

An introduction of Visual SLAM



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2013.11.

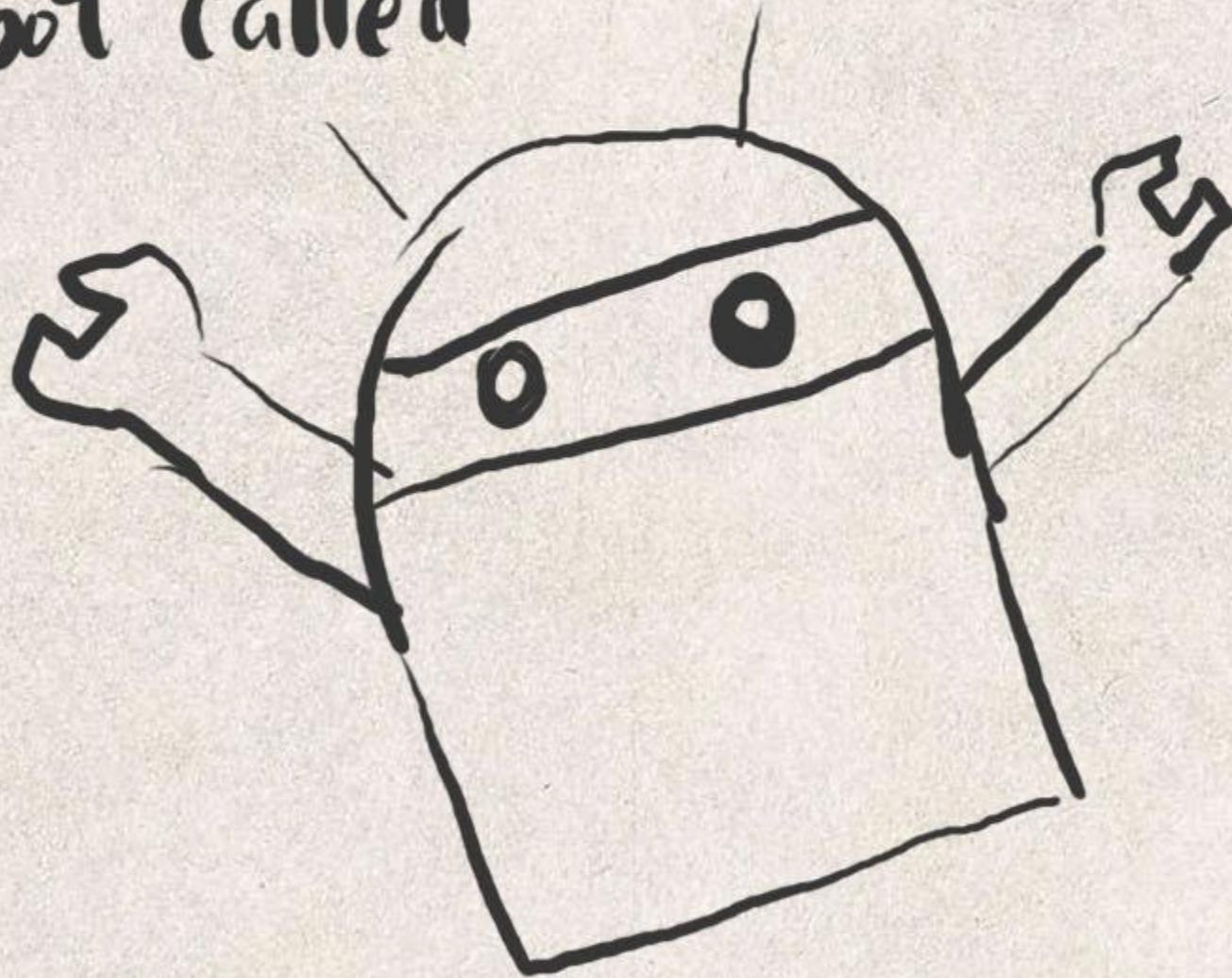
• Contents •

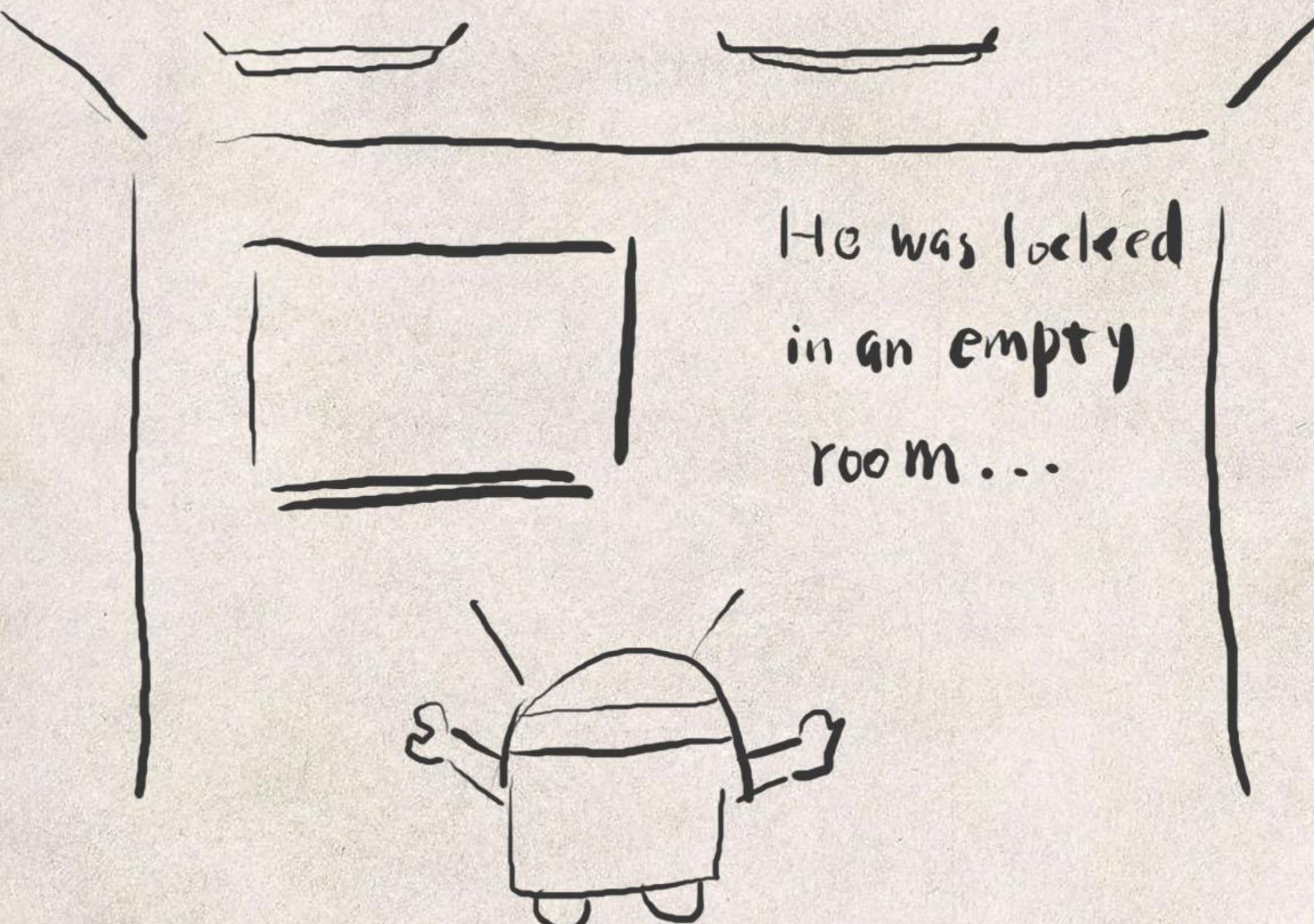
1. What's SLAM
2. What's vSLAM
3. Some Keypoints in VSLAM
4. Frontier Study
5. Experiments
6. References

Once upon a time

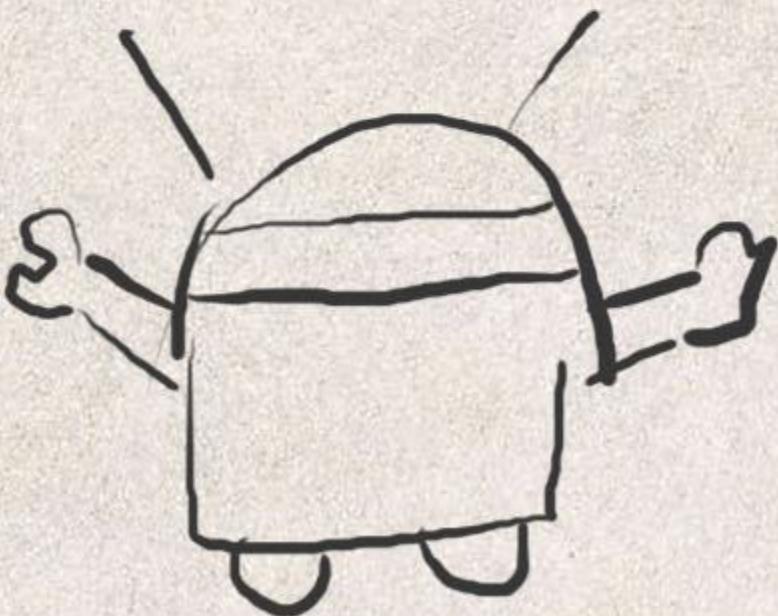
There is a robot called

"little R"





He was locked
in an empty
room...



He was scared and didn't know
where am I?



Where is
this?

Then

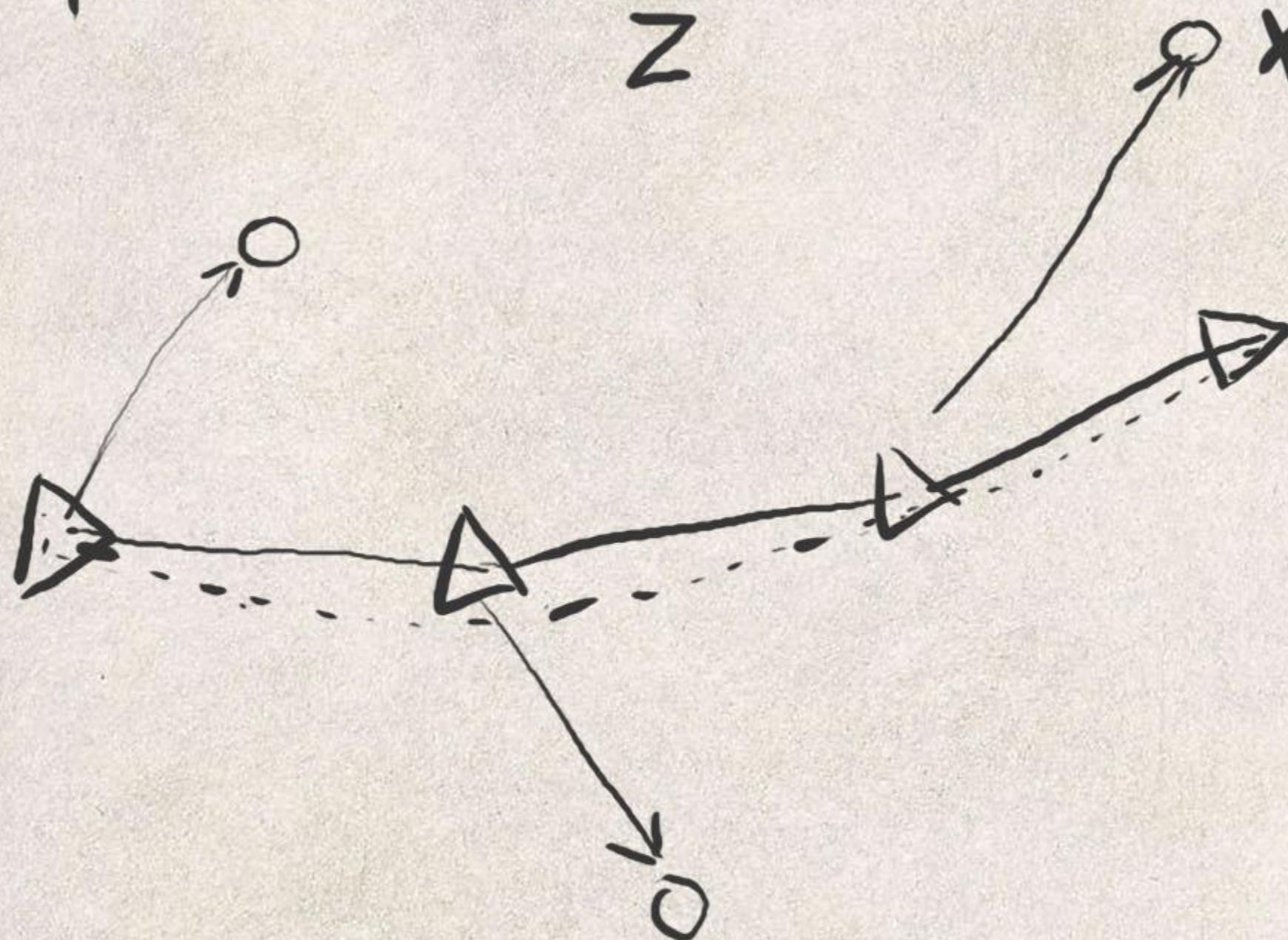


He went to ask
the scientist to see
what they can
help

Then, the research of
SLAM began . . .

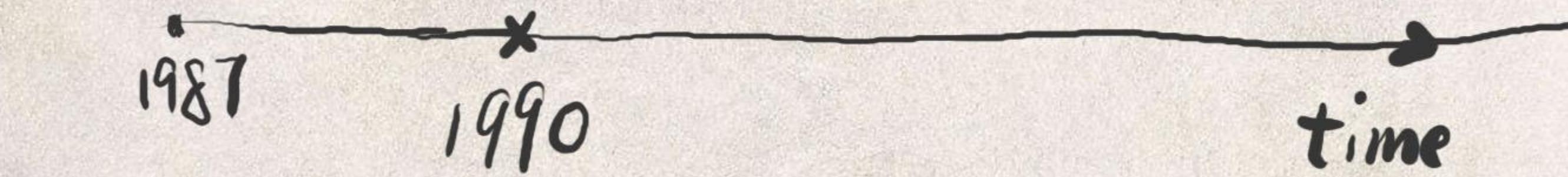


Def. of SLAM: observations, locations, map

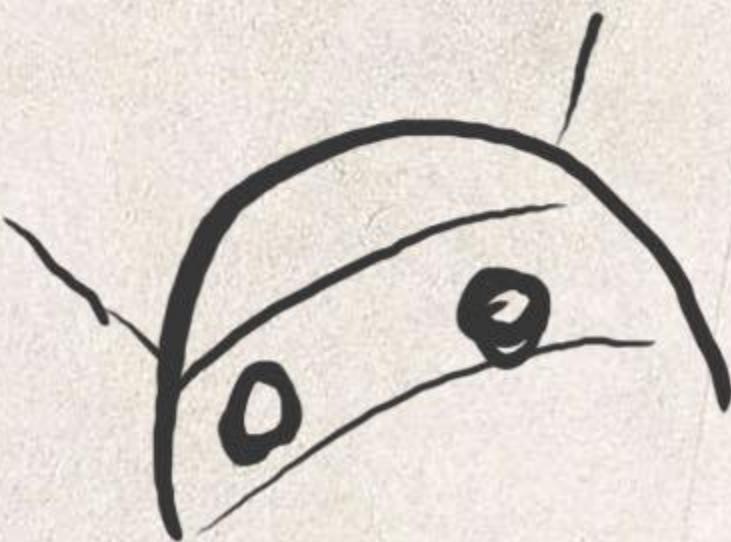


- ▷ robot
- Landmark
- real path
- - - estimated

"Estimating Uncertain spatial relationships in Robotics"
Randall Smith et.al.



When SLAM began



Smith successfully formulated SLAM as an

Extended Kalman
Filter

→ EKF

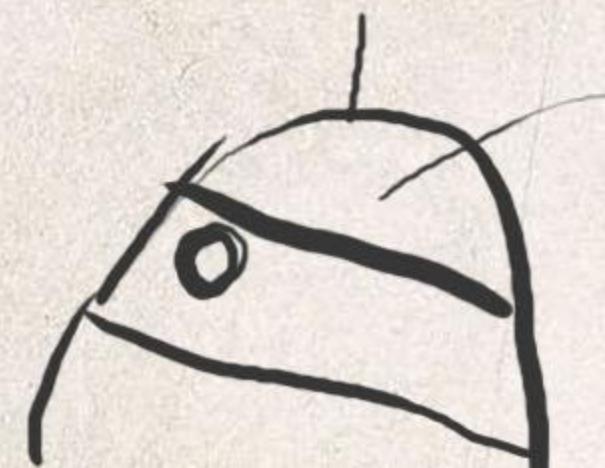
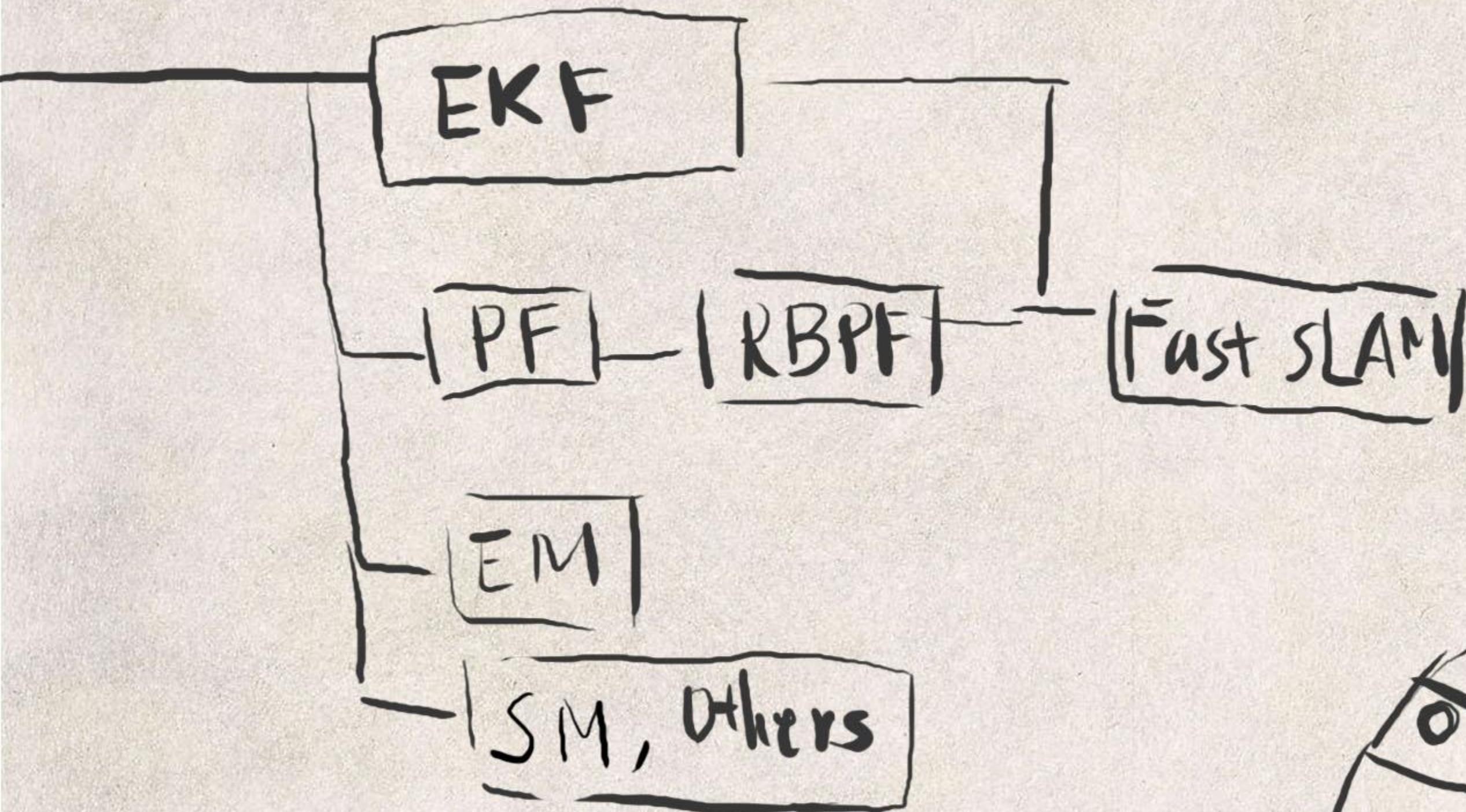
based Problem

$$x_k = f(x_{k-1}, u_k, w_k)$$

$$z_k = h(x_k, v_k)$$

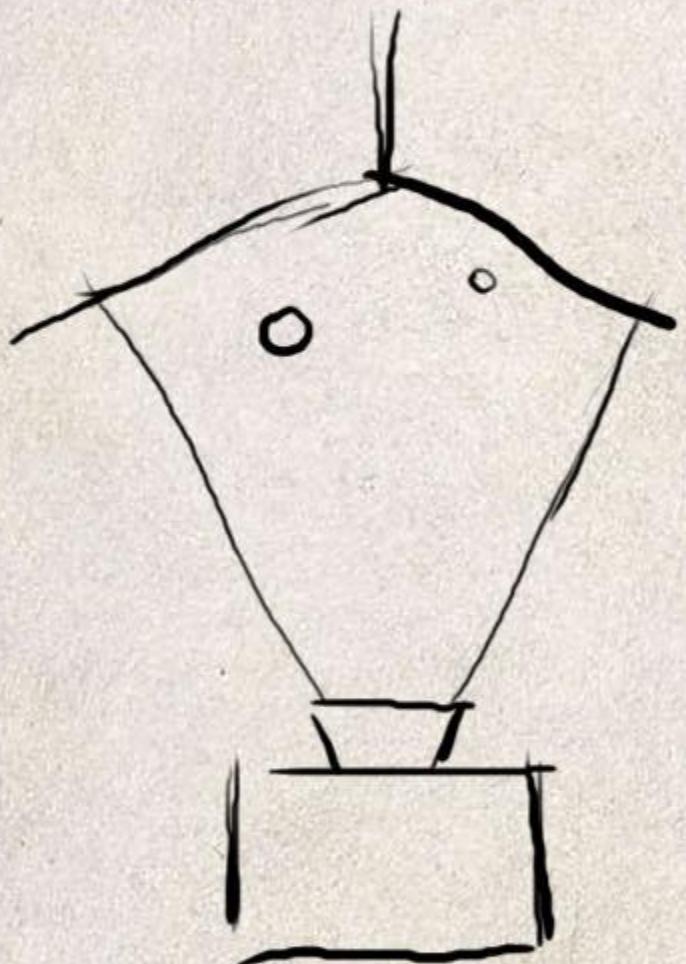


Since then, EKF became the dominant method

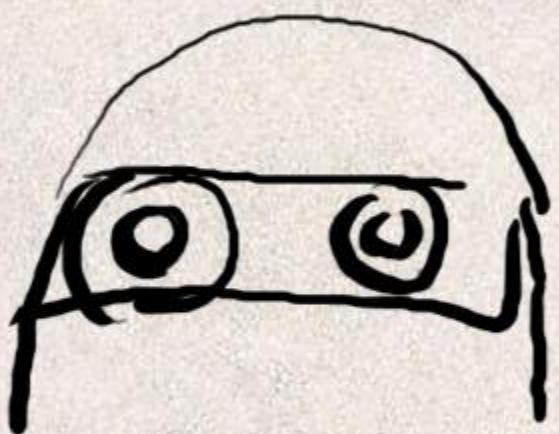


On the other hand.

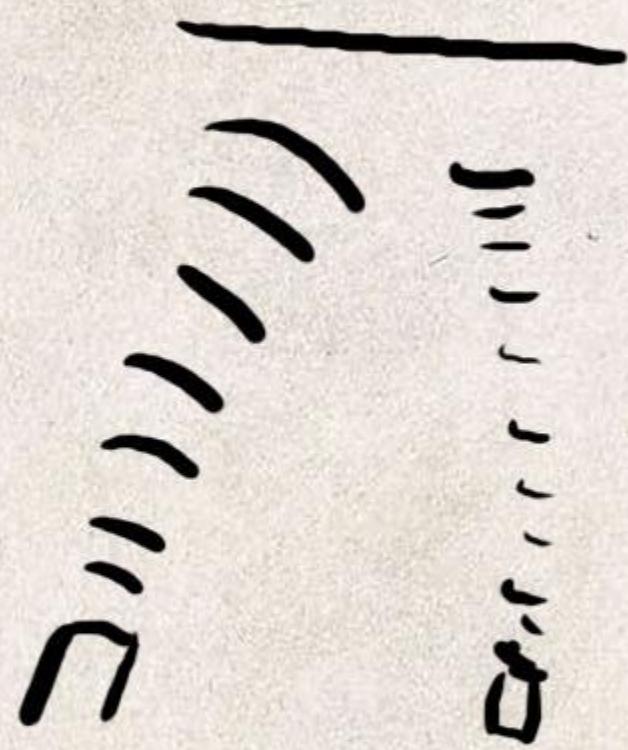
SLAM is different with sensors.



Laser



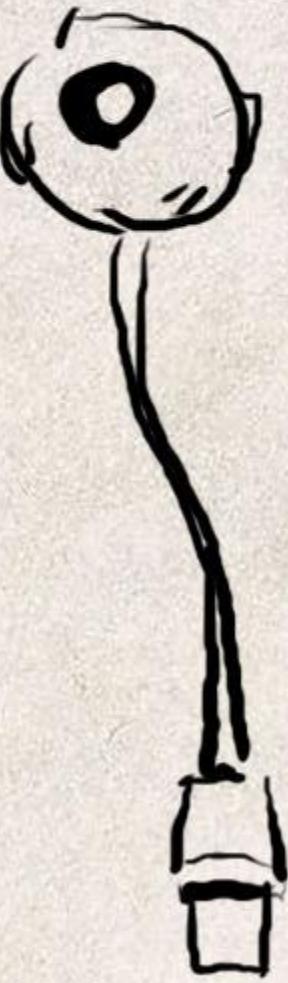
Camera



Sonar

With a camera, we can perform
visual SLAM!

v SLAM: cheap
long range
high resolution



Major

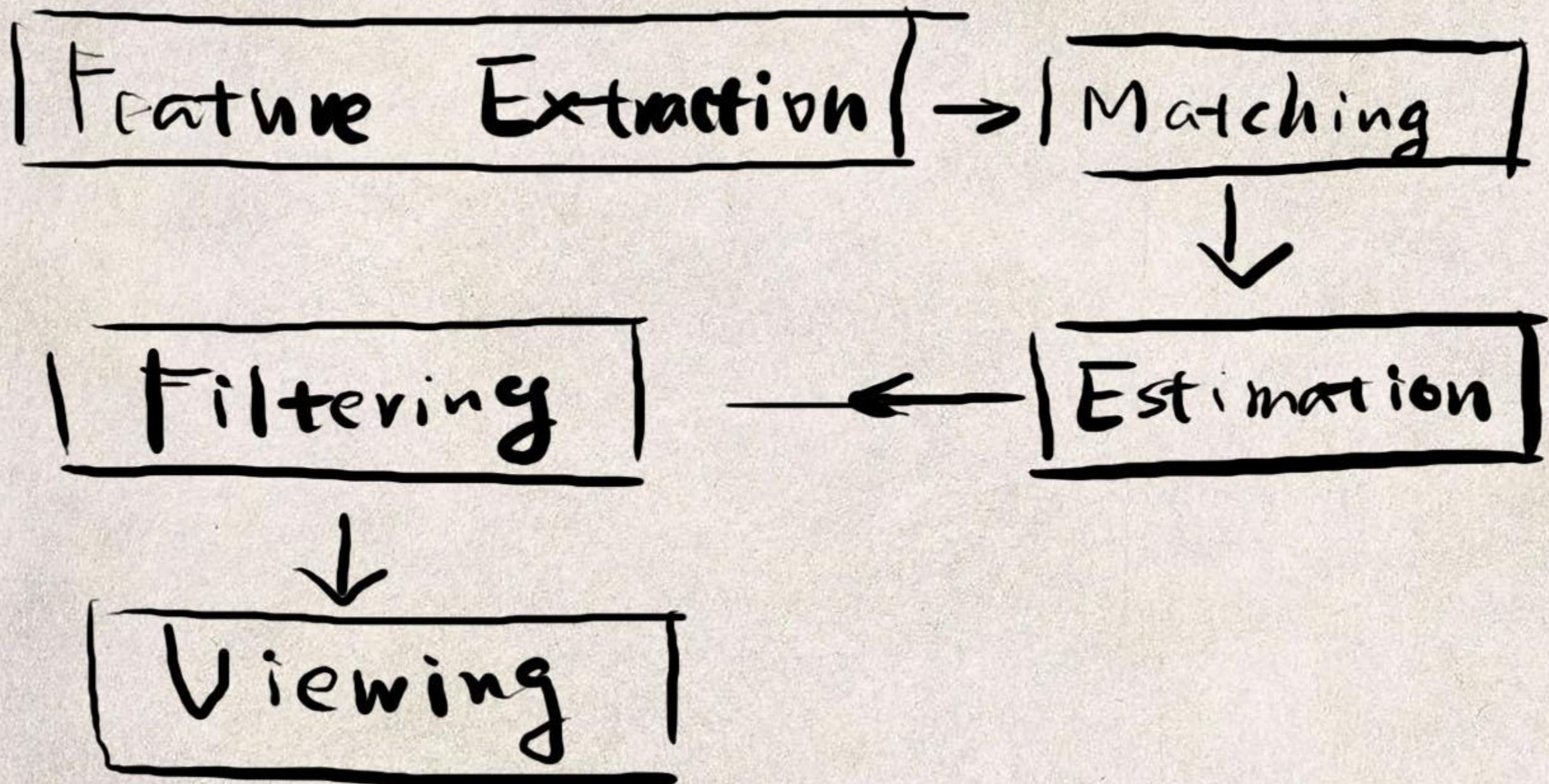
Feature based SLAM

v SLAM

Since 2000s

Direct Method

Feature-based SLAM



Important Works



David Lowe

"Mobile Robot Localization & Mapping
With Uncertainty using SIFT
Landmarks"

IJRR 2002



(a)



(b)



(c)



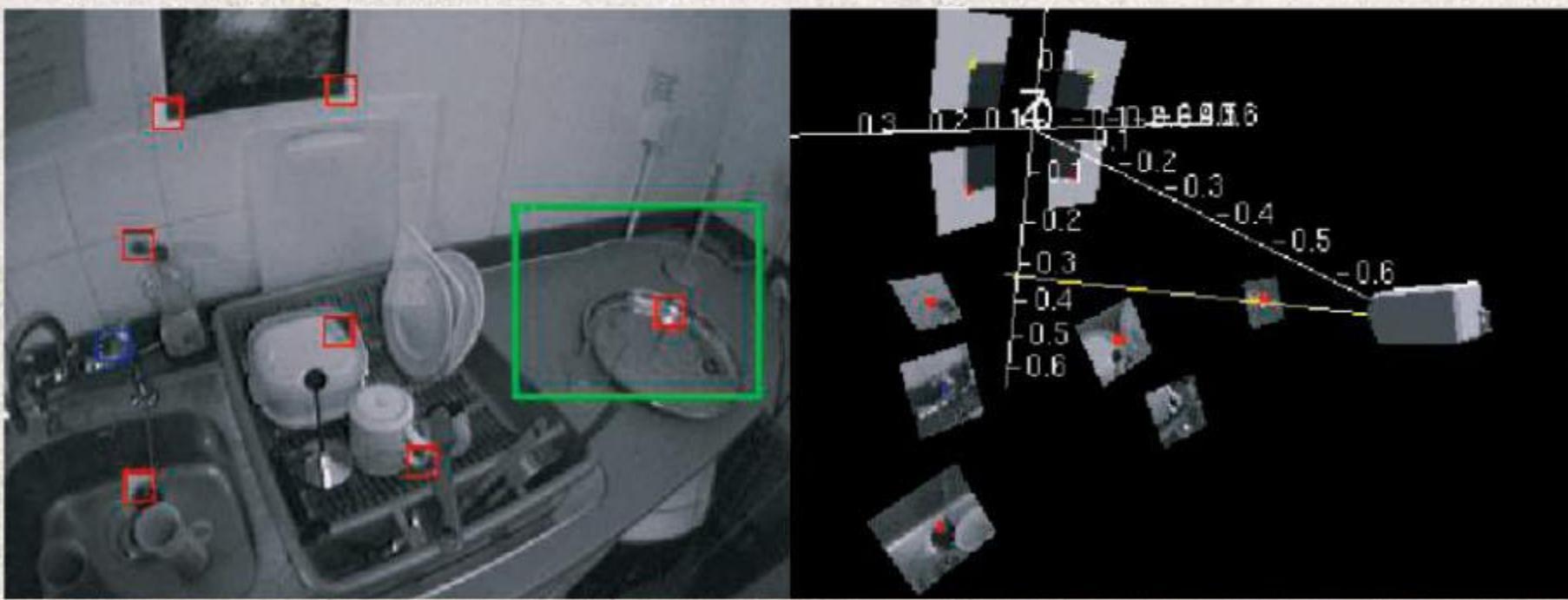
(d)

Fig. 3. The SIFT feature matches between consecutive frames: (a) between Figures 2(a) and (b) for a 10 cm forward movement; (b) between Figures 2(b) and (c) for a 5° clockwise rotation; (c) between Figures 2(c) and (d) for a 10 cm forward movement; (d) between Figures 2(d) and (e) for a 5° clockwise rotation.

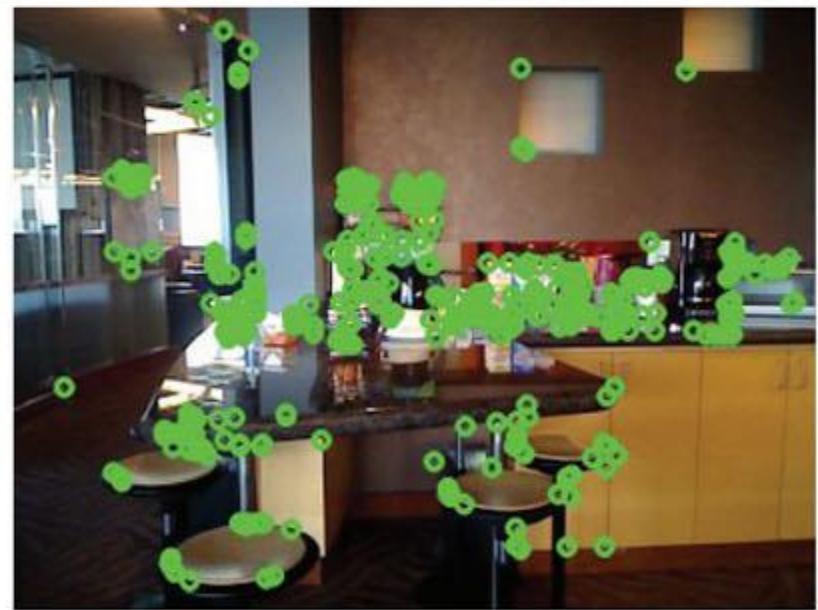
MonoSLAM : Real - Time Single camera SLAM

A.J. Davison

PAMI 2007



RGB-D mapping: Using Kinect-style depth camera for dense 3D modelling of indoor environments



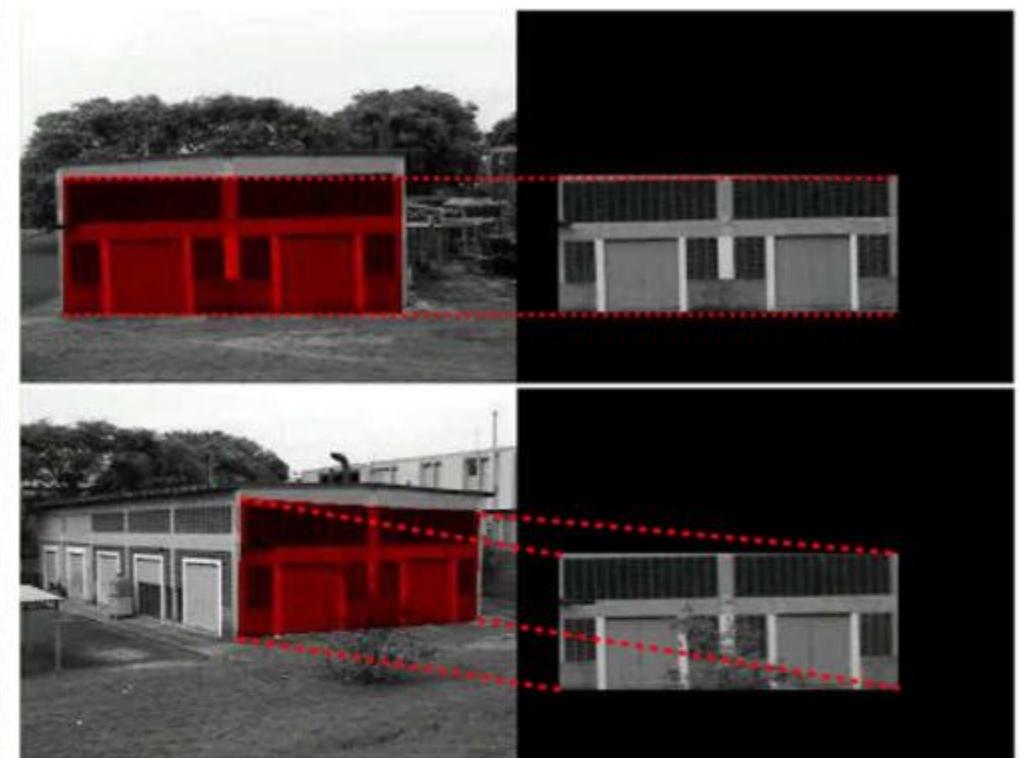
Henry Peter et.al.

IJRR 2012

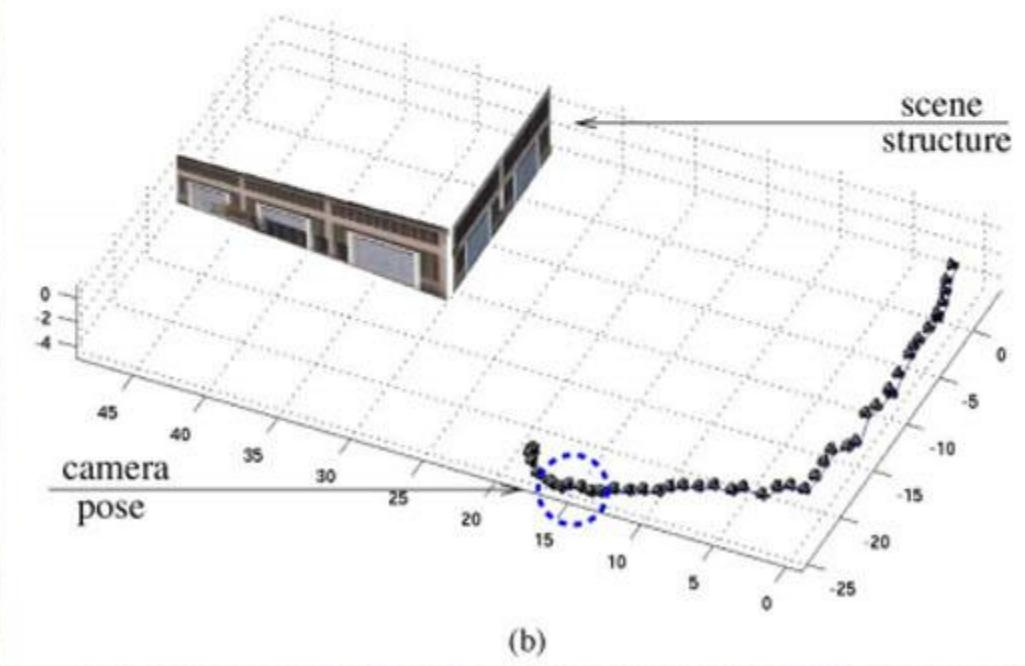
An Efficient Direct Approach to Visual SLAM

Geraldo S. et.al.

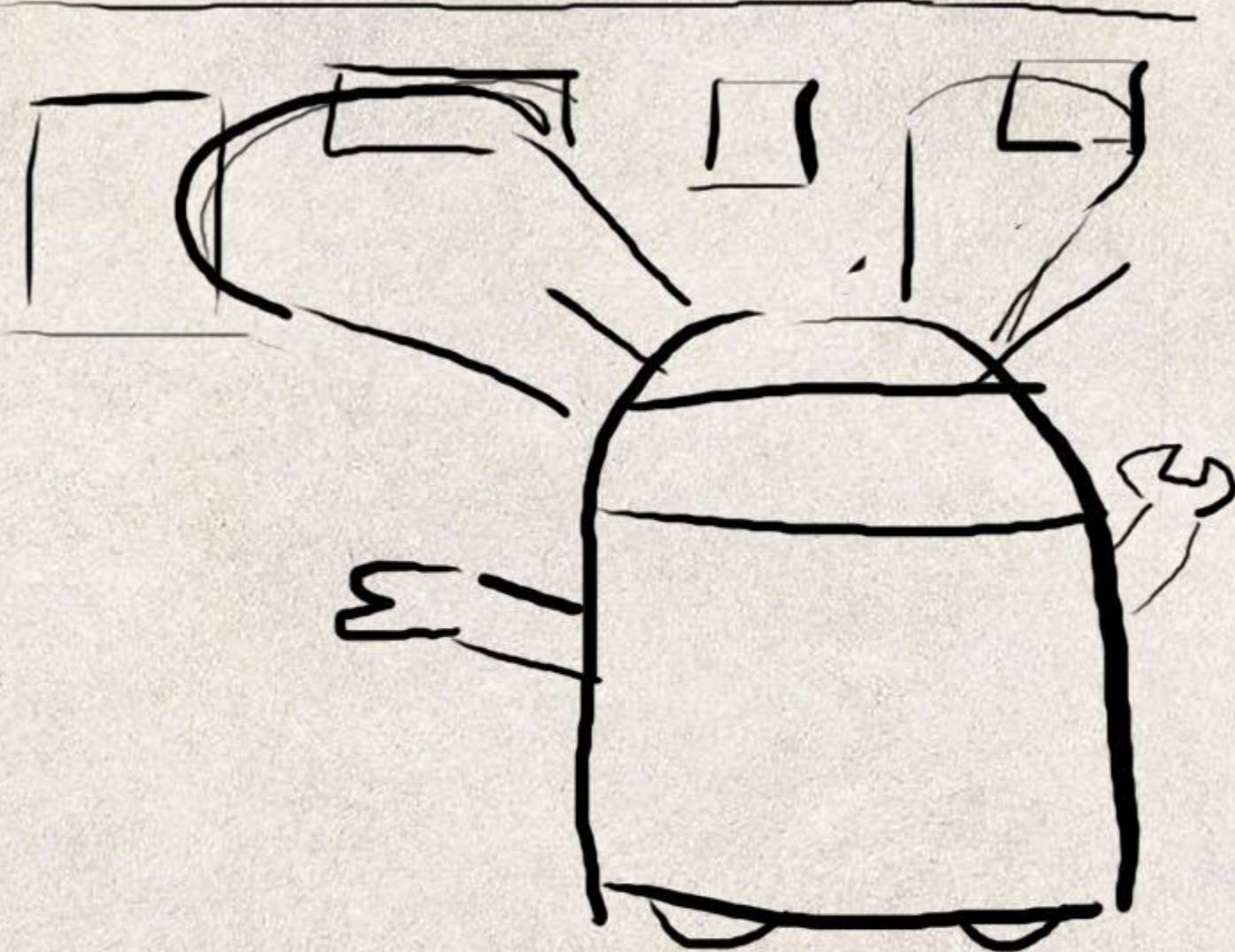
ITR 2008



(a)



(b)

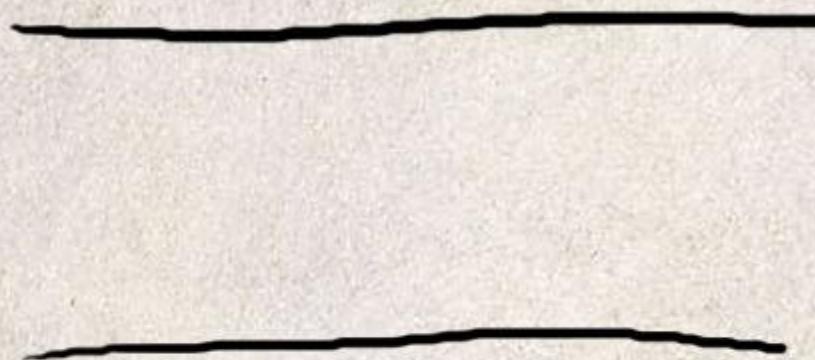


With visual SLAM, Little R is no longer
scared in empty rooms...

But there are still some issues under discuss

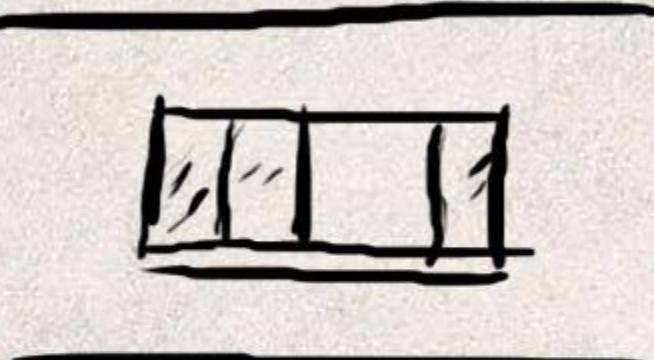
1. Data Association, Features
2. Loop Closing
3. Bearing only SLAM
4. Large scale, Dynamic Env.

1. Features & DA



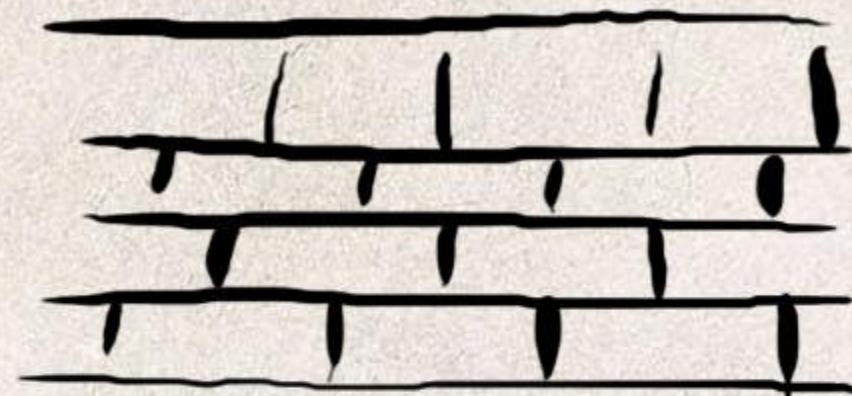
white wall

feature less



windows

feature rich



brick wall

rich ?
less ?

Features must be unique !

Popular features :

| Harris Corner.

| SIFT

| SURF

| SUSAN)

| MSER)

| FAST)

| Kaldr)

| ORB)

| BRIEF)

| Zernike)

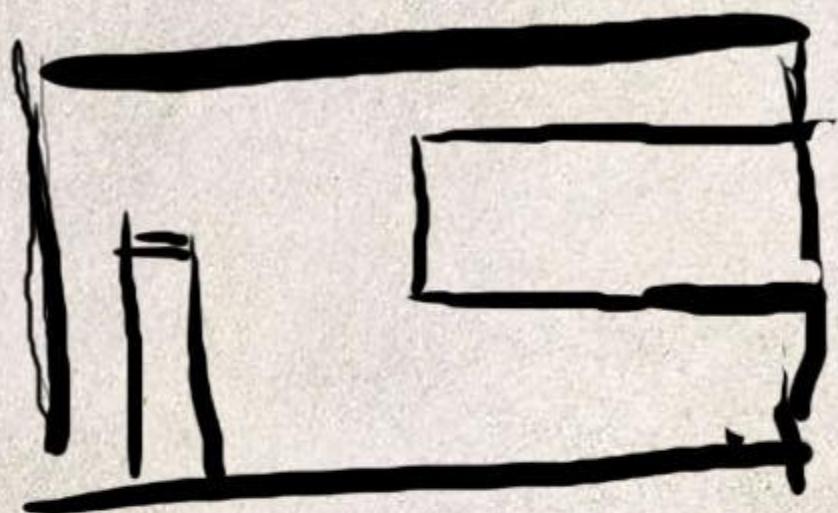
... .

DA

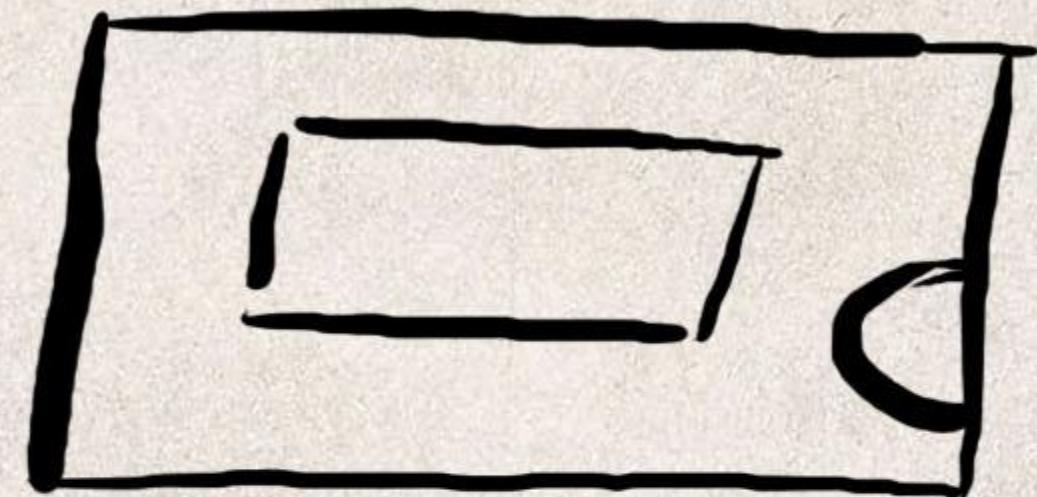
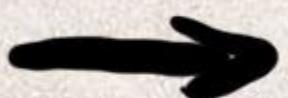


Which one is which one ?

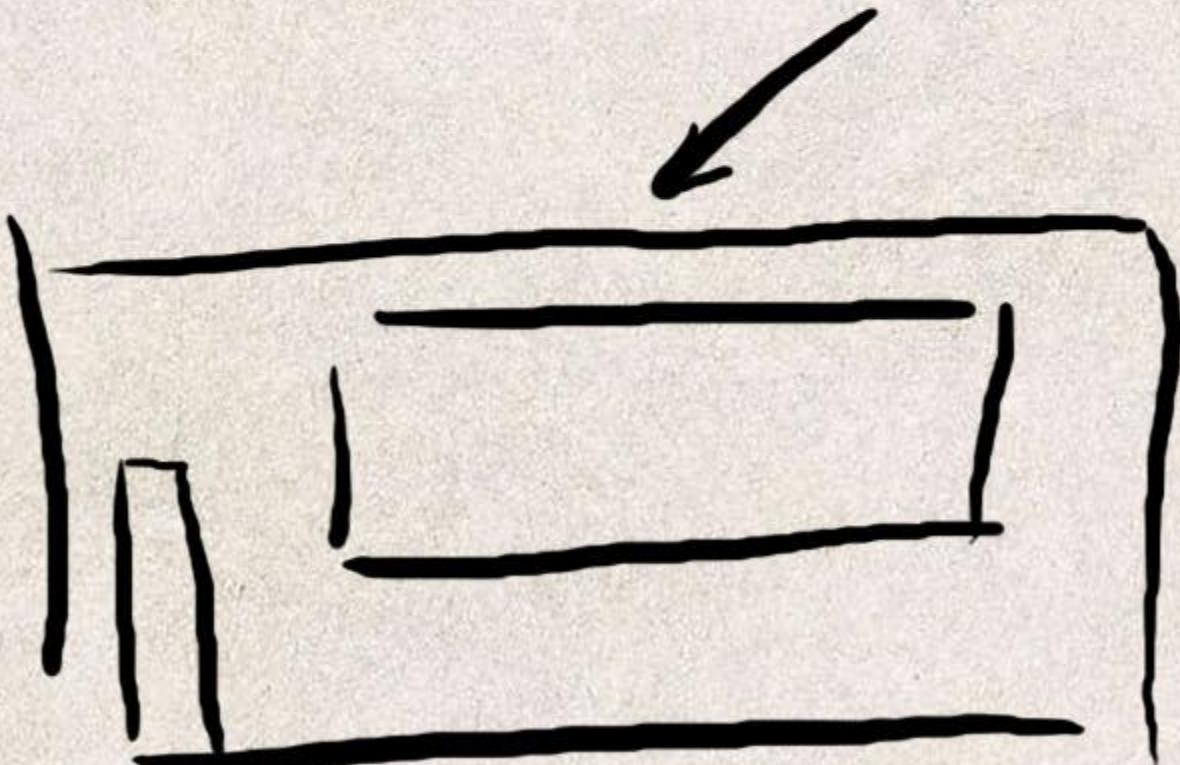
2. Loop Closing



f_1

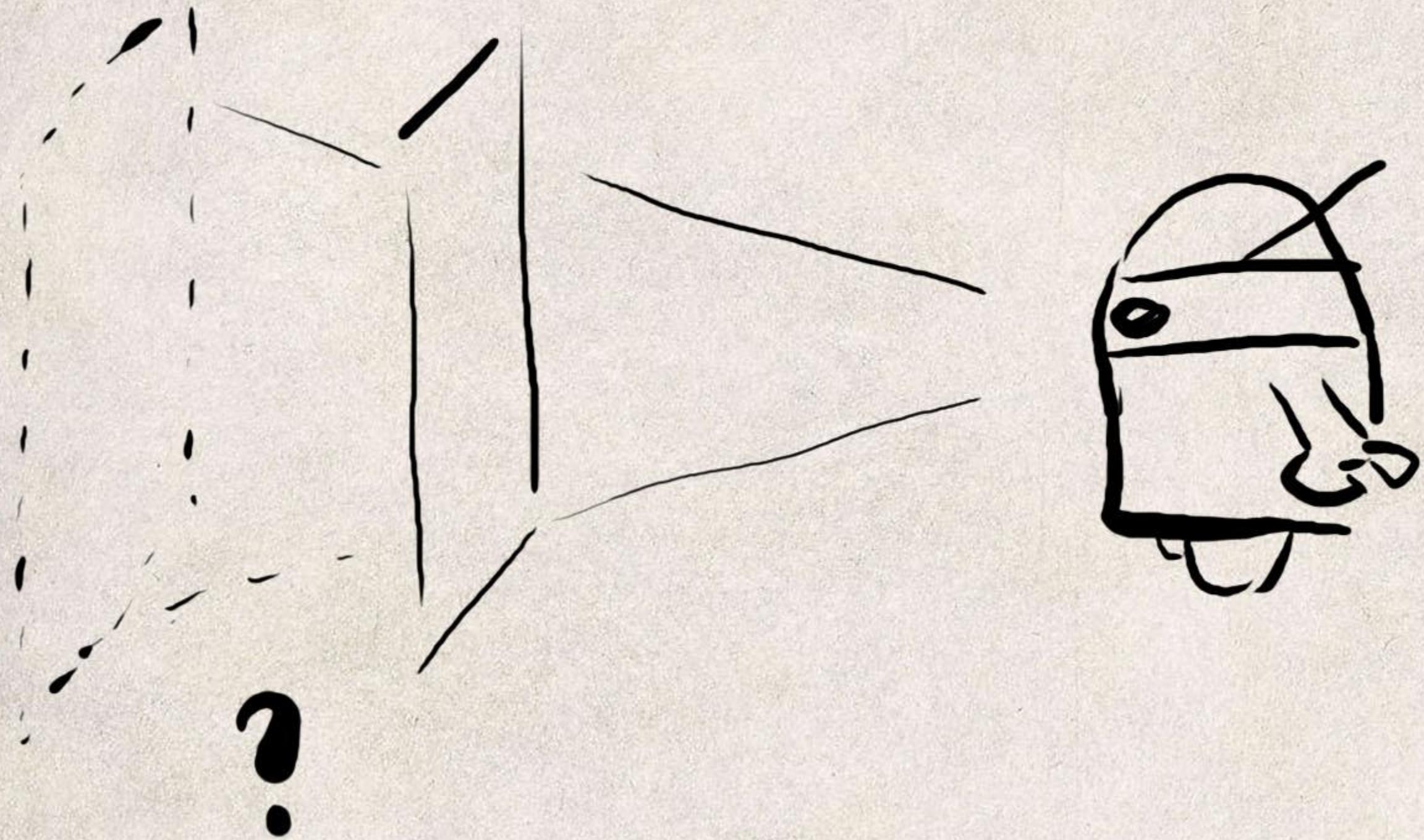


F_2



F_3

3. Bearing-only



4. Large-scale Dynamic



"SLAM is today routinely achieved in experimental robot systems using modern method and are now starting to cross over into practical systems."

A.J. Davison

SLAM in future :

1. Basic Theory . filter or not ?
2. Good Features . High level .
3. Large scale . Dynamic , occlusions
4. Loop closing detection
5. SLAM & Path Planning

Thank you for Attention!



G.X. 2013