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Title Multiview test video sequences for free navigation exploration obtained using pairs of cameras

Author Marek Domański (domanski@et.put.poznan.pl),
Adrian Dziembowski (adziembowski@multimedia.edu.pl)
Adam Grzelka (agrzelka@multimedia.edu.pl),
Dawid Mieloch(dmieloch@multimedia.edu.pl),
Olgierd Stankiewicz (ostank@multimedia.edu.pl),
Krzysztof Wegner (kwegner@multimedia.edu.pl).

1. Introduction

Free Navigation is considered as an important functionality of future interactive internet-based video services. Efficient commercial development of this functionality still needs substantial research that requires good test material.

The practical video acquisition systems for free navigation and free viewpoint television shall rely on limited numbers of cameras located around a scene. The limits on the number of cameras as well as the practical limitations implied by the geometry of an event hall and the accessibility requirements for the players, viewers, staff, rescue teams etc. imply that the angles between the neighboring cameras must be large. On the other hand, the large angles between the optical axes of the neighboring cameras yield substantial occlusions that impede exact depth estimation.

Therefore, the authors have proposed to use a pair or a triple of cameras instead of a single camera at a location. A comparative studies [1,2,3] have demonstrated the advantages of such an approach that is especially advantageous for the scenes with many occlusions [2].

A pair or a triple of cameras with small angles between the optical axes of the cameras ensure small amount of occlusions thus allowing at least rough but robust depth estimation. This rough depth estimations may be combined with more exact but also more occlusion-prone estimations obtained between camera pairs.

In this document, described are the new video test sequences obtained using close camera pairs sparsely distributed around a scene.

2. Description of the sequences

All the sequences have been acquired in the similar conditions using 10 cameras grouped into 5 pairs. The 5 pairs were located roughly on an arc.

The common features for 3 sequences are:

Cameras:

10 cameras Canon XH G1 – 3 CCD sensors per camera

Camera sensors: 1/3” with native resolution 1440x1080 per each of RGB channels.

Camera output and test video format: 1920x1080, RGB uncompressed .

Frame rate: 25 fps.

Sequence length: 300 frames (each sequence).

Angle between the neighboring camera pairs: 15 degrees of arc.

Base for a camera pair: about 22 cm.

Individual setups for the sequences:

Sequence name	Approx. radius of the circular arrangement of the camera pairs	Approx. distance between the centres of the camera pairs (rough)
Poznan_Blocks2	3 m	80 cm
Poznan_Fencing2	4 m	100 cm
Poznan_Service2	3.5 m	90 cm

Video contents:

Sequence name	Scene description	Application scenario for this type of contents
Poznan_Blocks2	Two persons playing table game	Entertainment
Poznan_Fencing2	Two boys fencing	Sports reports
Poznan_Service2	Persons repairing a big computer server	Interactive manual

Interested parties may acquire the depth maps on request.

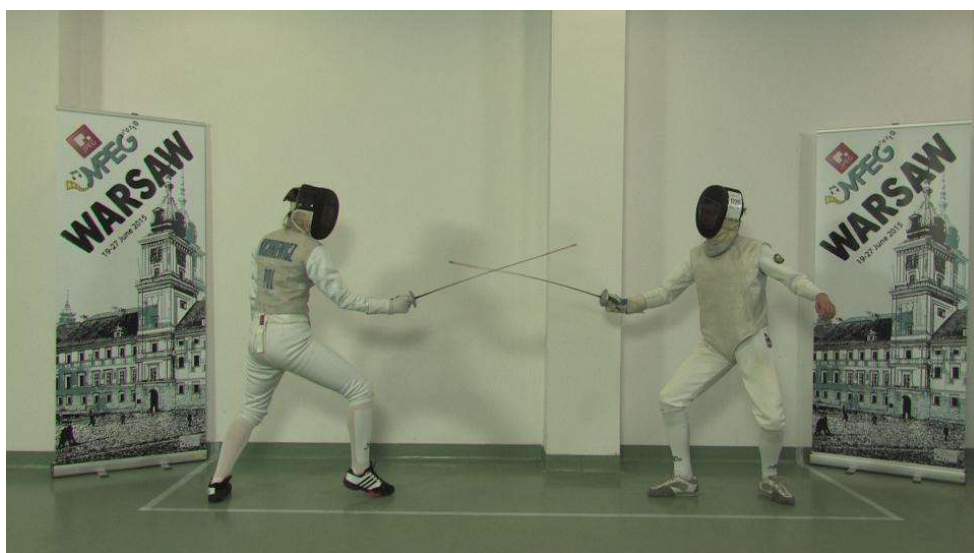
Poznan_Blocks2

The pairs 0 (the rightmost), 2 (the central) and 4 (the leftmost):



Poznan_Fencing2

The pairs 0 (the rightmost), 2 (the central) and 4 (the leftmost):



Poznan_Service2

The pairs 0 (the rightmost), 2 (the central) and 4 (the leftmost):



3. License

Individuals and organizations extracting video sequences from this archive agree that the video sequences and all intellectual property rights therein remain the property of the respective owners listed below. These materials may only be used for the purpose of developing, testing and promulgating technology standards and for academic usage. Acknowledgement and reference to the following source document:

M. Domański, A. Dziembowski, A. Grzelka, D. Mieloch, O. Stankiewicz, K. Wegner, “Multiview test video sequences for free navigation exploration obtained using pairs of cameras”, ISO/IEC JTC1/SC29/WG11 Doc. MPEG2016/ M38247, Geneva, Switzerland, May 2016.

are required in all documents that report any usage of the materials. The respective owners make no warranties with respect to the materials and expressly disclaim any warranties regarding their fitness for any purpose.

Owners of the video sequence set:

Sequence name	Owner
Poznan_Blocks2	Poznan University of Technology, Chair of Multimedia Telecommunications and Microelectronics, Polanka 3, PL 60-965 Poznan, Poland
Poznan_Fencing2	
Poznan_Service2	

The individuals and organizations willing to obtain the video sequences (with camera parameters) under the abovementioned conditions should contact the authors: Marek Domański (domanski@et.put.poznan.pl) or Olgierd Stankiewicz (ostank@multimedia.edu.pl) or Krzysztof Wegner (kwegner@multimedia.edu.pl) .

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- [2] M. Domański, A. Dziembowski, A. Grzelka, D. Mieloch, "Optimization of camera positions for free-navigation applications", to be published.
- [3] M. Domański, A. Dziembowski, A. Grzelka, D. Mieloch, O. Stankiewicz, K. Wegner, „Study on nonuniform distributions of cameras located on an arc”, ISO/IEC JTC1/SC29/WG11 Doc. MPEG2016/ M38248, Geneva, Switzerland, May 2016.
- [4] G. Lafruit, K. Wegner, T. Grajek, T. Senoh, P. Kovács, P. Goorts, L. Jorissen, B. Ceulemans, P. Carballeira Lopez, S. García Lobo, Qing Wang, J. Jung, M. Tanimoto, "FTV software framework" ISO/IEC JTC1/SC29/WG11 MPEG2014/N15349, June 2015, Poland, Warsaw.

Appendix: Camera parameters

Camera parameters are given in the representation described in the document [4].

Poznan_Blocks2 sequence:

param_cam0

```
1716.1990189999999000 0.0000000000000000 924.4635570000000400
0.0000000000000000 1713.4237539999999000 545.9123779999999900
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.2378953321735126 -0.8417253959624443 0.4846691332465074
10.4522885892335720
0.9008454811053281 0.3777788127802192 0.2139172451825195 0.0046760505668298
-0.3631573076535349 0.3857220844160141 0.8481363354388264
0.8363638109529260
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000
```

param_cam1

```
1717.7659100000001000 0.0000000000000000 943.5684209999999400
0.0000000000000000 1713.5155940000000000 507.7495789999999800
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.2686755432093492 -0.8508906346352826 0.4514405612825762
10.3009998618702120
0.8917800518139201 0.3968747367722910 0.2172988322533903 0.5306400777701886
-0.3640628952089507 0.3442028053370440 0.8654378297313942
0.5273932469476830
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000
```

param_cam2

```
1718.4626579999999000 0.0000000000000000 931.4180350000000300
0.0000000000000000 1714.5157540000000000 523.9959129999999700
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.3807568345738061 -0.8830927058325232 0.2741742253216516
9.6159461138413675
0.8772226512741922 0.4387387494746124 0.1949069773018146 2.3181148161604921
-0.2924117867268897 0.1662996771339194 0.9417217021861299-
0.2195596505640338
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000
```

param_cam3

```
1716.1050020000000000 0.0000000000000000 929.5401160000000100
0.0000000000000000 1711.8807409999999000 547.3053089999999700
0.0000000000000000 0.0000000000000000 1.0000000000000000
```


0
0
0.3899755009297958-0.8749776360785782 0.2869377023622000
9.3558478351796861
0.86806244377260360.45329127372883970.20247126925275572.8799953674436840
-0.3072241891291938 0.17012100847229230.9363077165602555-
0.3641937668176364
0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam4

1718.2137620000001000 0.0000000000000000934.3673020000000000
0.0000000000000000 1714.2028210000001000 528.869148999999900
0.00000000000000000.0000000000000000 1.0000000000000000
0
0
0.5107955270205581-0.8594996636512660 -0.0186616654977739
8.3956694291796268
0.84450765574525580.49758625315674410.19802711949903514.6586958749070284
-0.1609184543905479 -0.1169112862506998 0.9800188784833505-
0.5903643427153980
0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam5

1722.0026860000000000 0.0000000000000000932.1881919999999600
0.0000000000000000 1717.4953370000001000 541.669941999999900
0.00000000000000000.0000000000000000 1.0000000000000000
0
0
0.5215696251718482-0.8529016119672034 -0.0228903124016158
8.0772554756910004
0.83744284684497070.50661395547184950.20501653199036815.1726104292370003
-0.1632623789067418 -0.1260997241270284 0.9784908048667594-
0.5806392046727540
0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam6

1714.0429740000000000 0.0000000000000000928.4518990000000300
0.0000000000000000 1708.8573859999999000 529.8543979999999500
0.00000000000000000.0000000000000000 1.0000000000000000
0
0
0.5947647390584903-0.7670869455028281 -0.2404839354547971
6.9738873386657545
0.80346863074688410.55742790804574230.20907483525636166.8397399773586942
-0.0263261196991346 -0.3175716381714346 0.9478687620397129-
0.4595130376756125
0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam7

1722.2367190000000000 0.0000000000000000932.2839800000000400

0.0000000000000000 1717.1864089999999000 533.3571980000000400
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.6139043152655711 -0.7551040078567378 -0.2300856992883340
6.6055702319799572
0.7888400853784551 0.5760623028709395 0.2142044418567024 7.2999785038146898
-0.0292029347570034 -0.3130018538758537 0.9493034436216150 -
0.3045271790494514
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam8

1719.4866700000000000 0.0000000000000000 929.4762359999999700
0.0000000000000000 1714.7773000000000000 540.9316119999999700
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.6238409325818290 -0.6319607468078174 -0.4598348674573725
5.3082110995963951
0.7677861416499853 0.6054908037190981 0.2094882509875660 8.7798776751482297
0.1460374319332637 -0.4837421845422478 0.8629406511276607
0.4255812855221591
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam9

1720.5804400000000000 0.0000000000000000 940.3848010000000400
0.0000000000000000 1716.0606390000000000 518.5250879999999800
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.6337731671991215 -0.6287235237034871 -0.4505977177930057
4.9110604126511230
0.7633882241604614 0.60236055039851100 0.23323847567830699 1.584921330092524
0.1247797730064127 -0.4918012790400951 0.8617200880697831
0.7351898006335824
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

Poznan_Fencing2 sequence

param_cam0

1714.5630220000000000 0.0000000000000000 925.0774020000000100
0.0000000000000000 1711.5879279999999000 530.2545490000000000
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.6797931756163155 -0.2314943710665986 -0.6959106225299087 -
6.5032320716098910
-0.2123262592783841 0.8461222012906378 -0.4888709237661140
0.2810615662648424
0.70199629486652800.48009121700731540.5260357643222570-7.3541572560907218

0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam1

1714.1050220000000000 0.0000000000000000 946.6699320000000200
0.0000000000000000 1710.8562850000001000 499.7068150000000100
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.6578538406021793 -0.2338726794744318 -0.7159133286930843 -
6.3505359024442241
-0.2161288287709363 0.8519612477528508 -0.4769175627941467
0.2199456537263702
0.72146840109533970.46847155956669910.5099193505821082-7.5172747870688355

0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam2

1717.2979630000000000 0.0000000000000000 934.9559269999999700
0.0000000000000000 1713.8856639999999000 511.6576010000000000
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.8002414261547116 -0.1611086992723512 -0.5776310646811200 -
5.4056512871387437
-0.1908902132031357 0.8446942827268559 -0.5000524924763637 -
0.0842589179997970
0.56848446449233290.51042683682123680.6452052835210913-8.4061301766344076

0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam3

1713.2339770000001000 0.0000000000000000 933.6419200000000300
0.0000000000000000 1709.1602920000000000 540.7773069999999500
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0

0.8164107996471346-0.1470297888414116 -0.5584403705076991 -
5.1990713856252473
-0.1908464658272874 0.8440096041922096-0.5012239165408445 -
0.1050035291766307
0.54502388268841970.51578098959205490.6609984402967077-8.5222776473244348

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam4

1729.1197830000001000 0.00000000000000000939.3208080000000600
0.00000000000000000 1726.4888659999999000 531.2771890000000200
0.00000000000000000.00000000000000000 1.0000000000000000
0
0
0.9327170977762619-0.0142578253153952 -0.3603269764160085 -
3.7793014335229884
-0.1741006692603963 0.8572433738237942-0.4845851369968753 -
0.3496560188568342
0.31579704317632410.51471401035184000.7970832547912525-9.5493240839586697

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam5

1717.7668719999999000 0.00000000000000000937.7801160000000200
0.00000000000000000 1714.4287150000000000 541.3733580000000500
0.00000000000000000.00000000000000000 1.0000000000000000
0
0
0.9280743867899522-0.0040272452968108 -0.3723730842579436 -
3.5331928941791597
-0.1893082924671297 0.8559958837227231-0.4810752721279012 -
0.3395717311308441
0.32068723546102350.51696695092150120.7936654639502039-9.6239040806095453

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam6

1713.1018600000000000 0.00000000000000000943.8974319999999800
0.00000000000000000 1709.0667370000001000 528.9047769999999700
0.00000000000000000.00000000000000000 1.0000000000000000
0
0
0.98388031134747820.1317470717588428-0.1209224628667459 -
1.9668185753994669
-0.1748476290891306 0.8505905925297345-0.4959071994857756 -
0.1784350647441275
0.03752118794360090.50905633576538990.8599150001438605-9.9304798612731453

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam7

1714.998687999999000 0.0000000000000000 933.3044690000000400
0.0000000000000000 1710.6083040000001000 527.8225250000000400
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.98099102320309400.1477885521929660-0.1257583247171088 -
1.7474042388240494
-0.1908141148005074 0.8525524774961210-0.4865637128970109 -
0.1267251636254981
0.03530702462464960.5013110979780251 0.8645464689976018-9.9350092881949497

0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam8

1715.8420320000000000 0.0000000000000000 934.8495359999999400
0.0000000000000000 1711.8982840000001000 530.1573310000000000
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.95382093220069150.28948461554770190.0801516478745315-0.2331514428583486

-0.2066182280946141 0.8259925239368203-0.5244475743289538
0.3313881774943668
-0.2180241663551216 0.4836682827741351 0.8476617574973367-
9.7088629635041510
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam9

1716.2547360000001000 0.0000000000000000 946.1418680000000400
0.0000000000000000 1712.4455499999999000 512.6771579999999600
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.95809507115052740.2661900568173283 0.1058144049203774-0.0137193279545405

-0.1728844213922282 0.8318837224614198-0.5273333377889228
0.4009970272625576
-0.2283961722029083 0.4869418096193006 0.8430438082138676-
9.6746059472233608
0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

Poznan_Service2 sequence:

param_cam0

1714.5630220000000000 0.0000000000000000 925.0774020000000100
0.0000000000000000 1711.5879279999999000 530.2545490000000000
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.5860645262595180 -0.1209316369774184 -0.8011890602337057 -
8.8544021212182749
-0.2034377398205066 0.9351642025733673 -0.2899672399462427
0.2387331107911394
0.7843095416204821 0.3329316046927355 0.5234645064565405 -4.5229194623459685

0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam1

1714.1050220000000000 0.0000000000000000 946.6699320000000200
0.0000000000000000 1710.8562850000001000 499.7068150000000100
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.5596826091559527 -0.1079493395796797 -0.8216461020979143 -
8.5809547982226739
-0.2056229170315609 0.9423843452155550 -0.2638767930002213
0.1888962882262668
0.8027917494592337 0.3166365202830539 0.5052392710619615 -4.8892006082352495

0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam2

1717.2979630000000000 0.0000000000000000 934.9559269999999700
0.0000000000000000 1713.8856639999999000 511.6576010000000000
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0
0.7038006764981757 -0.0513138428150948 -0.7085418105491433 -
7.4790322881341433
-0.2127318715437300 0.9363947261957502 -0.2791237495848180 -
0.1426606068517470
0.6777977268995613 0.3471769092096045 0.6481191519477370 -6.7363439104500644

0.0000000000000000 0.0000000000000000 0.0000000000000000 1.0000000000000000

param_cam3

1713.2339770000001000 0.0000000000000000 933.6419200000000300
0.0000000000000000 1709.1602920000000000 540.7773069999999500
0.0000000000000000 0.0000000000000000 1.0000000000000000
0
0

0.7280859260202507-0.0529996997664889 -0.6834339149880523 -
7.0861326325438814
-0.1980419961539260 0.9382276468945776-0.2837397581623560 -
0.1470903009728558
0.65625471586161010.34193554133392740.6726141787697251-7.0517816154408299

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam4

1729.1197830000001000 0.0000000000000000939.3208080000000600
0.0000000000000000 1726.4888659999999000 531.2771890000000200
0.00000000000000000.0000000000000000 1.0000000000000000
0
0
0.8314699166843237-0.0274898942285422 -0.5548892532427237 -
5.5076706356851064
-0.1721016252526449 0.9369006004344359-0.3042996803990957 -
0.2060889003691812
0.52824124056567380.34851337222680160.7742736087099578-8.4068142308975933

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam5

1717.7668719999999000 0.0000000000000000937.7801160000000200
0.0000000000000000 1714.4287150000000000 541.3733580000000500
0.00000000000000000.0000000000000000 1.0000000000000000
0
0
0.8230753667368757-0.0138102353168347 -0.5677642275376736 -
5.0321307826225441
-0.1889144556522059 0.9361190534810413-0.2966352072080960 -
0.1879307077399003
0.53559151329776330.35141200194394760.7678875801659764-8.6392744988384500

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam6

1713.1018600000000000 0.0000000000000000943.8974319999999800
0.0000000000000000 1709.0667370000001000 528.9047769999999700
0.00000000000000000.0000000000000000 1.0000000000000000
0
0
0.94932711981979300.0708516731449436-0.3061993794690294 -
3.0984736441840877
-0.1682636624828197 0.9374477574390687-0.3047606305944534 -
0.1284203766396696
0.26545312102615090.34083976071612190.9018663415675587-9.5777777735865079

0.00000000000000000.00000000000000000.0000000000000000 1.0000000000000000

param_cam7

1714.998687999999000 0.000000000000000 933.304469000000400
0.000000000000000 1710.6083040000001000 527.822525000000400
0.000000000000000 0.000000000000000 1.000000000000000
0
0
0.94768902405799790.0872295031844723 -0.3070448297141466 -
2.6155212346664229
-0.1823677850126759 0.9374421520012883 -0.2965538781414999 -
0.0668615729808866
0.26196851847038710.33703594085109580.9043114894244387 -9.6827004774310534

0.000000000000000 0.000000000000000 0.000000000000000 1.000000000000000

param_cam8

1715.842032000000000 0.000000000000000 934.849535999999400
0.000000000000000 1711.8982840000001000 530.157331000000000
0.000000000000000 0.000000000000000 1.000000000000000
0
0
0.98430188992705210.1450375015733491 -0.1005679502793718 -
0.4790670372212257
-0.1677482789191331 0.9459339986962959 -0.2776137335041348
0.1917461569709312
0.05486624103856720.29012582313161440.9554144139306781 -9.9849210269545061

0.000000000000000 0.000000000000000 0.000000000000000 1.000000000000000

param_cam9

1716.2547360000001000 0.000000000000000 946.141868000000400
0.000000000000000 1712.445549999999000 512.677157999999600
0.000000000000000 0.000000000000000 1.000000000000000
0
0
0.98652453270237200.1380794271431578 -0.0877691185792798
0.0161142681814658
-0.1575310100845682 0.9465214509052367 -0.2815690392034982
0.2649501385419422
0.04419646182786530.29160112272771320.9555184236768201 -10.0052053712539820

0.000000000000000 0.000000000000000 0.000000000000000 1.000000000000000