Robotics Assignment 2

Name:	Peter Atef Fathi
Section:	1
B.N:	18
ID:	9202395

(6.1)

$p\ (m = occ|z = d) = 0.8 \rightarrow \boldsymbol{l(0.8)} = \ln (0.8 / (1 - 0.8))) = 1.3863$

$p\ (m = occ|z > d) = 0.2 \rightarrow \boldsymbol{l(0.2)} = \ln (0.2 / (1 - 0.2))) = -1.3863$

$p(mi) = 0.35 \rightarrow \boldsymbol{l0} = l(0.35) = \ln (0.35 / (1 - 0.35)) = -0.619$

$\boldsymbol{l(x)} = \boldsymbol{inv\_sensor\_model\ (mi, xt, zt)} + \boldsymbol{l_{t-1,i}} - \boldsymbol{l_0}$

a) if z = d:
   $l(x) = inv\_sensor\_model(mi, xt, zt) + 1.3863 + 0.619$
   $l(x) = inv\_sensor\_model(mi, xt, zt) + 2.0053$
   if z > d:
   $l(x) = inv\_sensor\_model(mi, xt, zt) - 1.3863 + 0.619$
   $l(x) = inv\_sensor\_model(mi, xt, zt) - 0.7673$
b) Due to the recursion in the equation, it can be easily calculated as:
   $l(x) = 60 * 2.0053 - 40 * 0.7673 - lo \approx 90$
   $p(89.007) = 1 – (1/(1 + \exp(90))) \approx 1$
c) $Bel(m[xy]) = hits(x, y) / (hits(x, y) + misses(x, y))$
   $= 60 / (60 + 40) = 0.6$
d) Benefits:
   - Another way of representing occupations
   - Determines how often a cell reflects a beam.
   - Since it stores in each cell the probability that a beam is reflected by a cell, so it shows the material of the object to some level.
   - Simple way of considering the map as a grid of cells

- Problems:
    - Reflection probability could be very small even though it’s occupied.

(6.2)

C0	C1	C2	C3

At C0, there are 4 possible measurements: $Zt0$, $Zt1$, $Zt2$, $Zt3$.

The belief of the robot about the occupancy of the 4 cells is:

b_0 = 0.25, b_1 = 0.33, b_2 = 0.5, b_3 = 1

Given three measurements taken at $C0$: $Zt0$ = 0, $Zt2$ = 3, $Zt3$ = 1.

Meanwhile, b_0 = 0.25

Therefore, there are 4 rays at C0.

Zt0 = 0 => Zt1 > 0

Meanwhile, b_1 = 0.333

Therefore, there are 3 rays at C1.

Meanwhile, b_2 = 0.5

Therefore, there are 2 rays at C2.

Meanwhile, b_3 = 1

Therefore, there is 1 ray at C3.

So, $Zt2$ = 3, $Zt3$ = 1
So, 2 ≤ $Zt1$ < 3 → ***Zt1 = 2***

(7.2)

In bearing-only SLAM, where only inexpensive sensors are used such as a monocular (single) camera,

direct distance to the landmarks would not be provided, since it can only measure bearing of the

landmarks. And this causes initialization of landmarks to be harder.

Previously, most approaches used Gaussian PDFs, but this paper made a more efficient method using EKF.

to fuse the data obtained by the laser beam to obtain Range and Bearing EKF-SLAM instead of Bearing only.

A naive way for landmark initialization is done by taking two frames where in both a specific landmark.

appears. And then using feature extraction, matching and triangulation, the 3D location of the point could

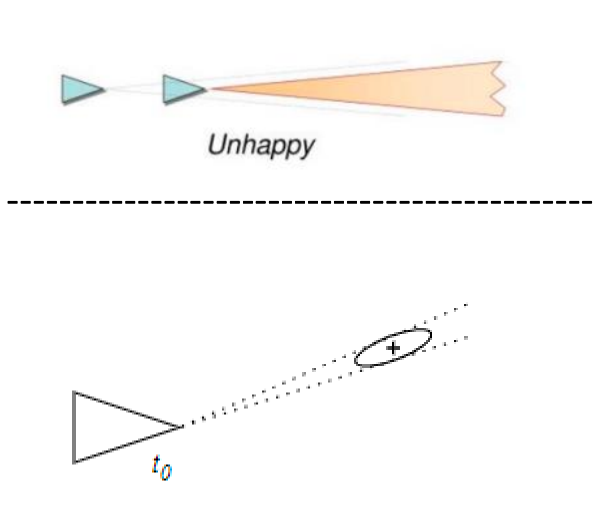
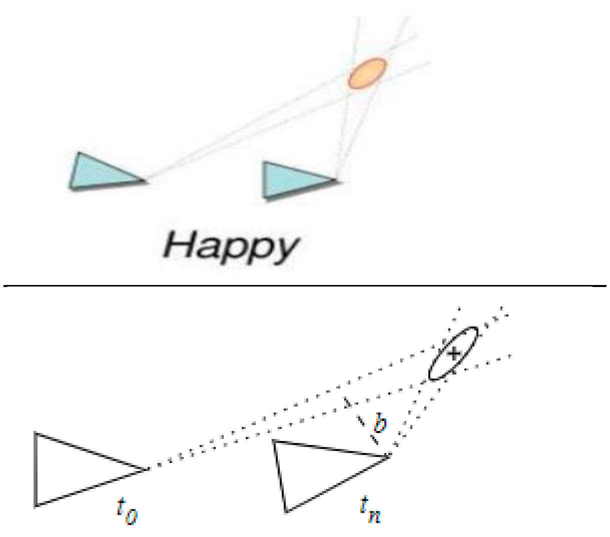
be obtained. The problem with this is when both frames are taken from same angle, only difference in

distance to the landmark. In such a case, applying triangulation is quite hard. After applying triangulation,

uncertainties are considered, and the result is a Gaussian, where the mean is the nominal solution, and

the covariance is obtained by transforming the robot and measuring uncertainties via Jacobians of the

observation’s function.

	Figure 1: Bad scenarios for Triangulation
	Figure 2: Good scenarios for Triangulation

<u>Solution:</u>

There are two methods mentioned in this paper for the un-delayed landmark representation.

<u>1. First method</u> is an offline method called the multi-map algorithm that uses Geometric Ray.

Figure 1: Bad scenarios for Triangulation

Figure 2: Good scenarios for Triangulation

Say the laser beam has two readings, r_{min} and r_{max}. Then we fill the distance between these two with gaussians, using different ranges for each gaussian, and keeping the linearization constraint.

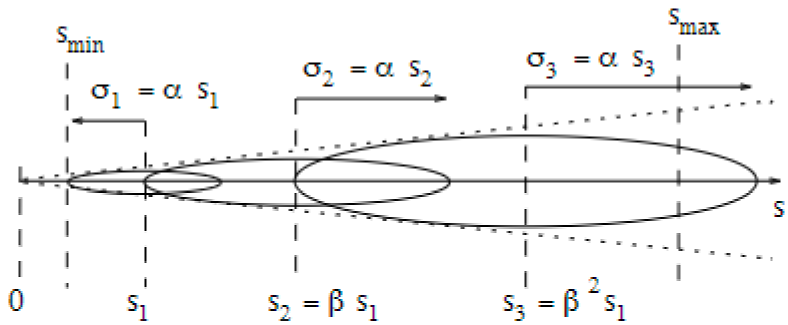


Fig. 3. The conic Ray: a geometric series of Gaussian distributions.

Then we have a logarithmic number of terms which are a relatively small number that can be easily handled with EKF. These terms initialize different maps, each with different mean and covariance for the gaussian of the landmark. Then, as the robot moves and obtains more frames, and measuring likelihood of landmarks, the maps with more unlikely landmark locations are pruned, till only one map remains with the right landmark member. And that remained member is Gaussian.

2. Second method is an online algorithm, called The Federated Information Sharing (FIS) algorithm, which could be done in real-time.

In this algorithm, the difference is all observations are obtained in the same map, along with subsequent observations. Then this map is continuously updated to do the member pruning. Till one member is left for each landmark.

Resource: https://sci-hub.se/10.1109/iros.2005.1545392