*Feature Extraction and Scene Interpretation for Map-Based Navigation and Map Building

Line segmentation & extraction

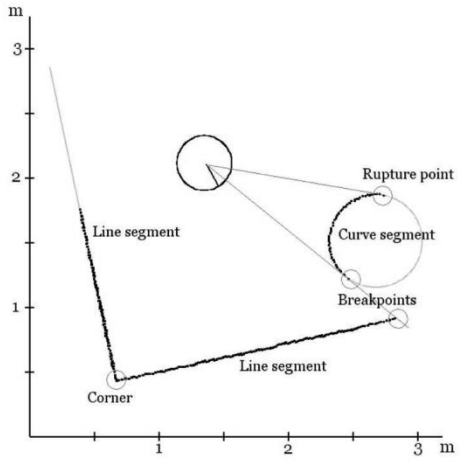
김진형

ISL seminar.

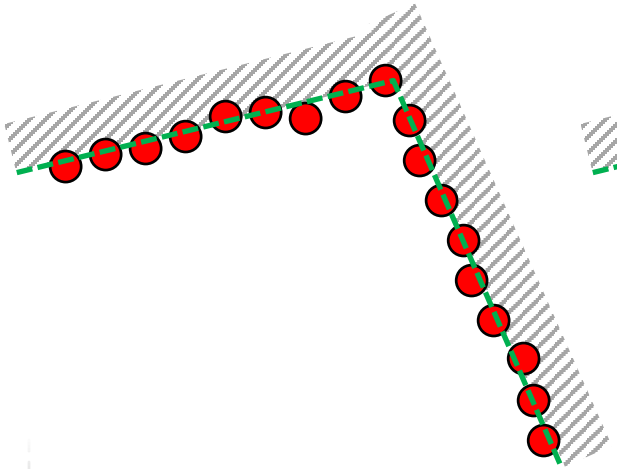
*Arras, Kai O., and Roland Y. Siegwart. "Feature extraction and scene interpretation for map-based navigation and map building." *Intelligent Systems & Advanced Manufacturing*. International Society for Optics and Photonics, 1998.

Line segmentation & extraction

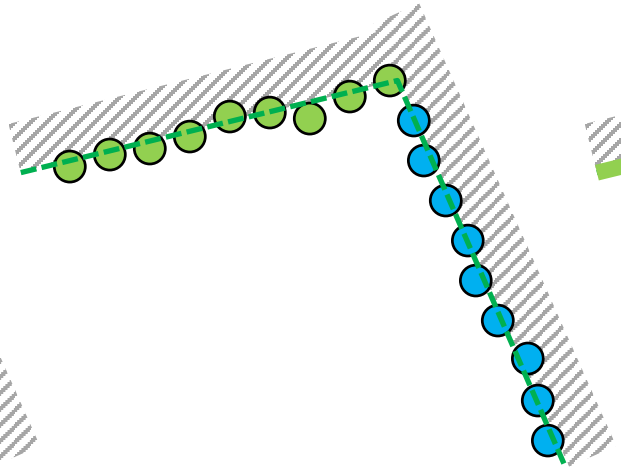
- **Feature**
  - Line segment, curve segment, corner, breakpoint
  - Line segment : the world is consist of several lines! Rather than curve.
- **Line segmentation**
  - Extract point group(which is representing line segments) from LRF measurements
- **Line extraction**
  - Extract LINE from point group



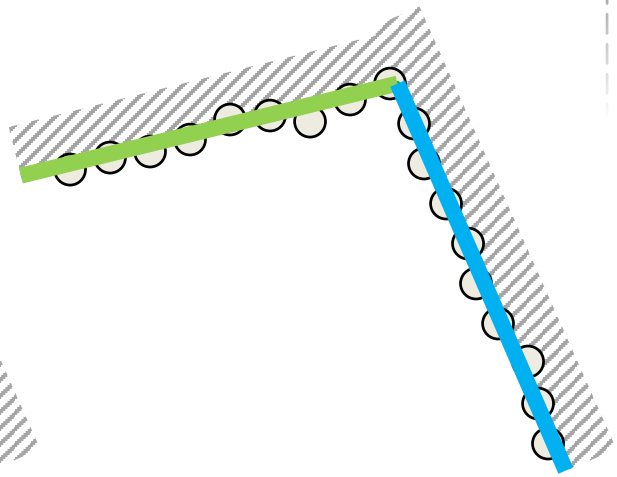
Line segmentation & extraction



LRF Measurements



Line Segmentation



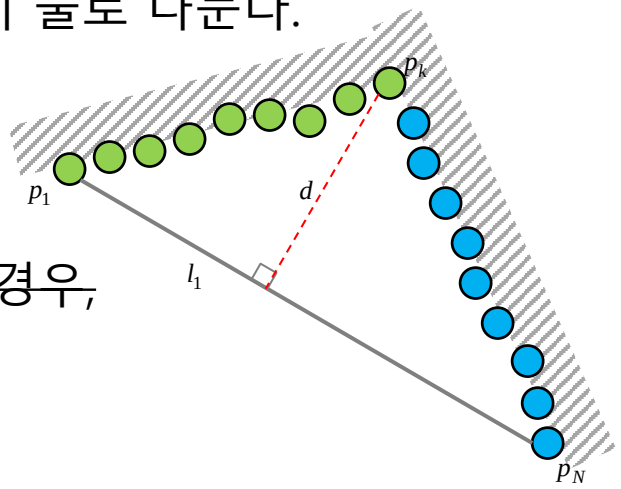
Line extraction

Line segmentation from LRF data

- **Line segmentation**
  - Split-and-Merge algorithm
    - N개의 점들로 이루어진 데이터 집합 $S_1=\{p_i|i=1,\ldots,N\}$에서 시작점 p_1과 끝점 p_N을 연결하는 선분 l_1을 구한다.
    - S_1에서 l_1과 가장 거리가 멀리 떨어진 점 p_k를 찾는다.

      여기서, 수선의 길이는 $d = \dfrac{\overline{p_1p_k} \bullet \overline{p_1p_N}}{\left|\overline{p_1p_N}\right|}$
    - d가 임계값을 넘어가면, S_1을 다음과 같이 둘로 나눈다.

$$S_2 = \{p_i \mid i = 1,\cdots,k\}, S_3 = \{p_i \mid i = k,\cdots,N\}$$



    - 집합 S_2와 S_3에 대하여 1~3과정을 반복
    - ~~모든 데이터가 각각의 선분으로 분해된 경우, 동일 직선상의 선분을 합친다.~~

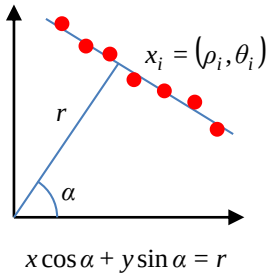
Line extraction

- **Probabilistic line extraction**
  - Line segment를 표현하는 점군에 대하여 least square 방법으로 각 점들로부터 오차가 최소화 되는 직선의 방정식을 구한다.

Polar coordinate

$$\alpha = \frac{1}{2}\tan^{-1}\left(\frac{\sum w_i\rho_i^2 \sin 2\theta_i - \frac{2}{\sum w_i}\sum\sum w_i w_j \rho_i \rho_j \cos\theta_i \sin\theta_j}{\sum w_i\rho_i^2 \cos 2\theta_i - \frac{1}{\sum w_i}\sum\sum w_i w_j \rho_i \rho_j \cos(\theta_i + \theta_j)}\right) + \frac{\pi}{2}$$

$$r = \frac{\sum w_i \rho_i \cos(\theta_i - \alpha)}{\sum w_i}$$



Cartesian coordinate

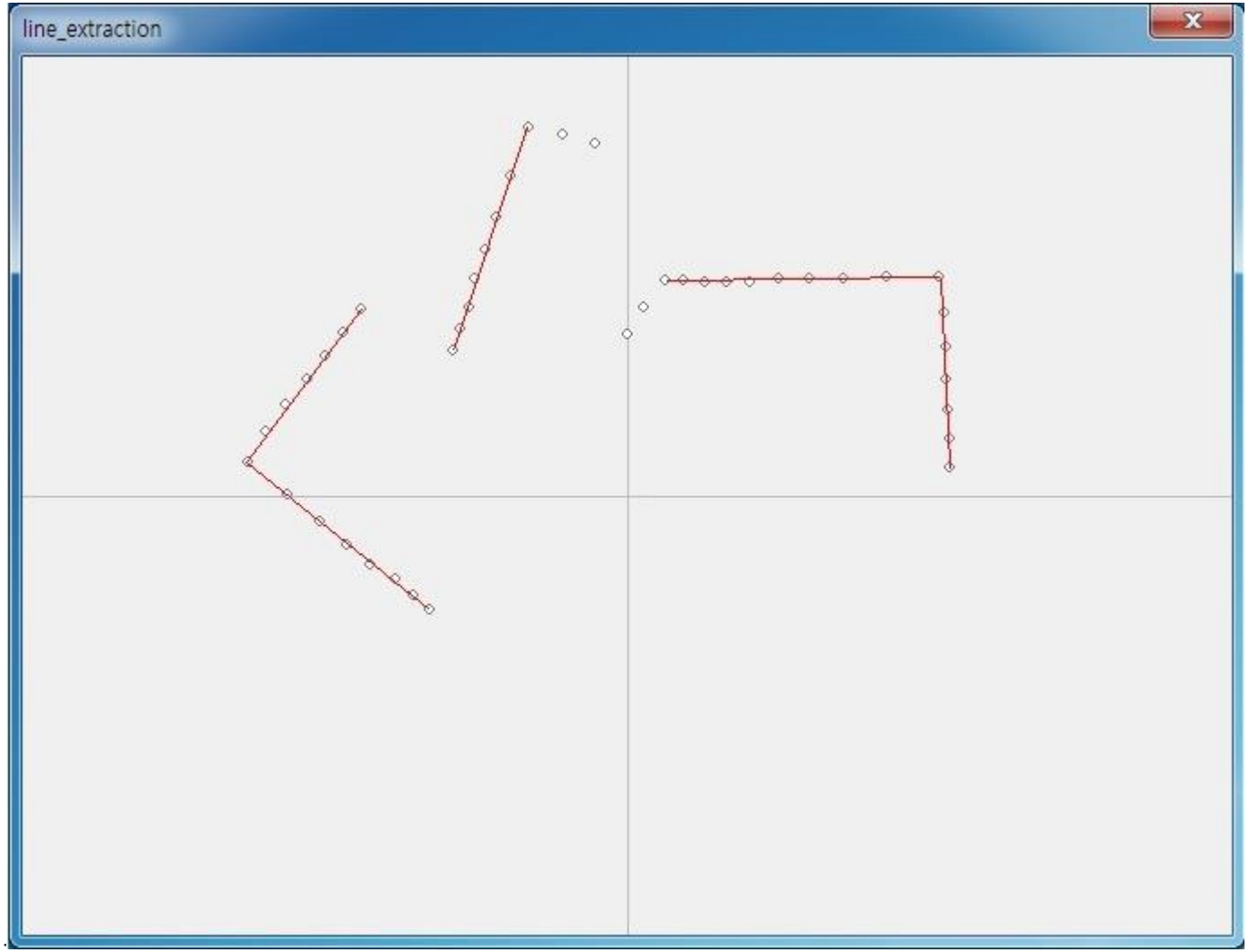
$$\alpha = \frac{1}{2}\tan^{-1}\left(\frac{-2\sum w_i(\bar{y}_w - y_i)(\bar{x}_w - x_i)}{\sum w_i\left((\bar{y}_w - y_i)^2 - (\bar{x}_w - x_i)^2\right)}\right)$$

$$r = \bar{x}_w \cos\alpha + \bar{y}_w \sin\alpha$$

$$\bar{x}_w = \frac{\sum w_i \rho_i \cos\theta_i}{\sum w_i}$$

$$\bar{y}_w = \frac{\sum w_i \rho_i \sin\theta_i}{\sum w_i}$$

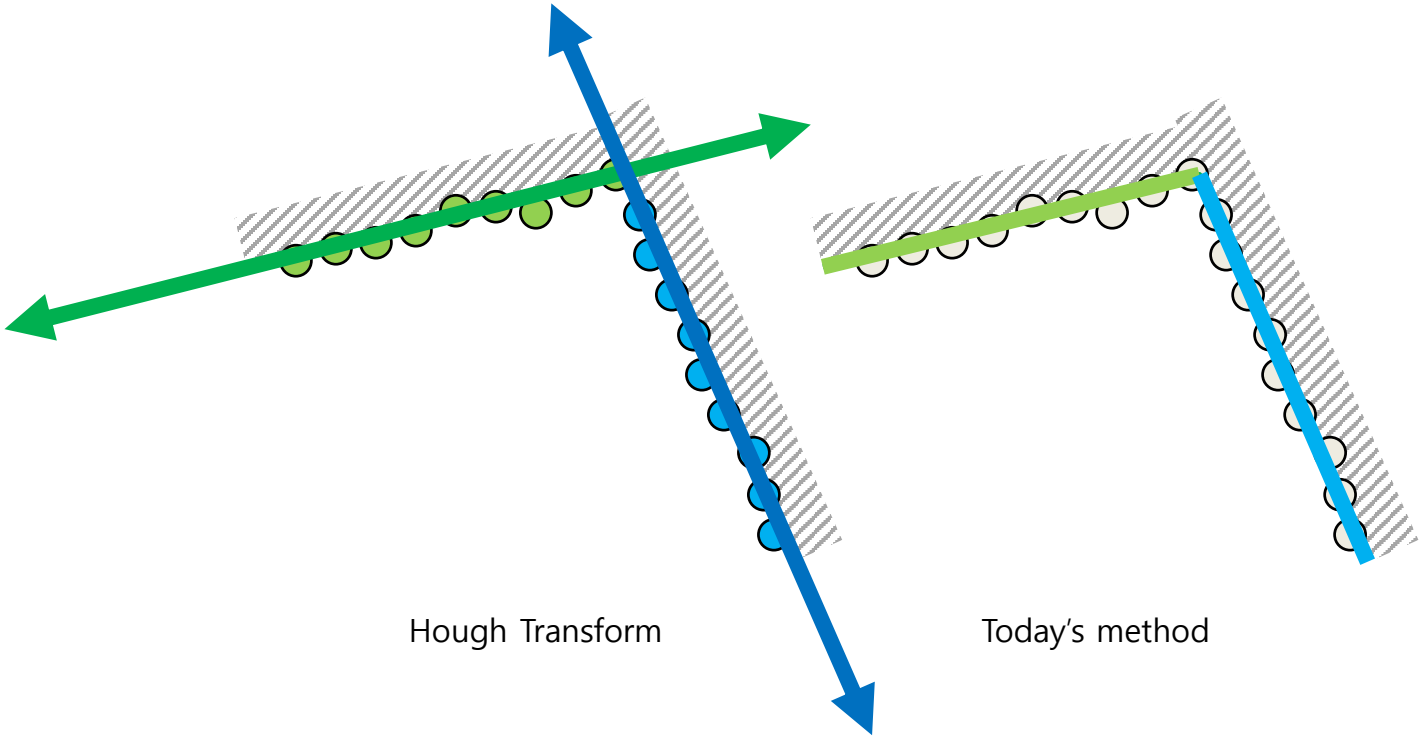
Experimental result



Experimental result

Conclusion

- **Hough transform과의 차이**
  - HT는 Dominant한 직선을 지날 듯 한 Measurements를 필터링
  - Line extraction은 Measurements가 내포하는 선분을 추출



Hough Transform

Today's method