1: **Algorithm likelihood_field_range_finder_model(**z_t, x_t, m**):**

2: $q = 1$

3: *for all* k *do*

4: *if* $z_t^k \neq z_{\max}$

5: $x_{z_t^k} = x + x_{k,\text{sens}} \cos\theta - y_{k,\text{sens}} \sin\theta + z_t^k \cos(\theta + \theta_{k,\text{sens}})$

6: $y_{z_t^k} = y + y_{k,\text{sens}} \cos\theta + x_{k,\text{sens}} \sin\theta + z_t^k \sin(\theta + \theta_{k,\text{sens}})$

7: $dist = \min_{x',y'} \left\{ \sqrt{(x_{z_t^k} - x')^2 + (y_{z_t^k} - y')^2} \,\middle|\, \langle x', y' \rangle \text{ occupied in } m \right\}$

8: $q = q \cdot \left(z_{\text{hit}} \cdot \mathbf{prob}(dist, \sigma_{\text{hit}}) + \frac{z_{\text{rand}}}{z_{\max}} \right)$

9: *return* q

Table 6.3 Algorithm for computing the likelihood of a range finder scan using Euclidean distance to the nearest neighbor. The function **prob**$(dist, \sigma_{\text{hit}})$ computes the probability of the distance under a zero-centered Gaussian distribution with standard deviation σ_{hit}.

before, the function **prob**$(dist, \sigma_{\text{hit}})$ computes the probability of $dist$ under a zero-centered Gaussian distribution with standard deviation σ_{hit}.

The search for the nearest neighbor in the map (line 7) is the most costly operation in algorithm **likelihood_field_range_finder_model**. To speed up this search, it is advantageous to pre-compute the likelihood field, so that calculating the probability of a measurement amounts to a coordinate transformation followed by a table lookup. Of course, if a discrete grid is used, the result of the lookup is only approximate, in that it might return the wrong obstacle coordinates. However, the effect on the probability $p(z_t^k \mid x_t, m)$ is typically small even for moderately course grids.

6.4.2 Extensions

A key advantage of the likelihood field model over the beam-based model discussed before is smoothness. Due to the smoothness of the Euclidean distance, small changes in the robot's pose x_t only have small effects on the resulting distribution $p(z_t^k \mid x_t, m)$. Another key advantage is that the pre-computation takes place in 2-D, instead of 3-D, increasing the compactness of the pre-computed information.