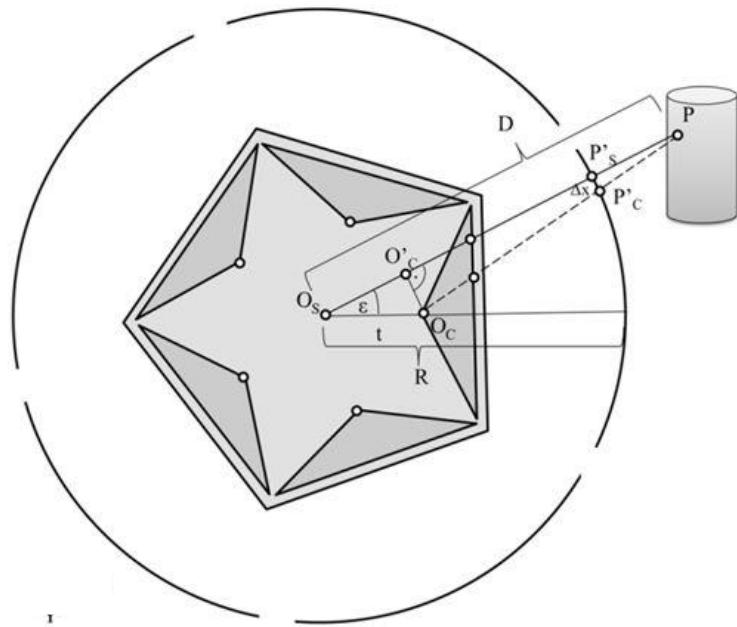


4. Errors of immersive panoramas

- a) Errors of the immersive model relative to the spherical model
- b) Geometry accuracy of the imaging model

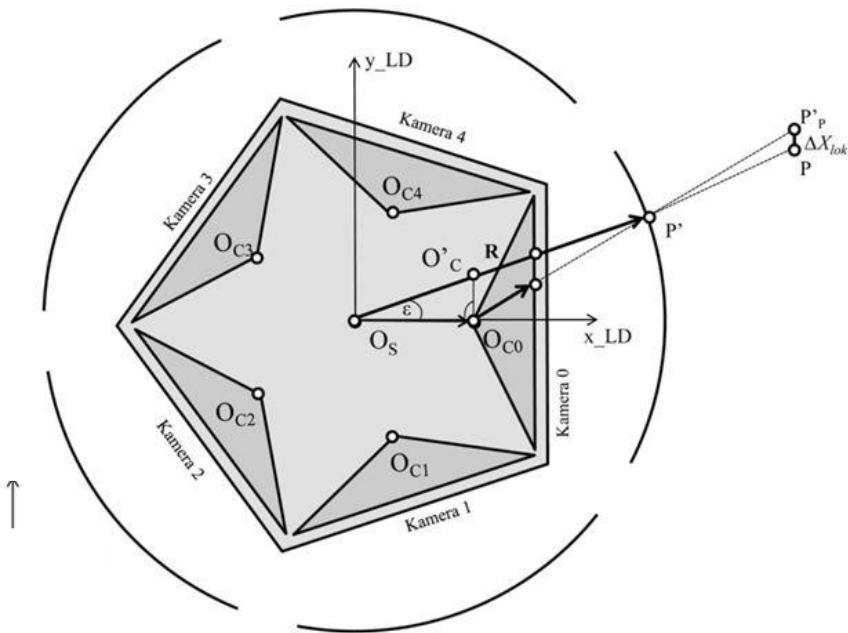


Errors of the immersive model (1/2)



Parallax error

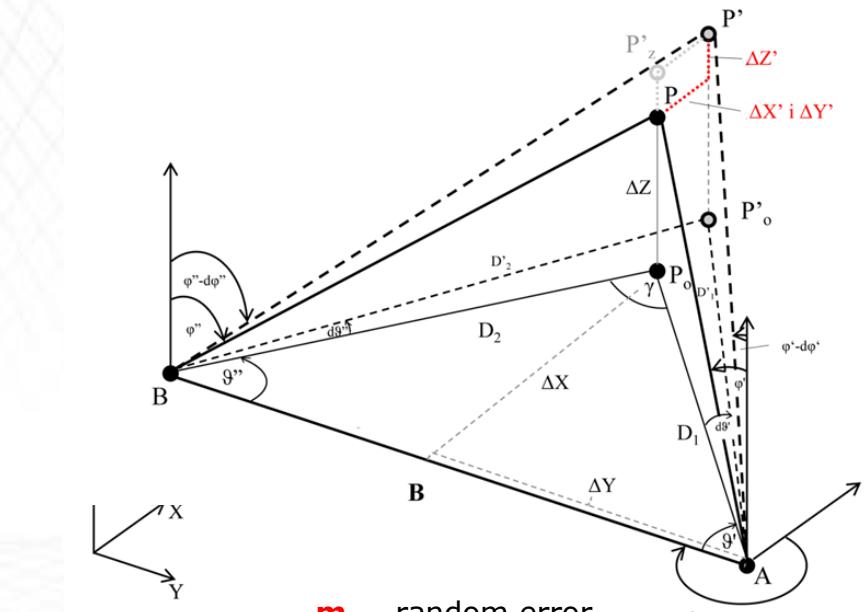
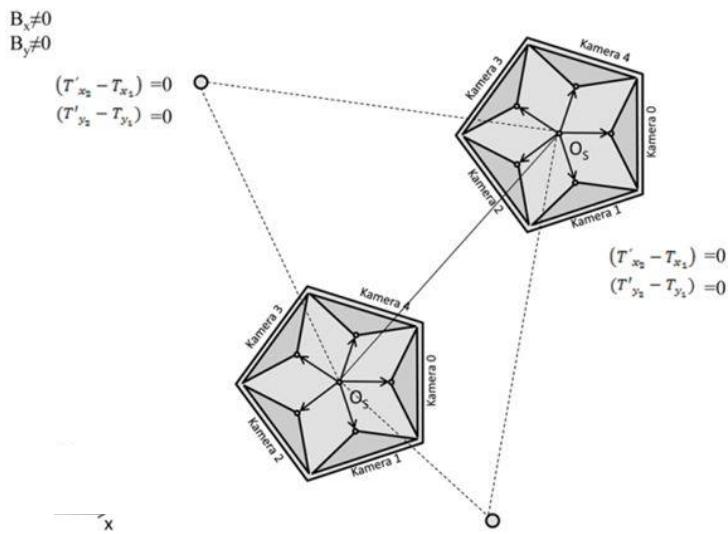
Error due to difference in image between spherical and immersive models



Localization error

The difference between projection rays reconstructed from the same image of a point on the sphere, but coming from different centres of projection.

Errors of the immersive model (2/2)



Epipolar error

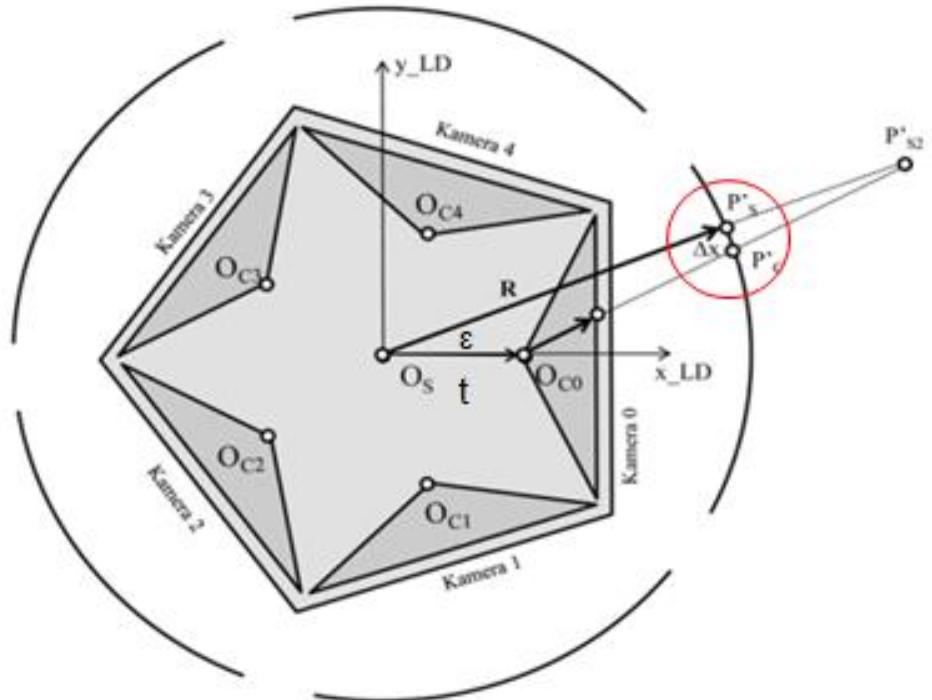
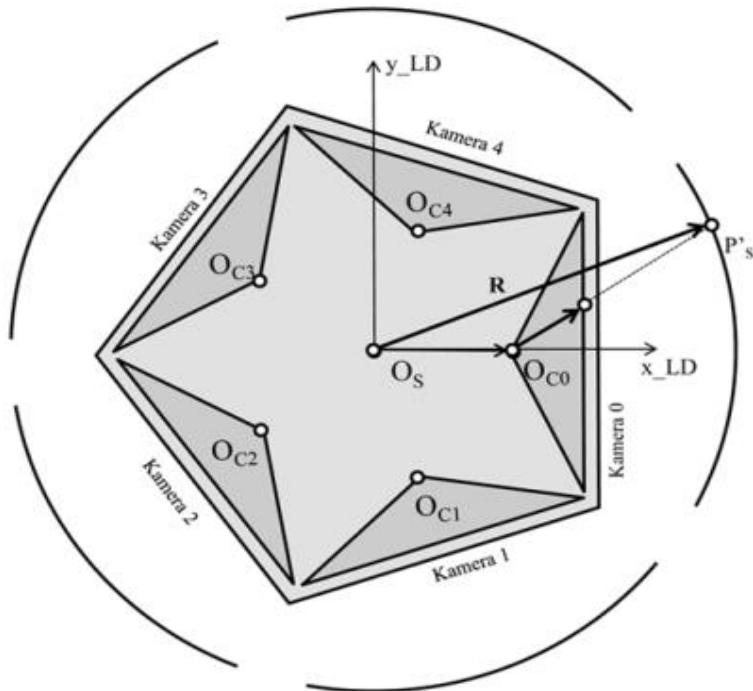
Non-fulfilment of the coplanarity equation for homology ray vectors

Error of forward spatial intersection

incorrect determination of the coordinates of the indented point and is mainly caused by parallax errors.

Errors of the immersion model with respect to the spherical model

1. Parallax error



$$\Delta x = \frac{(D - R) \cdot t \cdot \sin \xi}{D} \quad \Delta y = \frac{(D - R) \cdot t \cdot \sin \xi}{D}$$

The largest parallax errors are obtained for large values of R and small values of D

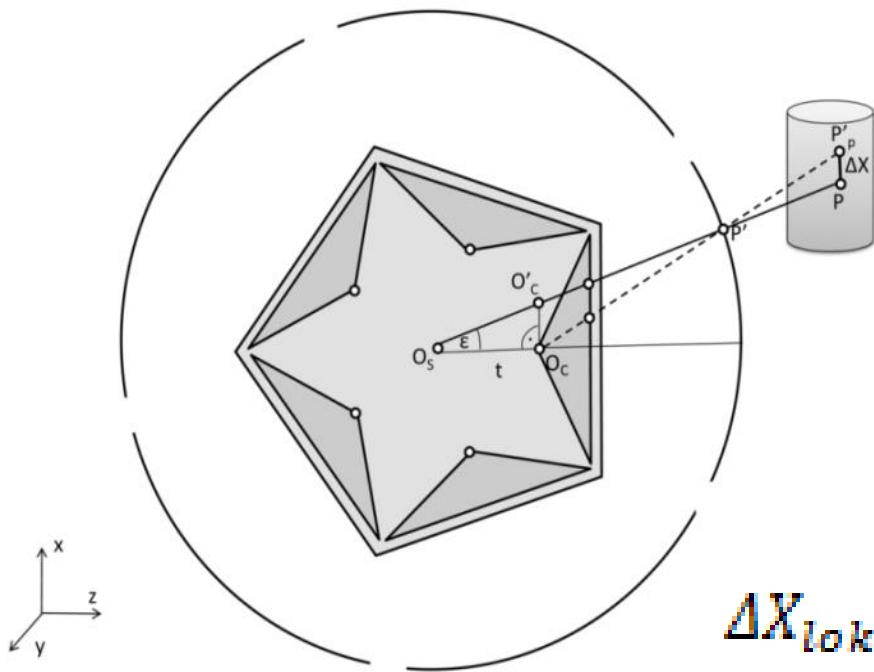
Errors of the immersion model with respect to the spherical model

2. Stitching error



Errors of the immersion model with respect to the spherical model

3. Localization error



$$\Delta x_{\text{lok}} = \frac{(D - R) \cdot t \cdot \tan \varepsilon}{R}$$

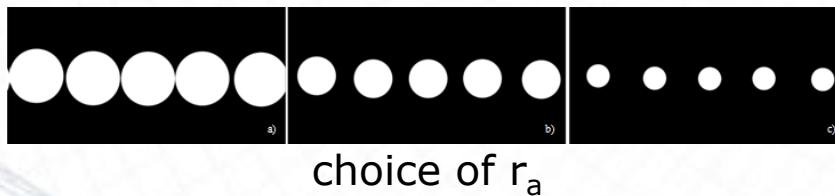
Measurements from immersive panoramas

1. Plan the registration distance
 - select R
 - examine the ground sampling distance
2. Calculate the favourable base

3. Calculate max. $\Delta X'$, $\Delta Y'$, $\Delta Z'$ and check how the accuracy will decrease



If the accuracy will decrease then change:
 r_a lub R lub B (which influences ϵ)



5. Immersive mobile mapping system

- a) Traditional vs mobile mapping measurements
- b) Calibration of immersive mobile mapping system

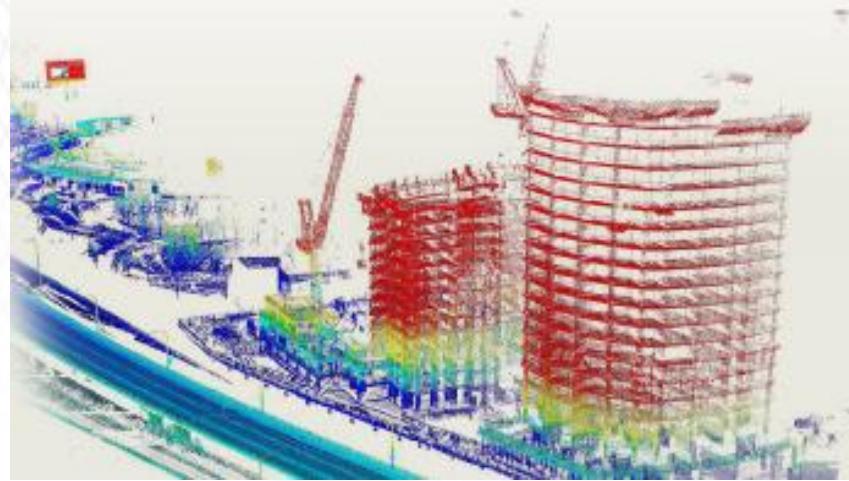


Traditional surveying along a road



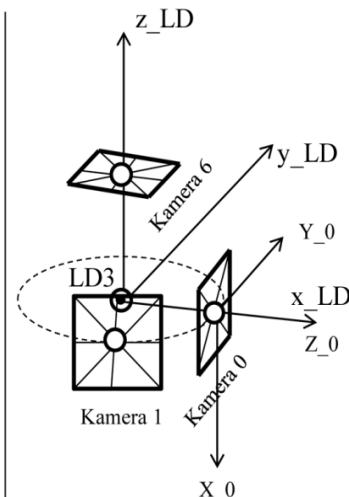
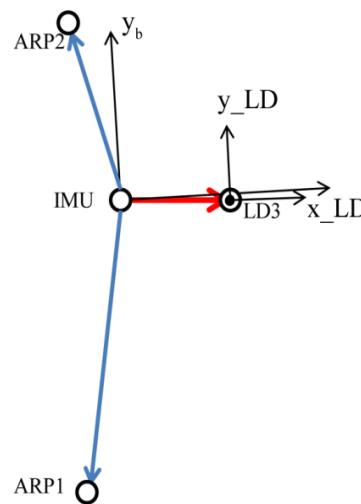
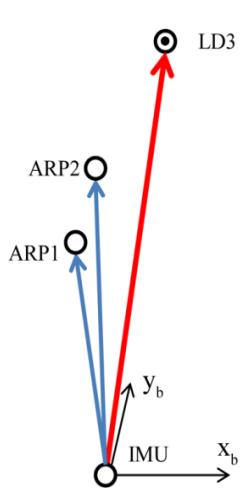
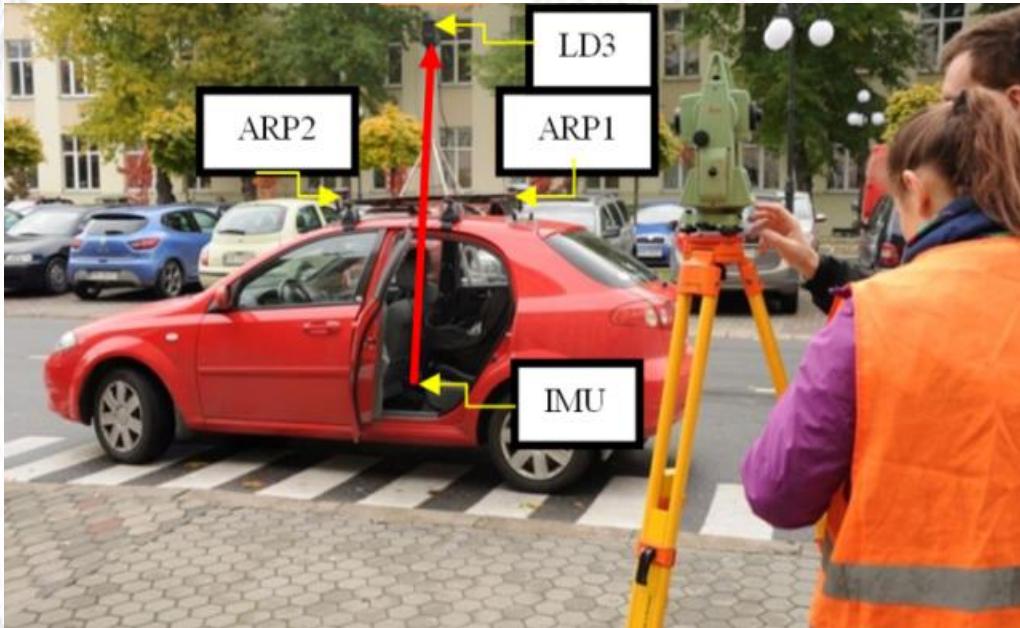
- Low efficiency
- Long measurement time
- Obstructions caused by vehicle traffic

Measurements using MMS



- High efficiency
- Very short measurement time
- No inconvenience caused by traffic

Calibration of immersive mobile mapping system



a)

b)

c)

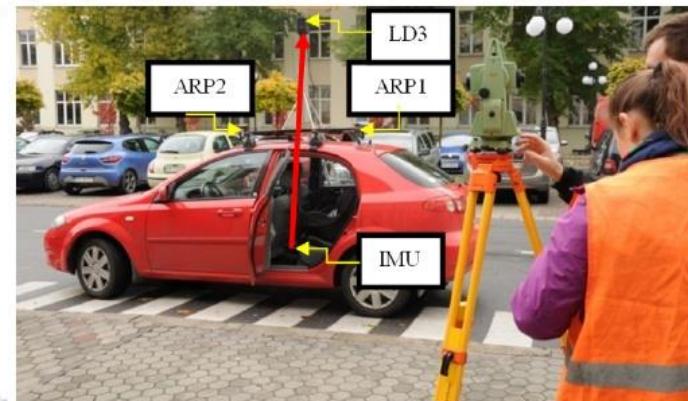
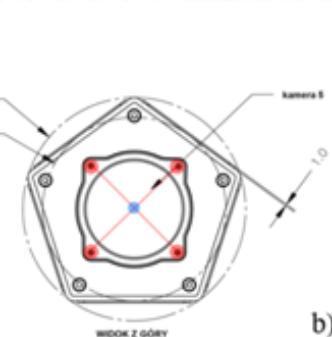
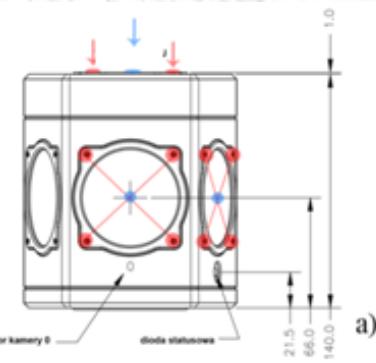
Calibration of immersive mobile mapping system

Two stage calibration:

calculate the difference between values acquired by SfM and measured by sensors

Determination of origins of coordinate systems:

- immersive camera (LD3)
- GNSS antennas (ARP)
- inertial unit (IMU)



Immersive mobile mapping system

Immersive panoramas allow to increase the accuracy of trajectory of moving camera through the integration of SfM with GNSS/INS measurements.

AIM:

Compare methods of acquisition of exterior orientation parameters and investigate their influence on photogrammetric measurements

Alignment of photogrammetric network based immersive panoramas

Indirect georeferencing (SPAN) and direct georeferencing was compared (13 control points)



Indirect georeferencing acquired through SfM proces based on immersive panoramas increases the accuracy of measurements from immersive panoramas

The application of indirect georeferencing triples the average error on control points

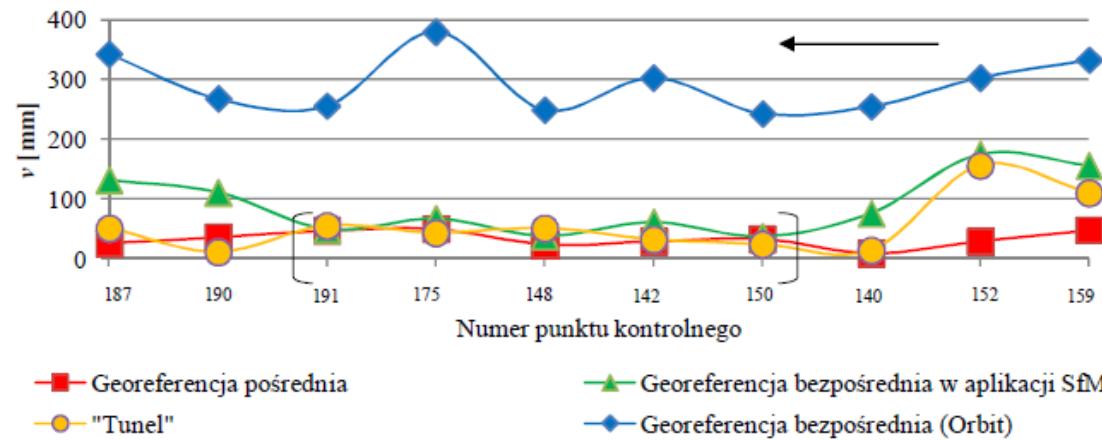
(Kwiatek 2020)

Integration of direct georeferencing with SfM alignment

4 cases:

- 1) Indirect georeferencing (13 control points)
- 2) Direct georeferencing with SfM alignment
- 3) Direct georeferencung at the beginning and at the end („tunnel”) with alignment
- 4) Direct georeferencing without alignment (measurements in Orbit GT software)

Average errors on control points



RMSE _{XYZ} [mm]			
Georeferencja pośrednia	Georeferencja bezpośrednią z wyrównaniem	„Tunel”	Georeferencja bezpośrednią z Orbit GT
33	90	55	293

Comparision of deviations on control points according to type of georeferencing

(Kwiatek 2020)

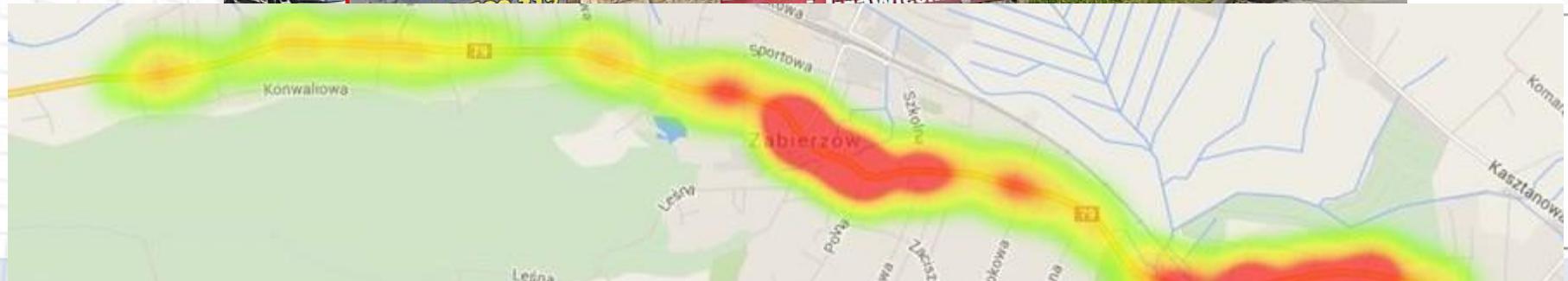
- It is possible to plan the realisation of photogrammetric measurements from immersive panoramas with a certain accuracy.
- This is done at the cost of reducing the field of view and the associated reduction in the number of points; this can be compensated by increasing the number of recorded panoramas (fps).
- This is associated with a shorter base, which leads to a reduction of the parallax error (systematic error), but at the same time to an increase in the random error

- The obtained accuracies confirm the usefulness of the constructed system and the proposed methodology of calibration and integration of observations for some photogrammetric studies
- The system can be used to create 3D models of buildings at LoD4 level of detail
- Following the principles described above during the measurements from immersive panoramas allows to create 3D models of streets or interiors of buildings with accuracy in the range of 0,01-0,04 m.

6. Application of immersive mobile mapping system



Advertising chaos measurements



reklamy

Naukowiec zmierzył reklamy przy krakowskich ulicach

Ewa Grużka, 11 lipca 2018 | 11:00



NAJCZĘŚCIEJ CZYTANE



ISTOTNY
Syn Józefa Kurasia "Ognia" domaga się milionów za śmierć ojca



ISTOTNY
Prezydent ma wymyśleć, jak ratować Wisłę Kraków

TWÓJ POMYSŁ TO
Dobry Pomysł OK

Pomysł o nazwie

Fotogrametryczna inwentaryzacja chaosu reklamowego

autorstwa

KAROLA KWIATKA

przeszedł pomyślnie wszystkie etapy oceny w programie **Dobry Pomysł** i został zakwalifikowany do grona najlepszych pomysłów, które otrzymają specjalnie dobrane usługi wsparcia w rozwoju i komercjalizacji.

Gratulujemy i życzymy powodzenia na dalszej ścieżce rozwoju!

Organizatory:

Florian Kwiatko, Michał Borczyk, Rafał Laskar, Małgorzata Ryzga
PFR, FIRE, INVESTIN, INNOVATION TECHNOLOGIES

Data:

21/03/2018

Dr inż. Karol Kwiatek z Politechniki Krakowskiej dokonał pomiaru wielkości reklam w Krakowie. Wśród tych, które badał, przodowała ulica Zakopiańska. Sytuację poprawić może uchwała krajobrazowa - radni zajmą się nią pod koniec roku.

<https://www.bip.krakow.pl/zalaczniki/dokumenty/n/245707>

CHAOS REKLAMOWY

Rabka-Zdrój





CHAOS REKLAMOWY

Zakopianka



CHAOS REKLAMOWY

Nowy Targ

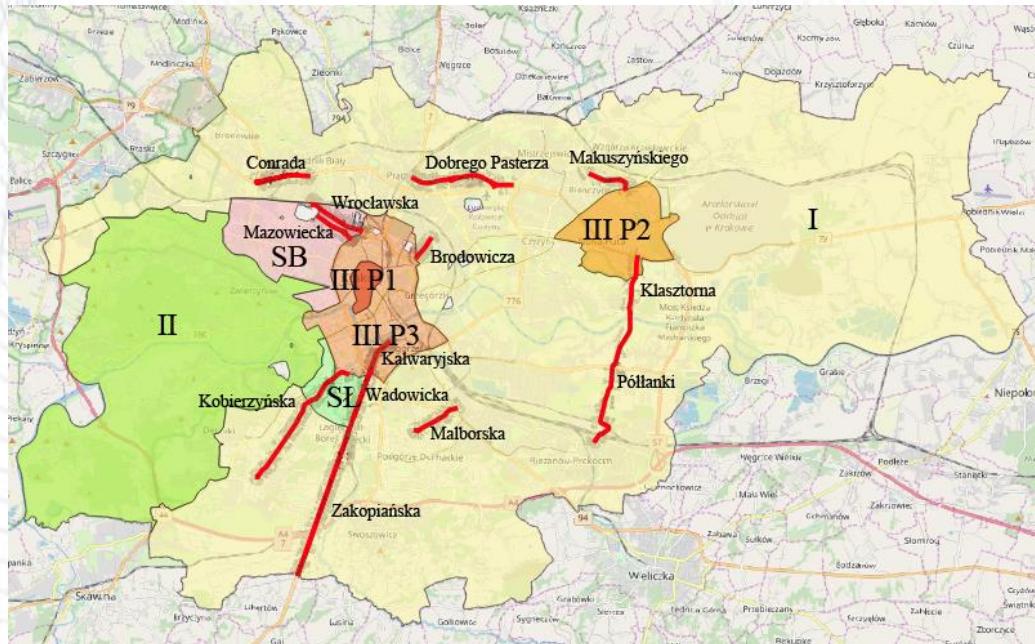
Project for City Council of Krakow



13 streets



total lenght 27,8km



Ulica w Krakowie	Długość ulicy [km]	Strefa	Czy ulica wylotowa?
Brodowicza	0,6	I	Nie
Conrada	1,3	I	Tak
Dobrego Pasterza	2,6	I	Nie
Kalwaryjska	1,0	III Strefa Podobszar 3	Nie
Klasztorna	1,7	670m w III Strefa Podobszar 2, pozostała część - Strefa I	Nie
Kłobierzyńska	4,3	I	Nie
Makuszyńskie go	1,3	I	Nie
Malborska	1,4	I	Nie
Mazowiecka	1,1	I	Nie
Półanki	4,4	I	Nie
Wadowicka	0,9	I	Tak
Wrocławska	1,6	I	Nie
Zakopiańska	5,6	I	Tak

Methodology

1

Photogrammetric measurements

- Inventory of advertisements using immersive mobile mapping system

2

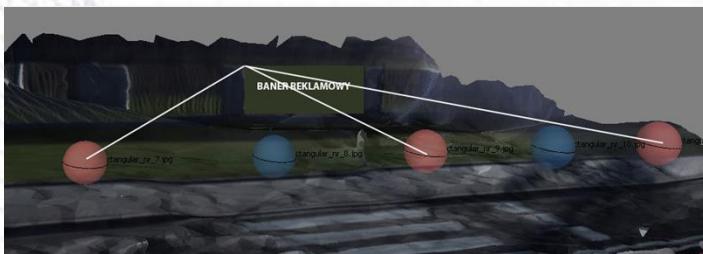
Measurements of advertisements using immersive panoramas

- Measurements of free standing ads
- Measurements of ads on building structures

3

Spatial analysis

- Elimination of ads inconsistent with the draft of the resolution
- Spatial analysis for consistent ads
- Carry out analyses of advertising coverage for ground floor and building facades



Types of ads



C044.jpg



C045.jpg



C046.jpg



C047.jpg



C048.jpg



C049.jpg



C050.jpg



C051.jpg



C052.jpg



C053.jpg



C054.jpg



C055.jpg



C056.jpg



C057.jpg



C058.jpg



C059.jpg



C060.jpg



C061.jpg

Free-standing ads on Conrada street

Types of ads



J744.jpg



J745.jpg



J746.jpg



J747.jpg



J748.jpg



J749.jpg



J750.jpg



J751.jpg



J752.jpg



J753.jpg



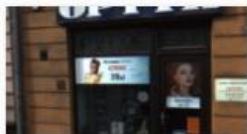
J754.jpg



J755.jpg



J756.jpg



J757.jpg



J758.jpg



J759.jpg



J760.jpg

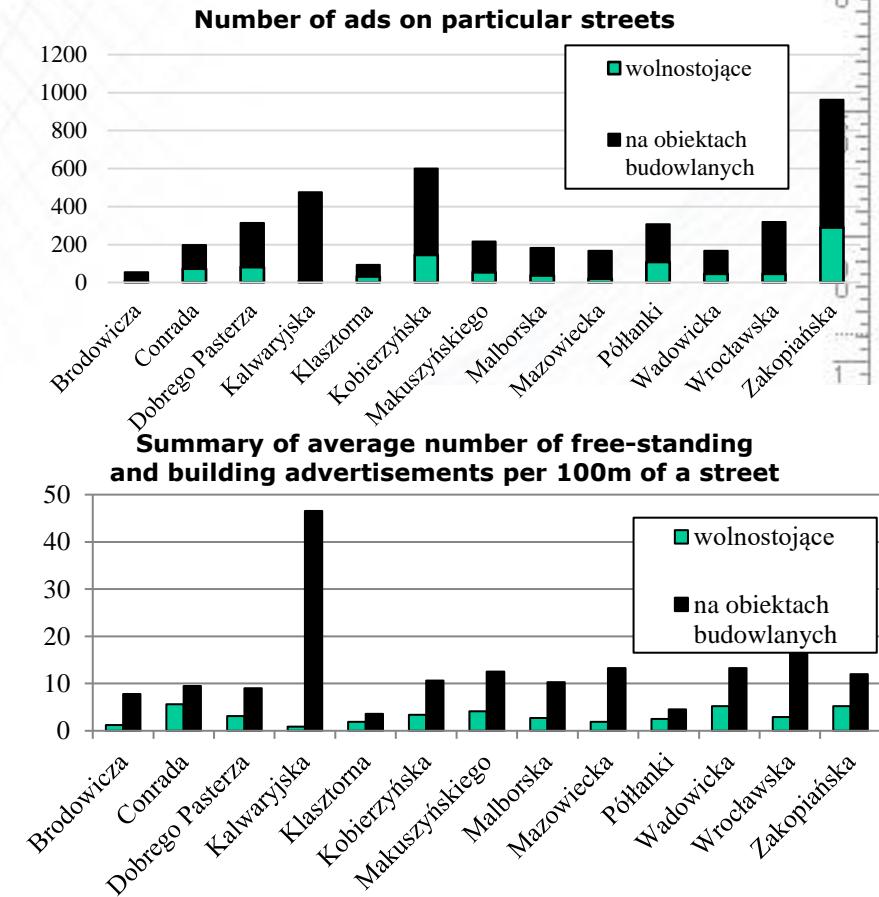


J761.jpg

Ads on building contructions on Kalwaryjska street

Development of a digital advertising inventory

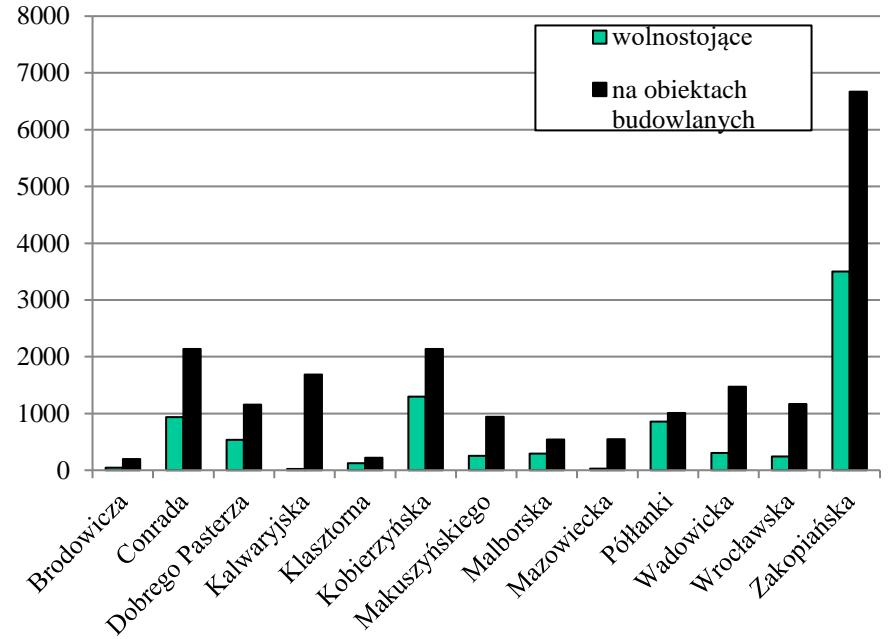
Ulica w Krakowie (skrót literowy)	Liczba reklam wolno- stojących	Liczba reklam na obiektach budowlanych	Długość ulicy [km]	Średnia liczba reklam wolnostojących na 100 m	Średnia liczba reklam na obiektach budowlanych na 100 m
Brodowicza	7	47	0,6	1,2	7,8
Conrada	73	124	1,3	5,6	9,5
Dobrego Pasterza	81	233	2,6	3,1	9,0
Kalwaryjska	9	466	1,0	0,9	46,6
Klasztorna	32	61	1,7	1,9	3,6
Kobierzyńska	146	454	4,3	3,4	10,6
Makuszyńskie go	54	163	1,3	4,1	12,5
Malborska	38	144	1,4	2,7	10,3
Mazowiecka	21	146	1,1	1,9	13,3
Półanki	109	199	4,4	2,5	4,5
Wadowicka	47	120	0,9	5,2	13,3
Wrocławska	46	273	1,6	2,9	17,1
Zakopiańska	290	672	5,6	5,2	12,0
Suma	953	3102	27,8		
Średnia			3,4		13,1



Development of a digital advertising inventory

Ulica w Krakowie	Łączna powierzchnia reklam wolnostojących (bez okrąglaków) [m ²]	Liczba okrąglaków	Łączna powierzchnia reklam na obiektach budowlanych [m ²]
Brodowicza	49,06	0	197,24
Conrada	935,58	4	2136,46
Dobrego Pasterza	538,98	4	1154,32
Kalwaryjska	24,15	5	1687,07
Klasztorna	126,19	0	220,74
Kobierzyńska	1299,31	9	2140,34
Makuszyńskiego	256,33	0	941,07
Malborska	295,50	0	541,18
Mazowiecka	30,74	12	550,44
Półanki	859,49	0	1011,43
Wadowicka	306,99	11	1473,57
Wrocławska	244,51	8	1168,24
Zakopiańska	3501,05	5	6668,04
Suma:	8467,88	58	19890,14

Summary of total advertising space on selected streets



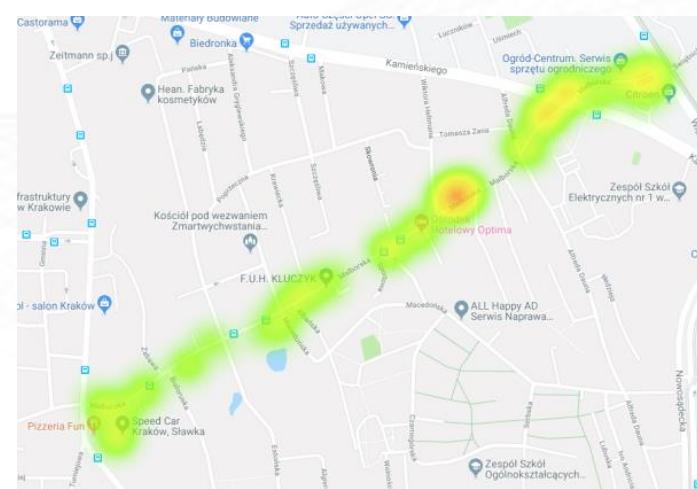
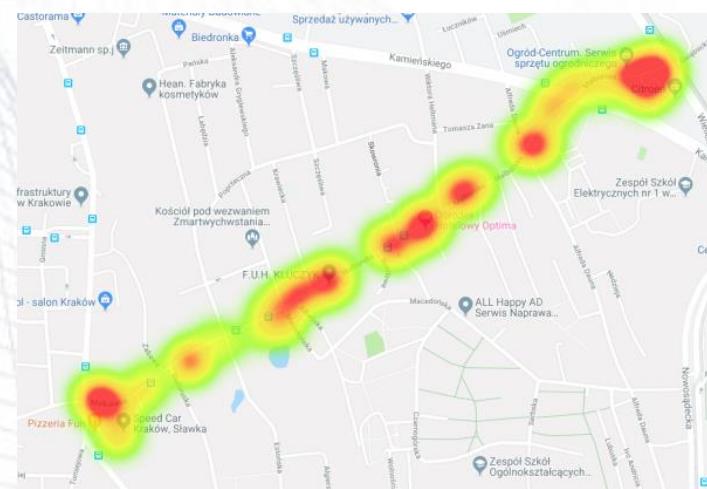
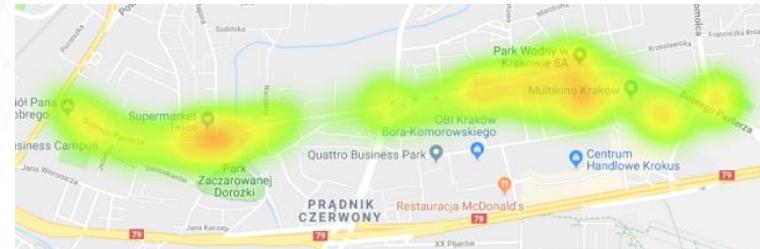
Development of a digital advertising inventory

Dobrego Pasterza and Malborska streets

Advertising intensity by number of advertisements



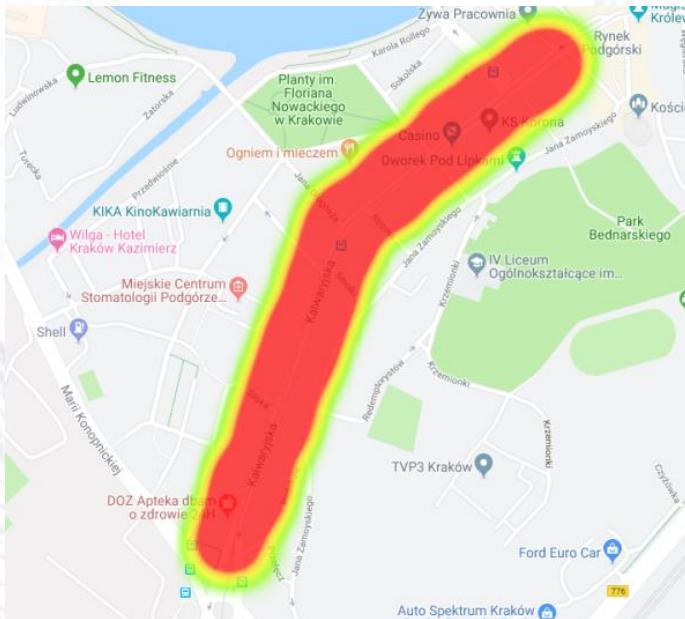
Advertising intensity by area



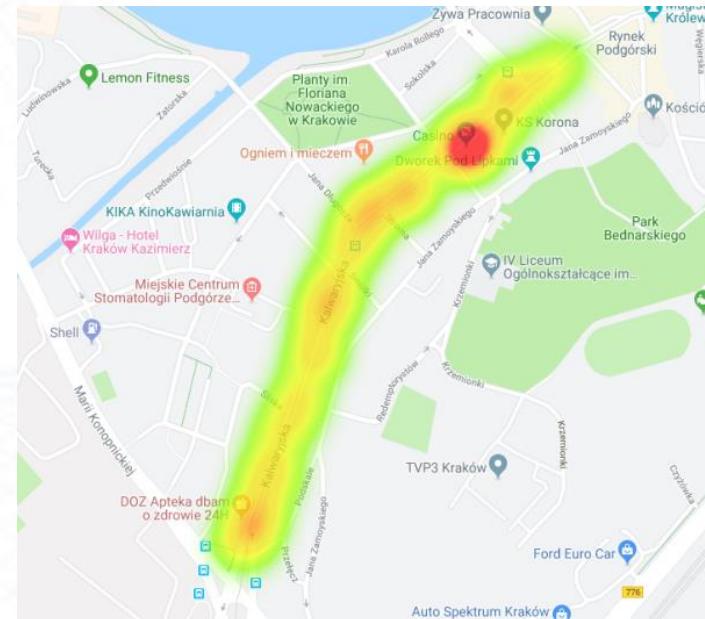
Development of a digital advertising inventory

Kalwaryjska street

Advertising intensity by number of advertisements



Advertising intensity by area



0
100
200
300
400
500
600
700
800
900
1000

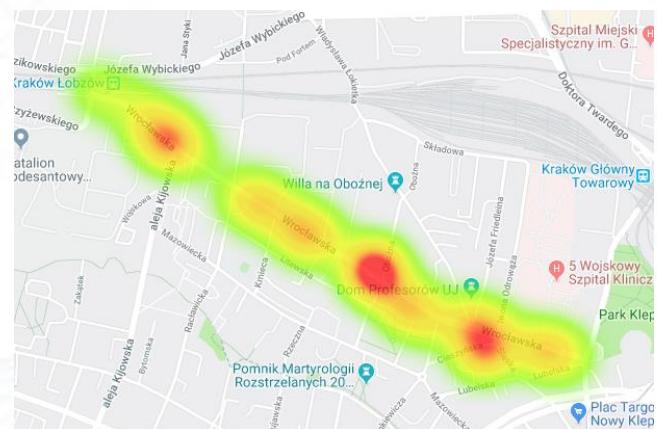
Development of a digital advertising inventory

Wrocławska street

Advertising intensity by number of advertisements



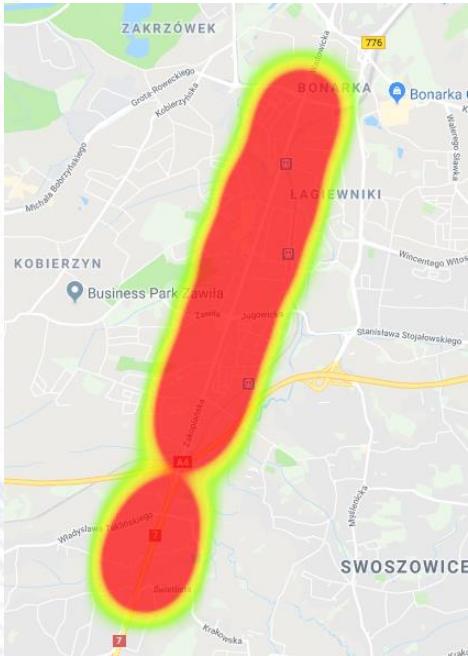
Advertising intensity by area



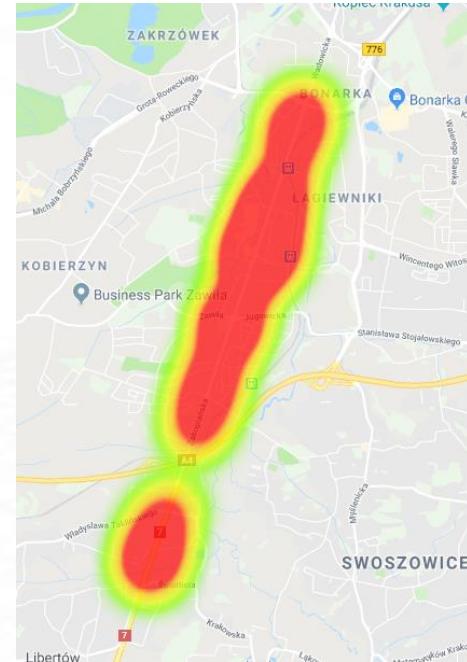
Development of a digital advertising inventory

Zakopiańska street

Advertising intensity by number of advertisements



Advertising intensity by area



0 50 100 150 200 250 300 350 400 450

Spatial analysis

**Elimination of advertisements incompatible with the draft resolution
of the Municipal Council of Krakow**



W581 – beyond the ground floor level



P009 – distance from the bottom edge of the
billboard below 3m from the ground

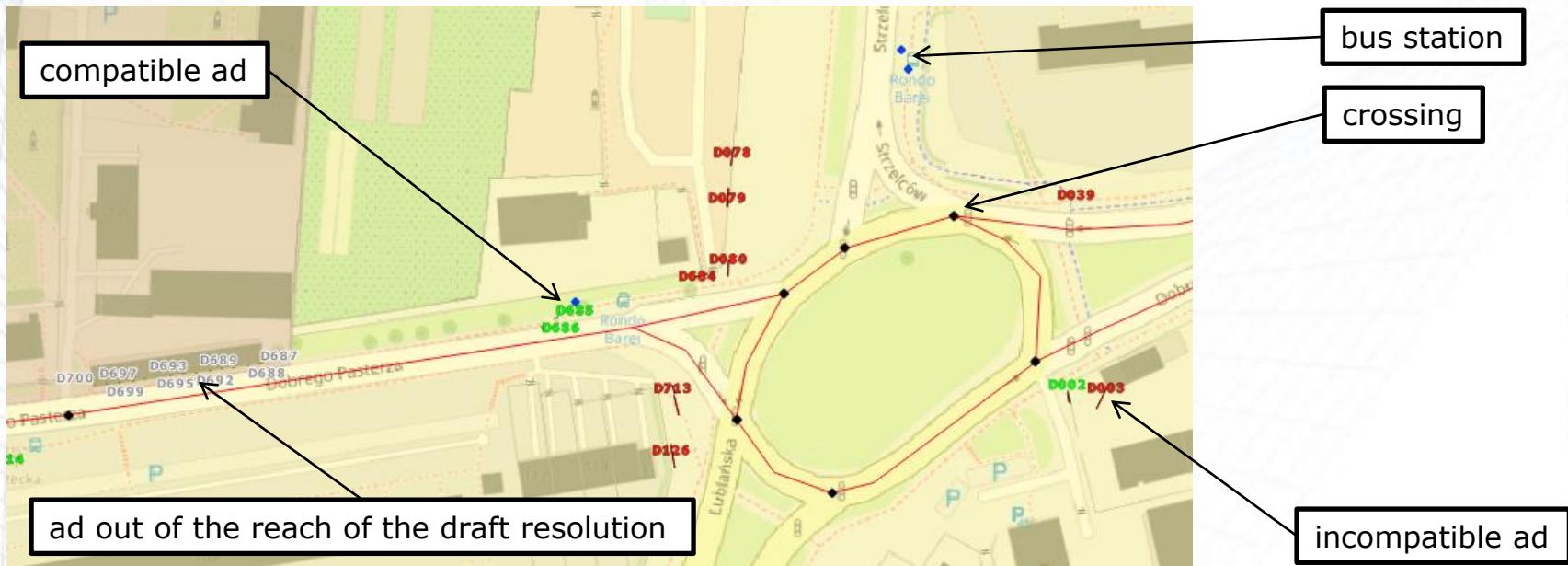


K111 – distance from bus shelter
less than 15m



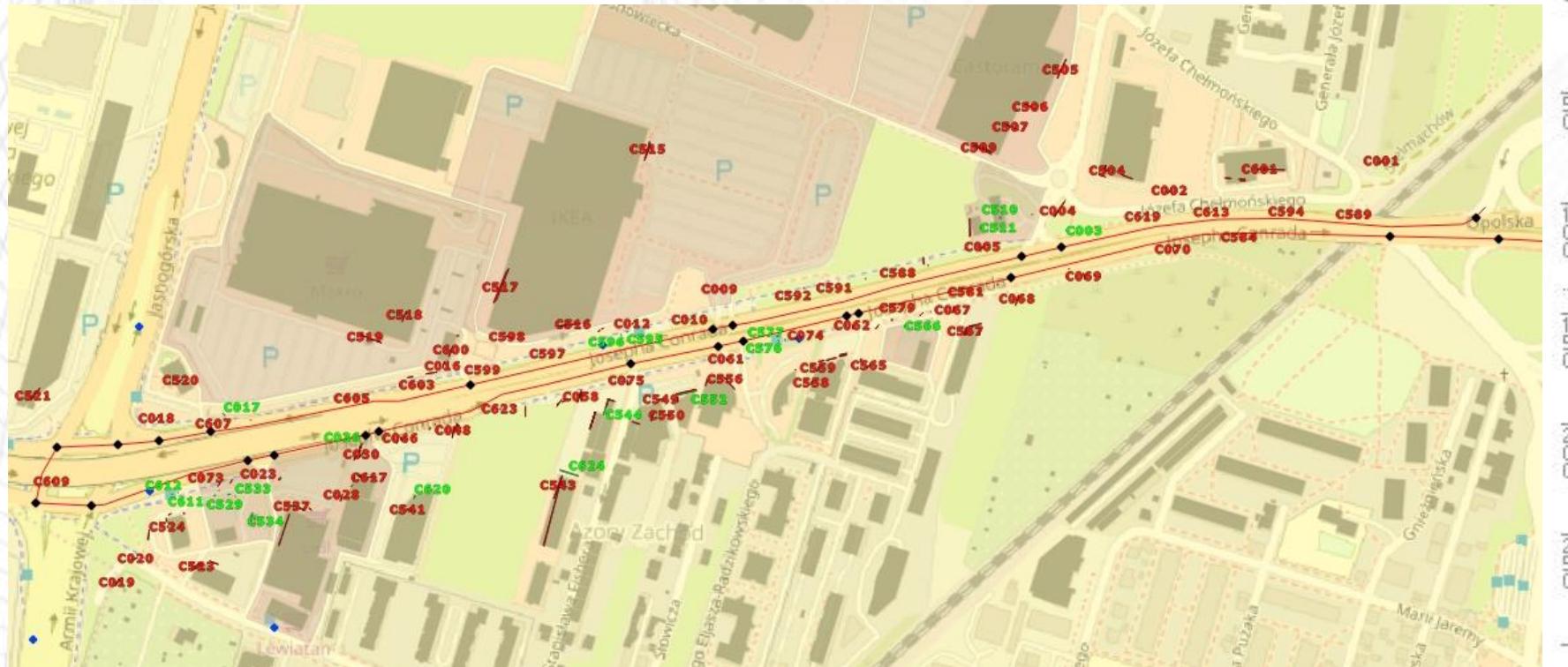
Spatial analysis

*compatible
incompatible
out of the reach of the draft resolution*



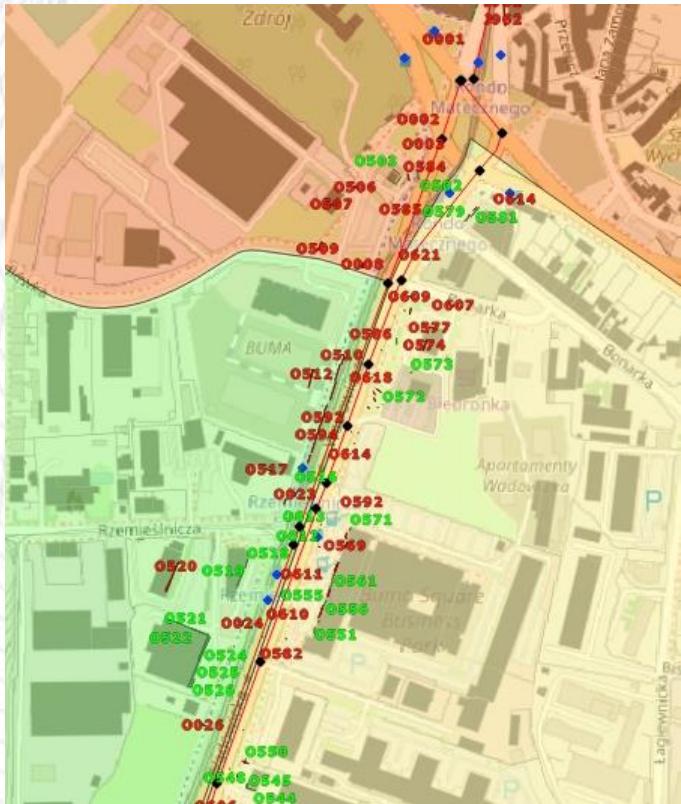
Fragment ulicy Dobrego Pasterza

Compatibility of ads

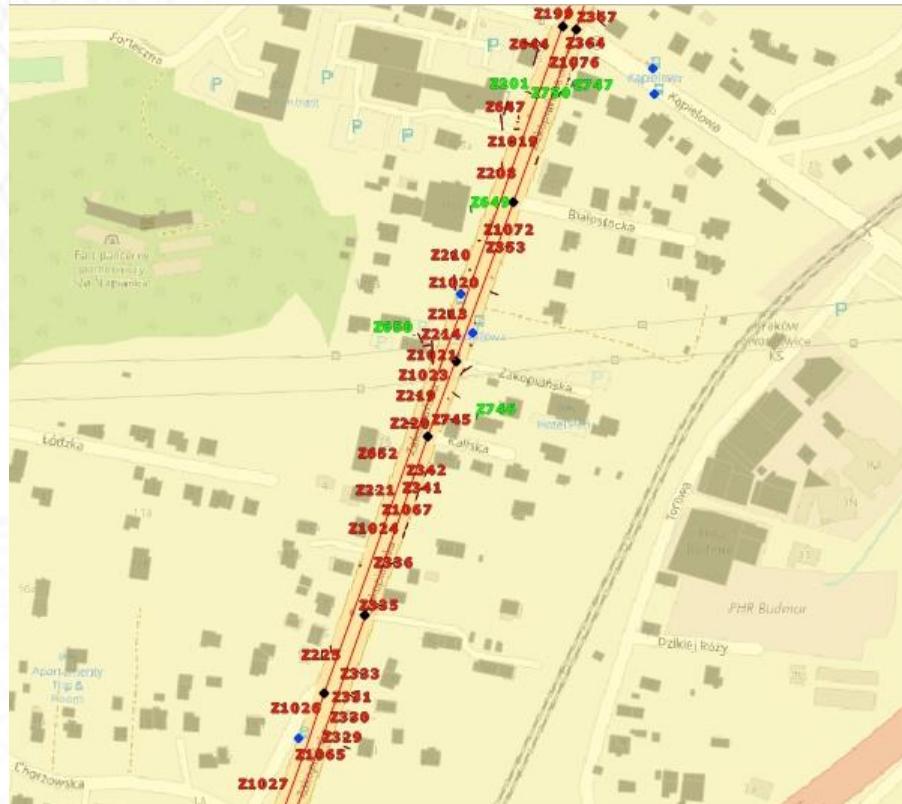


Conrada street

Compatibility of ads



Wadowicka street

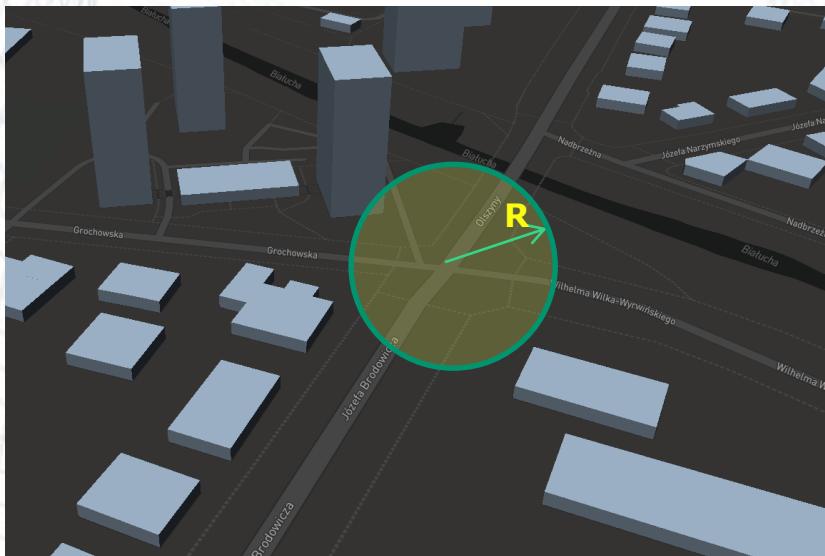


Zakopiańska street

Compatibility of ads

Zgodność reklam	Number of free-standing ads	Number of ads on building structures	Total numer of ads
all ads	953 (100%)	3102 (100%)	4055 (100%)
compatible ads	286 (30%)	177 (5%)	463 (11%)
incompatible ads	657 (69%)	2901 (94%)	3558 (88%)
out of the reach of the resolution	10 (1%)	24 (1%)	34 (1%)

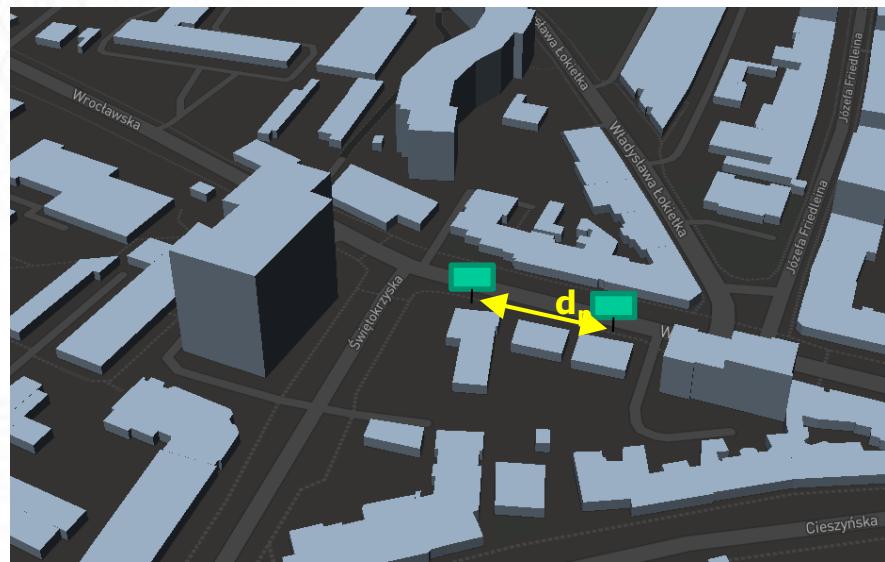
Spatial analysis for compatible ads



Distance from the intersection of the cross axis(**R**)

$$\mathbf{R=100m}$$

$$\mathbf{R=50m}$$



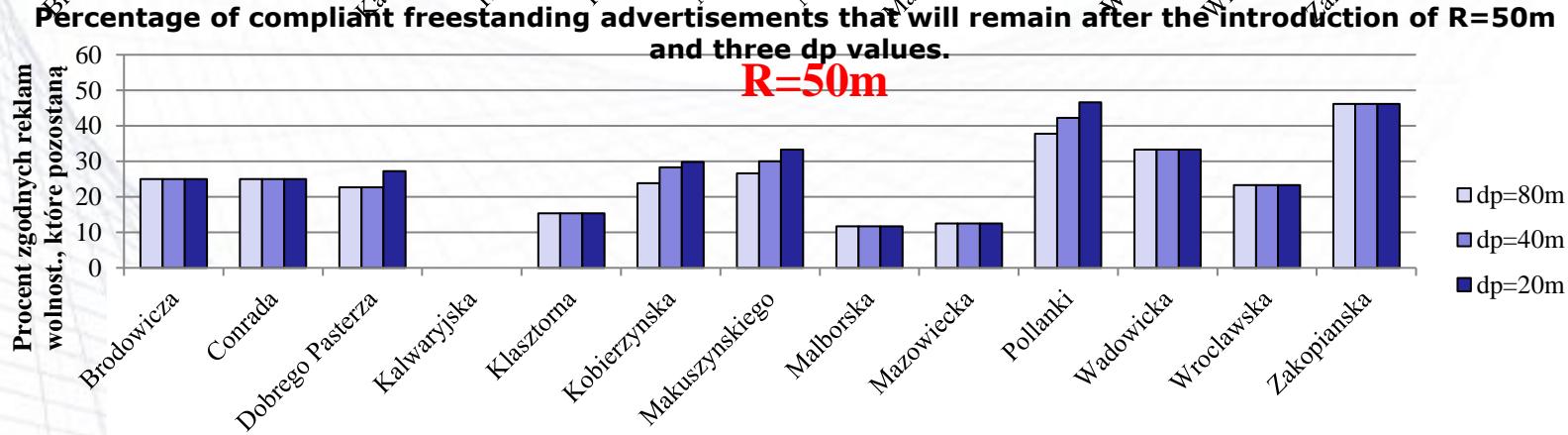
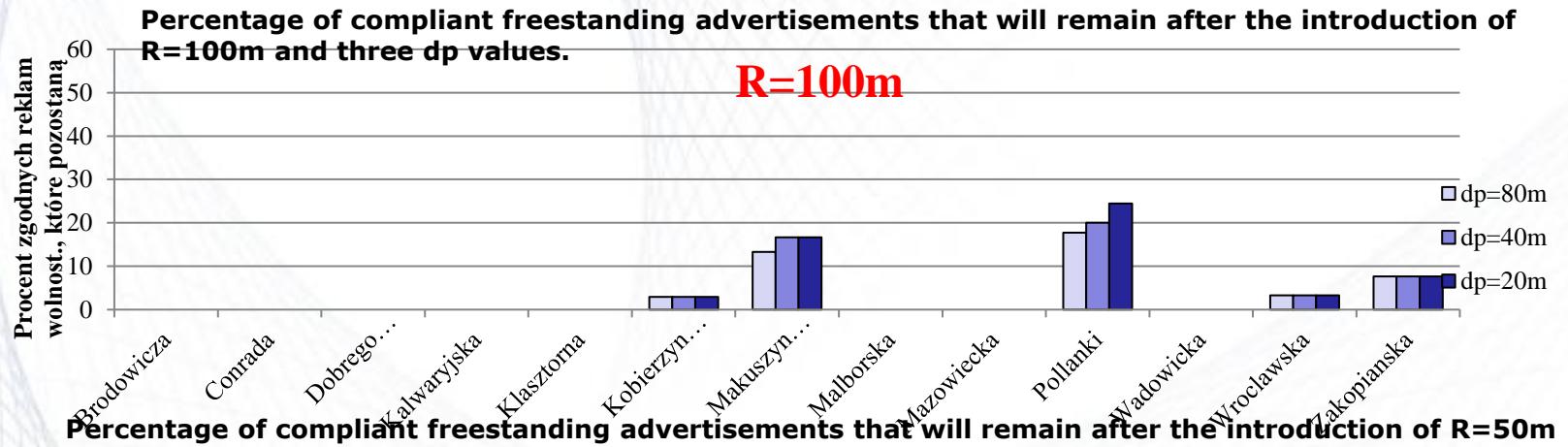
Distance between other free-standing ads
and other free-standing devices (**d_p**)

$$\mathbf{d_p = 80m}$$

$$\mathbf{d_p = 40m}$$

$$\mathbf{d_p = 20m}$$

Spatial analysis for compatible ads



Spatial analyses of advertising coverage for ground floor and building facades

Ulica w Krakowie	Liczba fasad budynków, na których znajdują się nośniki reklamowe	Liczba fasad parteru, na których znajdują się reklamy na obiektach budowlanych	Średnia wartość wyrażona w procentach zajętości reklam na fasadzie parteru [%]	Liczba reklam na fasadzie parteru zgodnych z projektem uchwały	Liczba reklam na fasadzie parteru niezgodnych z projektem uchwały	Liczba reklam zgodnych z projektem uchwały	Liczba reklam niezgodnych z projektem uchwały
Brodowicza	17	13	23,6	8	5	8	39
Conrada	38	1	22,0	1	0	1	123
Dobrego Pasterza	57	15	10,5	14	1	14	219
Kalwaryjska	88	70	16,1	37	33	37	429
Klasztorna	14	0	0,0	0	0	0	61
Kobierzyńska	83	23	27,1	17	6	17	437
Makuszyńskiego	24	12	17,7	9	3	9	154
Malborska	38	12	12,0	11	1	11	133
Mazowiecka	50	27	14,6	22	5	22	124
Półanki	29	2	7,1	2	0	2	197
Wadowicka	19	5	23,5	3	2	3	117
Wrocławska	59	37	12,1	34	3	34	239
Zakopiańska	156	28	22,2	19	9	19	629
Suma	672	245		177	68	177	2901
Średnia	52	19	16,0	14	5	14	225



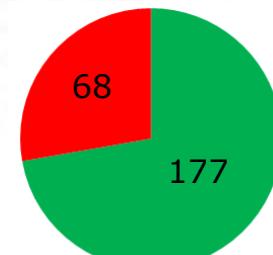
Building facade



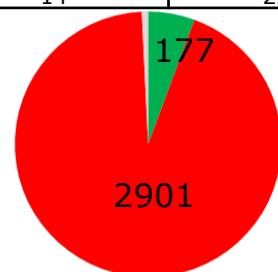
Ground floor facade



Advertising placed on the ground floor façade



Number of advertisements on the ground floor façade

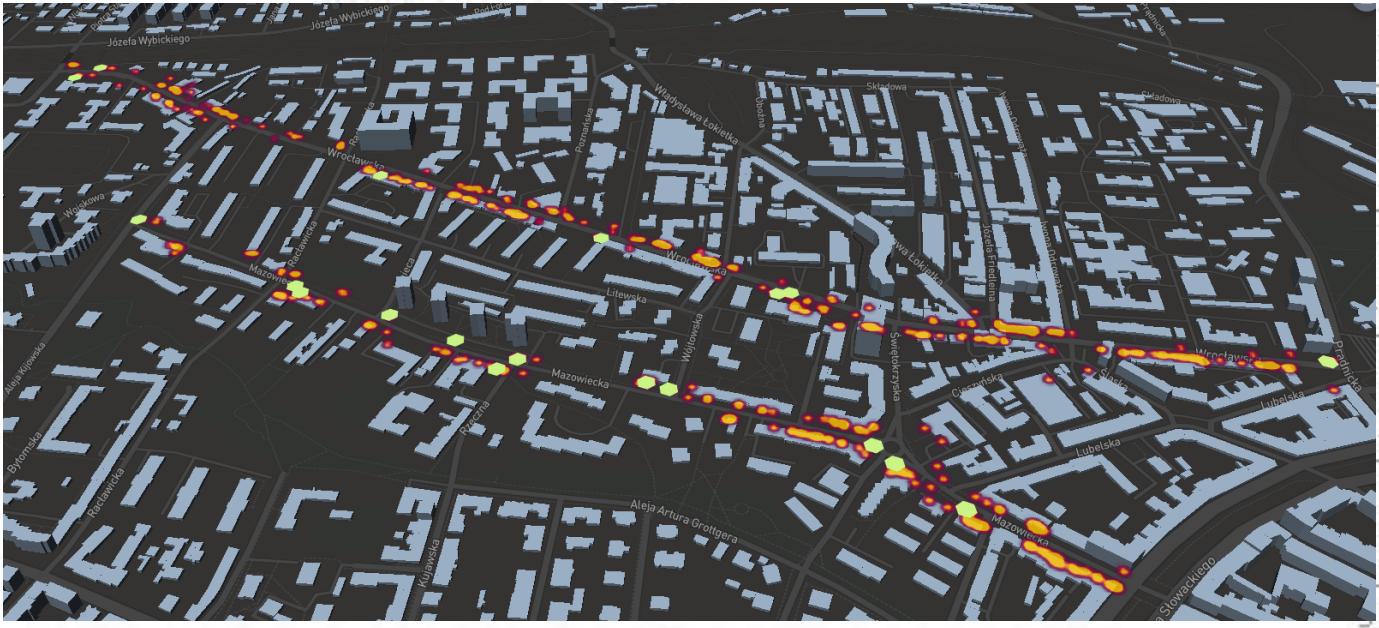


Number of ads on building structures

Visualisation

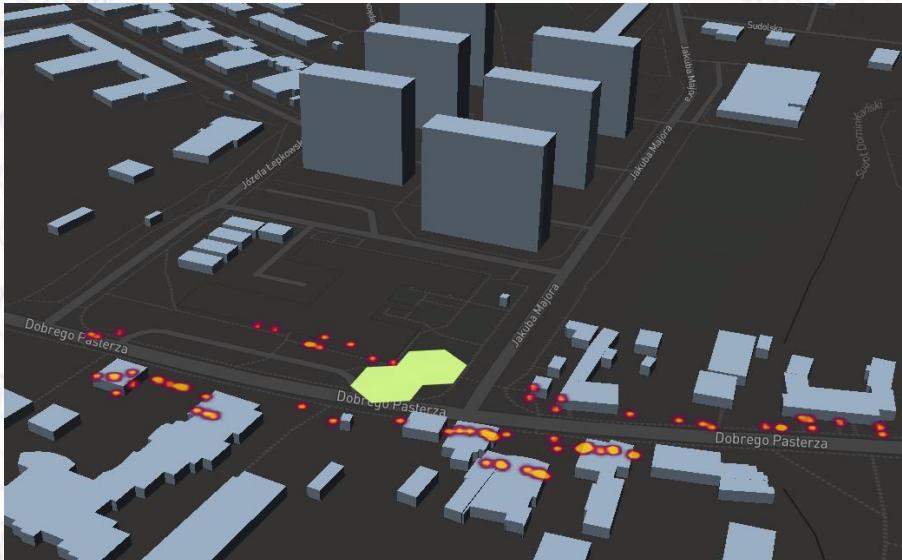


Kalwaryjska street

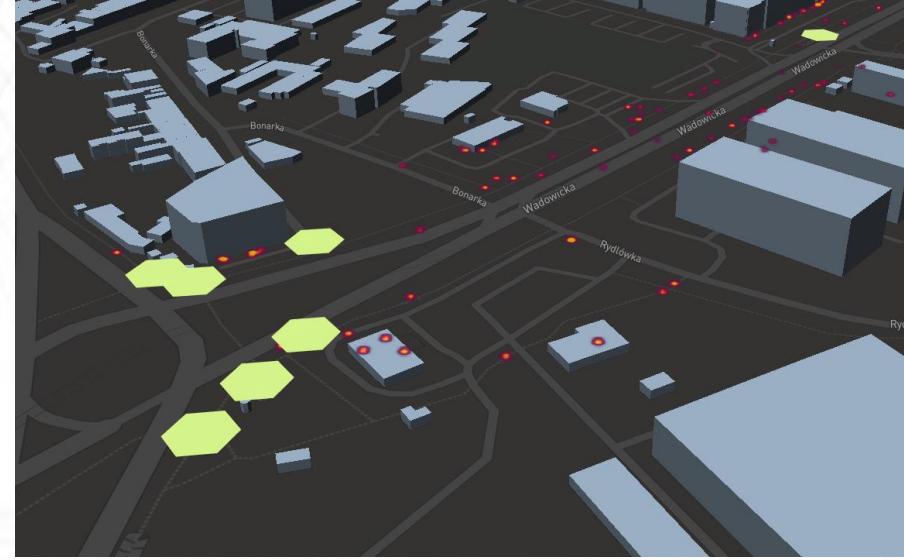


Mazowiecka street and Wroclawska street

Visualisation



Dobrego Pasterza street



Wadowicka street

0 10 50 100 150 200 250 300 350 400 450

Wizualizacja

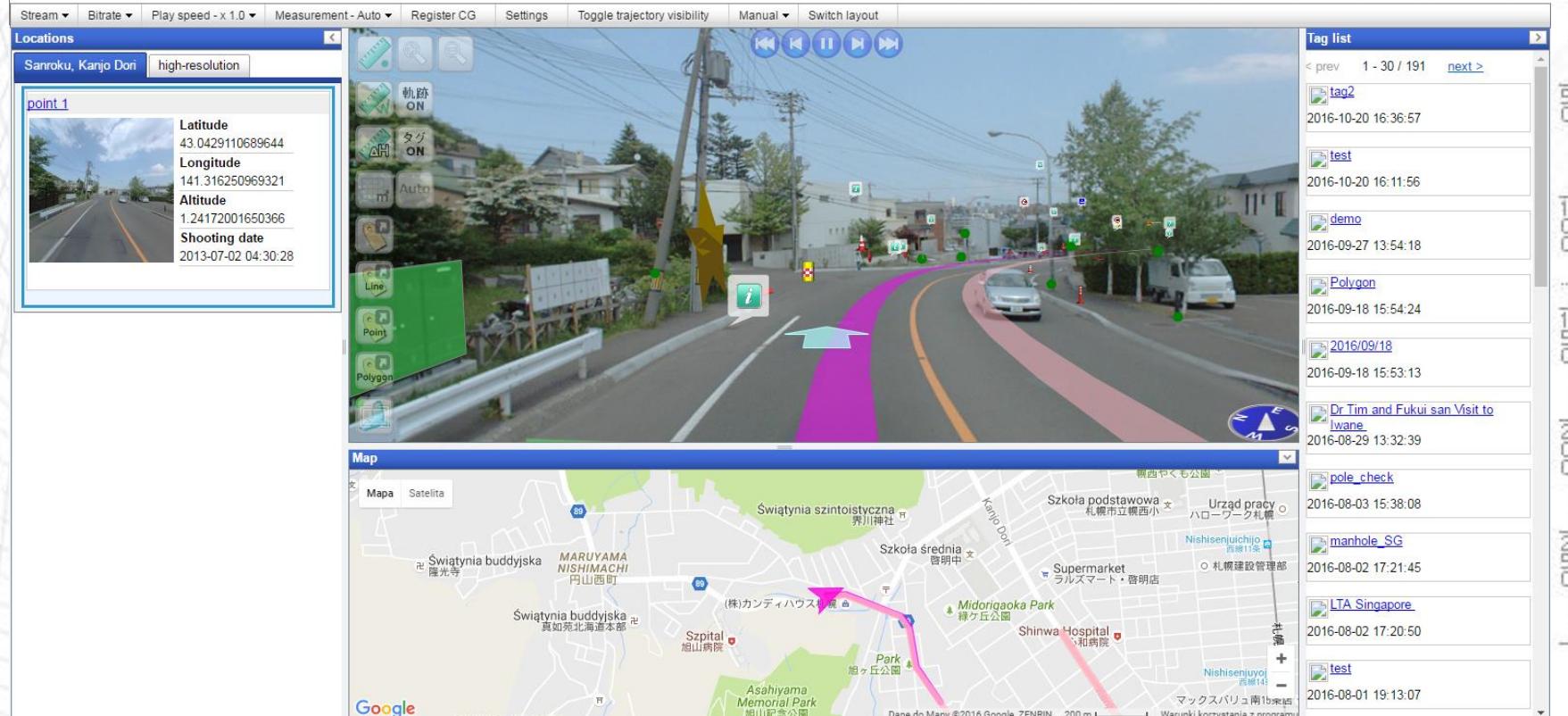


Dobrego Pasterza street

7. Applications to MMS

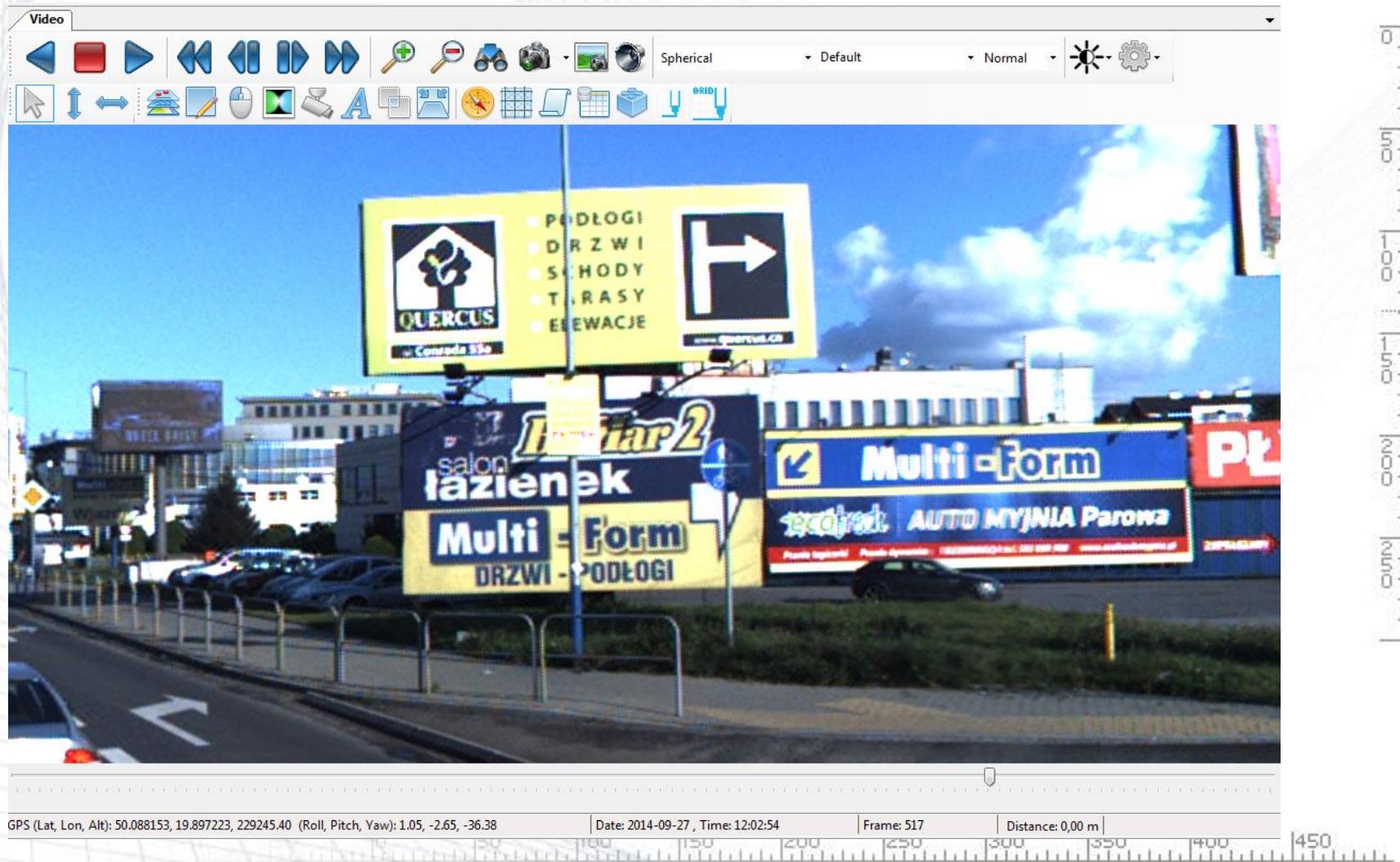
Iwane Labs (Japan)

WebALP 3.0 - rev.29 -

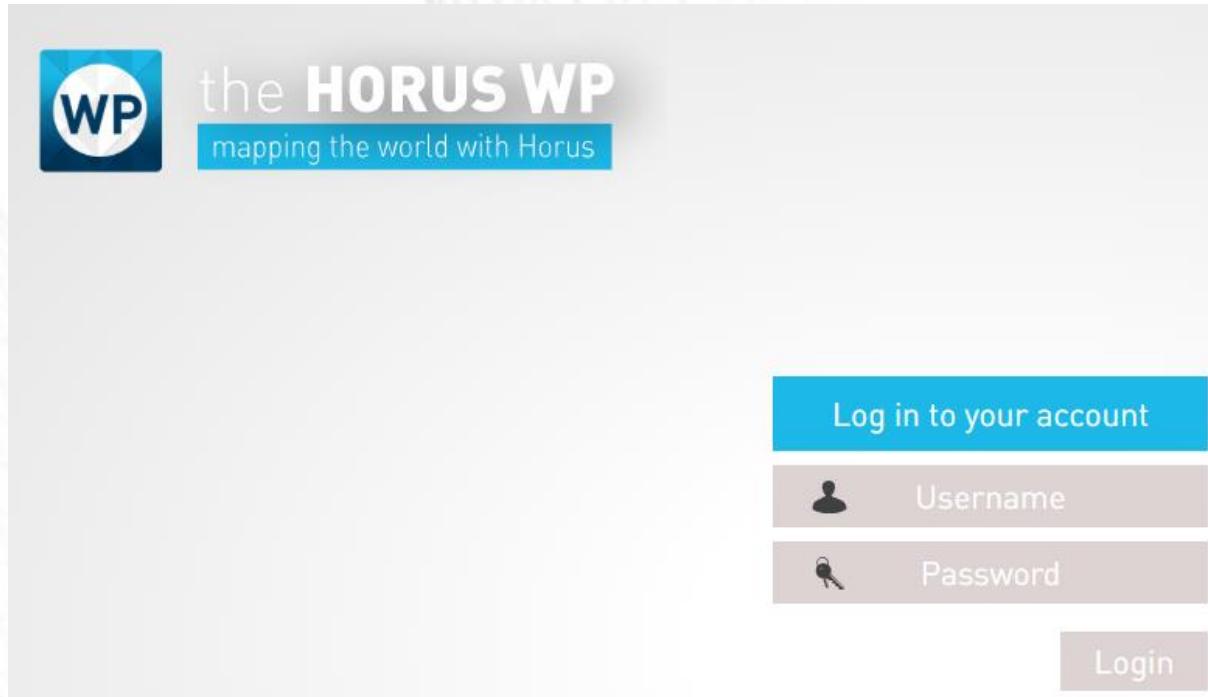


<http://sns.iwanelab.com/mercury/webalp3.0/demo/index.html>

Horus Movie Player



Horus WebPlayer



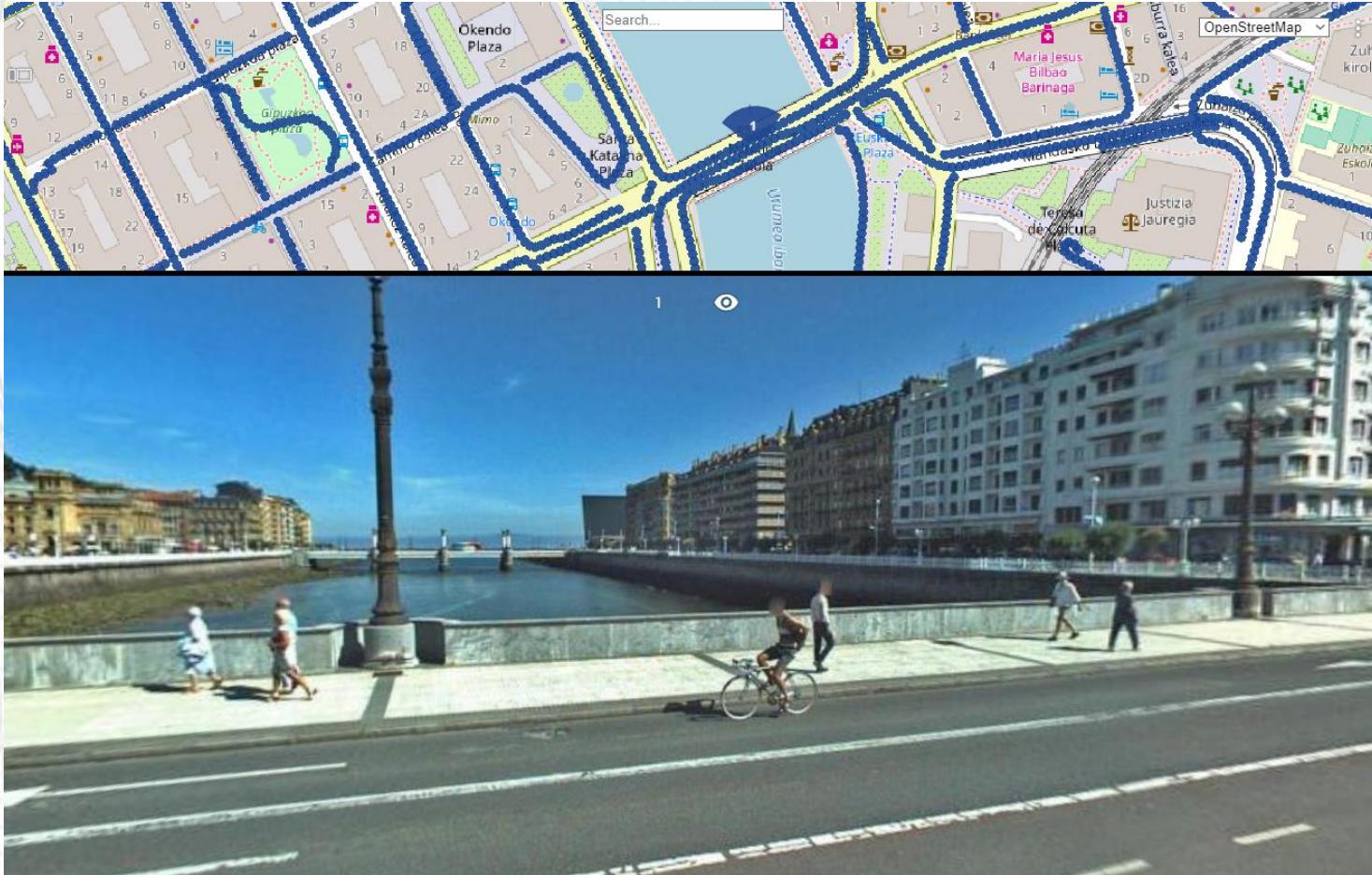
<https://webplayer.horus.nu/>

(demo, demo)

Orbit GT



Orbit's 3dmapping.cloud



<https://3dmapping.cloud/publication/UqftKR8bABexU4PnjGJ8>

8. News from MMS



Riegl VMX-2HA



Horus



Siteco



Horus

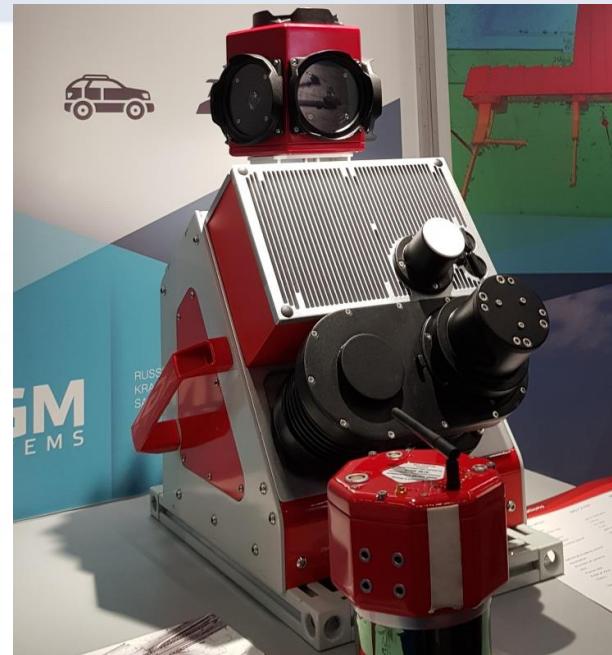


Trimble MX9

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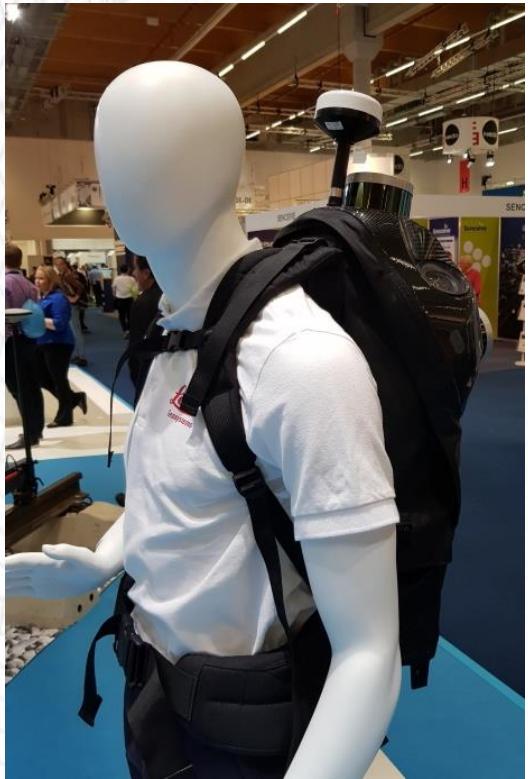


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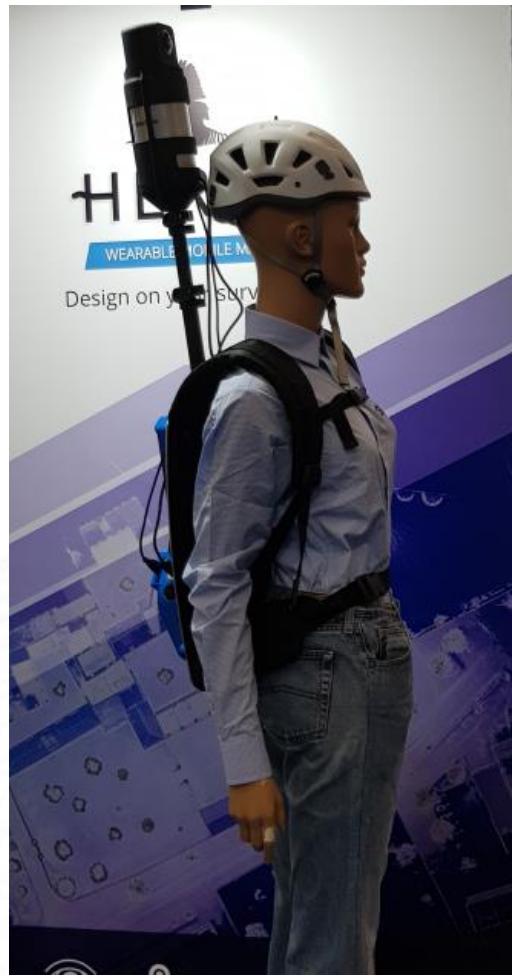
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Commissions

Commission I

Working Groups

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 AERO ASAHI CORPORATION
ISPRS Sustaining Members

WG I/7: Mobile Mapping Technology

Our Mission

ISPRS Working group I/7 aim is to co-ordinate the research and development activities that address future trends of Mobile Mapping Systems (MMS), new areas of MMS applications; and emerging intelligent processing techniques for MMS.

To this purpose, the WG will lead the organization of the Mobile Mapping Technologies Series which has been going for almost 22 years.

Furthermore, the WG provides (links to) publicly available datasets and organizes international comparative tests on the performance of algorithms for processing MMT for various emerging applications.

Finally, the WG will continue to work closely with WGs I/2 and III/2, and international organization that have activities related to MMS such as FIG and IAG.

Working Group Officers:

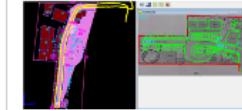
Chair



Naser El-Sheimy

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ISPRS WG I/7



<http://www2.isprs.org/commissions/comm1/wg7.html>

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Thank you for your attention

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