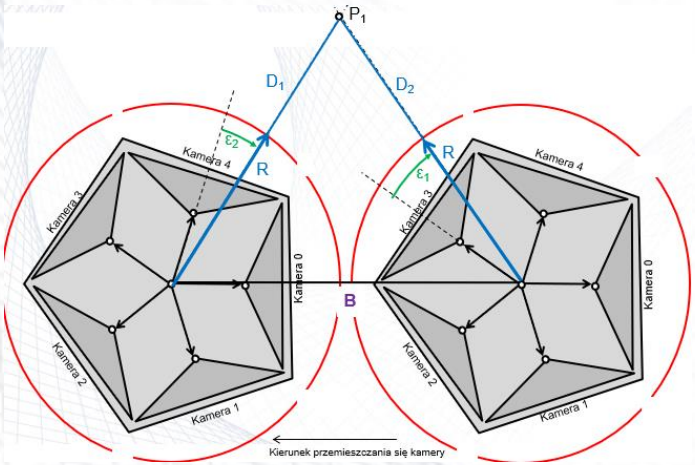
Immersive photogrammetry



Karol Kwiatek, PhD

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14th June 2021

Plan of the lecture

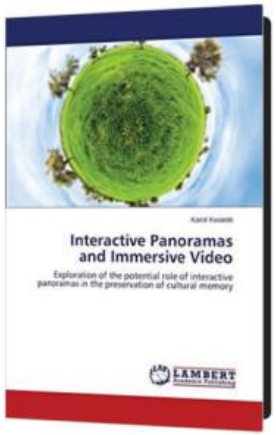
1. Introduction
2. Immersive camera
3. Immersive photogrammetry
4. Errors of immersive panoramas
5. Immersive mobile mapping system
6. Applications of immersive mobile mapping system
7. Applications to MMS
8. News from MMS

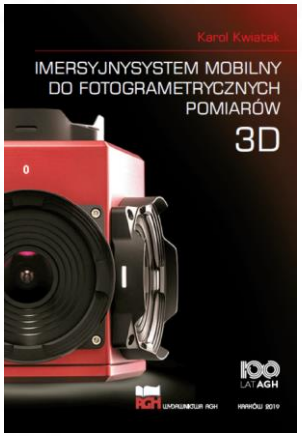
www.kwiatek.krakow.pl

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

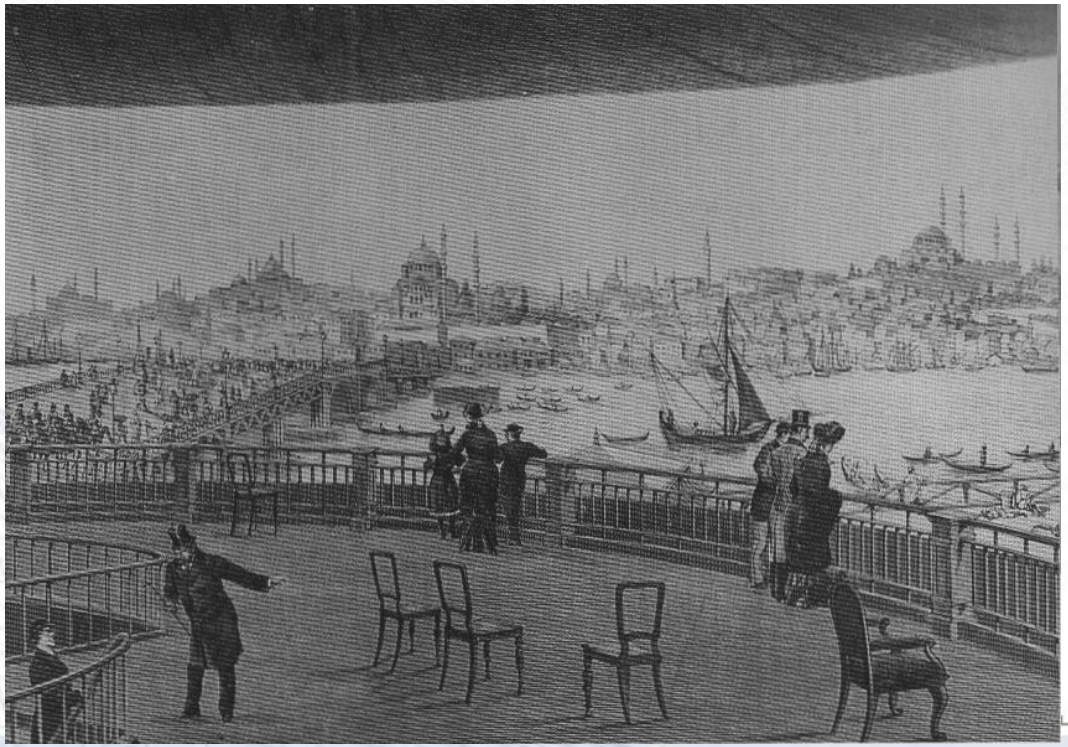
a) History of panoramas
b) History of cinematographic panoramas
c) Immersion
d) The beginning of the concept of immersive photogrammetry

2007

2017

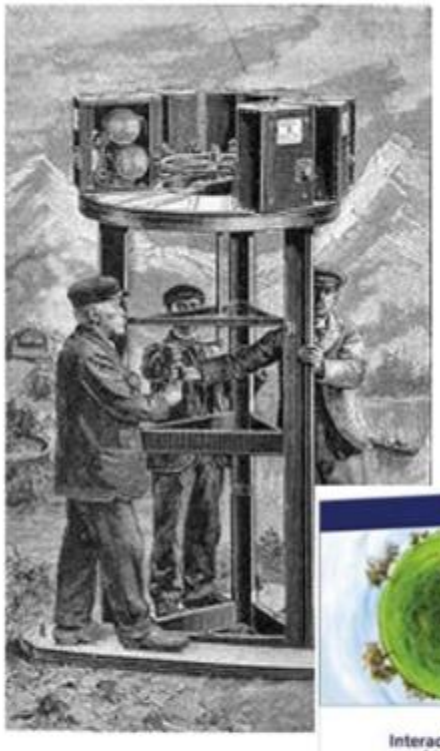
History of panoramas

- 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**

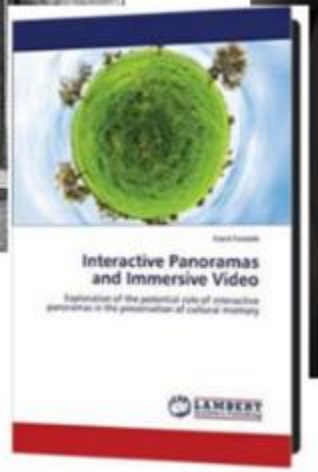


History of panoramas

History of panoramas



1900



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

(Kwiatek 2015)

Panoramic video

History of panoramas

time

Prehistoric cave paintings

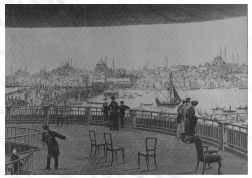
How to present distant locations or past events?

1600

Baroque ceiling panoramas

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

1800



Painted panoramas

Photographic panoramas

Cinematographic panoramas

Rotundas

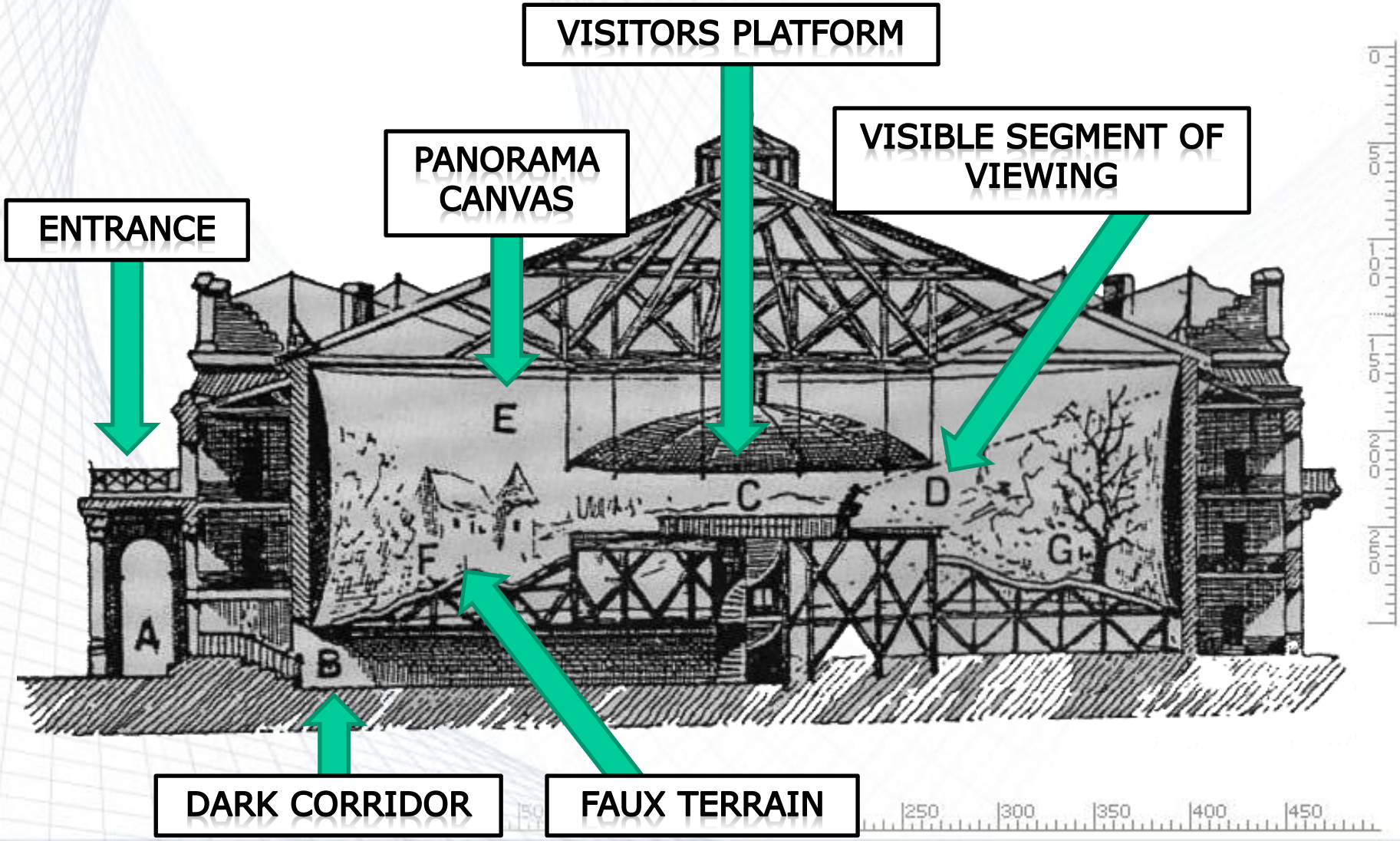
2000

Digital panoramas

'Digital rotundas' and panoramic viewers

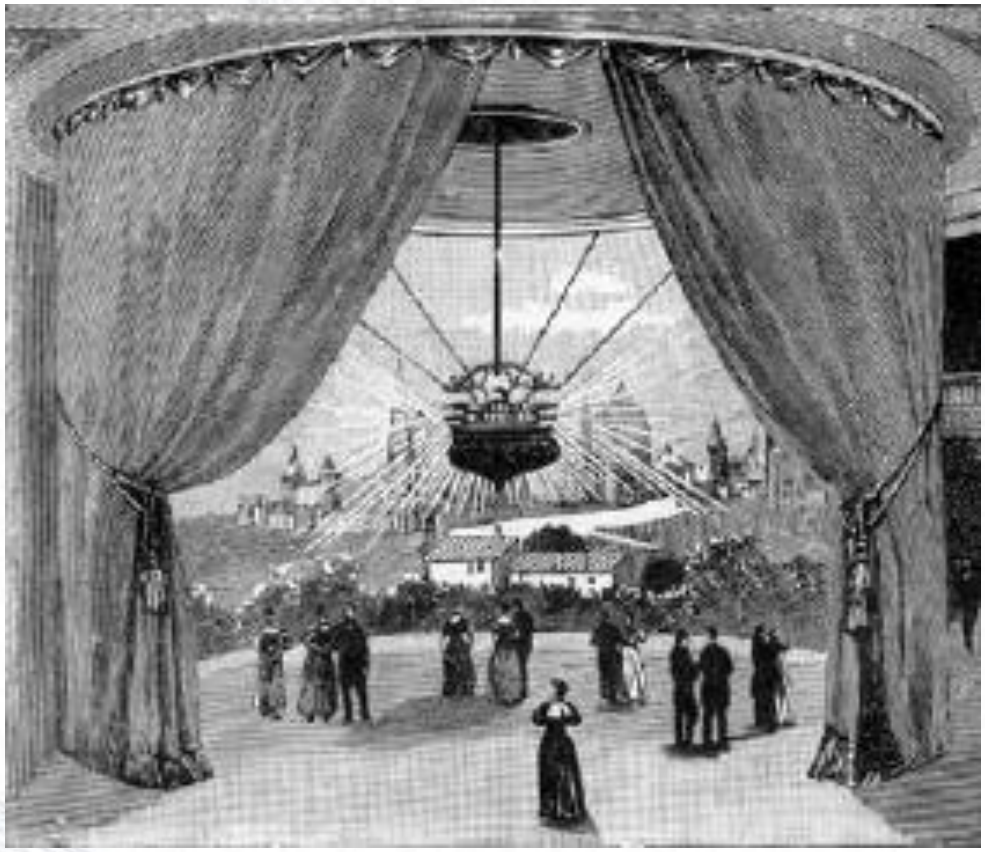
History of panoramas

Rotunda and painted panorama



History of cinematographic panoramas

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



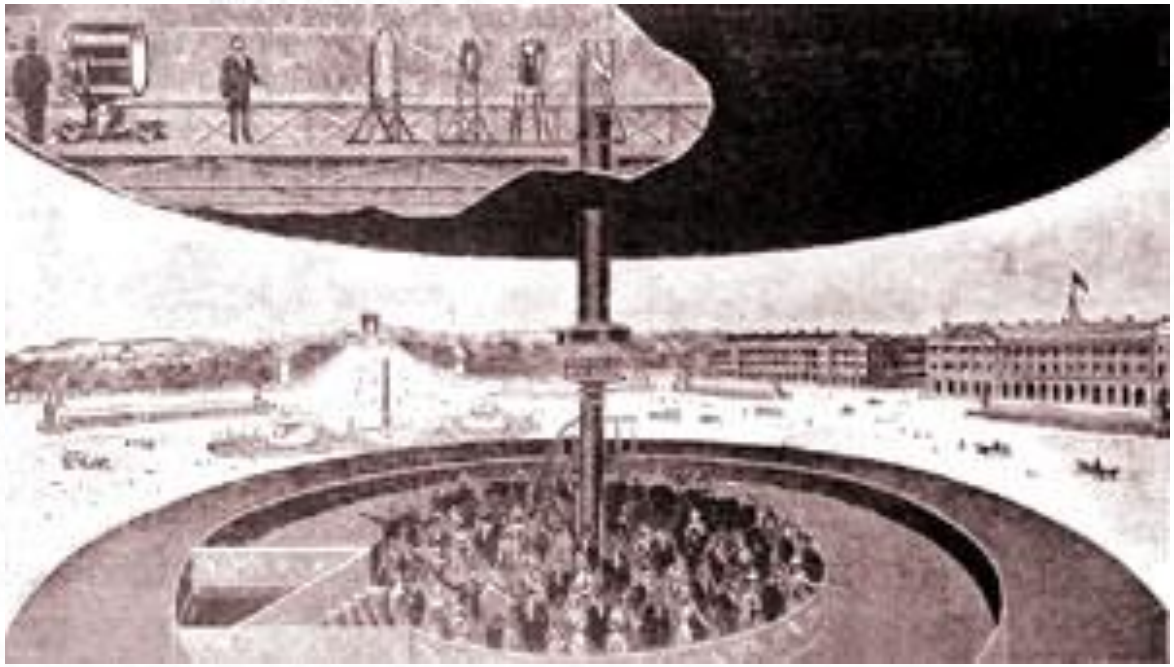
Stereopticon (1894)

Charles Chase – Chicago

History of cinematographic panoramas

Screen:
21 metres in circumference and six metres high

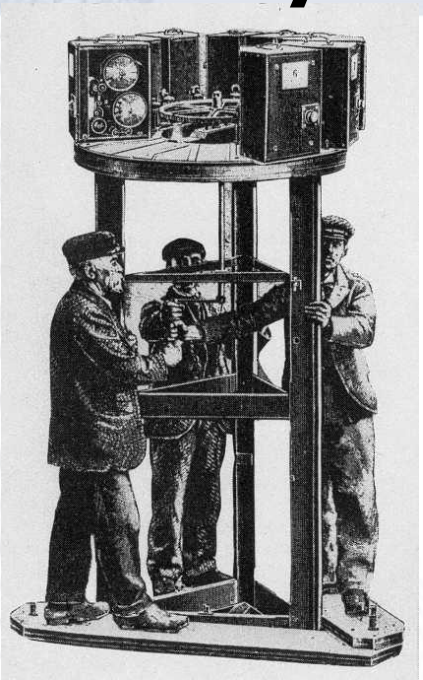
360 degree panoramic projector which used 70mm film

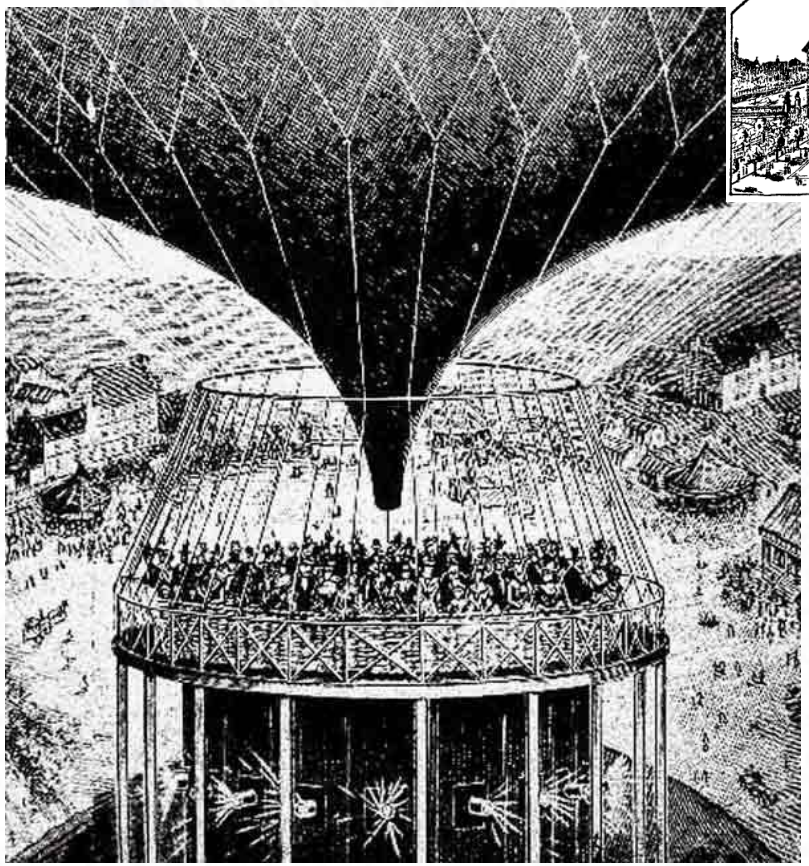


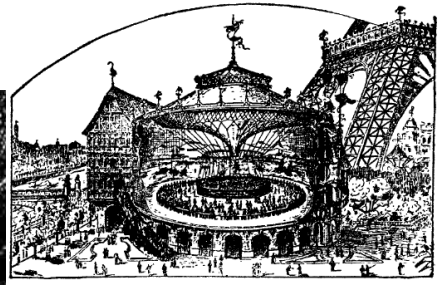
Photorama (1900)

Auguste and Louis Lumière - Paris

History of cinematographic panoramas





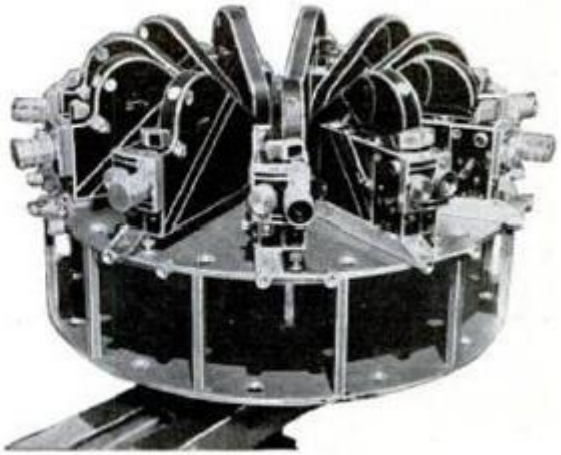


Ten synchronised cameras arranged in a circle filmed a balloon ascent from the balloon basket

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

Moscow

2x11 synchronised cameras arranged in a circle

Circular Kinopanorama (late 1950s)

Immersion

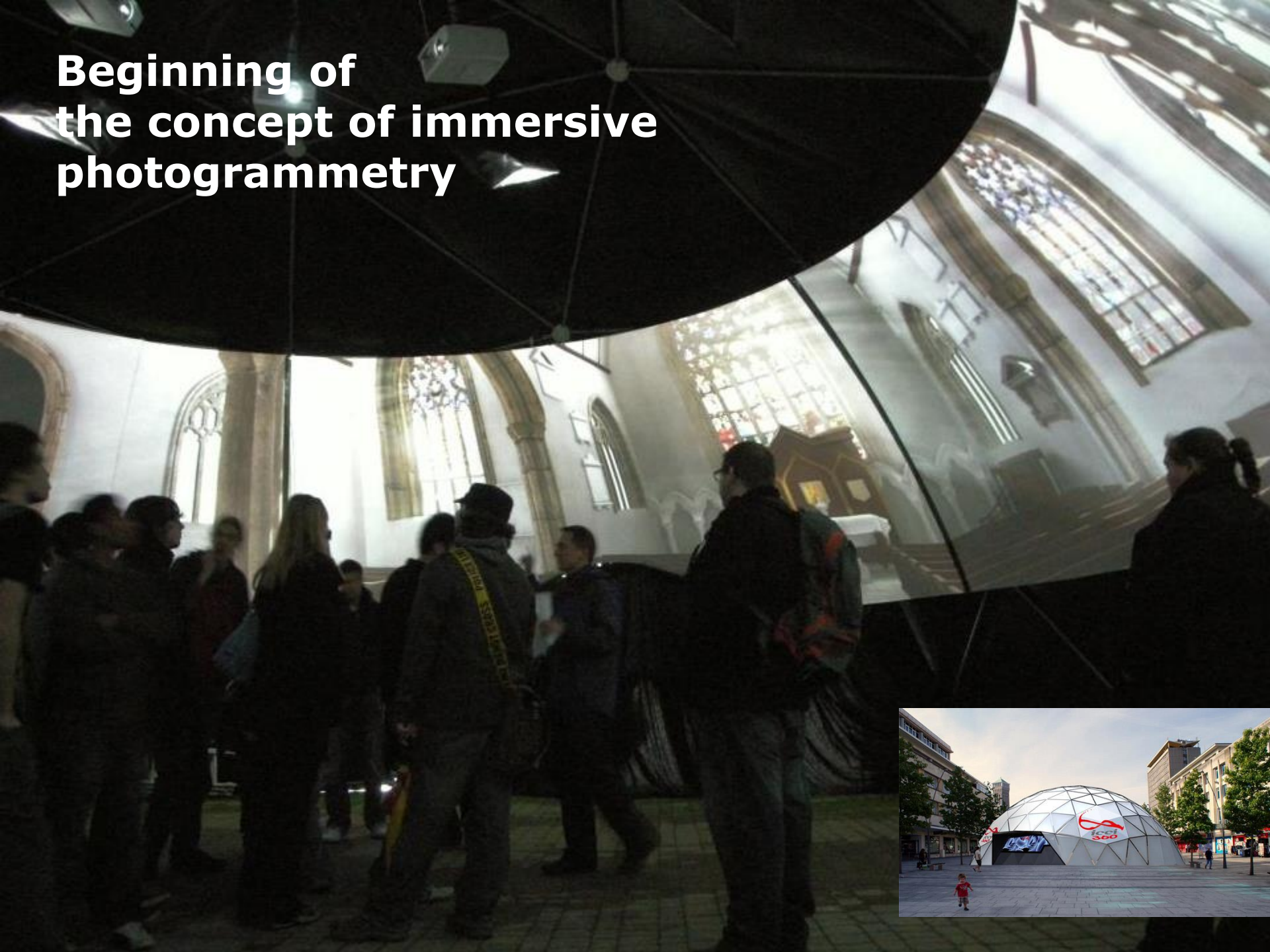
Circarama, 1956

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

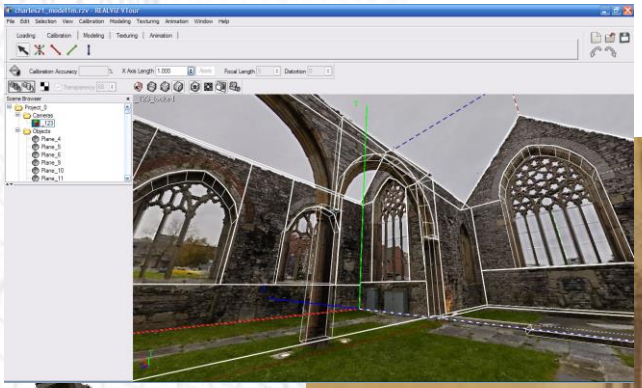
Beginning of the concept of immersive photogrammetry



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

Computer 3D reconstruction of Charles Church



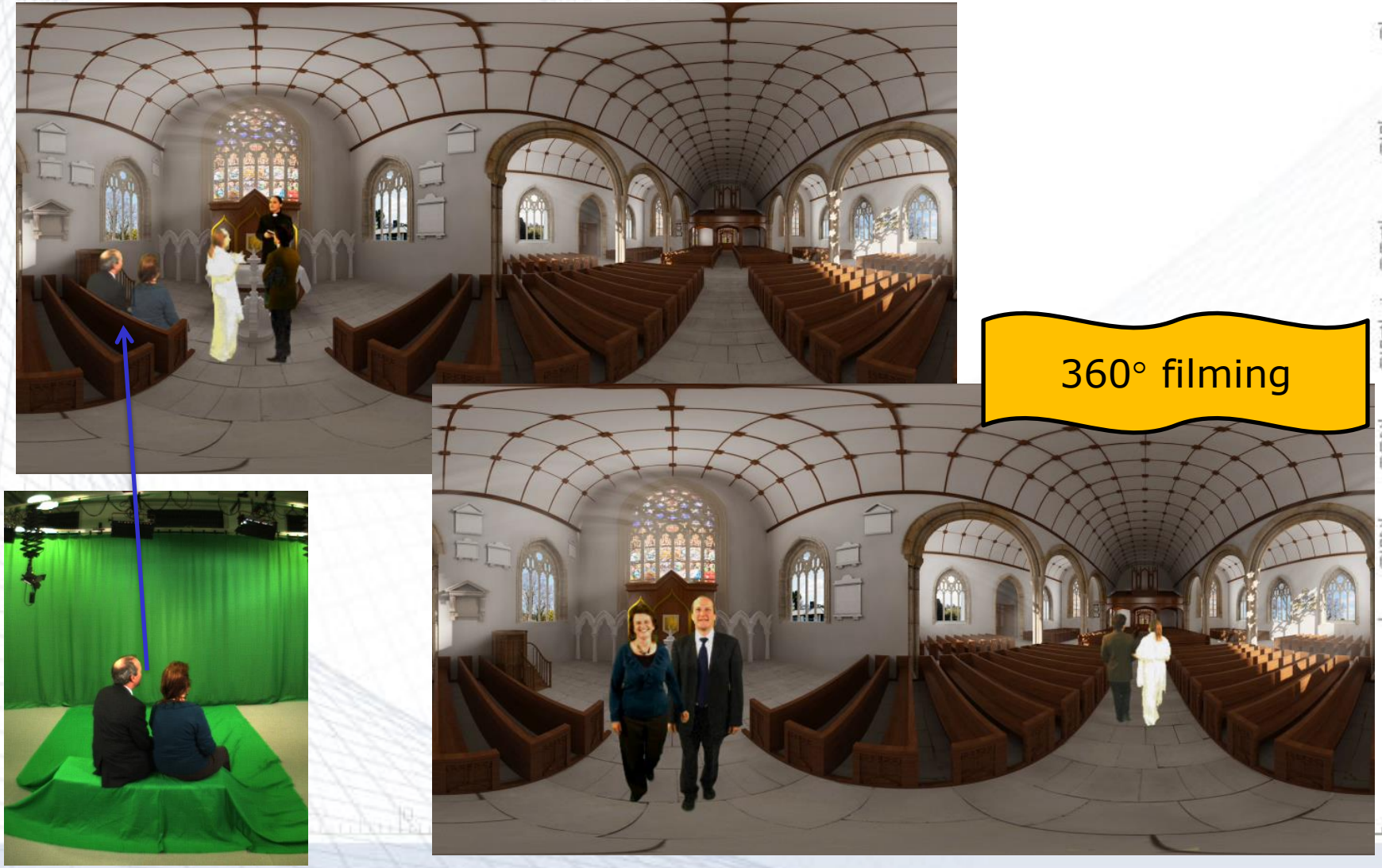
Historical images

Computer 3D reconstruction of Charles Church

Front ⟷ Back

360°

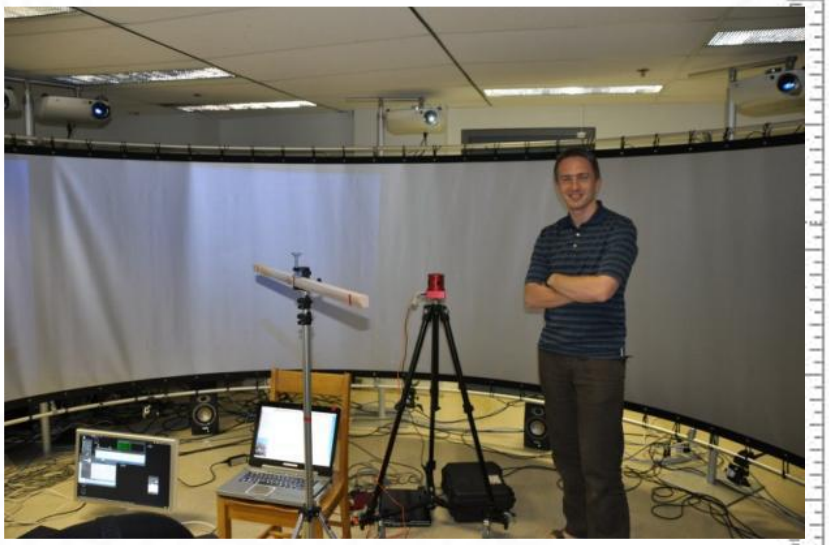
Reconstruction of the wedding in a computer reconstructed Charles Church



(Kwiatek 2011)

„Discover Krakow” displayed during Immersive Film Festival

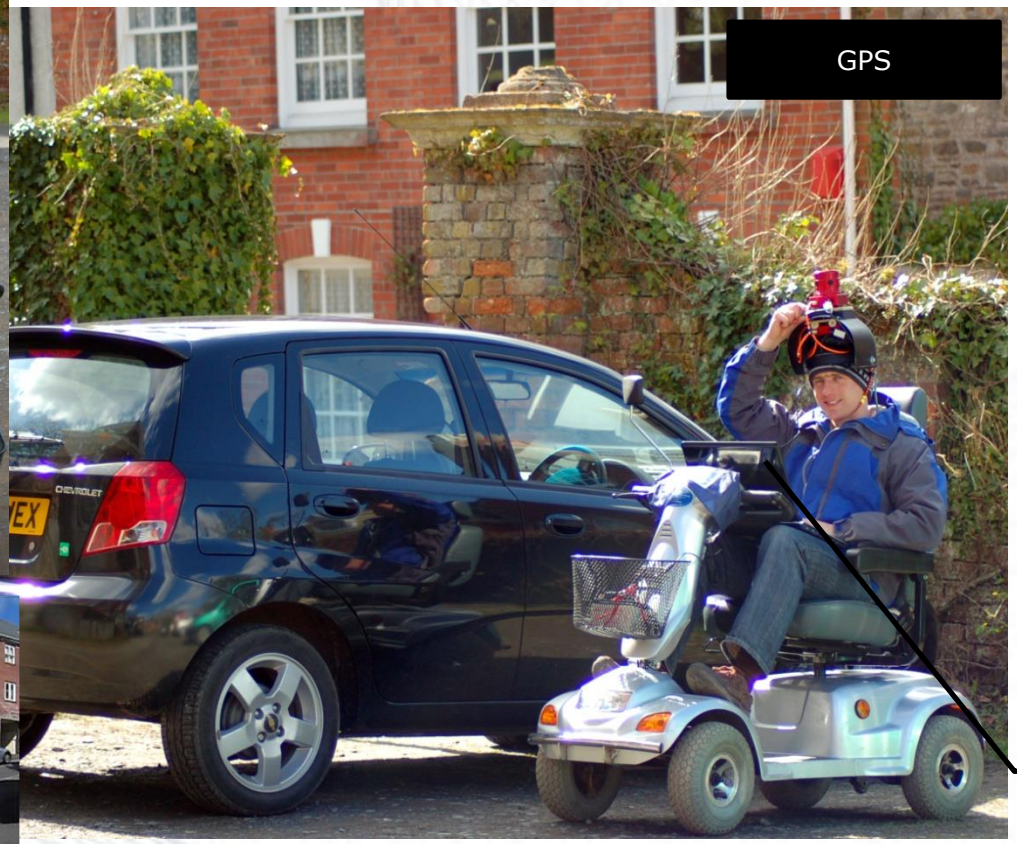

Hong Kong

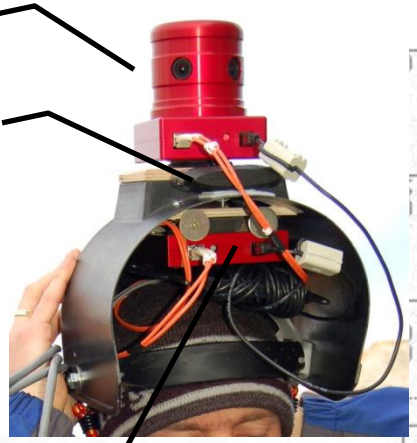



Montreal


Plymouth

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






bubi

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

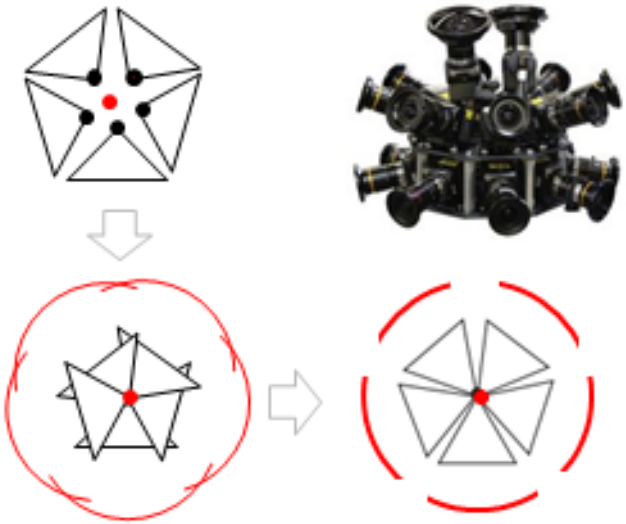
- Doing so simplifies the mobile system but can have **negative consequences on the accuracy** and completeness of the developed products

- 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

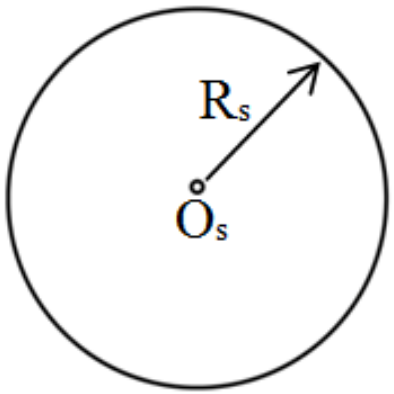
Spherical panorama vs immersive panorama

One common perspective centre	Multiple perspective centres
	
Spherical panorama	Immersive panorama

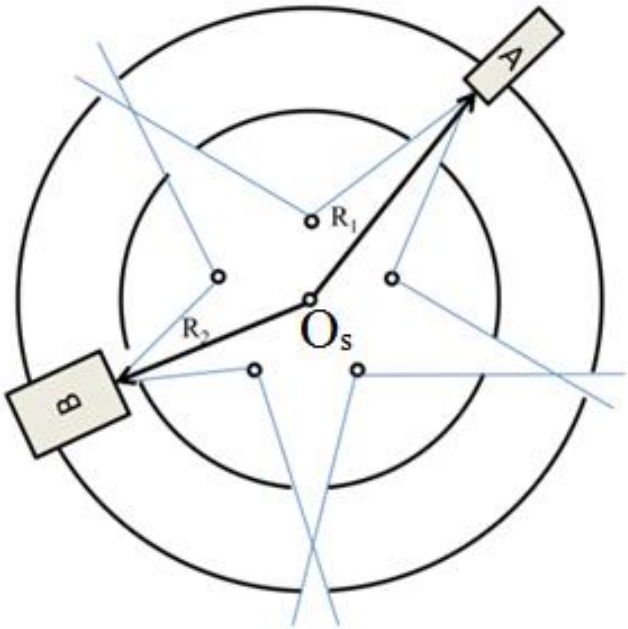
Immersive panorama - omnidirectional image, acquired with the use of various sensors, giving a "flawed" spherical panorama due to the offset of the perspective centres of the frame images.

(Kwiatek, Tokarczyk 2018)

Immersive panorama



Spherical panorama

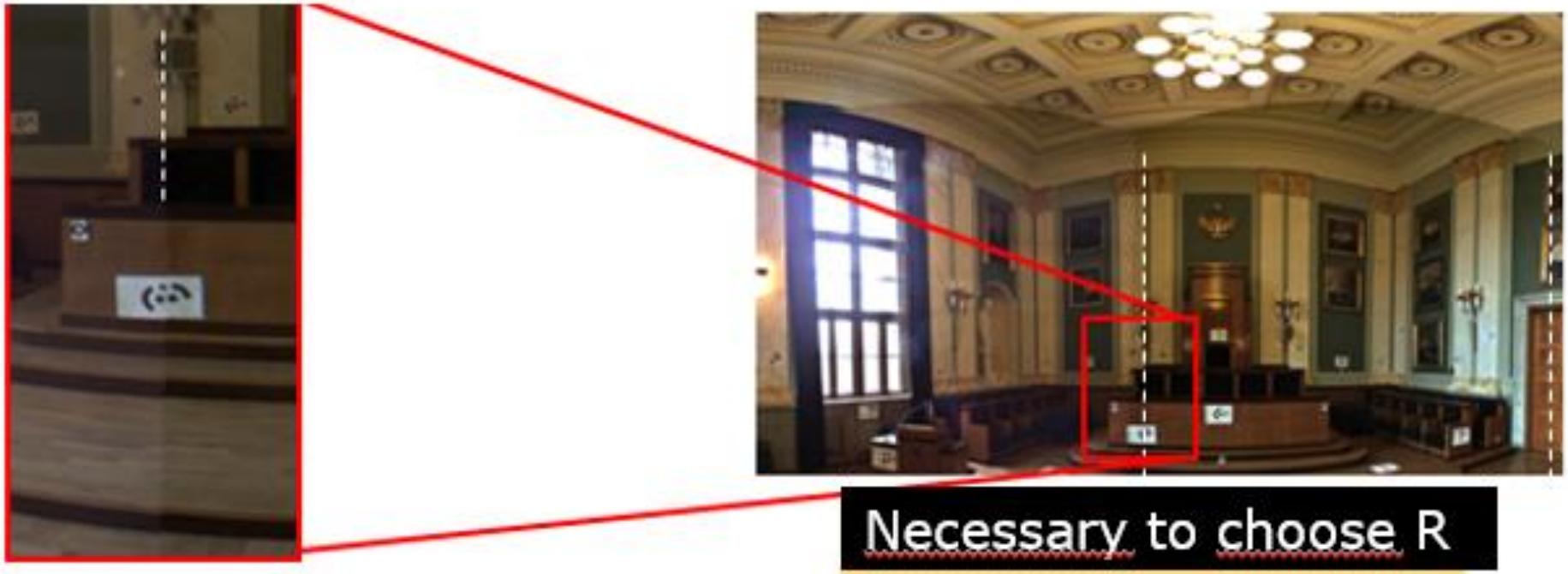


Immersive panorama
- the neccessity of choosing radius R

(Kwiatek, Tokarczyk 2018)

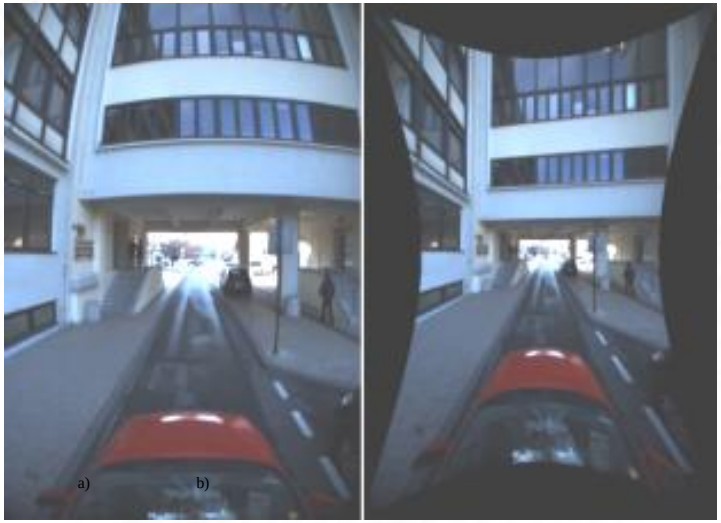
In the immersive panorama it is important to assume a certain radius for the sphere to be created (R), for which the object points lying on the sphere are not affected by the eccentricity.

Immersive panorama



Immersive cameras

a) b) c)



a) b)

d)

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

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

(Flir 2019)

Immersive cameras

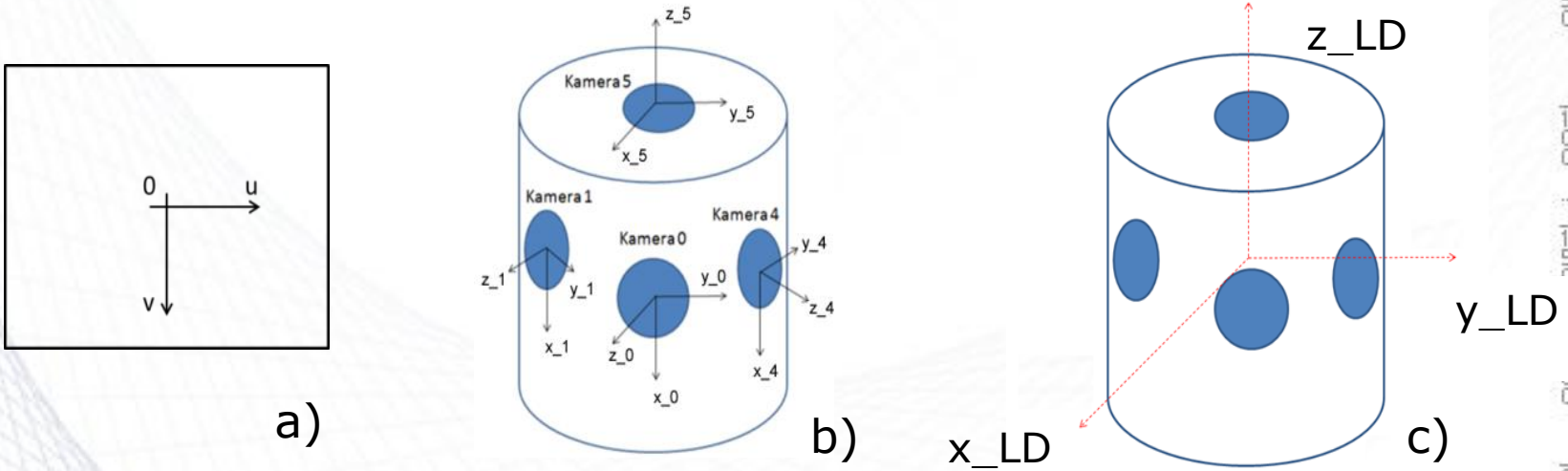
Features of immersive cameras:

- shift of persperctive 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



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

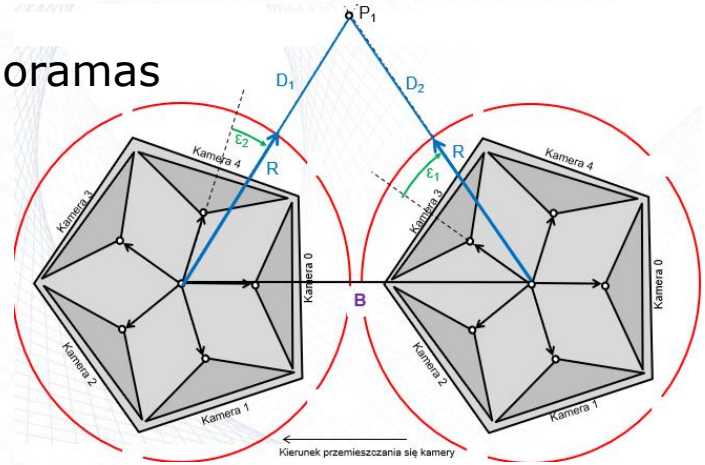
1. Rectification of each raw image registered by a frame camera for the influence of lens distortion.

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.

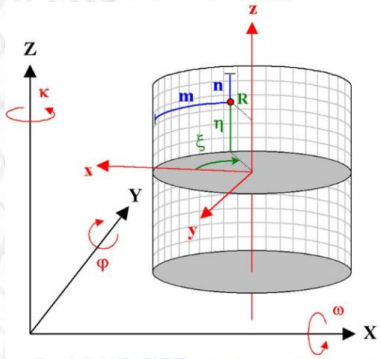
3. Immersive photogrammetry

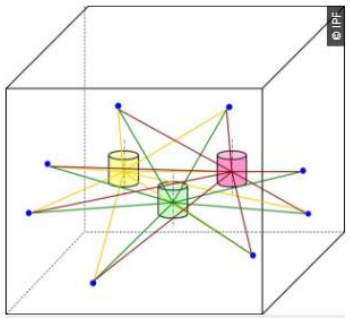
a) Panoramic and spherical photogrammetry
b) Measurements from spherical panoramas
c) Immersive model
d) Spherical vs immersive model
e) Measurements from immersive panoramas
f) Immersive photogrammetry



Panoramic and spherical photogrammetry

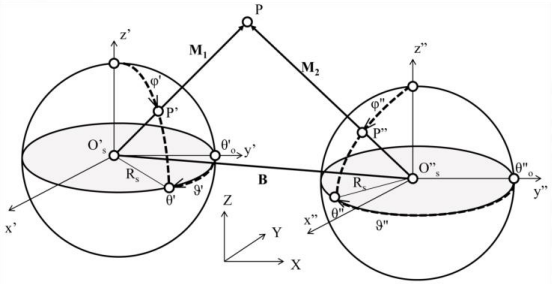
Panoramic photogrammetry



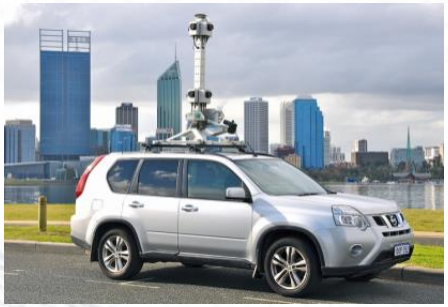


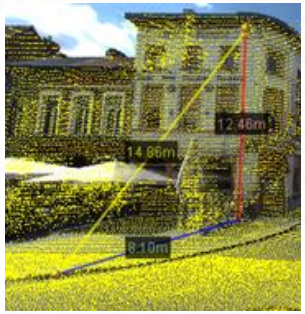
(Schneider i Maas 2003, Schneider i Maas 2004, Parian i Gruen 2004)

Spherical photogrammetry



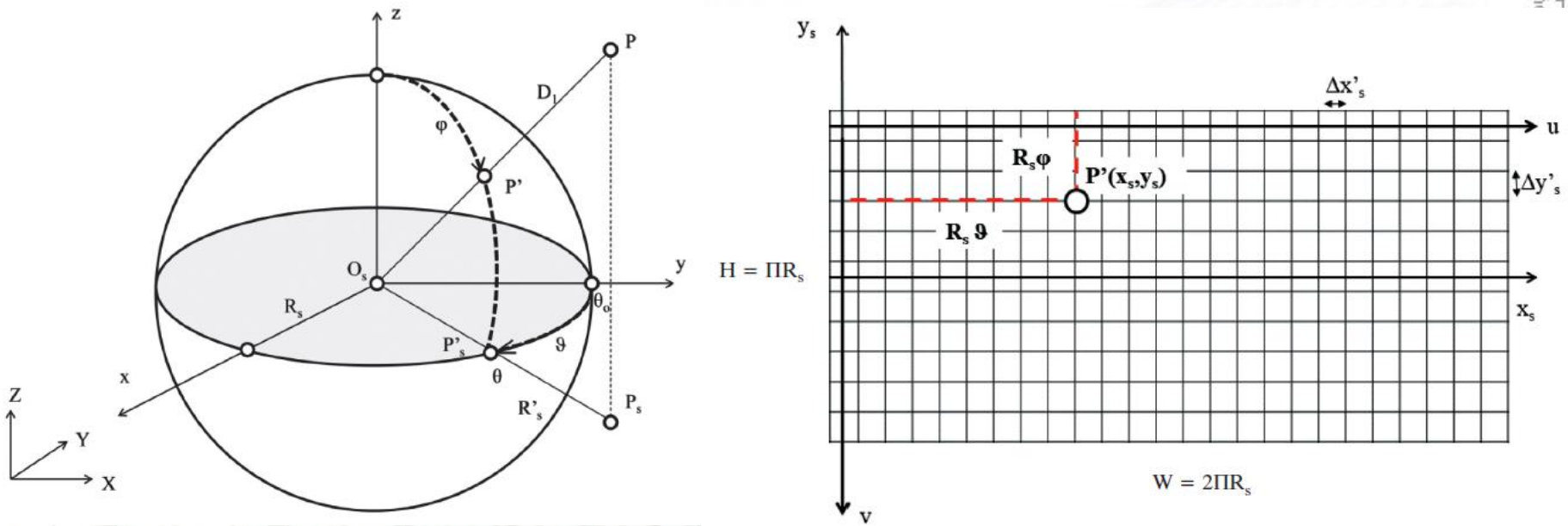
(Fangi 2006, Fangi 2007, Fangi i Nardinochi 2013, Fangi 2017)





Panoramic and spherical photogrammetry

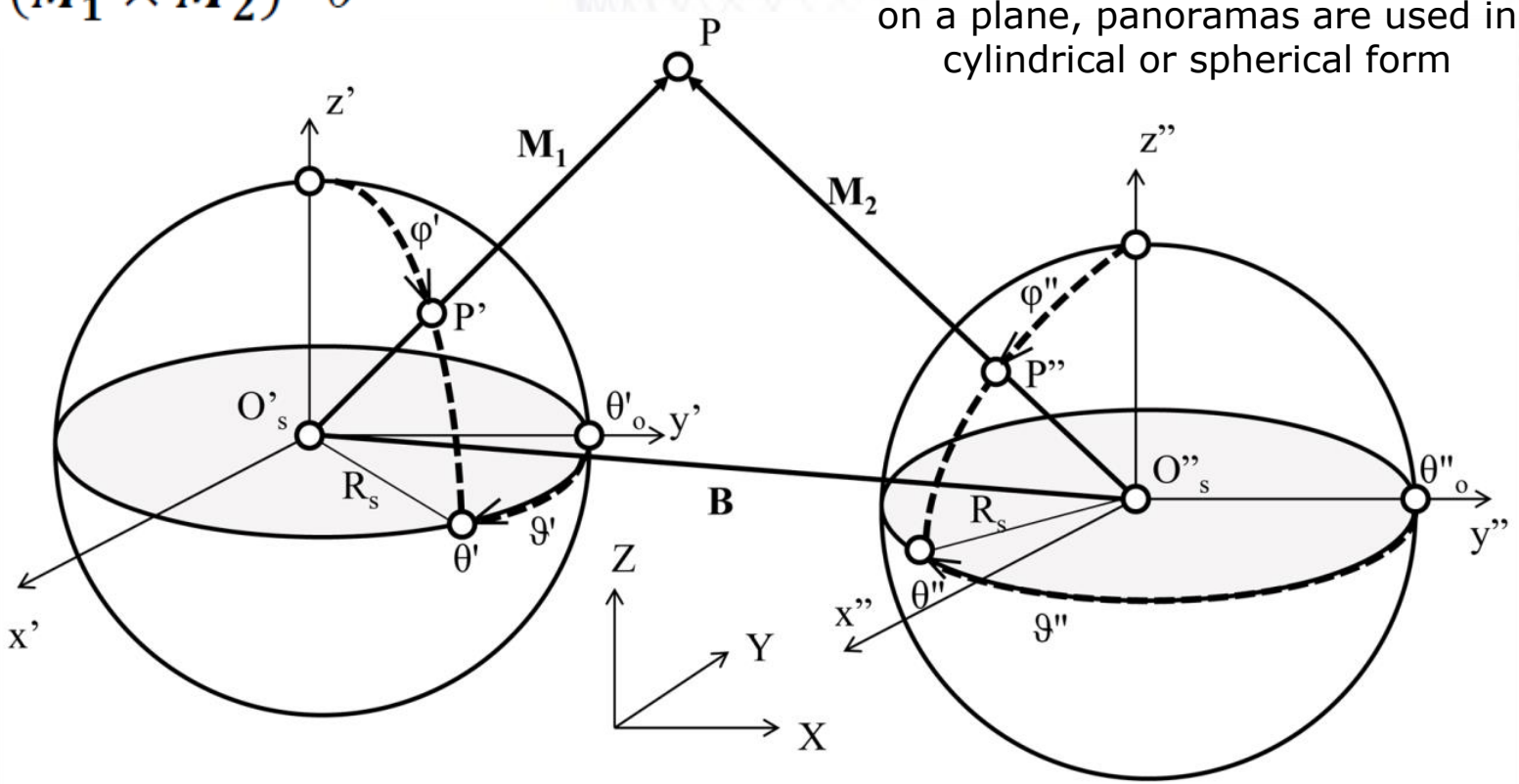
- In spherical photogrammetry, it is fundamental to know **two angular values** (ϑ and φ) and the **length of the sphere radius** (R_s), which is calculated from the circumference of the spherical panorama.
- Measurement using spherical panoramas can be compared to measuring directions with **a theodolite**,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



Measurements from spherical panoramas

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

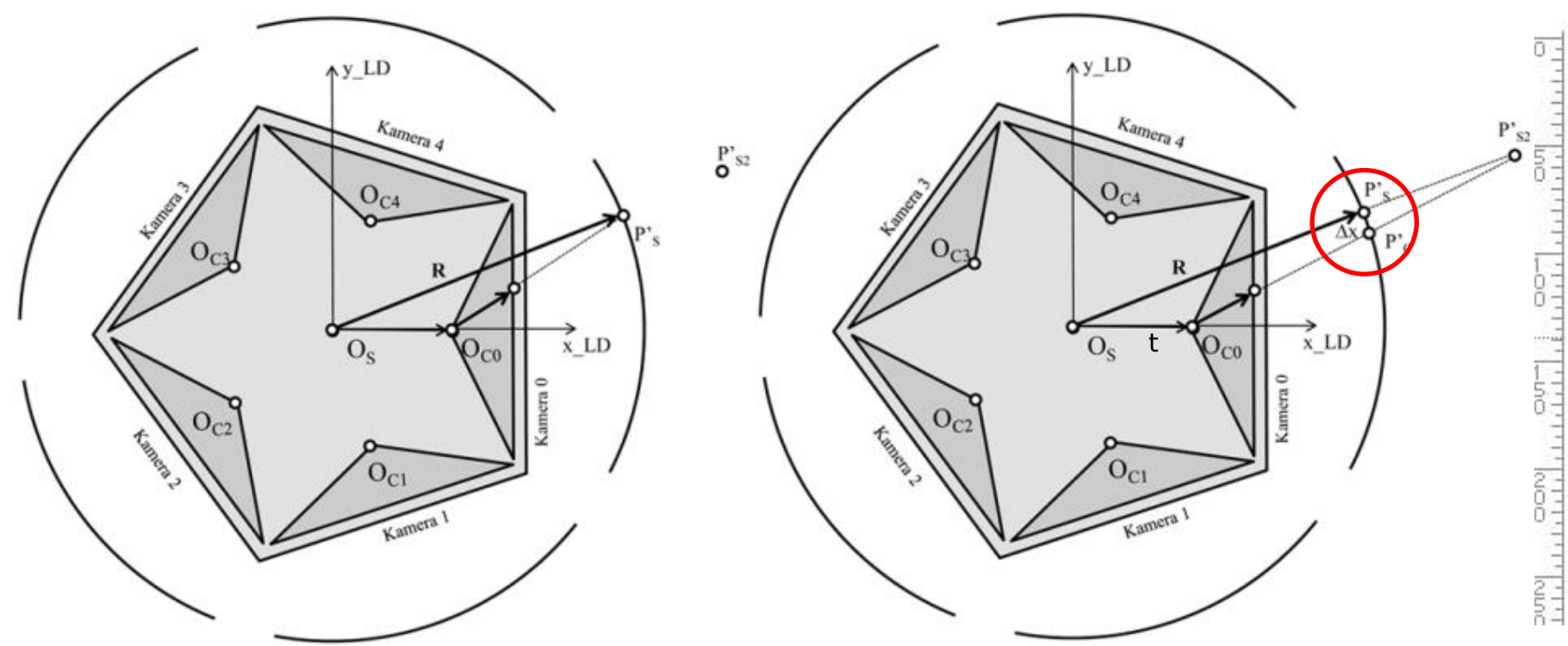
$$\boldsymbol{B} \cdot (\boldsymbol{M_1} \times \boldsymbol{M_2}) = 0$$



(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
•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	•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.

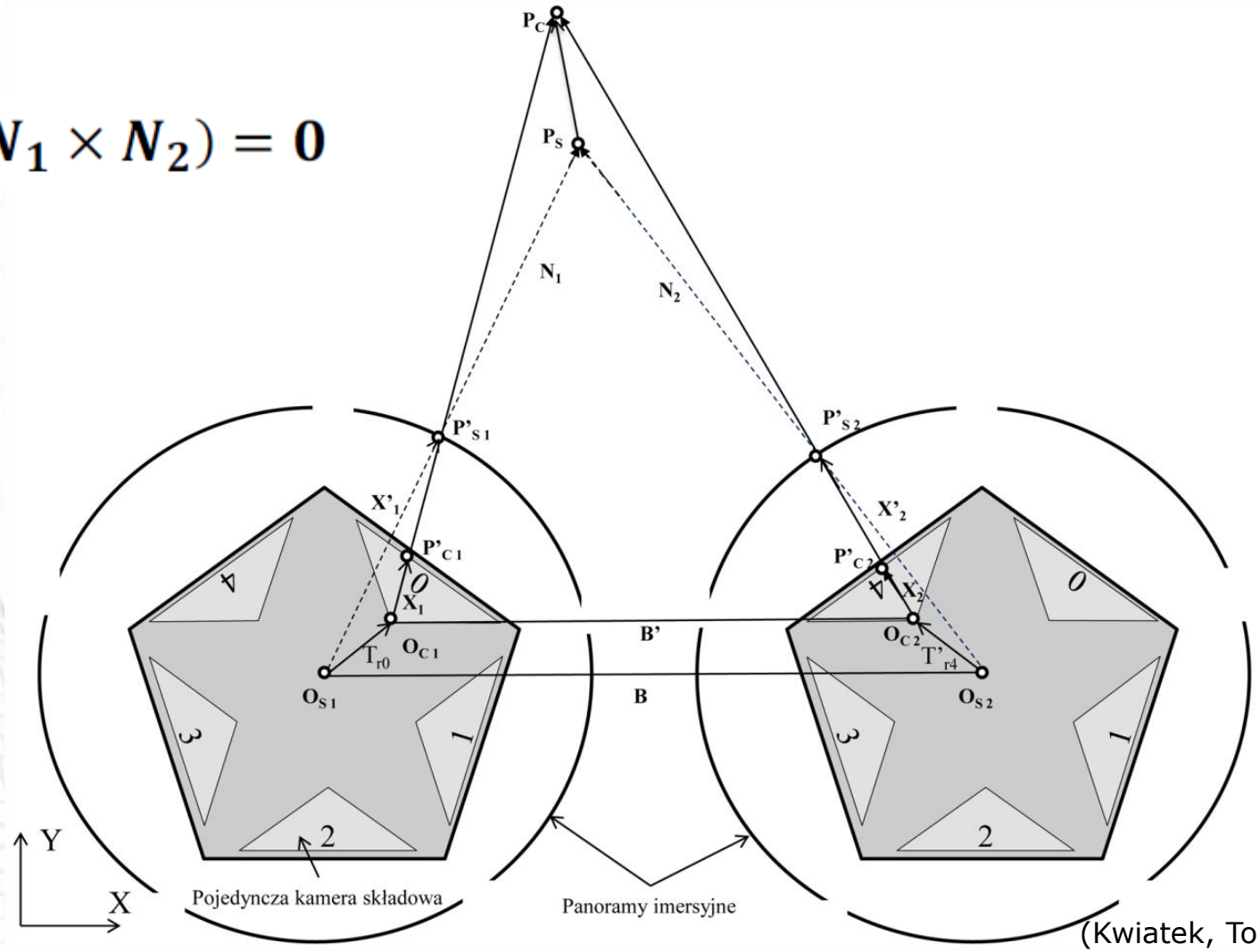
Model sferyczny

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

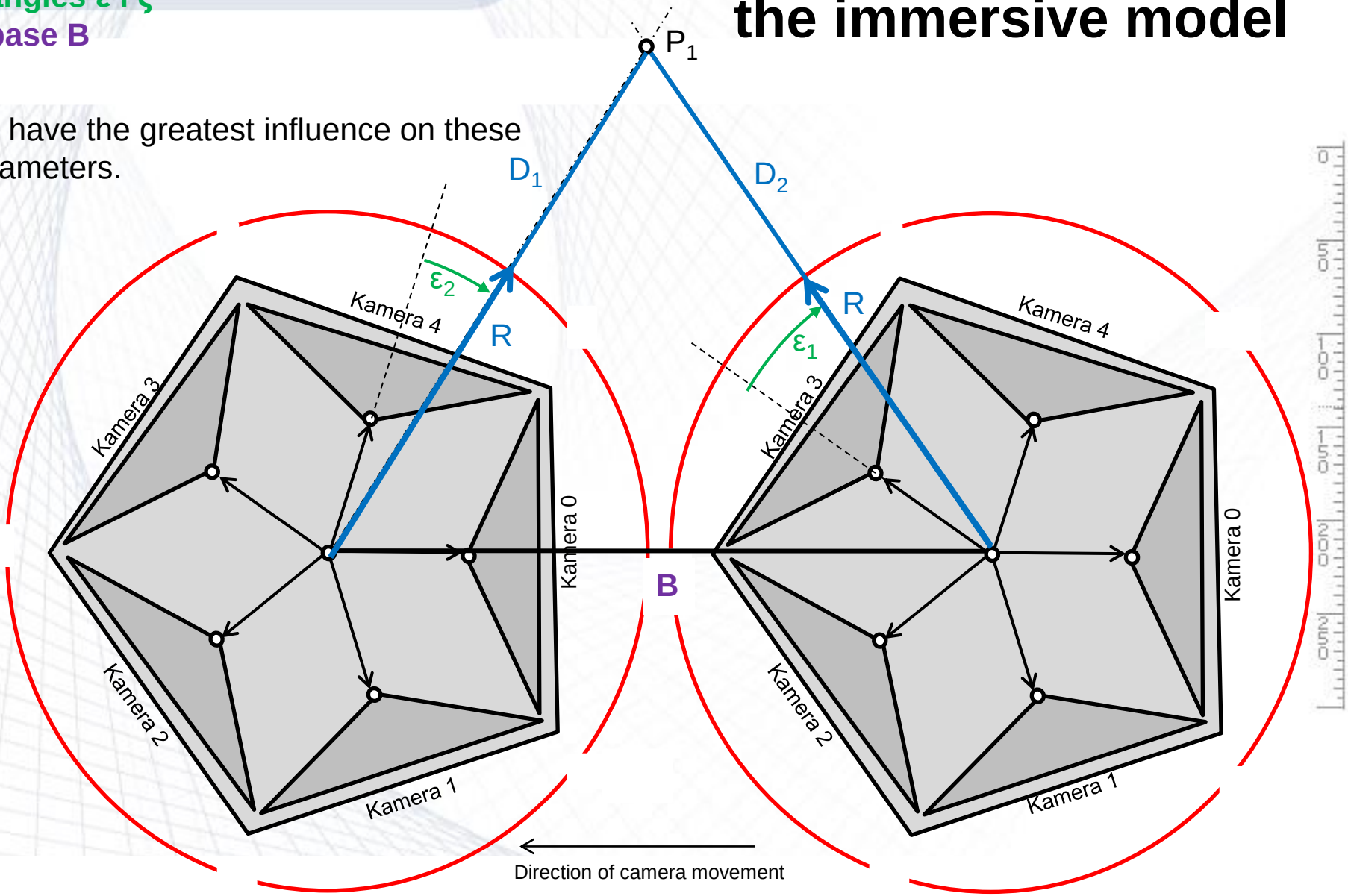
- determination of **factors** influencing generation of spherical and immersive panoramas
- determination of **errors** in photogrammetric measurements using immersive imaging in a spherical model

Geometric accuracy of the immersive model

Accuracy depends mainly on:

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

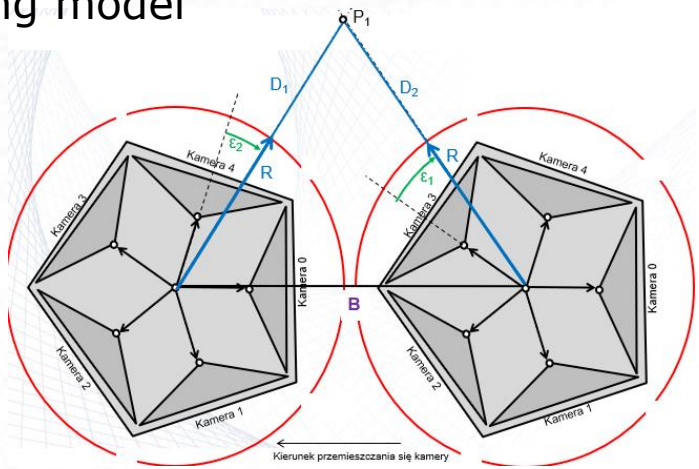
We have the greatest influence on these parameters.



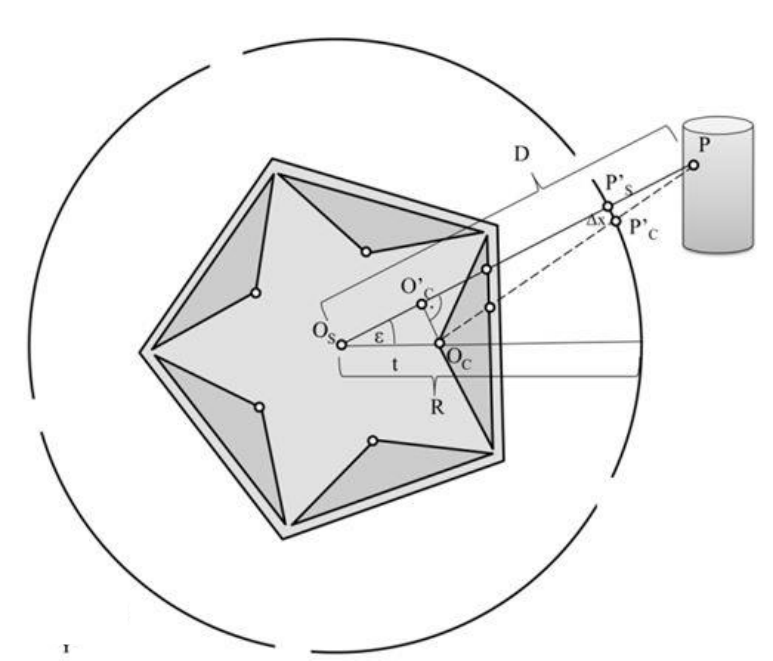
(Kwiatek, Tokarczyk 2018)
(Kwiatek 2020)

4. Errors of immersive panoramas

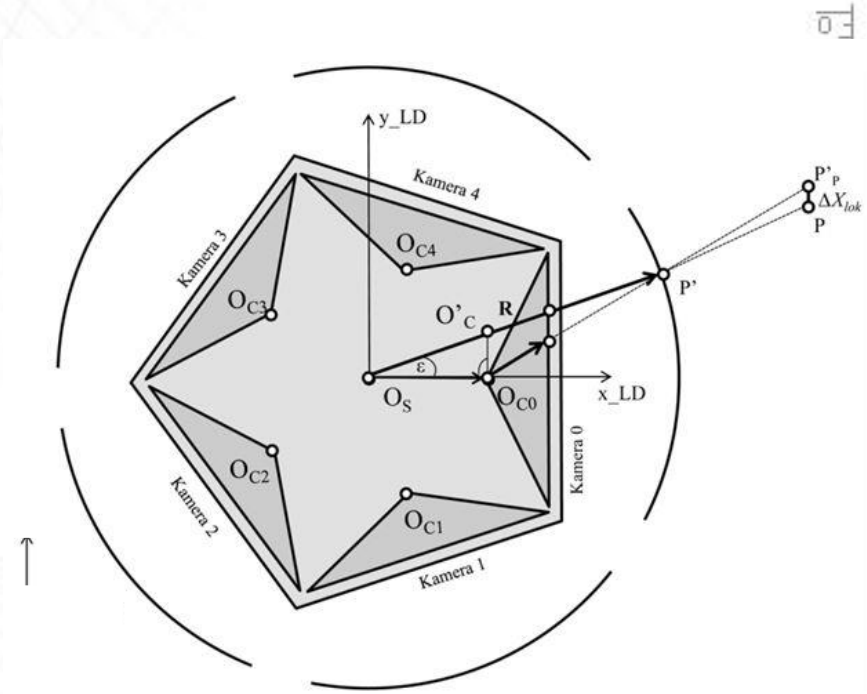
a) Errors of the immersive model relative to the spherical model
b) Geometry accuracy of the imaging model



Errors of the immersive model (1/2)



Parallax error

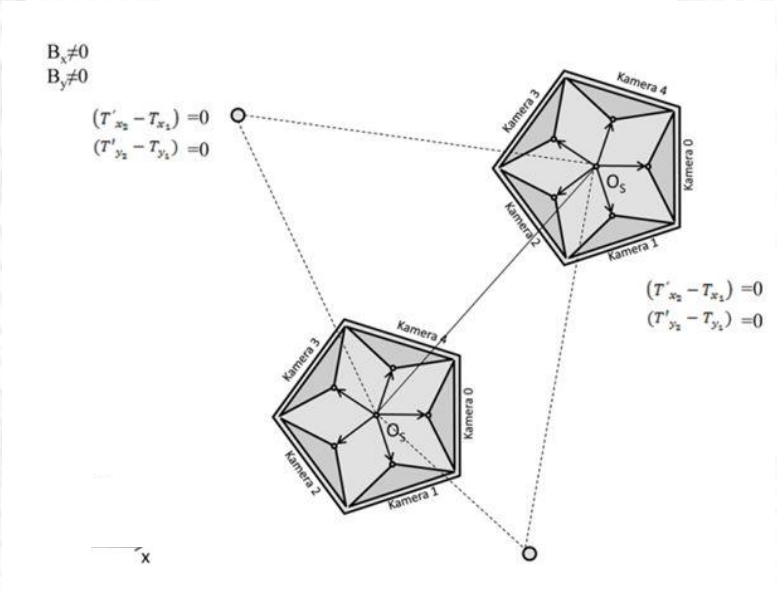


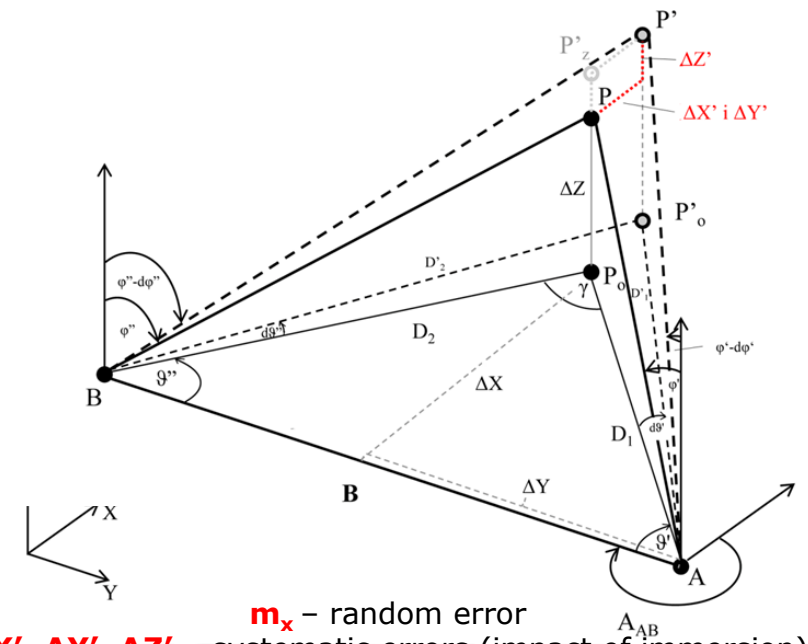
Localization error

Error due to difference in image between spherical and immersive models

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)





m_x – random error

ΔX', ΔY', ΔZ' – systematic errors (impact of immersion)

Epipolar error

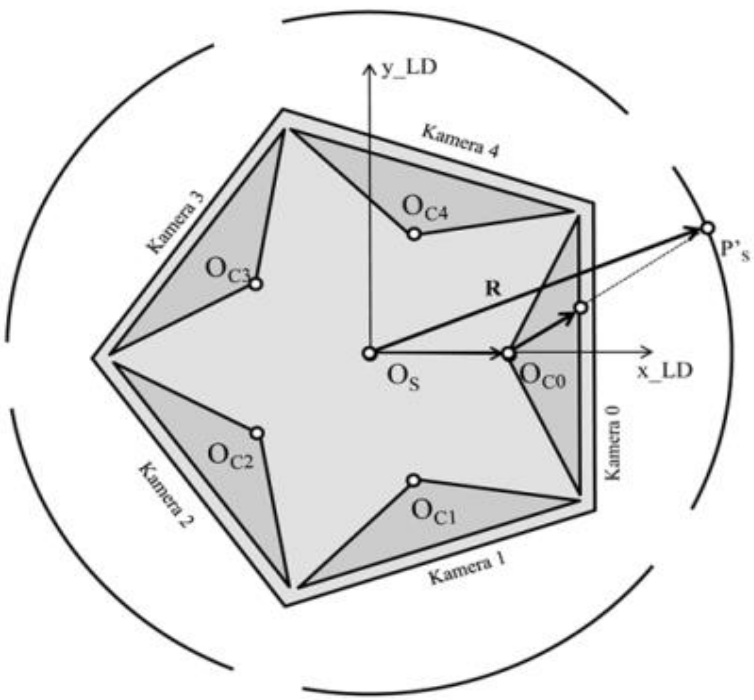
Non-fulfilment of the coplanarity equation for homology ray vectors

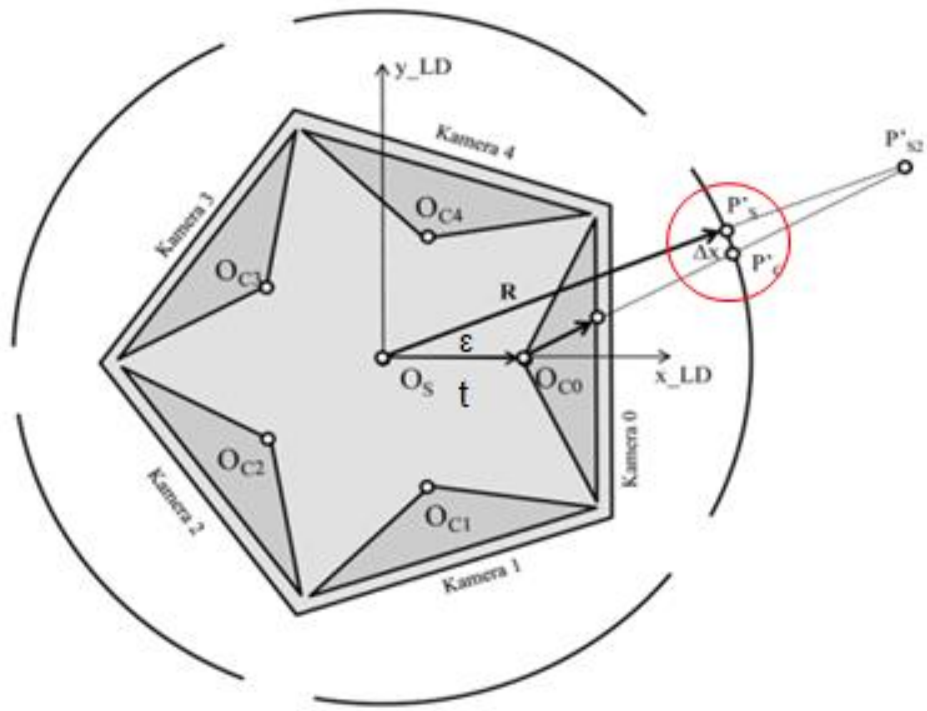
Error of forward spatial intersection

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





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

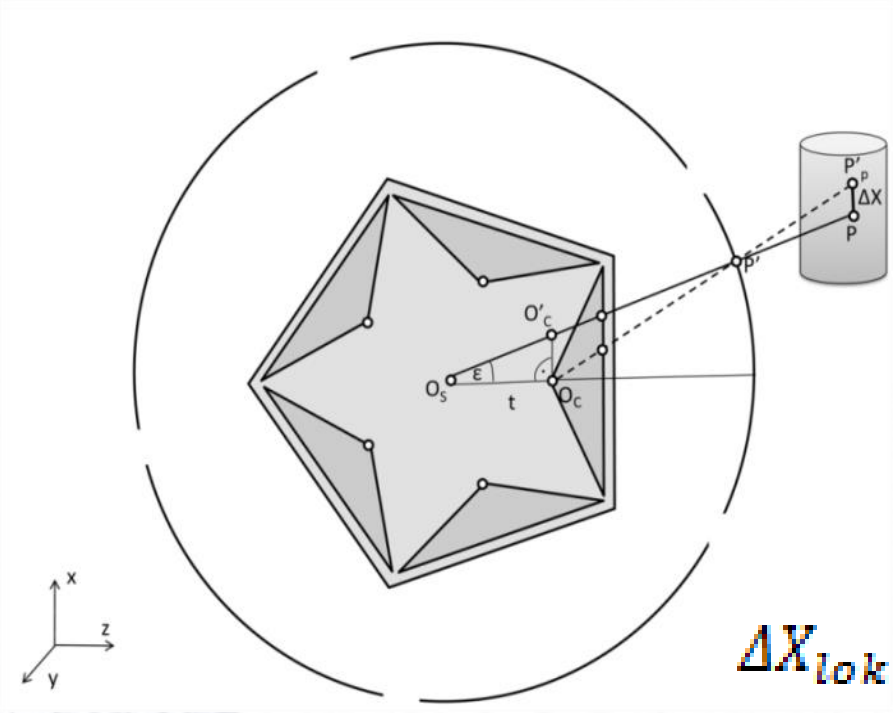
The largest parallax errors are obtained for large values of R and small values of D

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



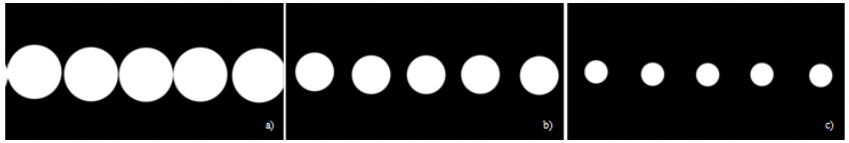
$$\Delta X_{lok} = \frac{(D - R) \cdot t \cdot tg\,\varepsilon}{R}$$

Measurements from immersive panoramas

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

3. Calculate max. ΔX′, ΔY′, ΔZ′ and check how the accuracy will decrease

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

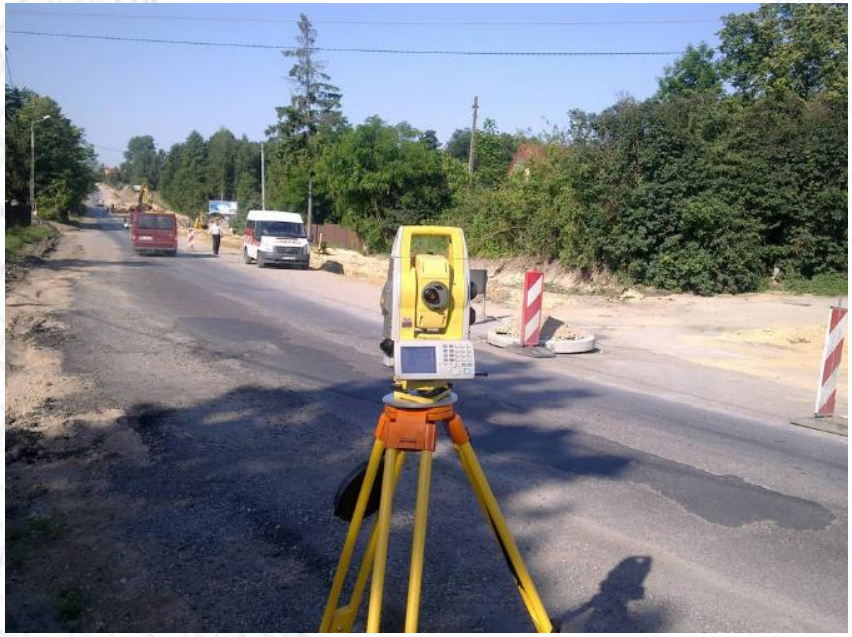


choice of r_a

5. Immersive mobile mapping system

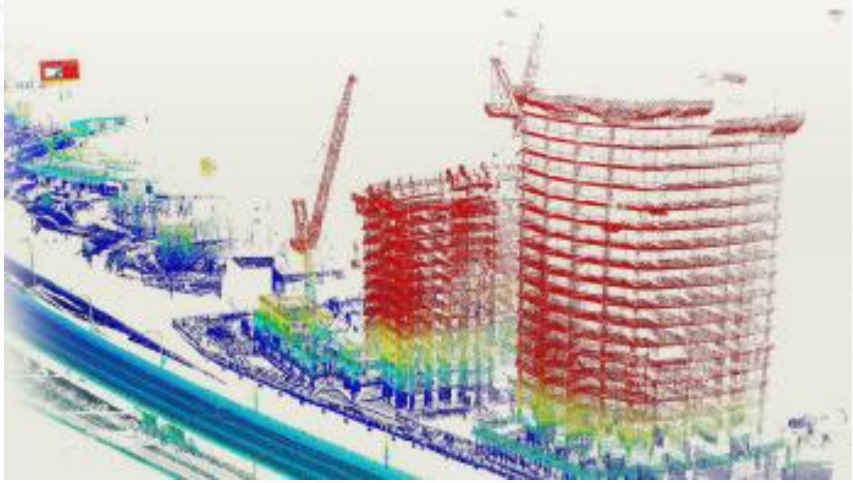
a) Traditional vs mobile mapping measurements
b) Calibration of immersive mobile mapping system

Traditional surveying along a road



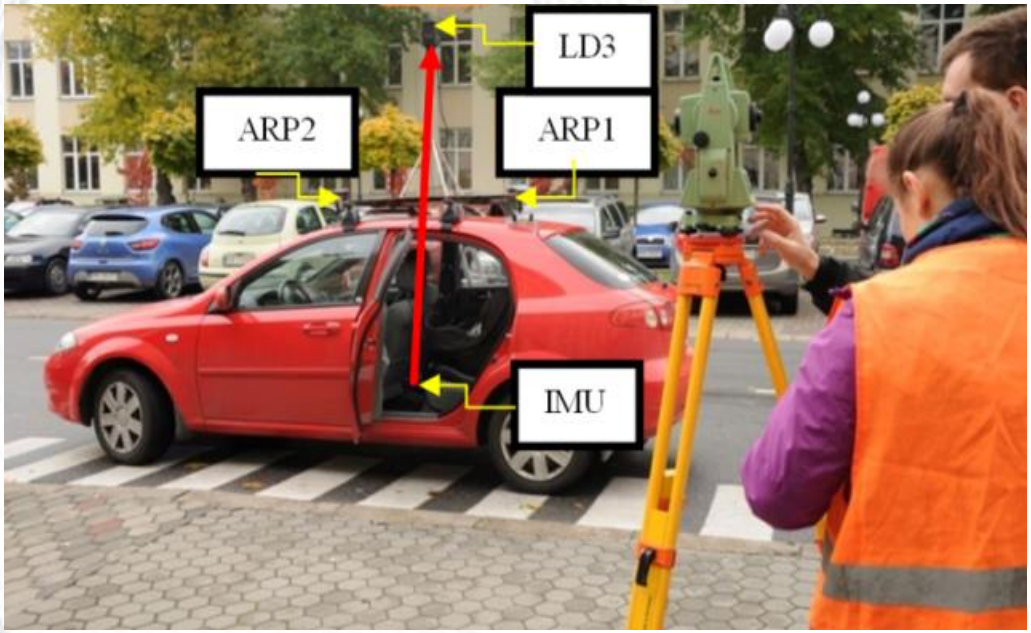
- Low efficiency
- Long measurement time
- Obstructions caused by vehicle traffic

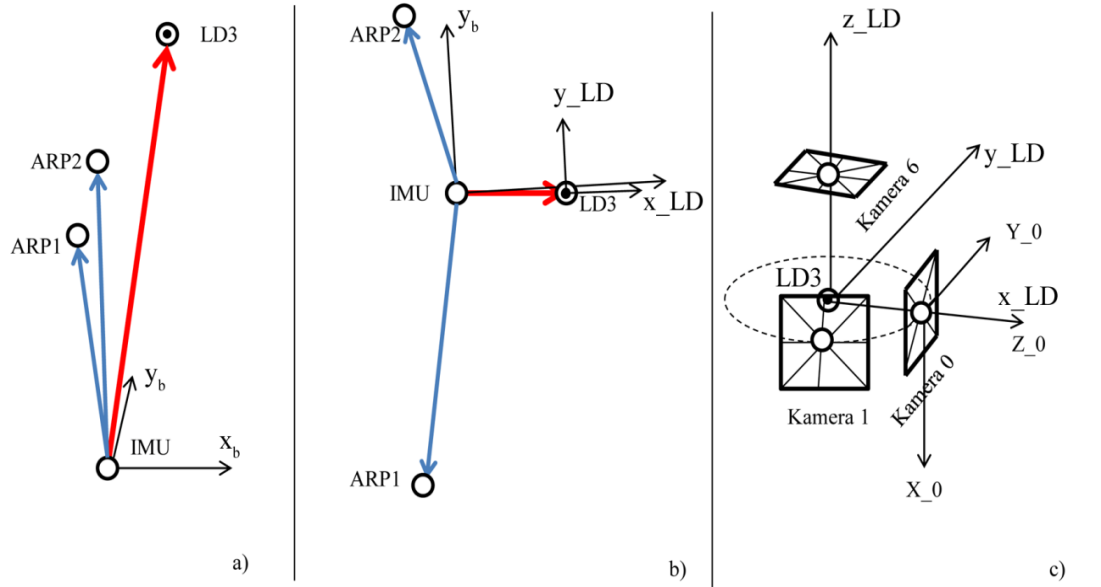
Measurements using MMS



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

Calibration of immersive mobile mapping system

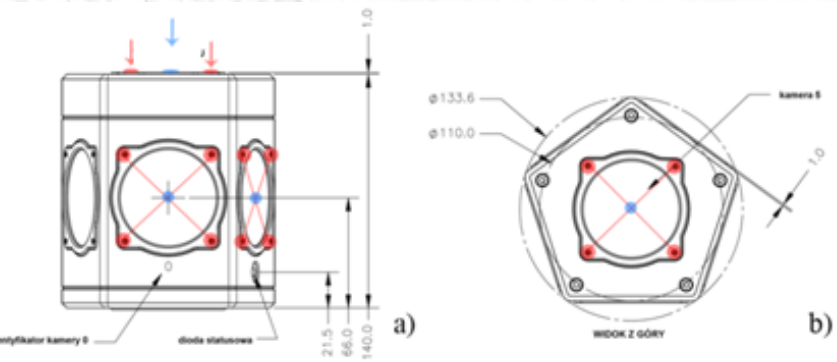


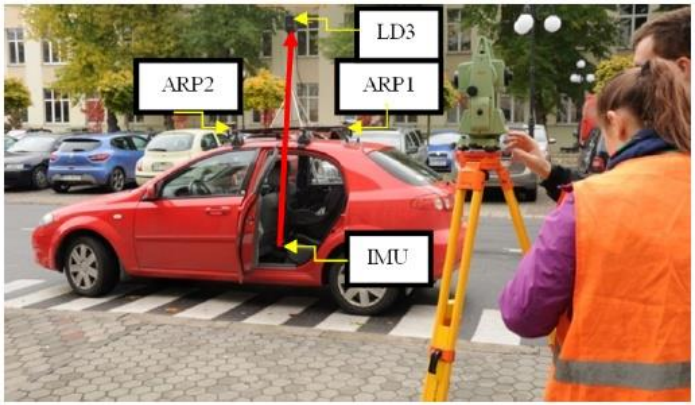


Calibration of immersive mobile mapping system

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)





a)

b)

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.

<u>AIM:</u>
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

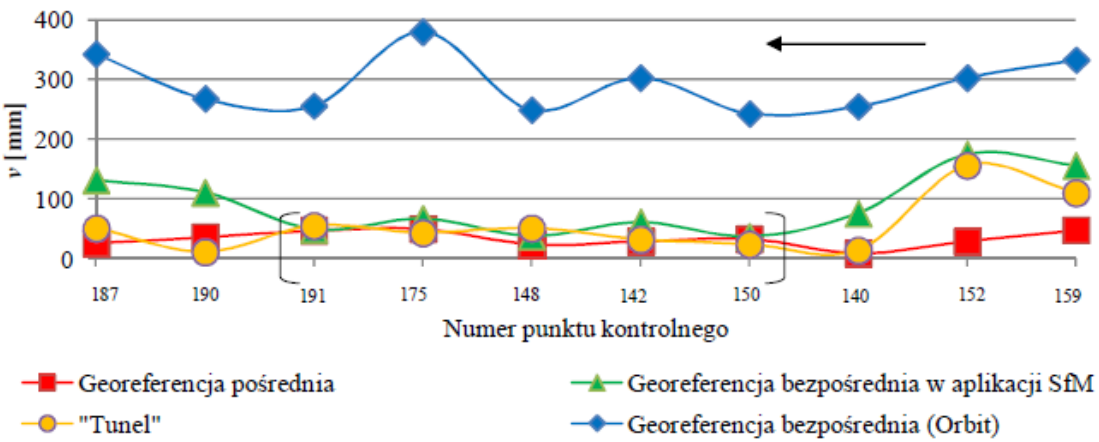
(Kwiatek 2020)

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 bezpośrednia z wyrównaniem	„Tunel”	Georeferencja bezpośrednia 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

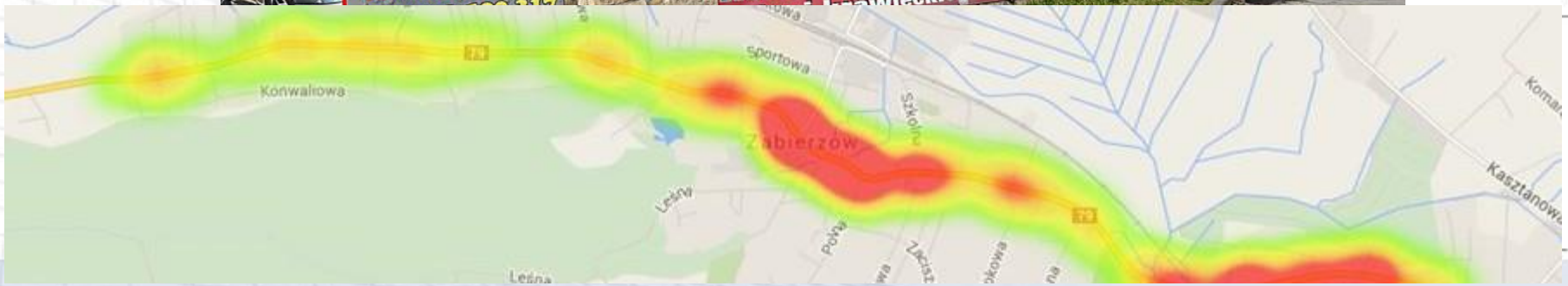
- The obtained accuracies confirm the usefulness of the constructed system and the proposed methodology of calibration and integration of observations for some photogrammetric studies

- 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



wyborcza.pl
KRAKÓW
Czwartek 11.07.2019 Dzisiejsze wydanie papierowe

reklamy

Naukowiec zmierzył reklamy przy krakowskich ulicach

Ewa Grzeszka 11 lipca 2019 | 11:00

Ul. Conrada (MICHAŁ ŁEPECKI/AG)

NAJCZĘŚCIEJ CZYTANE


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


KRAKÓW
Prezydent ma wymyślić, 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!

Organizatorzy:
Data: 21/03/2018
PFR FIRE INVESTIN Start in Poland

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

Zabierzów

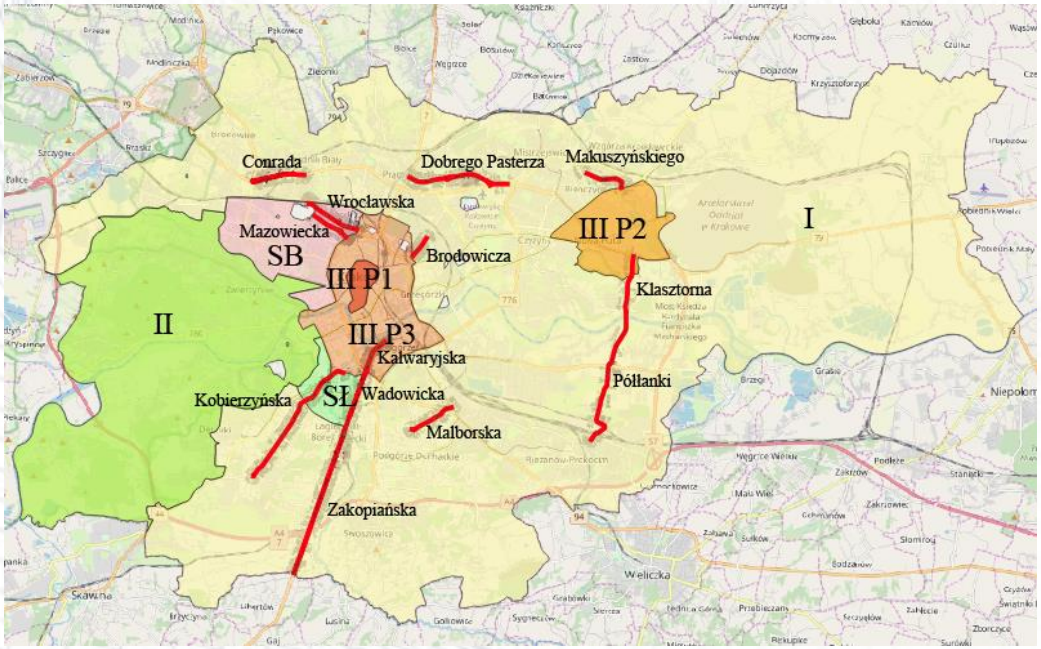

CHAOS REKLAMOWY
Zakopianka
PRODUCENT SIATKI OGRODZENIOWEJ


CHAOS REKLAMOWY
Nowy Targ
GASPOL
5 km
ORLEN

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
Kobierzyńska	4,3	I	Nie
Makuszyńskiego	1,3	I	Nie
Malborska	1,4	I	Nie
Mazowiecka	1,1	I	Nie
Półłanki	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

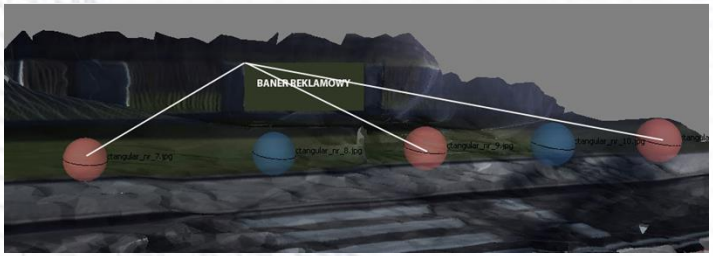
Measurements of advertisements using immersive panoramas

• 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

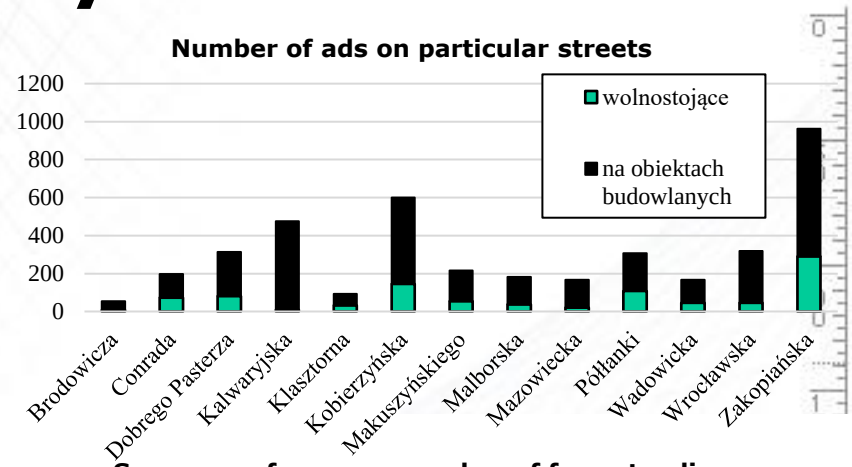

J760.jpg

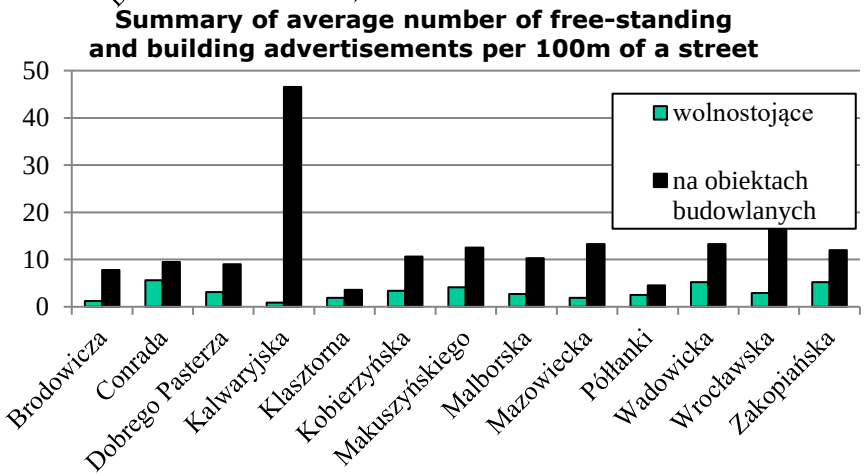

J761.jpg

Ads on building contructions on Kalwaryjska street

Development of a digital advertising inventory

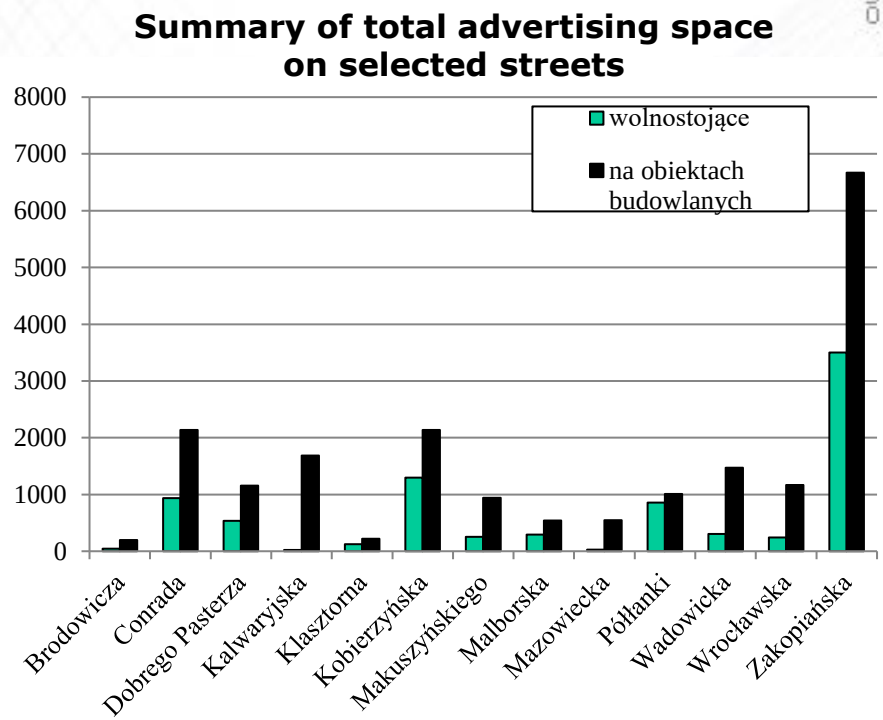
Ulica w Krakowie (skrót literowy)	Liczba reklam wolno-stoją-cych	Liczba reklam na obiektach budow-lanych	Dłu-gość ulicy [km]	Średnia liczba reklam wolnostojących na 100 m	Średnia liczba reklam na obiektach budowlanych na 100 m
Brodowicza	7	47	0,6	1,2	7,8
Conrada	73	124	1,3	5,6	9,5
Dobrego Pasterza	81	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
Makuszyńskiego	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
Półłanki	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

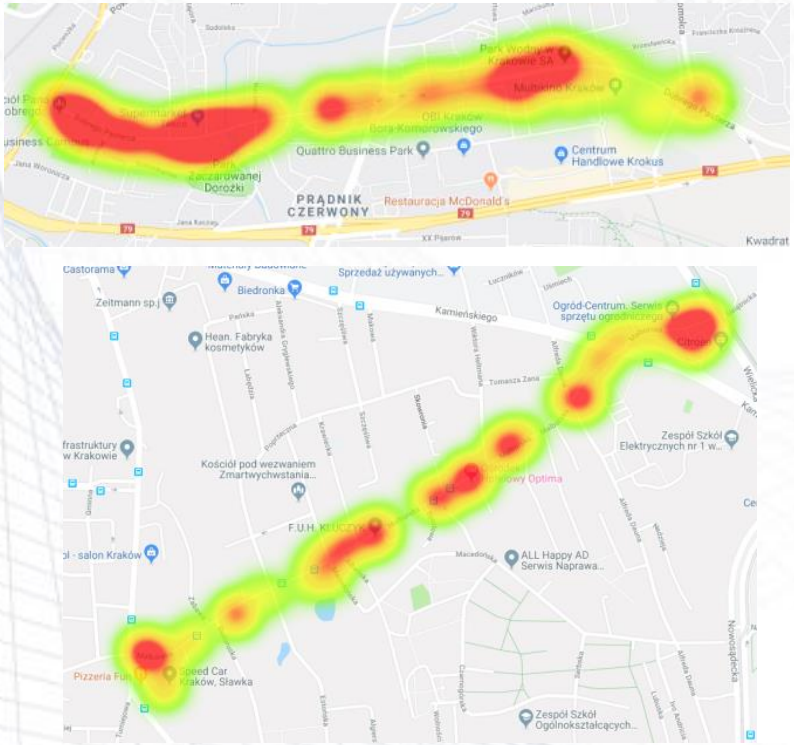
Ulica w Krakowie	Łączna powierzchnia reklam wolnostojących (bez okrąglaków) [m²]	Liczba okrąglaków	Łączna powierzchnia reklam na obiektach budowlanych [m²]
Brodowicza	49,06	0	197,24
Conrada	935,58	4	2136,46
Dobrego Pasterza	538,98	4	1154,32
Kalwaryjska	24,15	5	1687,07
Klasztorna	126,19	0	220,74
Kobierzyńska	1299,31	9	2140,34
Makuszyńskiego	256,33	0	941,07
Malborska	295,50	0	541,18
Mazowiecka	30,74	12	550,44
Półłanki	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**



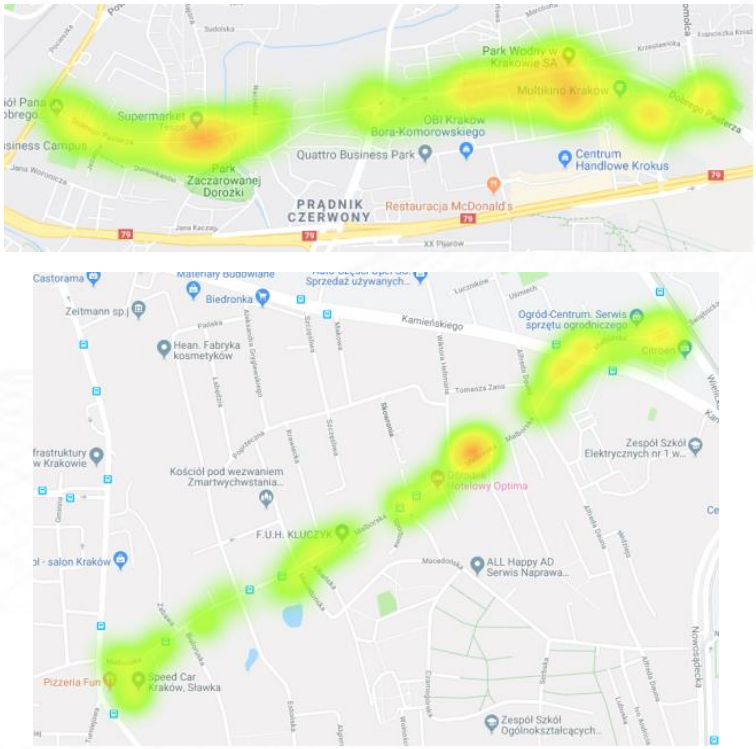
Development of a digital advertising inventory

Dobrego Pasterza and Malborska streets

Advertising intensity by number of advertisements



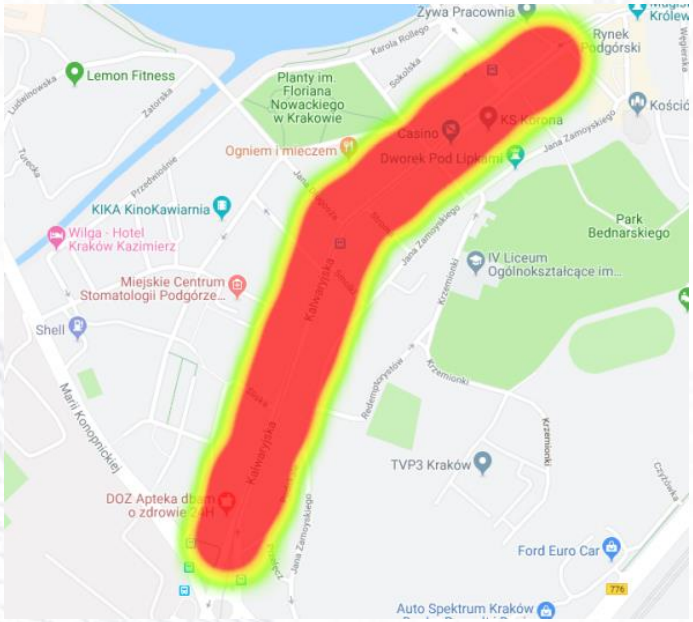
Advertising intensity by area



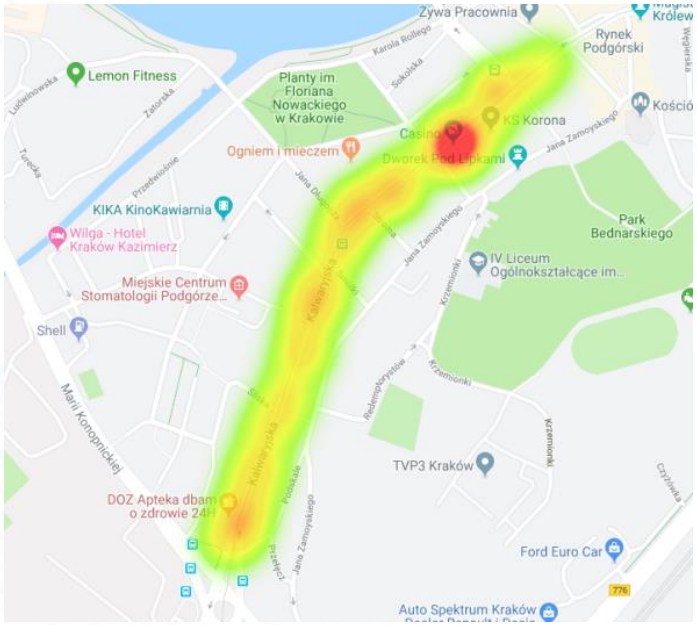
Development of a digital advertising inventory

Kalwaryjska street

Advertising intensity by number of advertisements



Advertising intensity by area



Development of a digital advertising inventory

Wrocławska street

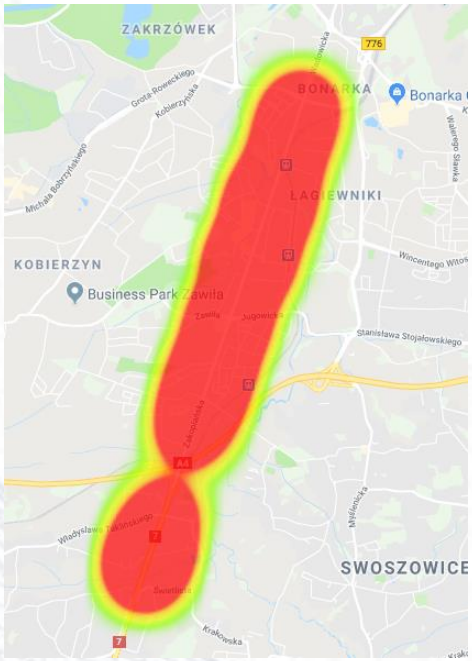
Advertising intensity by number of advertisements

Advertising intensity by area

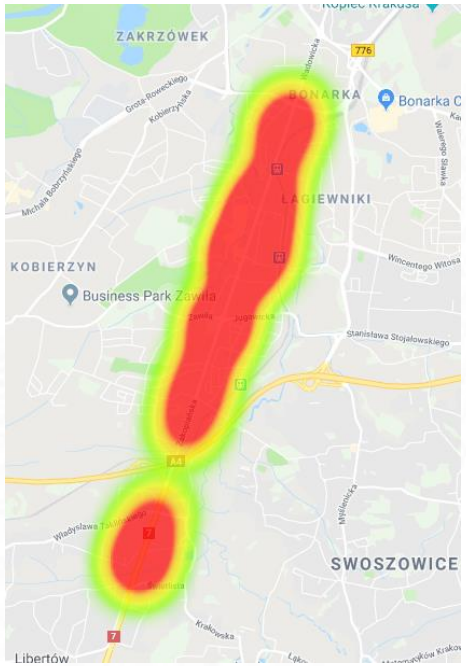
Development of a digital advertising inventory

Zakopiańska street

Advertising intensity by number of advertisements



Advertising intensity by area



Spatial analysis

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

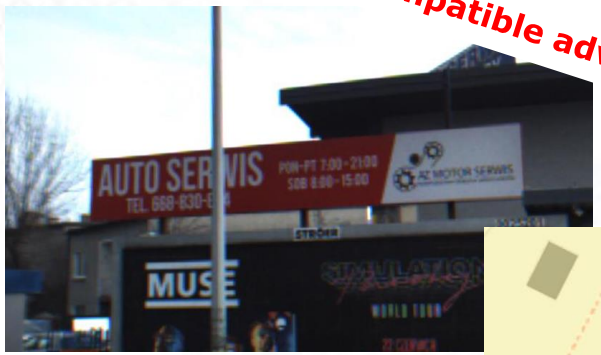
incompatible advertising

W581 – beyond the ground floor level

incompatible advertising

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

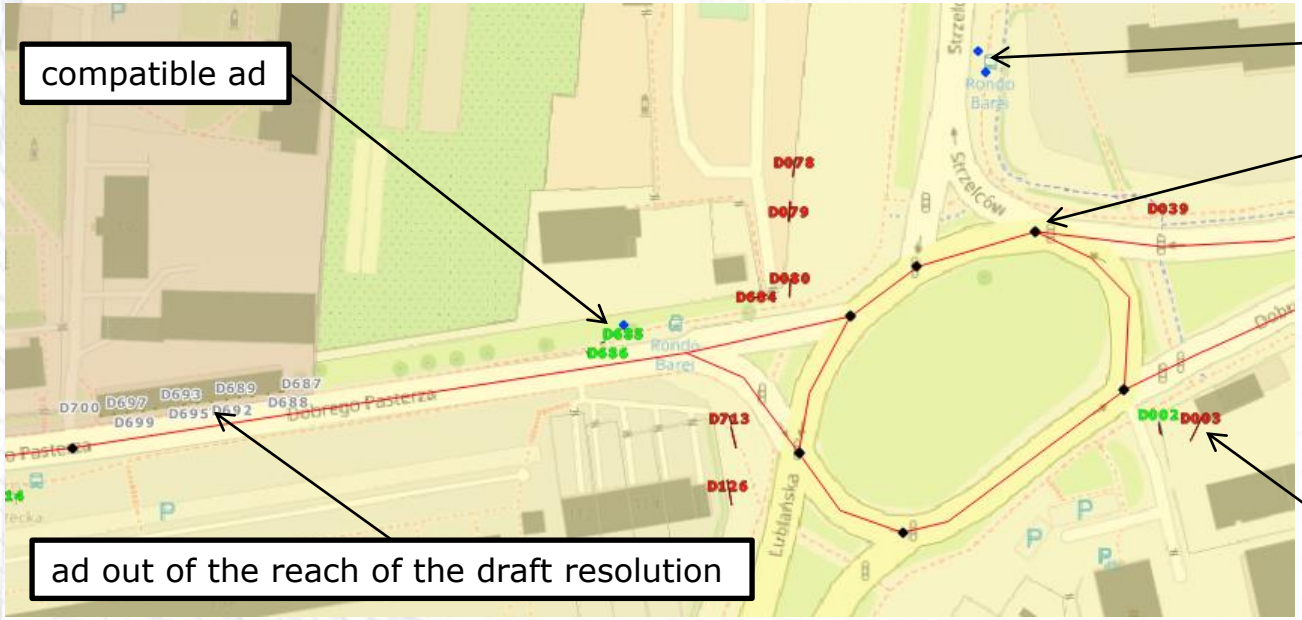
incompatible advertising



K111 – distance from bus shelter less than 15m

Spatial analysis

compatible
incompatible
out of the reach of the draft resolution

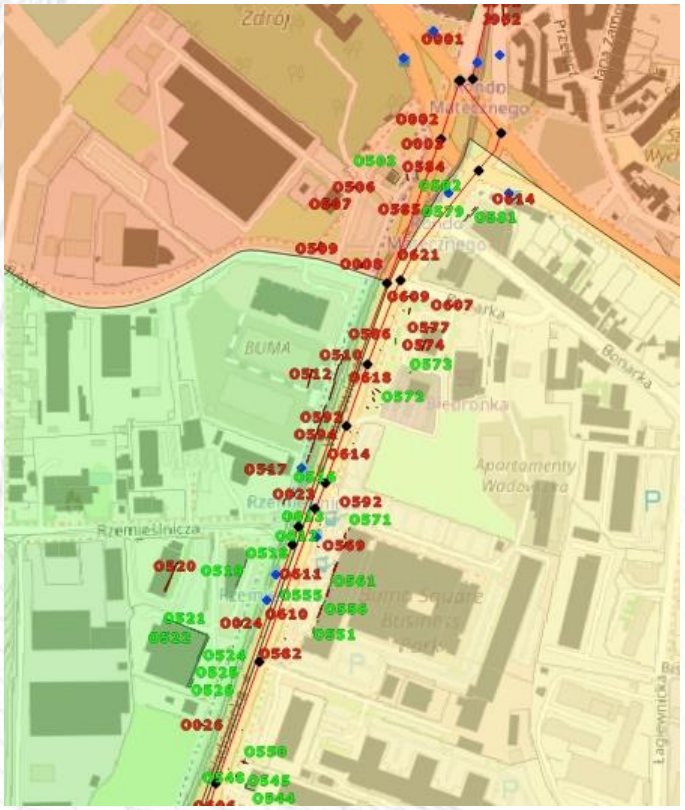


Fragment ulicy Dobrego Pasterza

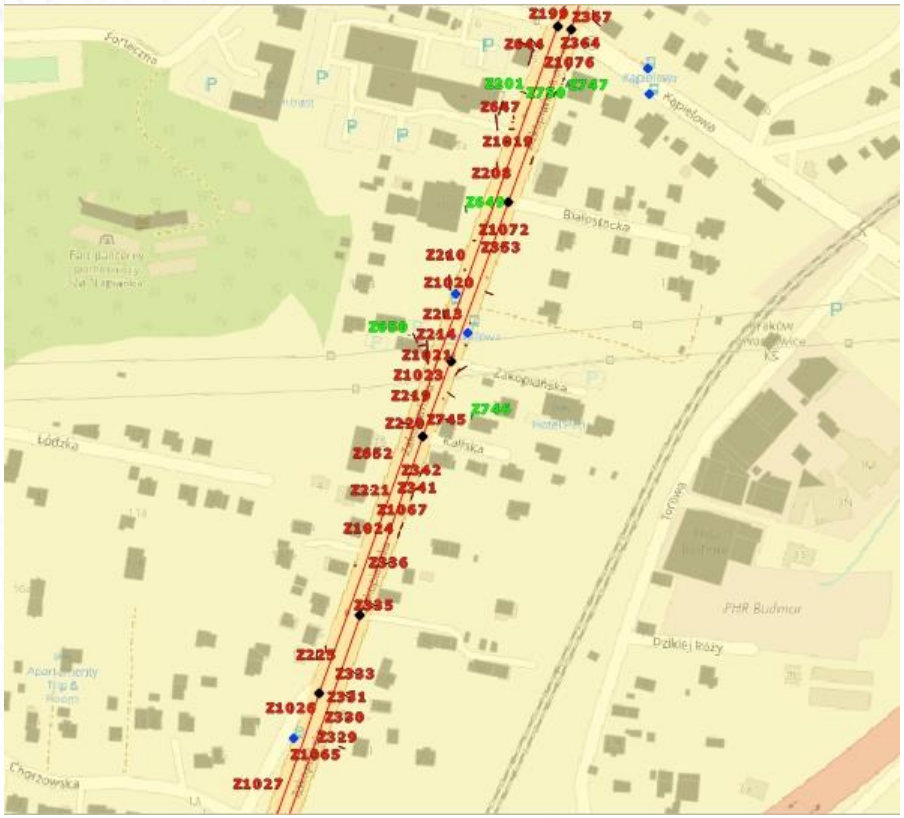
Compatibility of ads

Conrada street

Compatibility of ads



Wadowicka street

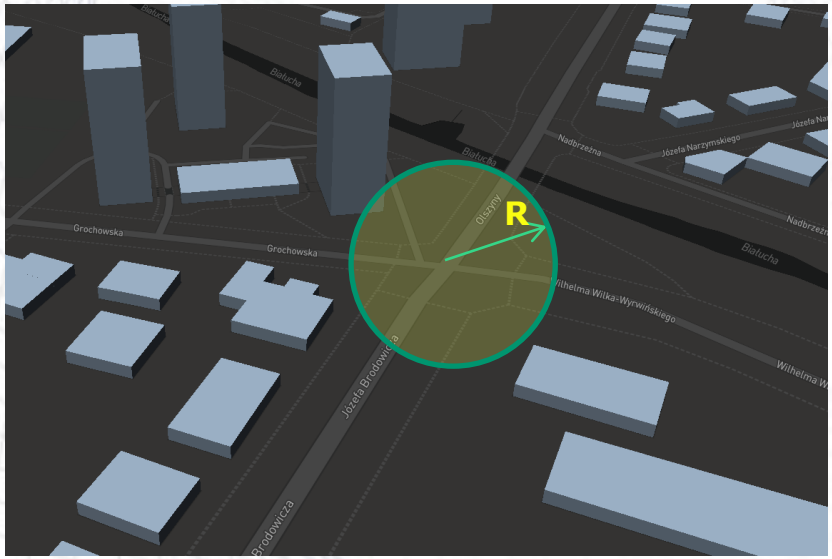


Zakopiańska street

Compatibility of ads

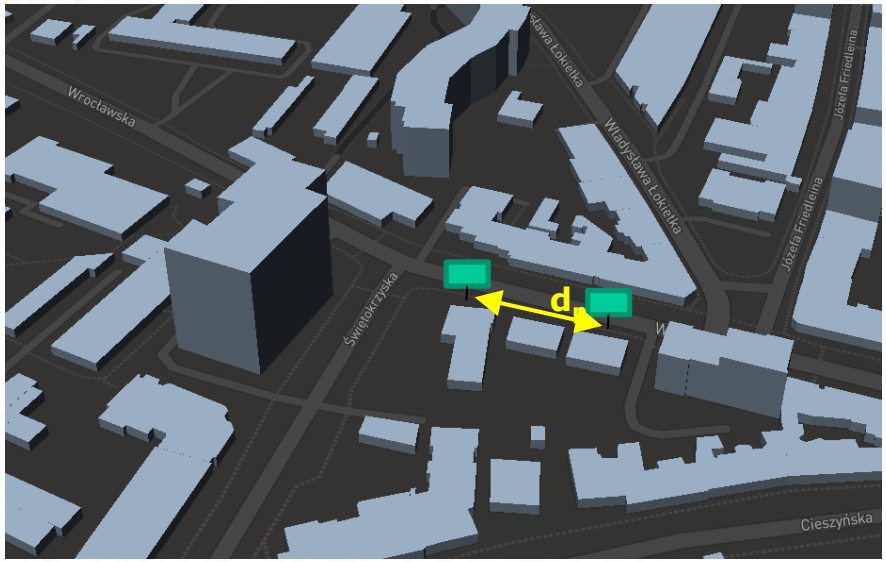
Zgodność reklam	Number of free-standing ads	Number of ads on building structures	Total numer of ads
all ads	**953 (100%)**	**3102 (100%)**	**4055 (100%)**
compatible ads	286 (30%)	177 (5%)	463 (**11%**)
incompa-tible ads	657 (69%)	2901 (94%)	3558 (**88%**)
out of the reach of the resolution	10 (1%)	24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

Spatial analysis for compatible ads



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

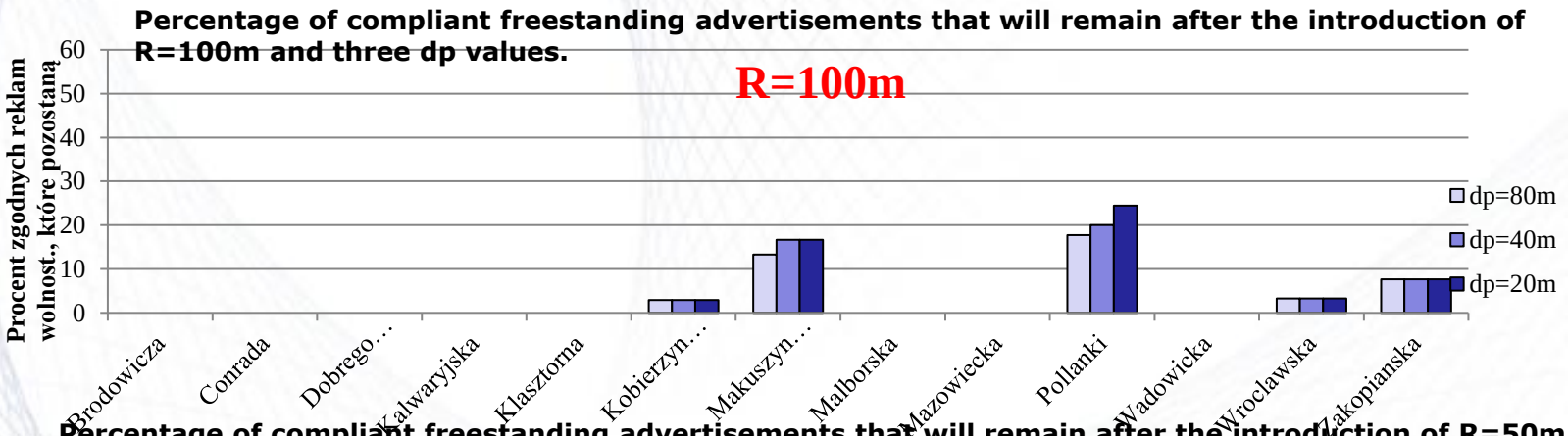
R=100m
R=50m

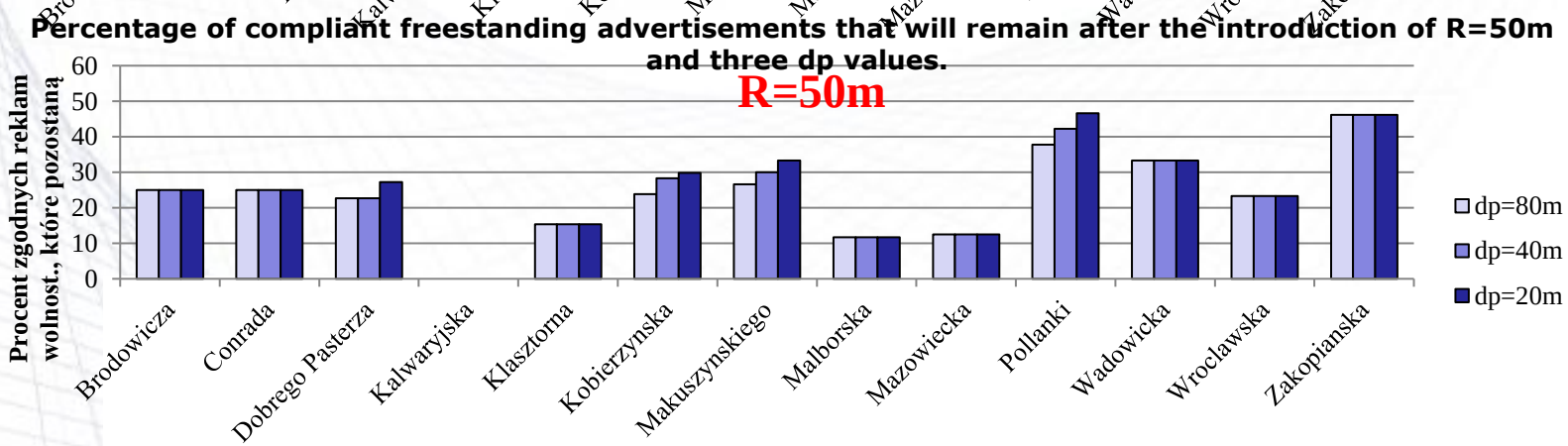


Distance between other free-standing ads and other free-standing devices (**d_p**)

d_p =80m
d_p =40m
d_p =20m

Spatial analysis for compatible ads





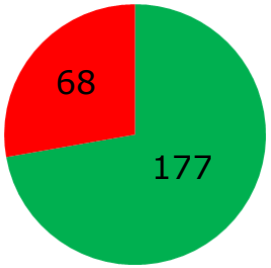
Spatial analyses of advertising coverage for ground floor and building facades

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
Półłanki	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

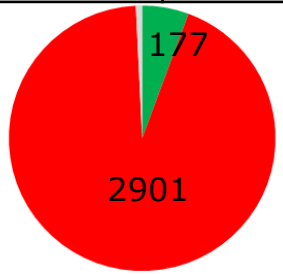
Building facade

Ground floor facade

Advertising placed on the ground floor façade

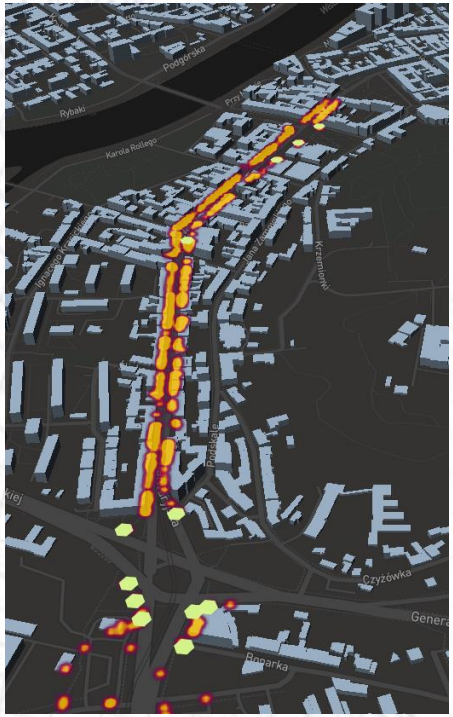


Number of advertisements on the ground floor façade

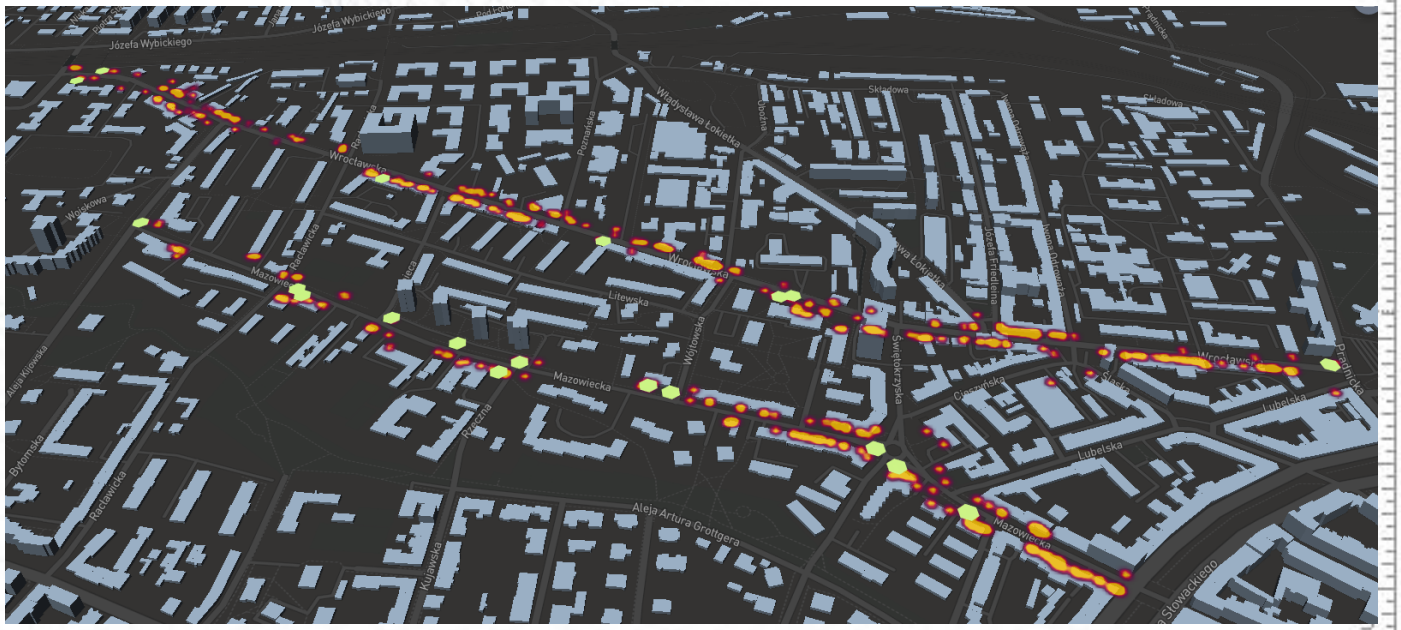


Number of ads on building structures

Visualisation

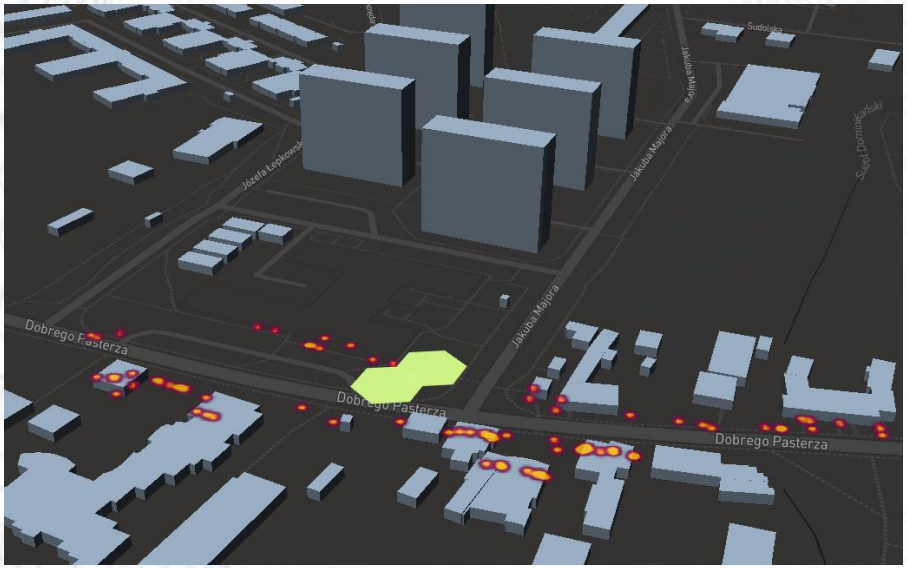


Kalwaryjska street

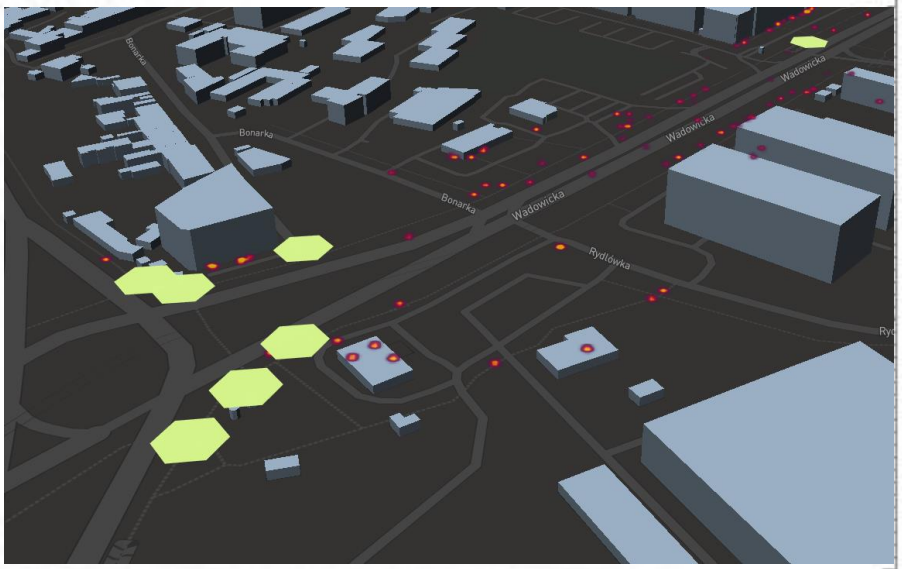


Mazowiecka street and
Wroclawska street

Visualisation



Dobrego Pasterza street



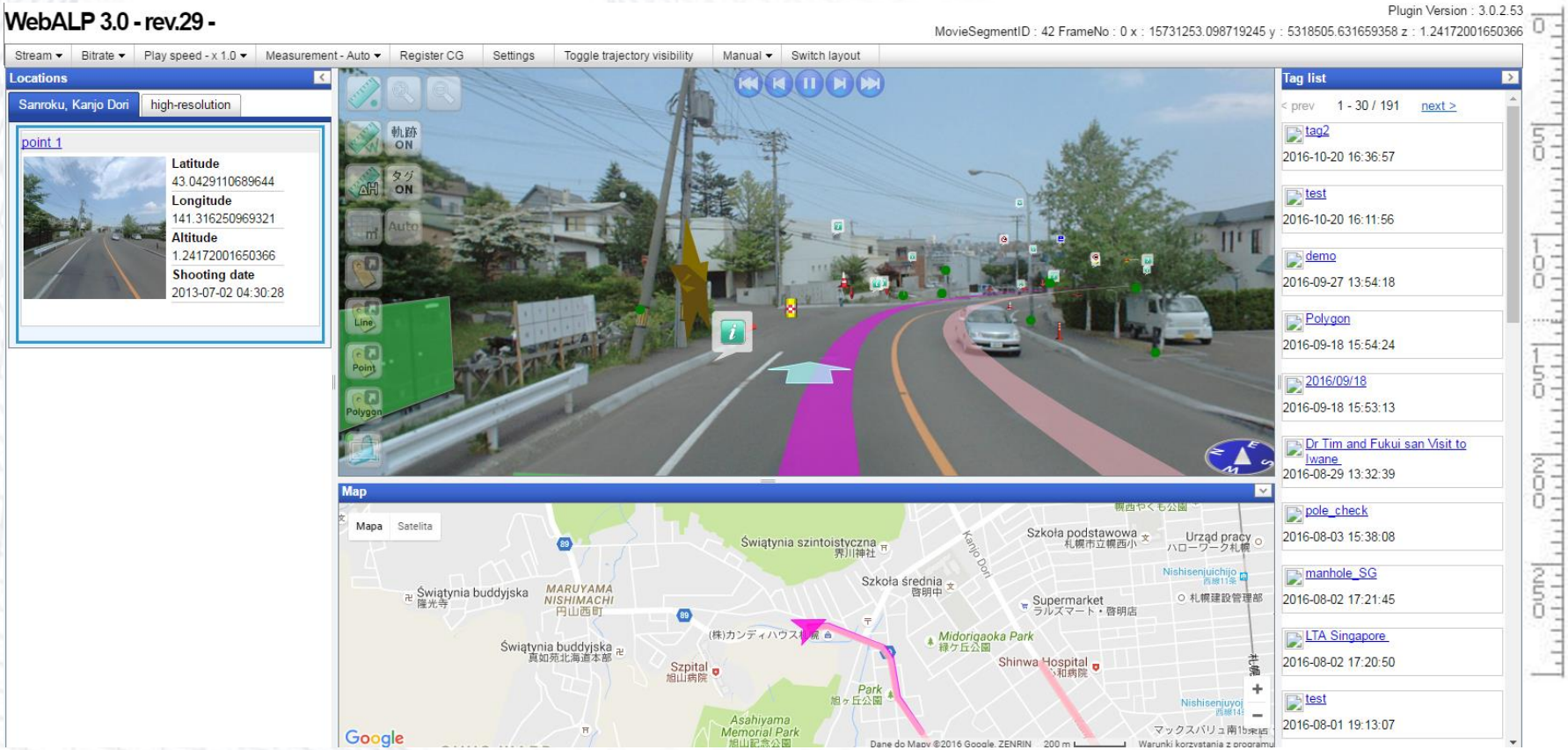
Wadowicka street

Wizualizacja

Dobrego Pasterza street

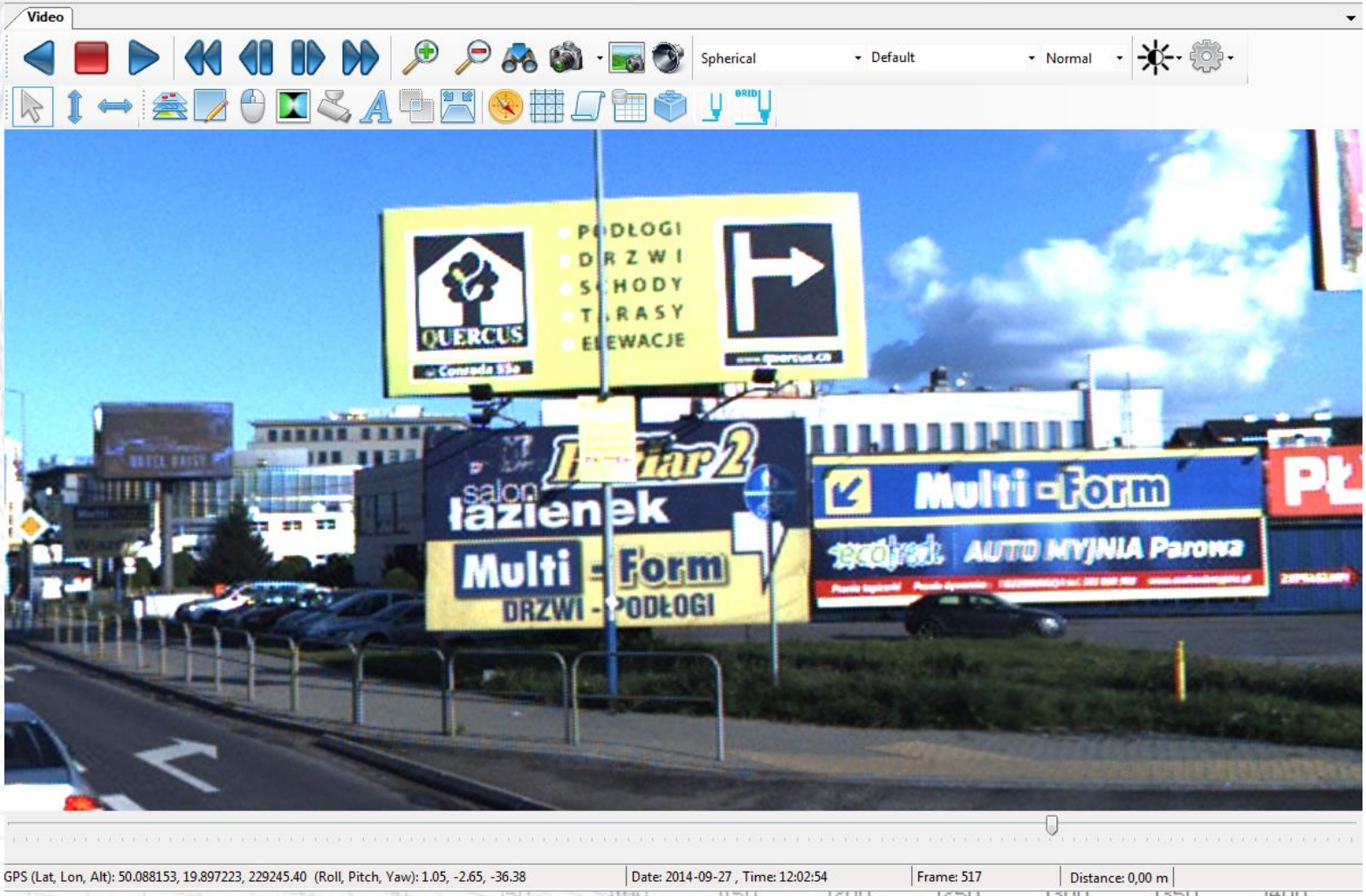
7. Applications to MMS

Iwane Labs (Japan)

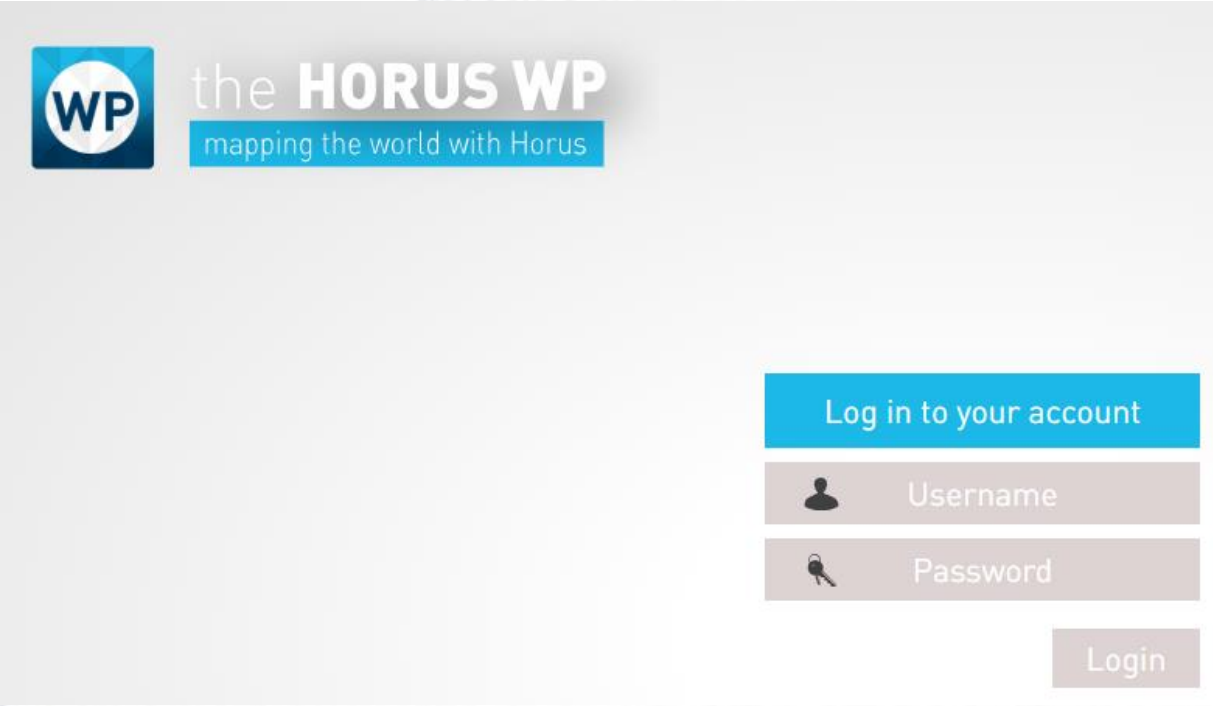


http://sns.iwanelab.com/mercury/webalp3.0/demo/index.html

Horus Movie Player



Horus WebPlayer



https://webplayer.horus.nu/

(demo, demo)

Orbit GT


Workspace
Inspector
Preferences
Save all
Print
Measure
Select
Tools
Extensions
Library
Help
Map 2D
Layout
Navigation
Selection
Edit
panoramic view
Place Point
WGS 84 / World Mercator
Object Inspector
Asset Inventory
Mobile Mapping
Select
Follow Focus
Clear all
BE Ghent Gasmeterlaan

Orbit’s 3dmapping.cloud

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

8. News from MMS

Riegl VMX-2HA

Horus

Siteco

Horus

Trimble MX9

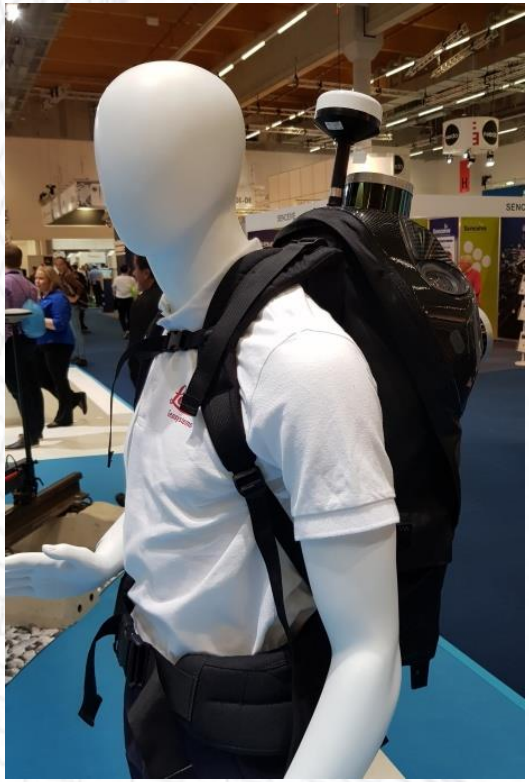
Nebula LP (S.Korea)

AGM-MS7 (Russsia)

Ginger (India)

CHCNAV Alpha 3D (China)

Mitsubishi MMS-G220 (Japan)



Leica

Vexcel

Gexcel

Commissions

- Commission I
- Working Groups
- WG I/1
- WG I/2
- WG I/3
- WG I/4
- WG I/5
- WG I/6
- WG I/7
- Activities
- WG I/8
- WG I/9
- WG I/10
- ICWG I/II
- ICWG I/IV
- Commission II
- Commission III
- Commission IV
- Commission V

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.

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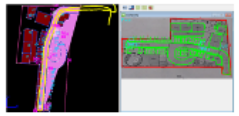
ISPRS WG I/7



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

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Thank you for your attention

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