assume landmarks to be identifiable (for now?...)

MULTI-POINT REGISTRATION

NOTE: RANSAC is a scheme not an algorithm !

input: only vector-to-point measurement → OUTPUT [landmark location, robot positions

1° - STATE -

X = data structure

↓

component < vector ~~rotation~~ matrices (homogeneous); matrix $3 \times M$ points

(for octave)

→ until now | state space, perturbation vector, utility functions to extract index for state/landmark

⇓

$\boxplus$ → extend the definition of the operator for $SE(3)$

to landmarks in euclidean ⇒ $\boxplus = +$

2° - MEASUREMENTS

measurement = 1 observation of a landmark

$z^{[n,m]} \in \mathbb{R}^3$

robot position in which landmark was seen; observed landmark

$e^{[n,m]}(x \boxplus \Delta x) = v2t(z(x_R^{[n]}) \ldots$

only appears $\Delta x_R^{[n]}$ and $\Delta x_L^{[m]}$

due to when perturbation other robot poses and landmarks do not affect the combination $[n, m]$!

3° - JACOBIANS - how large

J $(\cancel{3 \cdot M}) \times (6 \cdot N + 3 \cdot M)$?.....

| assuming m measurement to m landmarks

↓ ↓

state: 3

dim $(e^{[n,m]})$!

why not sparse instead of dense matrices ...?

It was quite a silly idea to compute the entire H matrix .....

⇓

we know it is sparse!

Only access the specific blocks ! ⇐ only modify the block, not copying the entire matrix!

Why under-determined?

- perfect solution w/ 0 error by the landmark in robot coordinates that we estimated

if we move everything, we would still obtain 0 error

⇓

1° - force some variable to be locked in the origin

or

2° - add another constraint = prior that we force to stay in where we wanted ($\approx$ defining the origin)

nothing → if we do not know where robot started!

Δx of one of the positions to 0 ! ↪ variable to which is attached remain the same

⇓

suppress the rows & columns in the matrix

02

PRIOR = soft-constraint
- you can lose w/ certain probability (e.g. GPS)
- we might receive GPS measurement along the way

$e_{prior} = \Delta x_1^{[1]}$

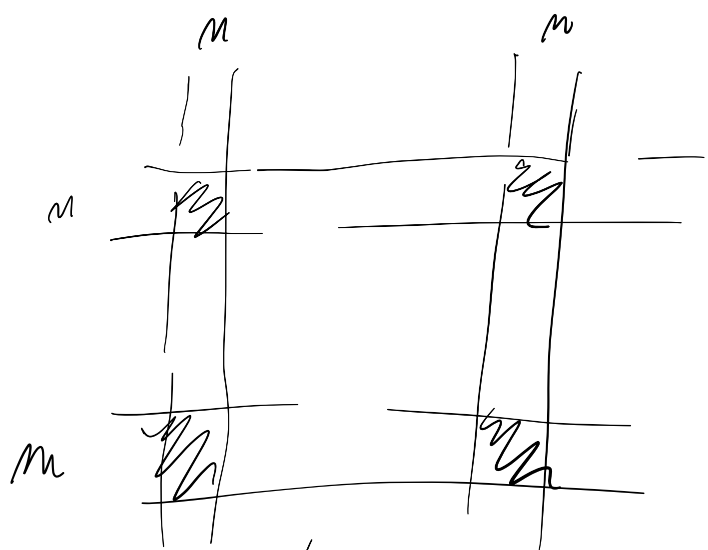
$\uparrow \Lambda_{prior} \Rightarrow$ stiff in the system $\Rightarrow$ the more will conform this constraint

$b \Rightarrow$ full diagonal matrix

$H \Rightarrow$ not quite !.....

matrix representation of the graph !!

↳ look



blocks grow linearly w/ trajectory of robot in total, at most # measurements

blocks grow QUADRATICALLY! w/ trajectory of the robot

(less sparse structure)

a lot of non-zero elements for H matrix

SPARSE IS THE KEY FOR MODERN SLAM