are generated from the control $u_t = (v_t \ \omega_t)^T$ and the individual components of the sigma points. For example, $\mathcal{X}_{i,t}^{u[v]}$ represents the translational velocity v_t of the i-th sigma point. The predicted sigma points, $\bar{\mathcal{X}}_t^x$, are thus a set of robot locations, each resulting from a different combination of previous location and control.

Lines 8 and 9 compute the mean and covariance of the predicted robot location, using the unscented transform technique. Line 9 does not require the addition of a motion noise term, which was necessary in the algorithm described in Table 3.4. This is due to the state augmentation, which results in predicted sigma points that already incorporate the motion noise. This fact additionally makes the redrawing of sigma points from the predicted Gaussian obsolete (see line 6 in Table 3.4).

In line 10, the predicted sigma points are then used to generate measurement sigma points based on the measurement model defined in Equation (6.40) in Chapter 6.6:

$$\bar{\mathcal{Z}}_{i,t} = \begin{pmatrix} \sqrt{(m_x - \bar{\mathcal{X}}_{i,t}^{x[x]})^2 + (m_y - \bar{\mathcal{X}}_{i,t}^{x[y]})^2} \\ \operatorname{atan2}(m_y - \bar{\mathcal{X}}_{i,t}^{x[y]}, m_x - \bar{\mathcal{X}}_{i,t}^{x[x]}) - \bar{\mathcal{X}}_{i,t}^{x[\theta]} \end{pmatrix} + \begin{pmatrix} \mathcal{X}_{i,t}^{z[r]} \\ \mathcal{X}_{i,t}^{z[\phi]} \end{pmatrix} \tag{7.33}$$

Observation noise is assumed to be additive in this case.

The remaining updated steps are identical to the general UKF algorithm stated in Table 3.4. Lines 11 and 12 compute the mean and covariance of the predicted measurement. The cross-covariance between robot location and observation is determined in line 13. Lines 14 through 16 update the location estimate. The likelihood of the measurement is computed from the innovation and the predicted measurement uncertainty, just like in the EKF localization algorithm given in Table 7.2.

7.7.2 Illustration

We now illustrate the UKF localization algorithm using the same examples as were used for the EKF localization algorithm. The reader is encouraged to compare the following figures to the ones shown in Chapter 7.4.4.

Prediction Step (Lines 2–9) Figure 7.12 illustrates the UKF prediction step for different motion noise parameters. The location components $\mathcal{X}_{t-1}^x$ of the sigma points generated from the previous belief are indicated by the cross marks located symmetrically around μ_{t-1}. The 15 sigma points have seven different robot locations, only five of which are visible in this x-y-projection.