Semi-Global Matching 추가 이론 및 구현

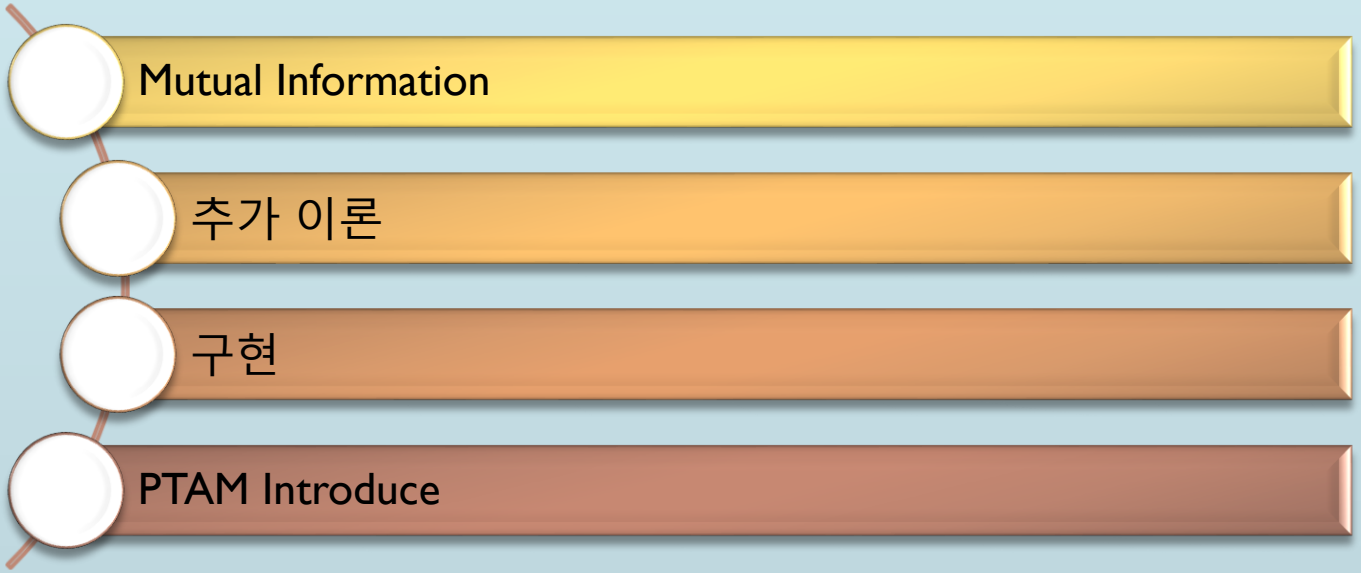
Heiko Hirschmuller, 2005, IEEE CVPR,
Accurate and Efficient Stereo Processing by Semi-Global Matching and Mutual Information

PTAM Introduce

Georg Klein, David Murray, 2007, ISMAR
Parallel Tracking and Mapping for Small AR Workspace

유 용길

목차

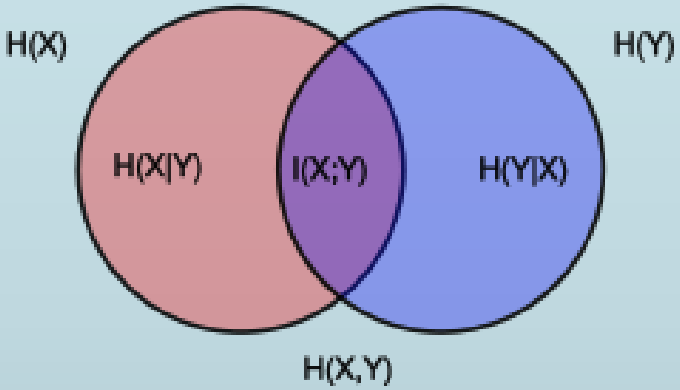


Mutual Information

- Mutual Information(상호 정보량)

$$MI(A,B) = \int_{A \in a} \int_{B \in b} \frac{P(A \cap B)}{P(A) * P(B)} dA dB$$

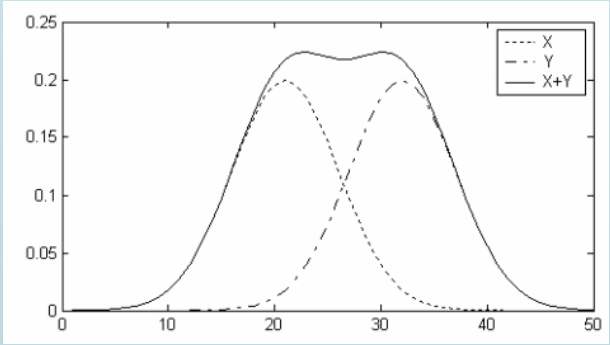
  - 두 사건 사이의 확률로 서로의 연관성이 얼마나 깊은지 확인하는 척도.



Mutual Information

$$MI_{I_1,I_2} = H_{I_1} + H_{I_2} - H_{I_1,I_2}$$

- Smooth Kernel을 이용한 MI 추정
  Parzen Window를 가우시안 밀도 함수로 사용



- 제안된 새로운 Entropy Function

$$h(i) = -\frac{1}{n}\log(P_I(i) \otimes g(i)) \otimes g(i)$$

$$H_I = \sum_p -\frac{1}{n}\log(P_I(i) \otimes g(i)) \otimes g(i)$$

$$P_{I_1,I_2}(i,k) = \sum_p \frac{1}{n} T[(i,k) = (I_{1p}, I_{2p})]$$

$$H_{I_1,I_2} = \sum_p -\frac{1}{n}\log(P_{I_1,I_2}(i) \otimes g(i)) \otimes g(i)$$

추가 이론

- Cost Function

$$L_r(p,d) = C(p,d) + \min(L_r(p-r,d), L_r(p-r,d-1) + P_1, L_r(p-r,d+1) + P_1, \min_i L_r(p-r,i) + P_2)$$
$$- \min_k L_r(p-r,k)$$
$$\therefore L_{r_{max}} = C_{max} + P_2$$

- 최종 Cost 계산

  $S(p,d) = \sum_r L_r(p,d)$

  pixel p에서 $S(p,d)$가 작은 d를 Disparity로 선정

- Disparity with Median Filter

  성능 향상을 위해 작은 사이즈(3X3) Window를 가진 Median filter를 Disparity Image에 사용.

- Occlusion 판별

$$D_p = \begin{cases} D_{bp} - if\ |D_{bp} - D_{mq}| \le 1, q = e_{bm}(p, D_{bp}) \\ D_{inv} - otherwise. \end{cases}$$

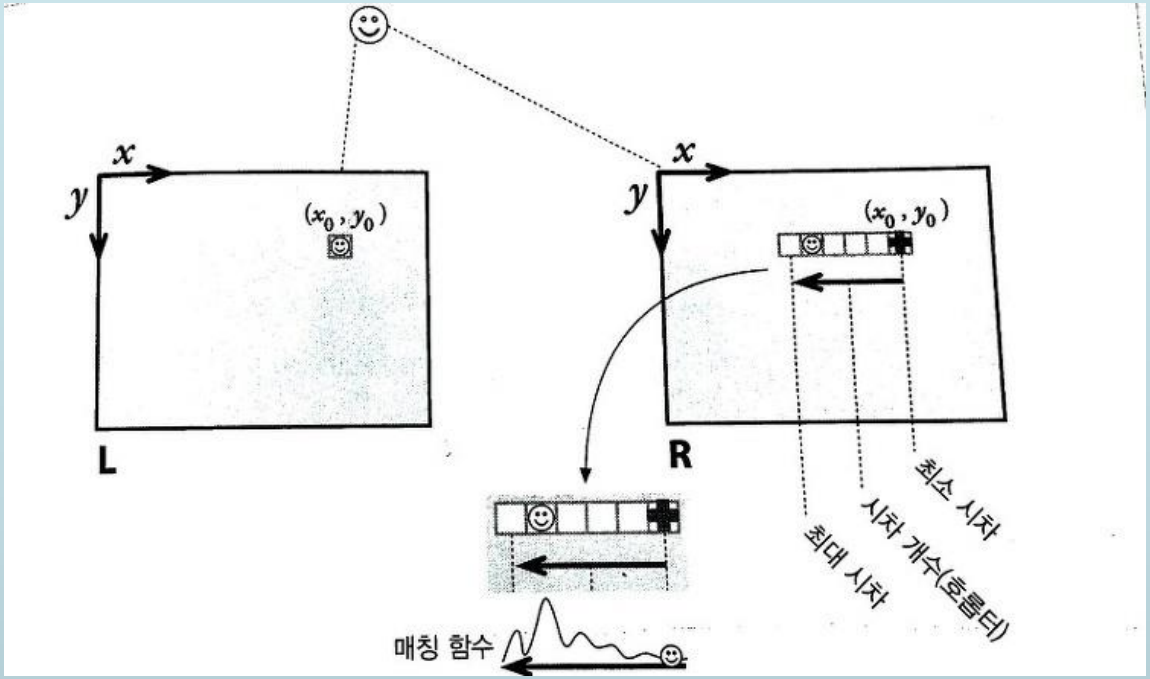
구현

- OpenCV
  SGBM function
  (Semi-Global Block-Matching)

```
//configuration of the algorithm
int mindisp = 0;
int maxdisp = 368;
int channels = m1.channels( );

//prefilter values
int SADsize = 9;
int Pground = channels*SADsize*SADsize;

//postfiltervalues
int disp12MaxDiff = 2;
int preFilterCap = 63;
int uniqueness = 10;
int speckleWS = 100;
int speckleSize = 32;
bool orig=false;

StereoSGBM sgbm(mindisp, maxdisp, SADsize, 8*Pground, 32*Pground, disp12MaxDiff,
                preFilterCap, uniqueness, speckleWS, speckleSize, orig);
sgbm(m1,m2,disp);

Mat disp8;
disp.convertTo(disp8, CV_8U, 255/(maxdisp*16.));
```

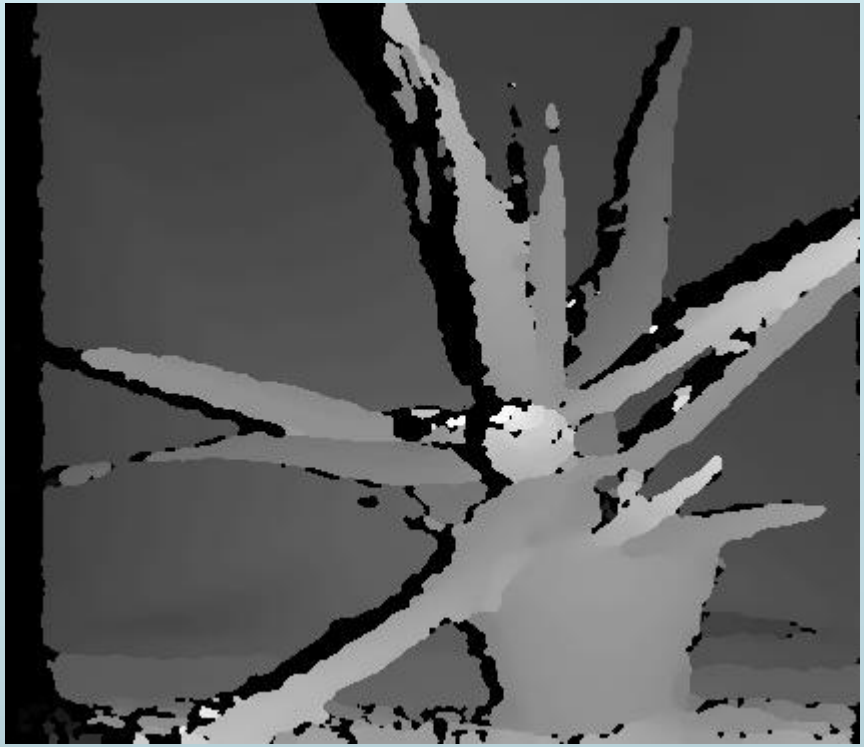
구현

- SAD
  Sum of Absolute Difference.

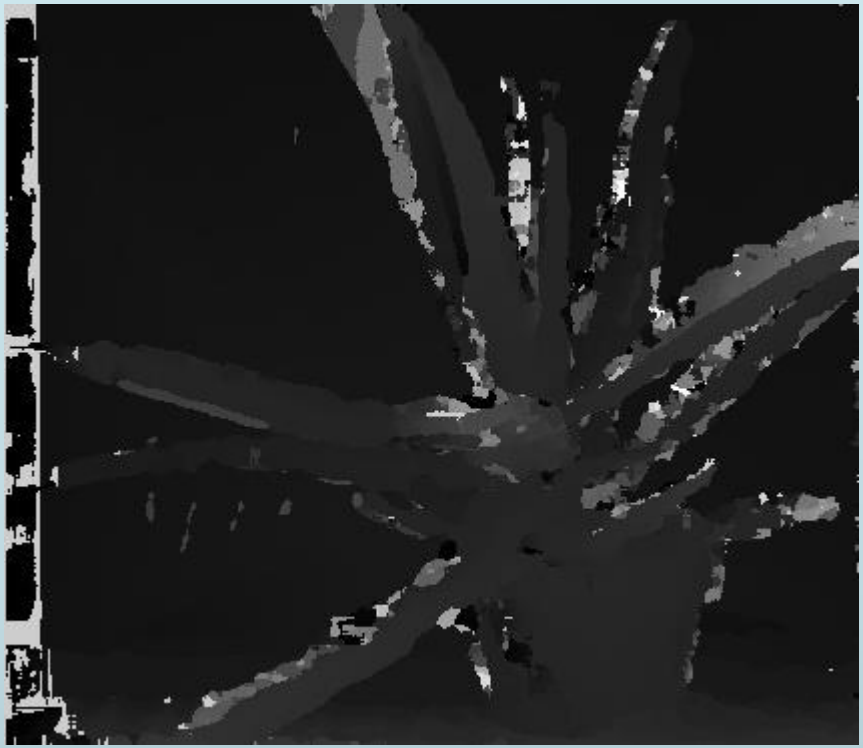


구현

- 결과



<SGBM>



<SAD>

PTAM Introduce

- Parallel Tracking and Mapping.

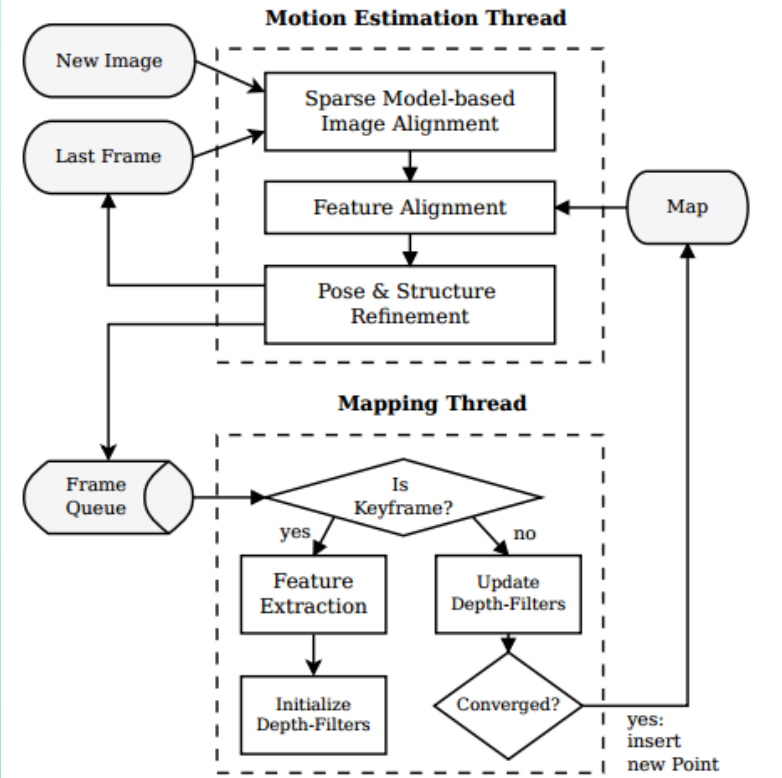
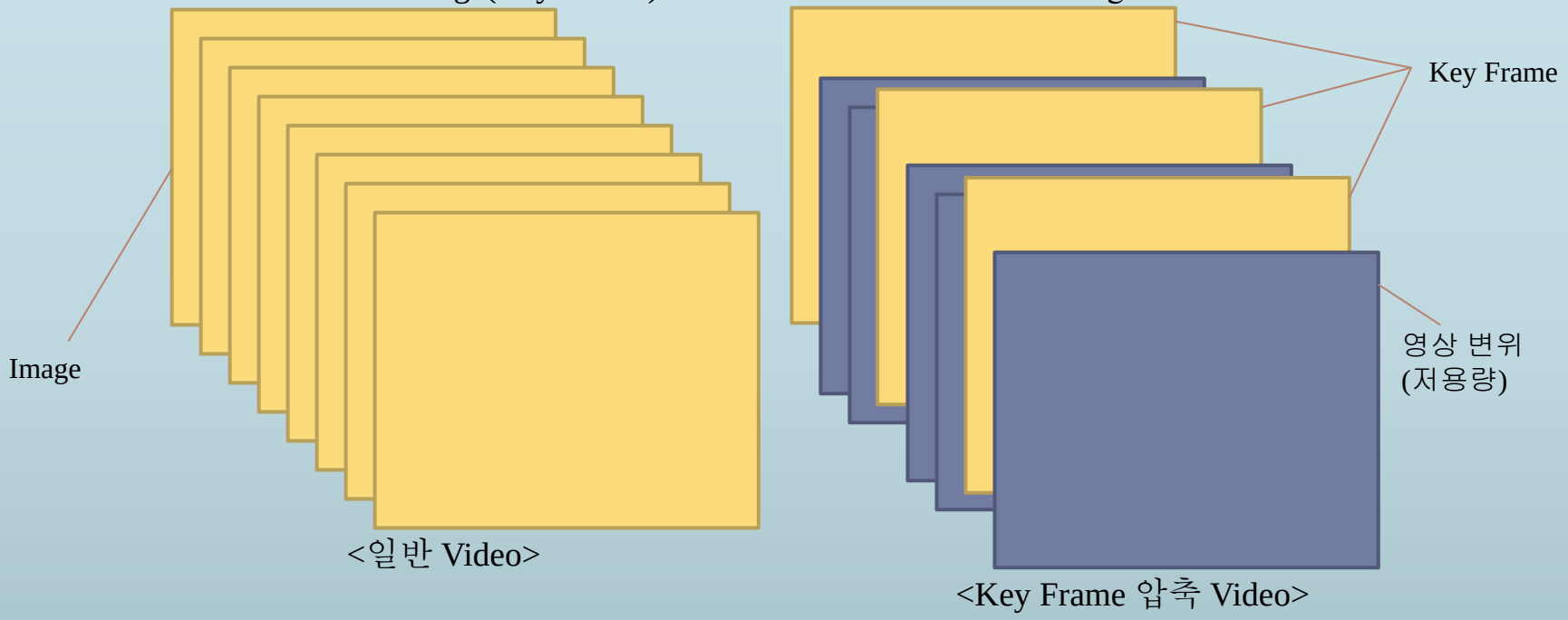


Fig. 1: Tracking and mapping pipeline

<SVO: Fast Semi-Direct Monocular Visual Odometry>
(Christian Forster, Matia Pizzoli, Davide Scaramuzza, ICRA 2014)

PTAM Introduce

- Monocular Visual SLAM using Key Frame.
  - Single Camera.
  - Key Frame.
    - 일반 Video
      - Image + Image + Image … → 대용량 File
    - Key Frame 압축 Video
      - Image(Key Frame) + 영상 변위 + 영상 변위 + Image + … → 압축 File

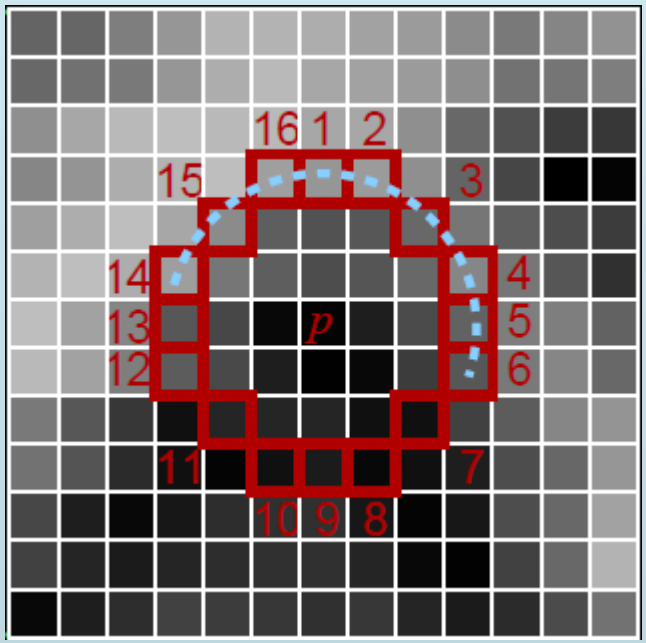


<일반 Video>

<Key Frame 압축 Video>

PTAM Introduce

- Using FAST Algorithm

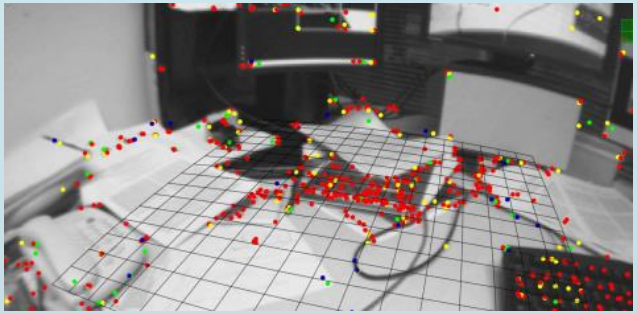


- All much brighter than p
  or
- All much darker than p

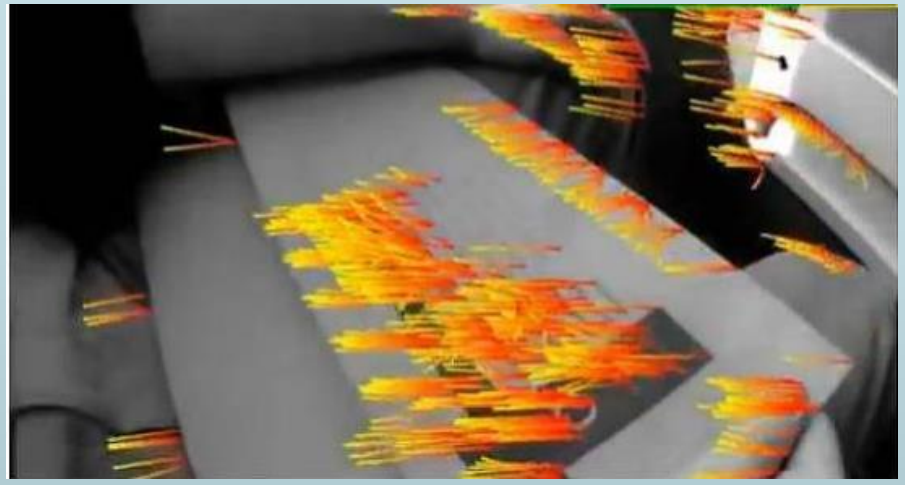
} Corner Pixel

PTAM Introduce

- PTAM
  - FAST 특징점 추출



  - 특징점 추적



  - Key Fame과 추적된 마지막 Frame의 특징점 간의 5-Point Algorithm

PTAM Introduce

PTAM Introduce

Q&A