

NAVER LABS Mapping & Localization Challenge

SejongRCV-Indoor

세종대학교 RCV 연구실

4학년 조 원

4학년 한대찬

문제 해결 전체 흐름도

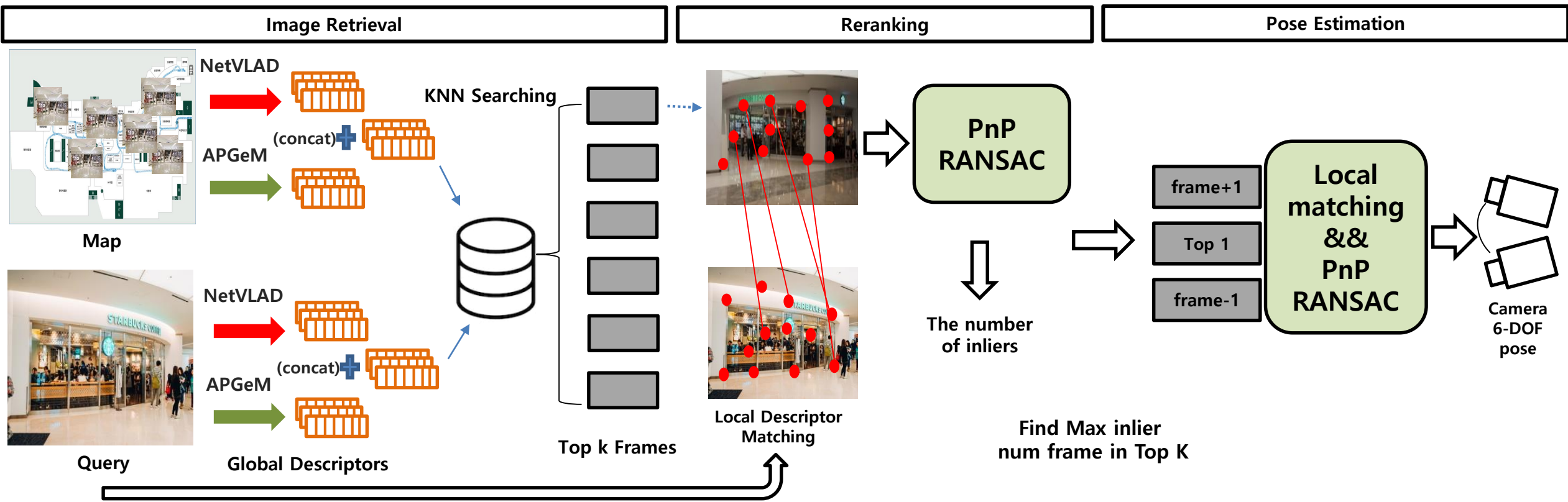


Image Retrieval

Image Retrieval

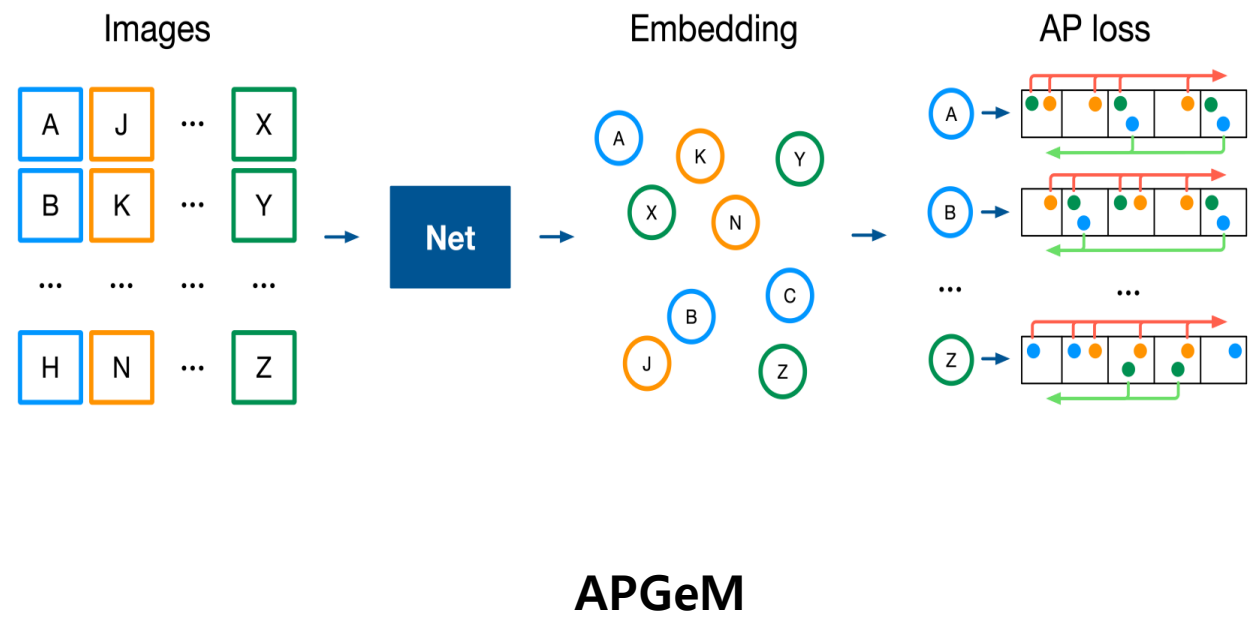
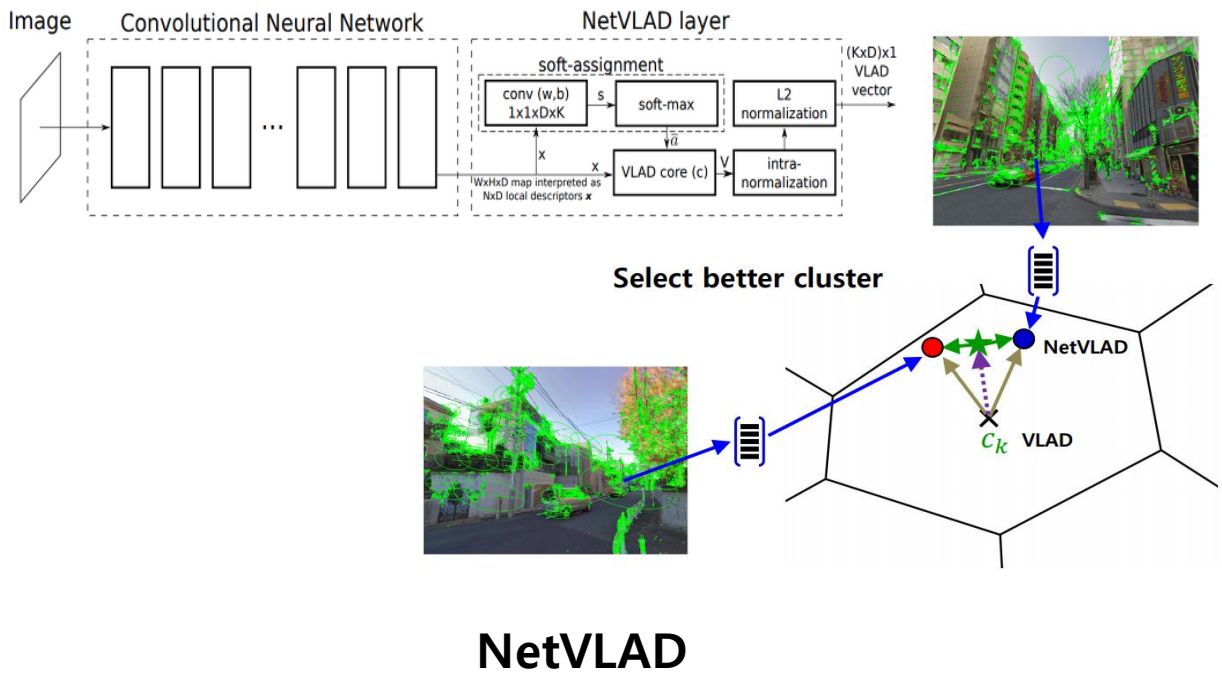


Image Retrieval

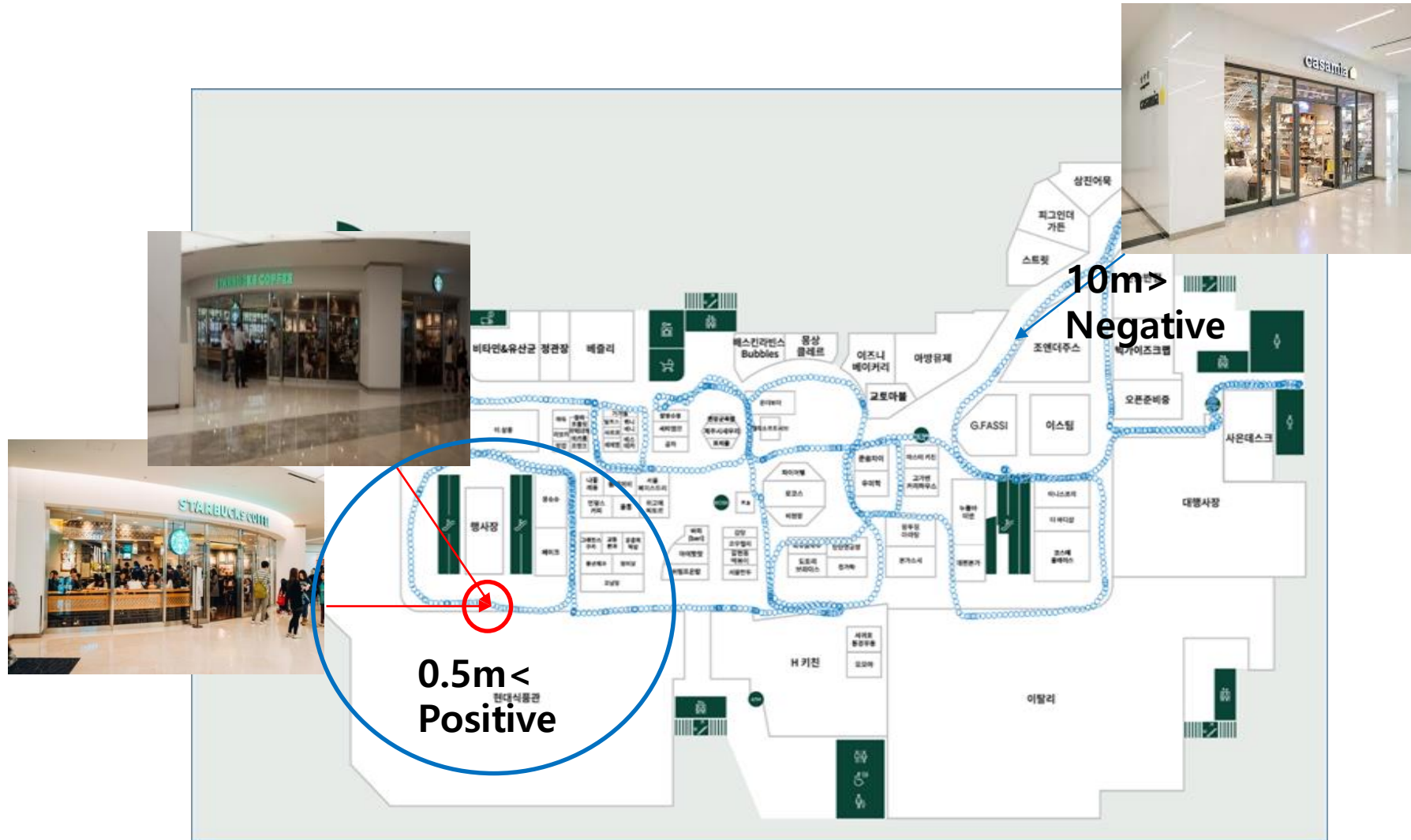
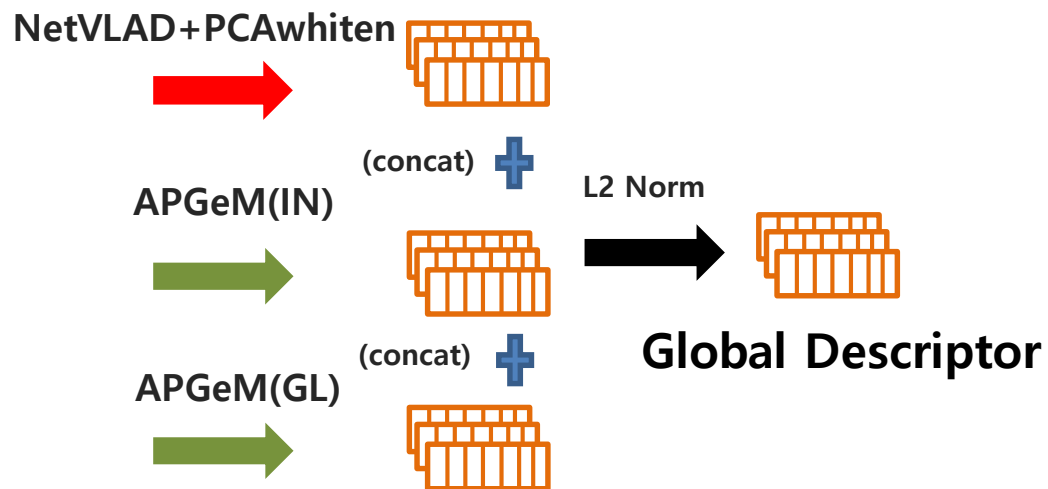


Image Retrieval

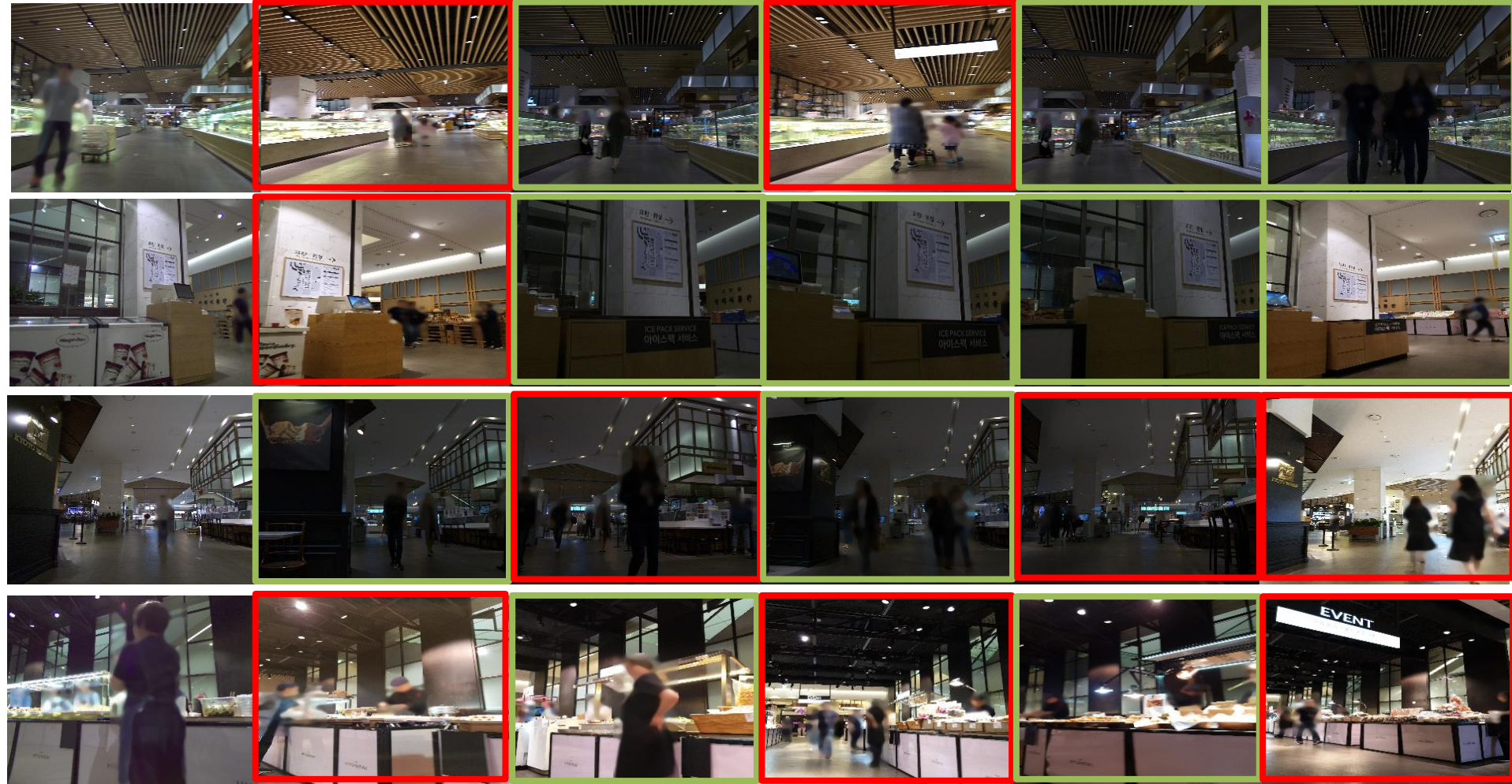
Ensemble



NetVLAD+PCAwhiten(4096)(Naver Indoor) , APGeM(1024)(Oxford+ImageNet) , APGeM(1024)(Google Landmark)
 총 (6144) 차원의 Ensemble 형태의 **Global Descriptor** 구성

Image Retrieval

정성적 성능 평가



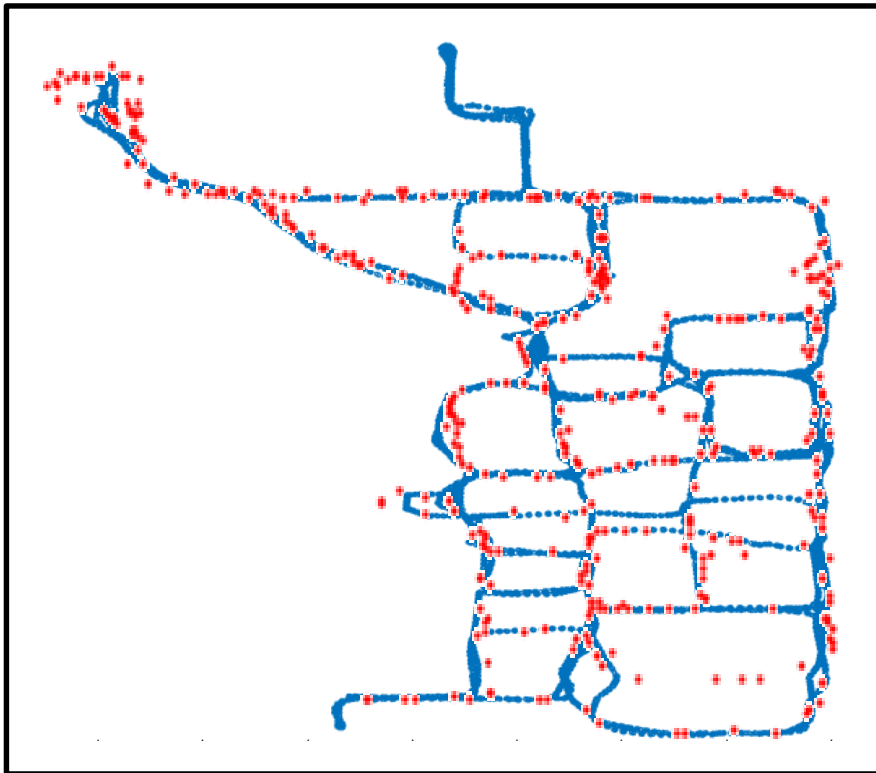
Query

Top 5

Image Retrieval

Train / Validation

Indoor b1 dataset -> Train(80%) / Validation(20%)



Train / Validation sampling

Indoor b1 dataset

Train (22738 장)	Validation (4049 장)
2019-04-16_15-35-46	2019-08-20_10-41-18
2019-04-16_16-14-48	2019-08-20_10-41-18



Validation sampling (405 장)
2019-08-20_10-41-18
2019-08-20_10-41-18

Image Retrieval

정량적 평가

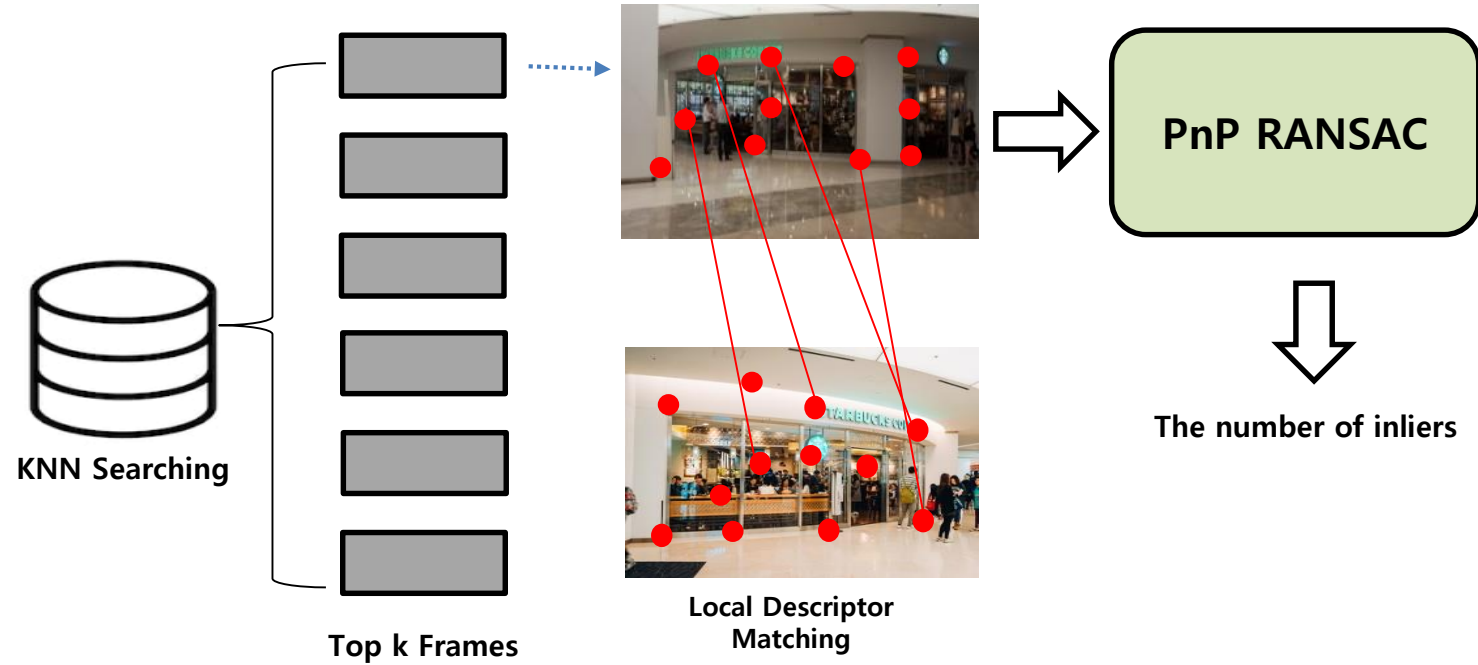
name	pca	performance (top 1)	performance (top 10)
SIFT + VLAD	x	2.22/9.38/40.00	4.68/17.53/64.20
rootSIFT + VLAD	x	1.98/8.89/40.00	4.44/17.78/66.42
D2_NetVLAD (train x)	x	0.99/3.70/17.53	1.48/4.94/29.63
D2_NetVLAD (train o)	x	1.98/7.41/46.91	4.94/20.25/76.30
D2_NetVLAD (train x)	4096	1.73/7.65/37.28	3.46/17.28/68.40
D2_NetVLAD (train o)	4096	1.73/8.89/45.68	4.44/19.75/75.31
Pitts_NetVLAD (train x)	x	1.23/5.43/29.88	3.21/14.07/56.79
Pitts_NetVLAD (train o)	x	1.23/8.40/45.93	4.20/19.75/71.36
Pitts_NetVLAD (train x)	4096	1.73/7.65/34.57	4.20/17.28/67.90
Pitts_NetVLAD (train o)	4096	1.98/9.63/45.68	4.69/20.25/75.80
APGeM	x	1.73/6.42/32.10	2.47/11.60/59.26
APGeM_LM18	x	1.23/7.41/34.32	2.47/14.32/64.94
Ensemble(APGeM + APGeM_LM18 + D2_NetVLAD)	x	1.98/9.88/46.42	4.44/20.00/76.05

D2 Backbone(vgg16)을 사용하고 학습 시키는 것이
더 나은 성능을 보이는 것을 확인

Reranking

Reranking

Pipeline



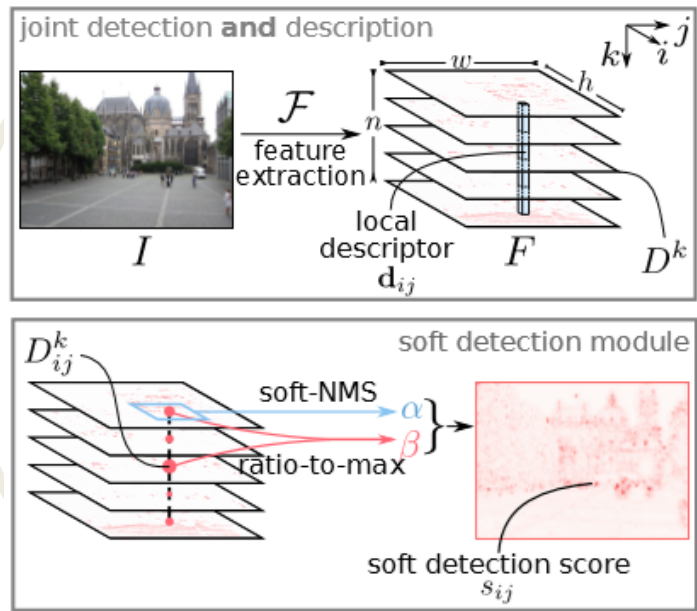
Top k 중 Inlier 개수가 가장 많은 Frame을 찾아 Top 1으로 선정한다.

Reranking

Local Matching

D2-Net

For Top-1

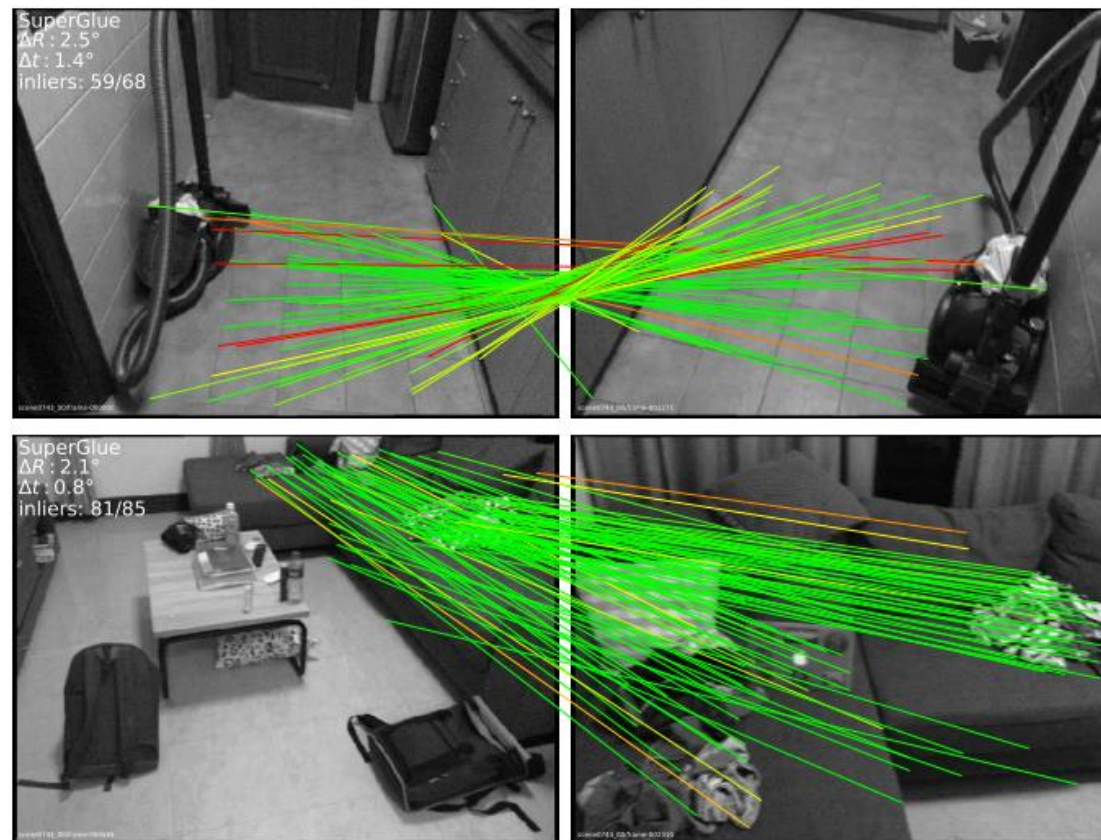
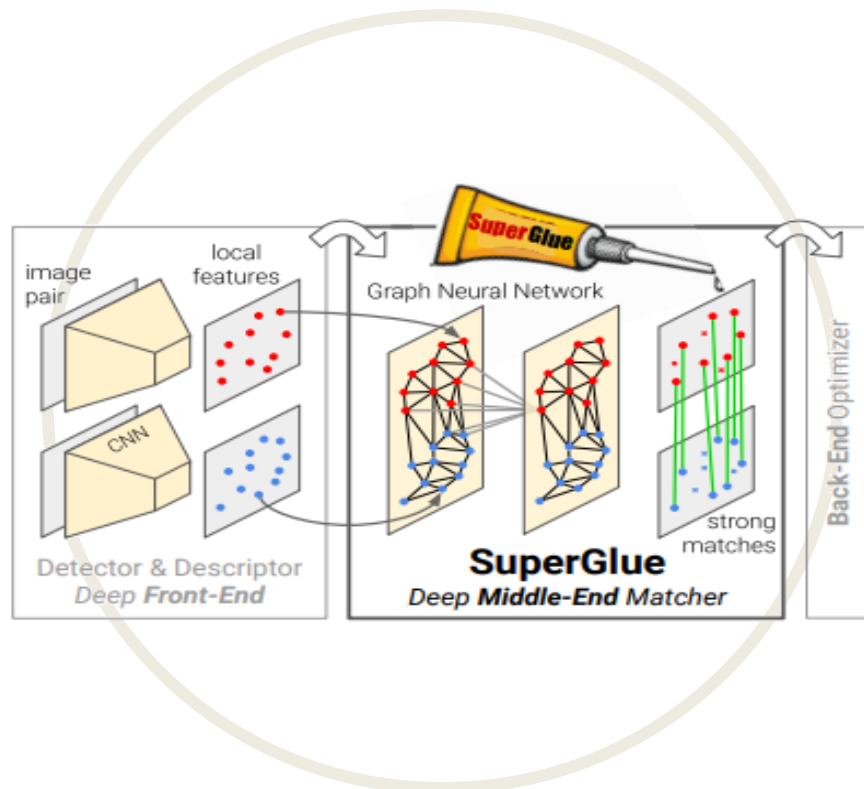


Reranking

Local Matching

SuperPoint & SuperGlue

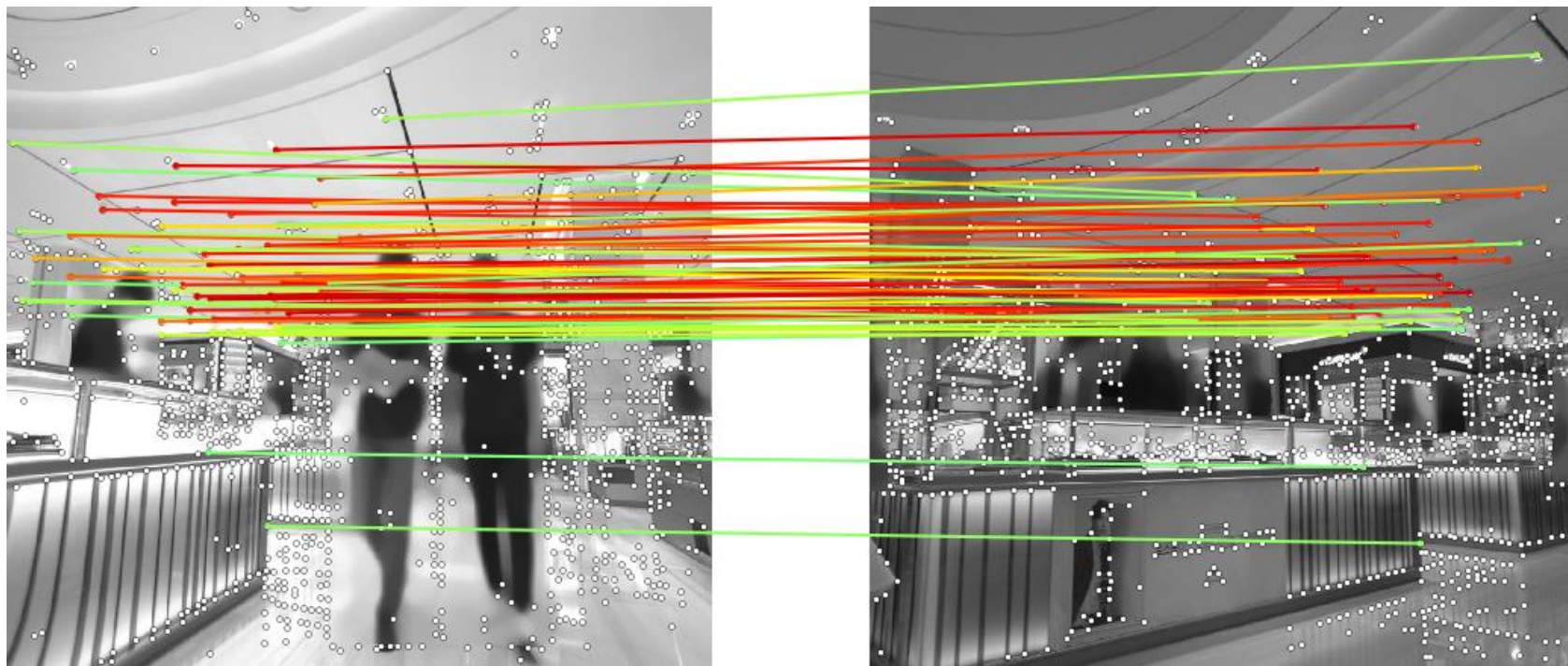
For Top-1



Multiple-view geometry problems

Reranking

Local matching



Query

Top 1

View Point 가 살짝 어긋나있더라도 **Matching 성공**

Reranking

정량적 평가

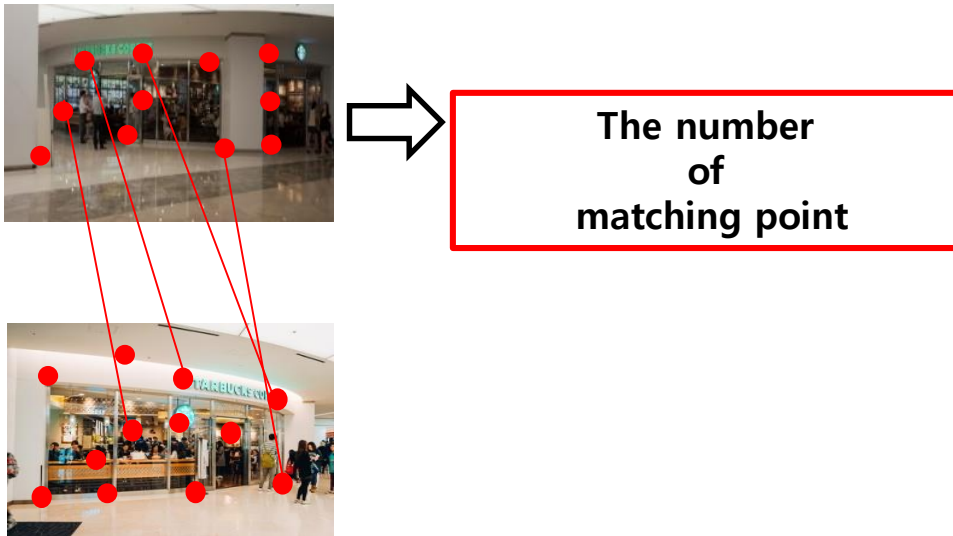
Local matching 평가
(Local matcher를 바꿔가며 pose estimation 까지 진행했을 때의 성능)

name	performance (top 1)
SIFT	17.28/29.63/54.32
rootSIFT	18.77/32.10/58.52
D2 Single Scale (D2 SS)	41.32/52.84/71.60
D2 Multi Scale (D2 MS)	39.75/53.58/70.86
SuperPoint & SuperGlue	37.78/51.36/69.88

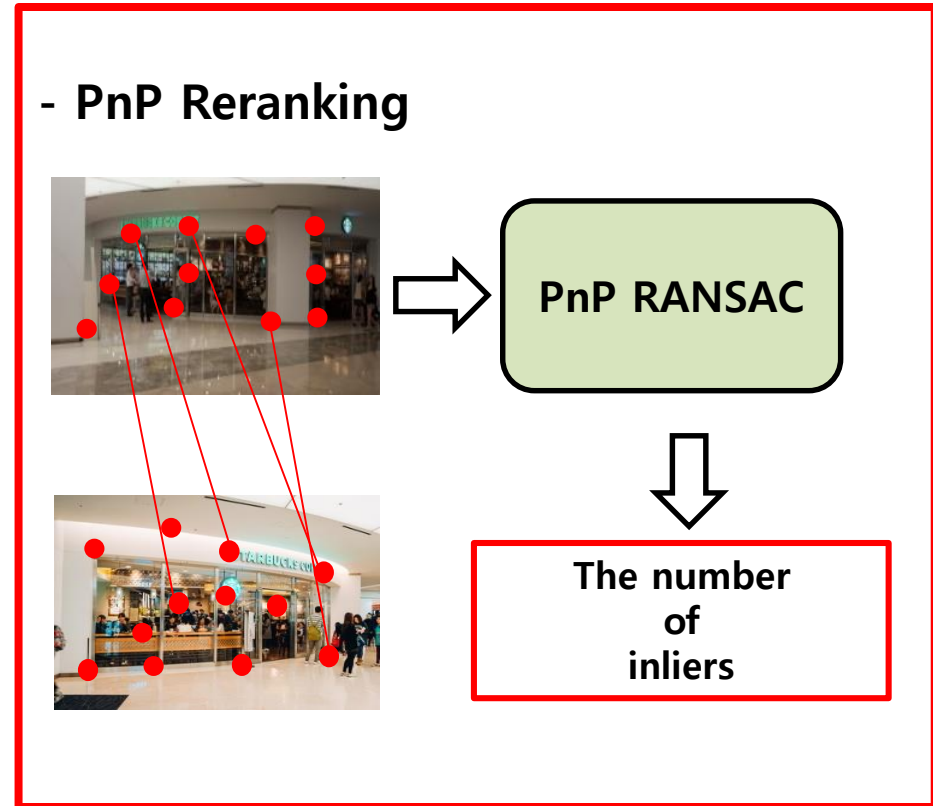
Reranking

Reranking algorithm

- Local Matching Reranking



- PnP Reranking

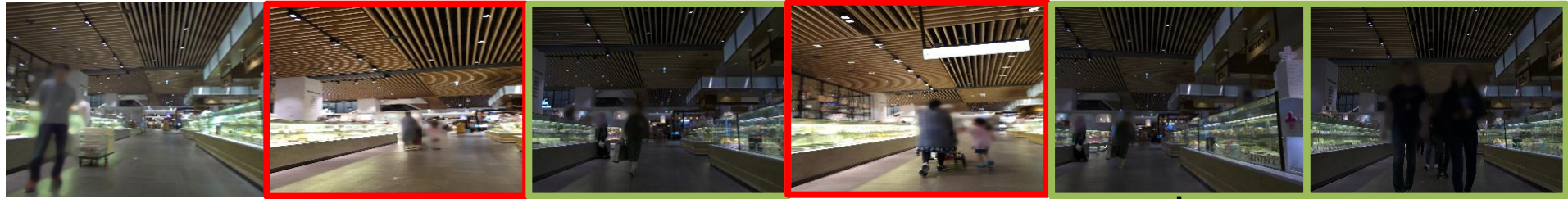


실험을 통해 선정

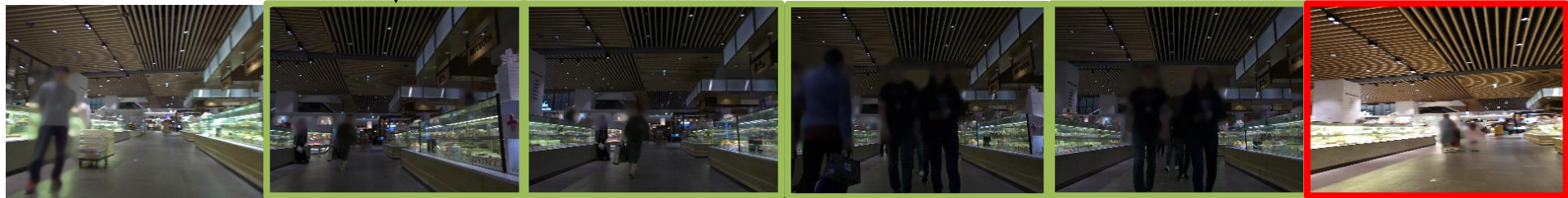
Reranking

정성적 평가

- Reranking 전



- Reranking 후



Reranking

정량적 평가

여러 Reranking 방법을 적용한 후
local matcher에 따른 pose estimation 성능

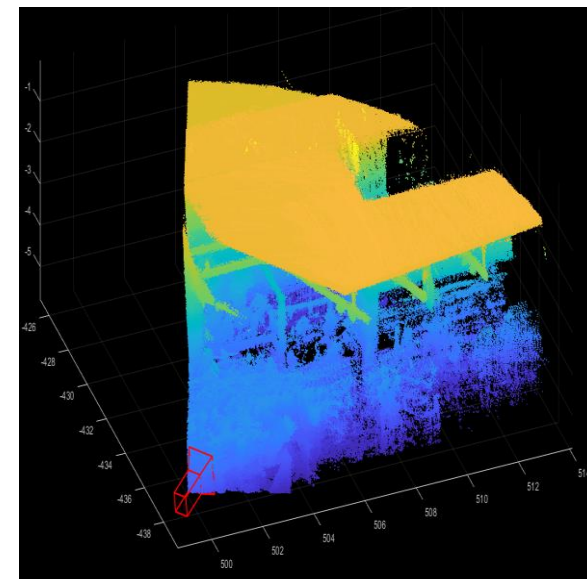
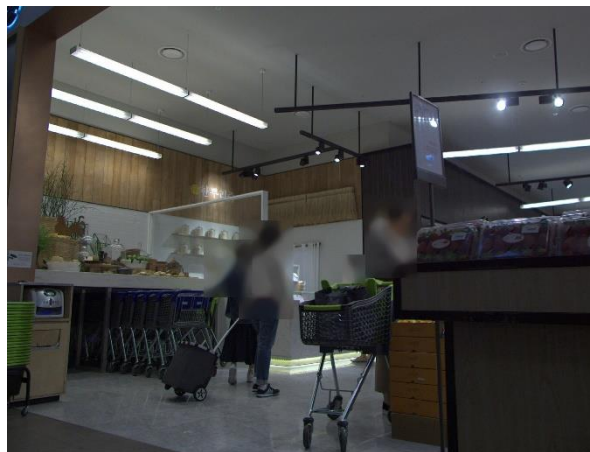
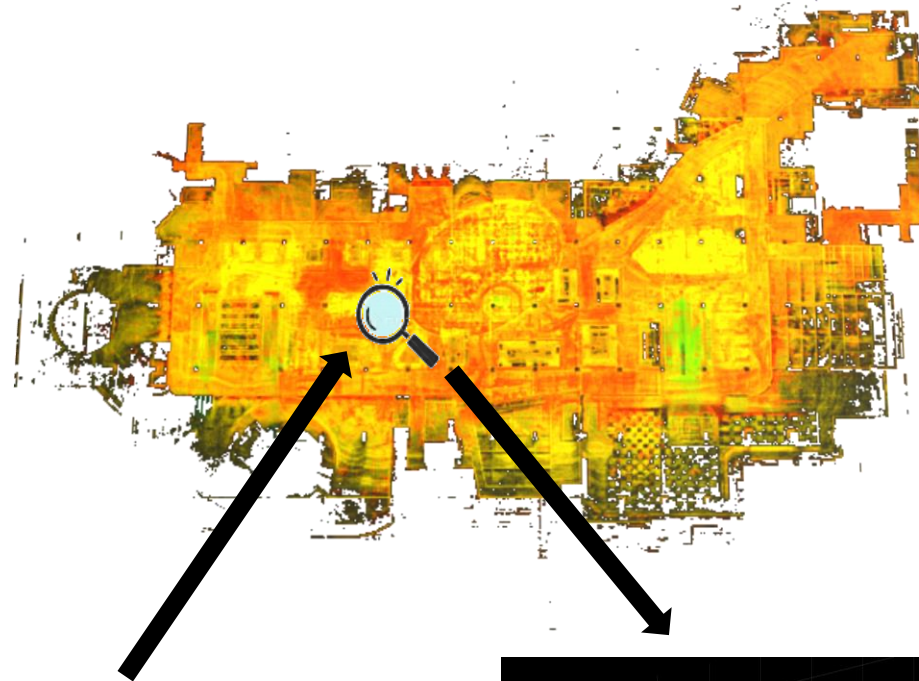
name	performance (Top 1)
Ensemble + D2SS	41.23/52.84/71.60
Ensemble + D2SS + PnPR	51.85/67.41/85.68
Ensemble + D2MS	39.75/53.58/70.86
Ensemble + D2MS + PnPR	51.36/68.40/84.94
Ensemble + SuperGlue	37.78/51.36/69.88
Ensemble + SuperGlue + PnPR	51.60/64.69/85.19

Pose Estimation

Pose estimation

DB 데이터 전처리

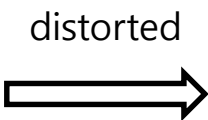
- 제공된 global 3D pointcloud map 사용
- 전체 map이 약 3.4GB에 2.9억개의 포인트로 연산 시 너무 많은 시간이 소요
- DataBase 속 영상 당 3D pointcloud 계산한후 Numpy 형식의 pickle로 저장 후 사용
- 영상 당 약 10초 -> 약 1초 단축



Pose estimation

QR 데이터 전처리

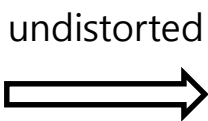
Basler camera



```

camera_parameters.txt - Windows 메모장
파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)
// Delimeter is a single space
// k1, k2, k3: radial distortion coefficient
// p1, p2: tangential distortion coefficient
// {camerald} {image width} {image height} {fx} {fy} {cx} {cy} {k1} {k2} {p1} {p2} {k3}
40027089 2592 2048 1716.28280 1713.79148 1299.03953 1013.52990 -0.2032717 0.2402597 -0.0005943499 -0.002147060 -0.1755963
40029628 2592 2048 1722.61355 1721.63577 1275.30243 992.13280 -0.1676073 0.09076241 -0.0008216913 -0.0006427209 -0.001445933
40030065 2592 2048 1705.26708 1705.66273 1279.42131 1043.08606 -0.2035782 0.2375905 -0.0004143076 -0.001001452 -0.1529464
40031951 2592 2048 1705.96608 1704.38140 1293.23000 1003.98063 -0.2277732 0.3183032 -0.002417126 -0.001141689 -0.2496837
40033113 2592 2048 1706.13584 1705.82533 1311.65649 1005.88848 -0.1755889 0.1322496 -0.001250907 -0.0007547798 -0.03799974
40033116 2592 2048 1735.26550 1733.47093 1264.83282 988.15107 -0.1884311 0.1090200 -0.00006484913 -0.0007721923 0.009144638
    
```

Galaxy s9 camera

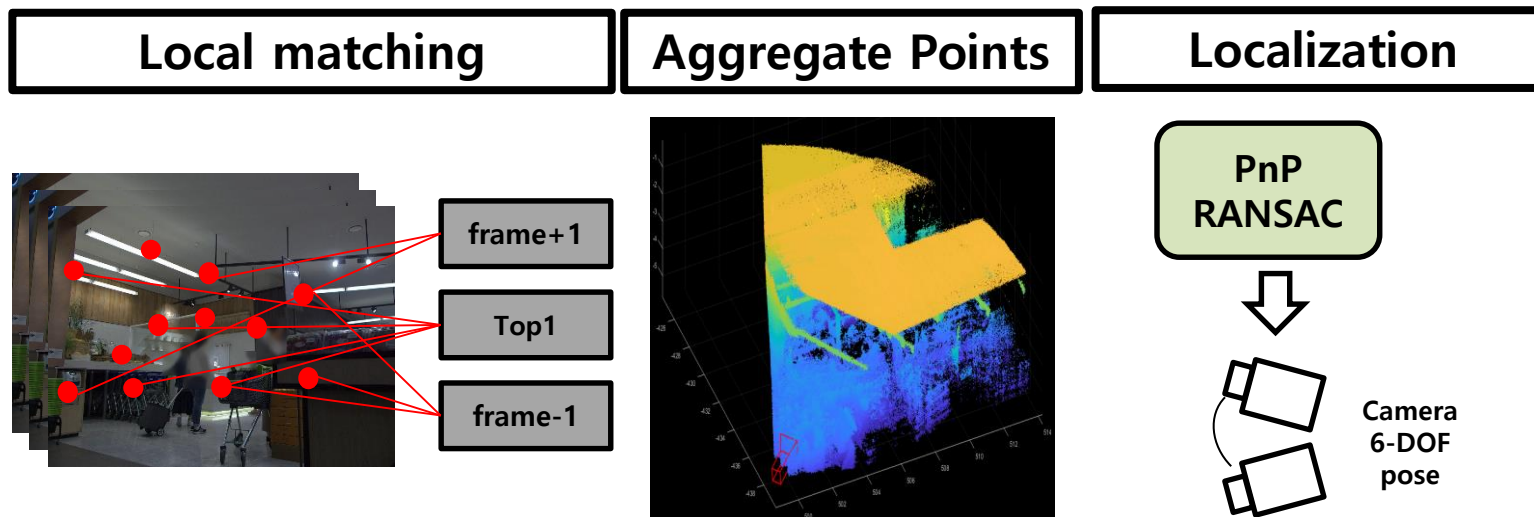


```

AC01324954 2160 2880 2192.6345 2192.6345 1080 1440 0.309526634993 -1.68546591669 0.000516016398484 0.000304875649237 2.77731885597
AC01324955 2160 2880 2192.6345 2192.6345 1080 1440 0.309526634993 -1.68546591669 0.000516016398484 0.000304875649237 2.77731885597
AC01324968 2160 2880 2192.6345 2192.6345 1080 1440 0.309526634993 -1.68546591669 0.000516016398484 0.000304875649237 2.77731885597
AC01324969 2160 2880 2192.6345 2192.6345 1080 1440 0.309526634993 -1.68546591669 0.000516016398484 0.000304875649237 2.77731885597
    
```

Pose estimation

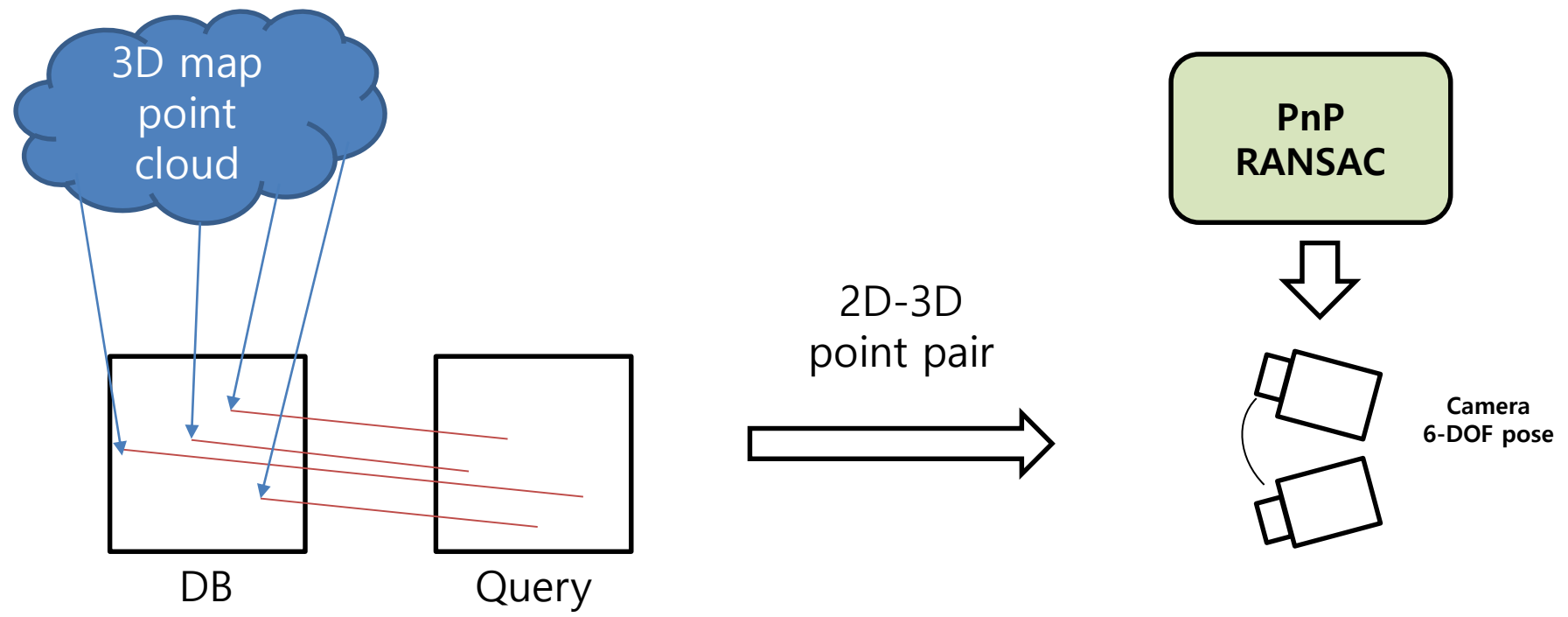
Pipeline



Outlier에 강인한 Pose Estimation을 위해
Top-1의 timestamp상 **앞, 뒤 프레임**을 추가적으로 사용,
총 3장의 영상과 Query의 matching keypoint를
Aggregate 후 PnP 알고리즘을 RANSAC 알고리즘으로 optimizing

Pose estimation

PnP 알고리즘



Pose estimation

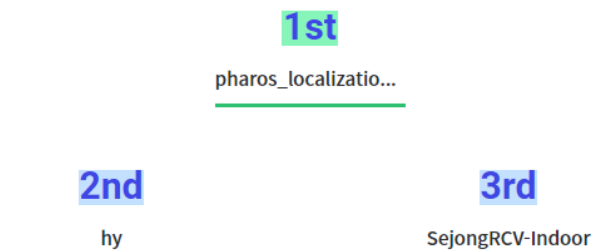
정량적 평가

name	performance (top 1)
D2 SS+ pnpr	51.85/67.41/85.68
D2 SS + pnpr + covis 1	53.83/71.36/87.65
D2 SS + pnpr + covis 2	51.36/68.64/86.67
D2 MS+ pnpr	51.36/68.40/84.94
D2 MS + pnpr + covis 1	54.32/72.35/87.65
D2 MS + pnpr + covis 2	53.33/69.14/85.68
SuperPoint & SuperGlue + pnpr	51.60/64.69/85.19
SuperPoint & SuperGlue + pnpr + covis 1	50.62/68.40/86.42
SuperPoint & SuperGlue + pnpr + covis 2	50.12/68.15/86.42

Result

KCCV 2020

Indoor Top3



Outdoor Top3



Indoor

순위	참가팀명	정확도(B1)	정확도(1F)	정확도(종합)	업데이트
1	pharos_localization.launch	82.61 / 92.71 / 95.36	86.74 / 98.07 / 99.44	84.68 / 95.39 / 97.40	2020.07.31, 23:54
2	hy	74.40 / 92.04 / 95.82	80.14 / 95.18 / 99.03	77.28 / 93.61 / 97.43	2020.07.31, 23:46
3	SejongRCV-Indoor	72.72 / 87.10 / 94.65	73.39 / 91.11 / 98.68	73.05 / 89.11 / 96.67	2020.07.31, 23:56
	RootSIFT+NetVLAD (baseline)	33.15 / 39.42 / 70.47	43.68 / 51.80 / 69.83	38.42 / 45.62 / 70.15	

Thank you for attention



jwon, dchan, ykchoi @rcv.sejong.ac.kr



Visit to our GitHub! : <https://github.com/sejong-rcv/SejongRCV-Indoor>