

# CE 59700: Digital Photogrammetric Systems

## Lab 1: Bundle Adjustment with Self Calibration (BASC)

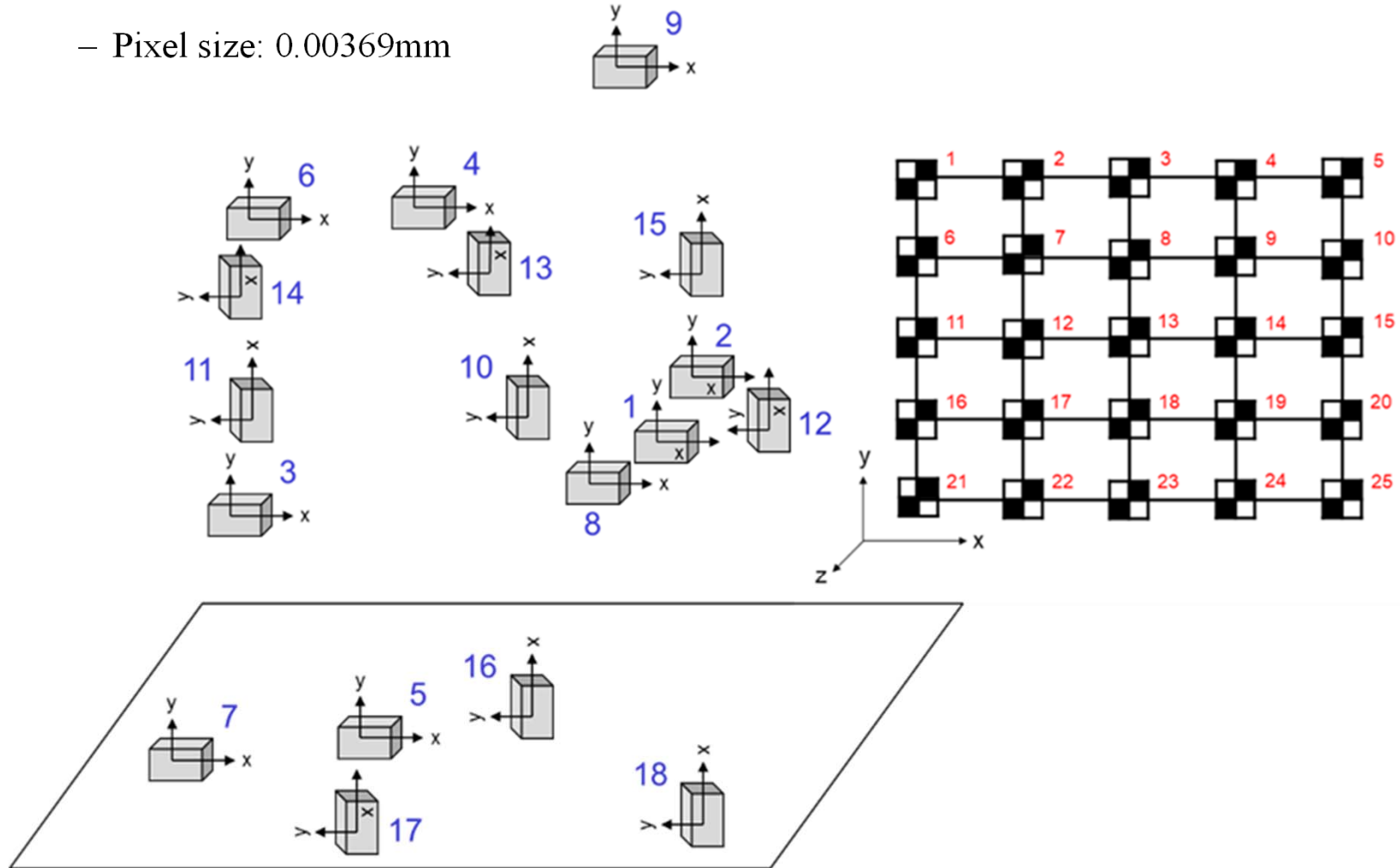
# Objectives

- Determine the camera's Interior Orientation Parameters (IOPs) using a bundle adjustment with self calibration procedure.

# Given

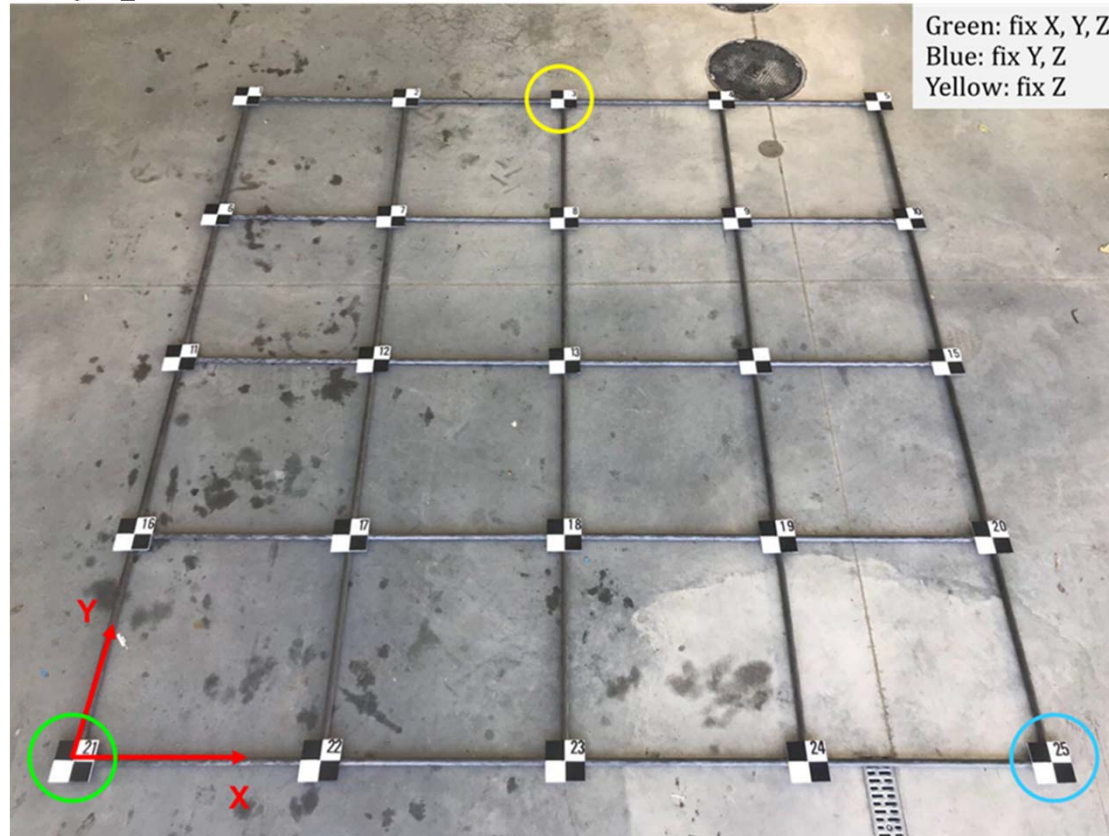
- Eighteen images of a calibration test field

– Pixel size: 0.00369mm



# Given

- Necessary parameters for datum definition

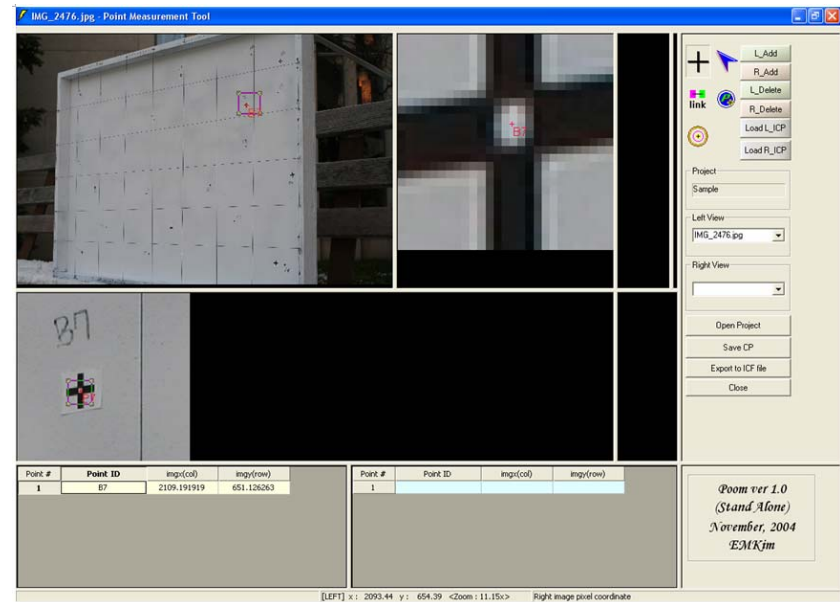


Fixed coordinates are shown.

Some distances have been also measured.

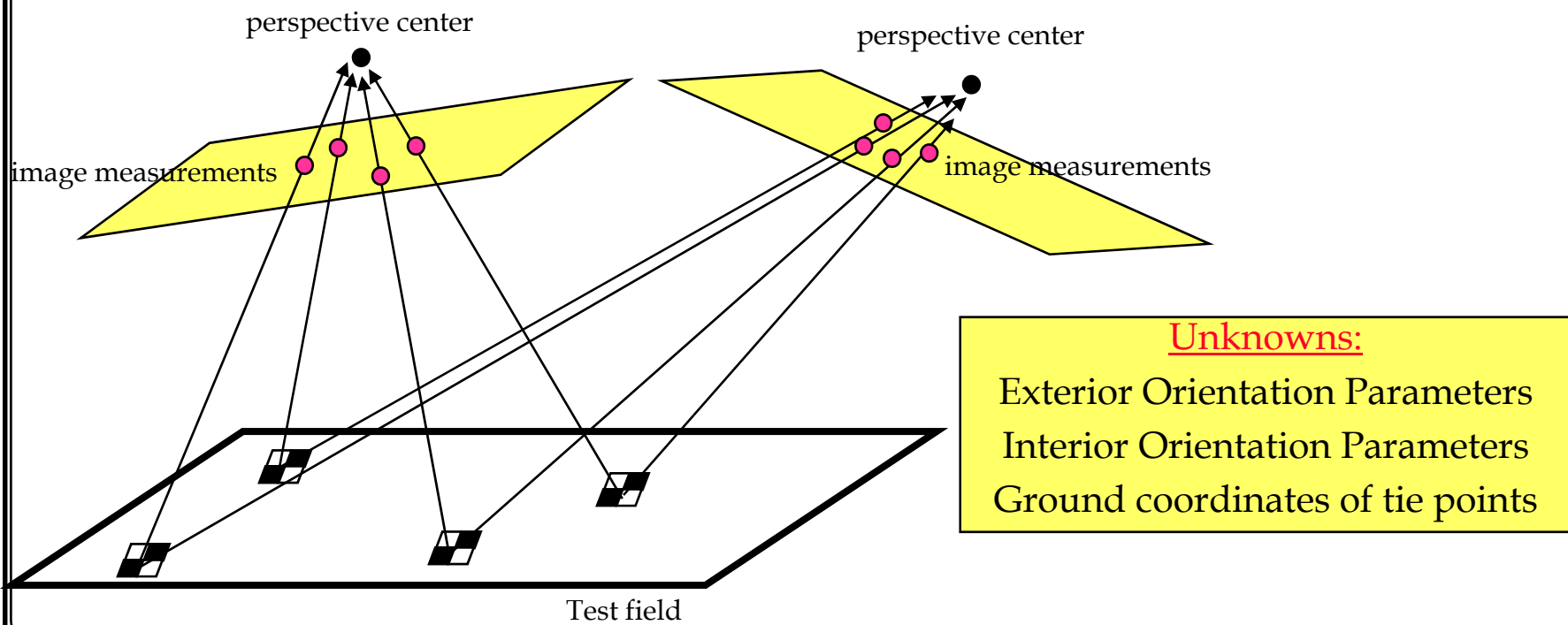
# Given

- Two Software Packages:
  - BASC (Bundle Adjustment with Self Calibration)
  - POOM (image measurement software)



# Camera Calibration

- In addition to the Exterior Orientation Parameters (EOPs) of all images, the camera characteristics and ground coordinates of tie points are also considered as unknowns.



# Step1: Image Measurement

1. Image measurements for sixteen images are provided.
2. Measure pixel coordinates in the remaining two images (65\_09\_20180803.jpg & 65\_17\_20180803.jpg) using **POOM** and convert the pixel coordinates to the image coordinate system.

## Step2: Prepare Input Files and Run BASC

1. Prepare the input files for BASC
  - Project file (\*.prj)
  - Image coordinate file (\*.icf)
  - Ground control points file (\*.gcp)
  - Camera file (\*.cam)
  - Orientation file (\*.ori)
  - Distance file (\*.dis)
  
2. Run BASC
  
2. Analyze the results



# Step2: Sample Files

## 1. Project file (\*.prj)

```
!noiter>>maxSigma>>minCov>>minCov2>>gpsAvail>>insAvail>>distanceAvail;
```

```
25      1.0e-8    1.0e+4    1.0e-7          0          0          1
```

## Step2: Sample Files

### 2. Image coordinate file (\*.icf)

Image ID	Point ID	x (mm)	y (mm)	weight matrix			
GOPRO0001.jpg	11	-6.57477	6.24022	1.0	0.0	0.0	1.0
GOPRO0001.jpg	13	-2.66084	5.63411	1.0	0.0	0.0	1.0
GOPRO0001.jpg	12	-4.54673	5.58374	1.0	0.0	0.0	1.0
GOPRO0001.jpg	14	-0.83127	5.49290	1.0	0.0	0.0	1.0
GOPRO0001.jpg	16	2.43619	5.29403	1.0	0.0	0.0	1.0

You need to add the image coordinate measurements for the remaining two images.

# Step2: Sample Files

## 3. Ground control points file (\*.gcp)

Point ID	X	Y	Z	variance covariance matrix								
11	0.045	-0.003	0.511	1.00E-09	0	0	0	1.00E-09	0	0	0	1.00E-09
12	0.140	0.000	0.497	1.00E+10	0	0	0	1.00E+10	0	0	0	1.00E+10
13	0.239	0.000	0.504	1.00E+10	0	0	0	1.00E+10	0	0	0	1.00E+10
14	0.341	-0.001	0.499	1.00E-09	0	0	0	1.00E-09	0	0	0	1.00E-09
15	0.452	0.000	0.501	1.00E+10	0	0	0	1.00E+10	0	0	0	1.00E+10
16	0.560	0.000	0.508	1.00E+10	0	0	0	1.00E+10	0	0	0	1.00E+10

Control point

Tie point

# Step2: Sample Files

## 4. Camera file (\*.cam)

!CameraID	type	xp	yp	c		
GOPRO	FRAME	0.0	0.0	3.0		
!Dispersion matrix of xp,yp,c (3x3)						
25.0	0.0	0.0				
0.0	25.0	0.0				
0.0	0.0	25.0				
!No. of distortion parameters						
7						
0.0	0.0	0.0	0.0	0.0	0.0	0.0
!Dispersion matrix of distortion parameters (7x7)						
1.0e-9	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	1.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	1.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	1.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	1.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	1.0e-9
!GPS offsets: dx, dy, dz						
0.0	0.0	0.0				
!Dispersion matrix of GPS offsets (3x3)						
1E-12	0.0	0.0				
0.0	1E-12	0.0				
0.0	0.0	1E-12				

# Step2: Sample Files

## 5. Orientation file (\*.ori)

!Image id	Camera	sig-XY				
!-----						
GOPRO0001.jpg	GOPRO	0.000755				
!time	omega	phi	kappa	X	Y	Z
!-----						
1.00	90.0	-30.0	0.0	-0.5	-1.5	0.5
GOPRO0002.jpg	GOPRO	0.000775				
2.00	90.0	-30.0	90.0	-0.5	-1.5	0.5
.						
.						
.						

You need to come up with the EOPs for eight out of the sixteen images.

## Step2: Sample Files

### 5. Distance file (\*.dis)

- This file provides the distance measurements between some points.

!Beginning point ID	End Point ID	Distance	Variance
2	6	2269	10

# Deliverables and Report Preparation

- Measured image coordinates in mm as exported from **POOM**
- The rationale and procedure behind preparing the initial approximations of the unknown exterior orientation parameters
- The final camera characteristics including the distortion parameters (found in the \*.out file)
- Tabulate your results for the EOPs of all images (found in the \*.out file)
- The final residuals of the image coordinates (found in the \*.res output file)
- The calculated variance component for each iteration (found in the \*.sigma file)
- Explanation of any problems encountered