TWORKS

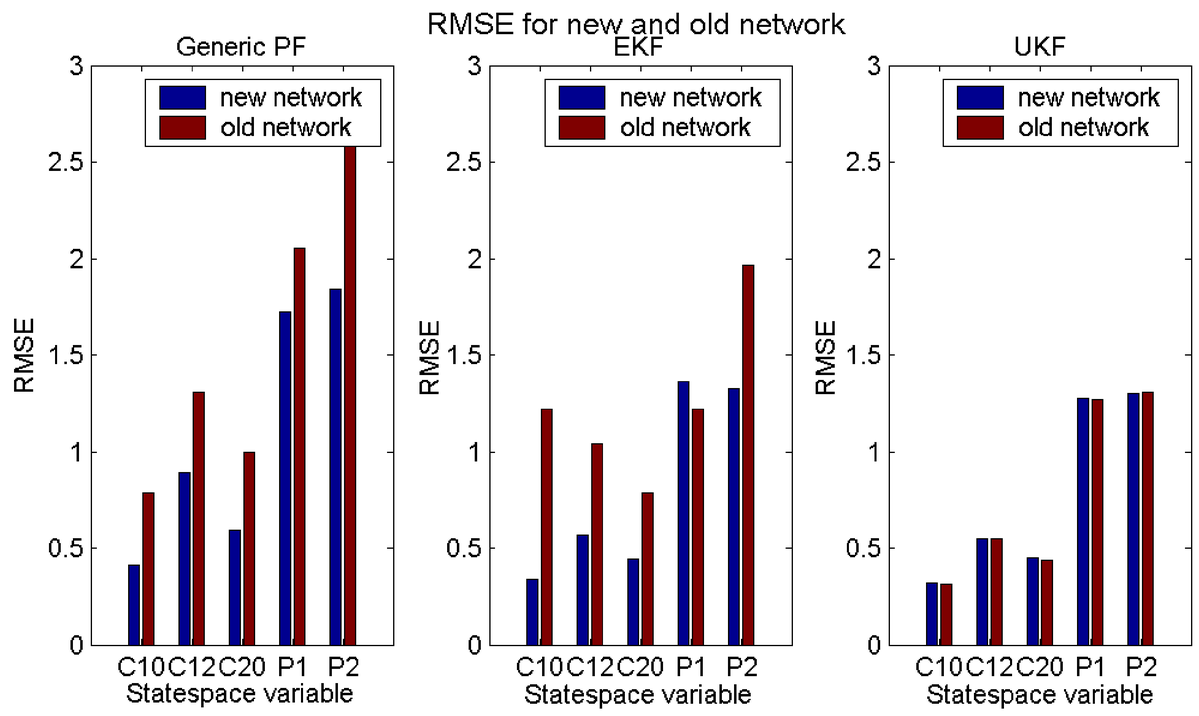

Figure 5

A new network without flow nodes and with conductance and pressure nodes connected to the observation nodes was created. Figure 5 shows how the new network clearly outperforms the old network in terms of conductance and pressure estimates using PF and EKF. The performance of UKF is superior in both cases and does not depend on the choice of network structure. In UKF, the Kalman gain is based on sigma points propagated through the *true* process and measurement models making UKF able to update all continuous variables.

Adding 5% to all flow estimates (data not shown) PFUKF was is by far the best filtering algorithm to handle a wrong measurement model. PFUKF is able to move the particles generated from the UKF towards regions of higher likelihood which reduces the RMSE and makes tracking of the discrete failure nodes easier.

We showed that the generic PF (and EKF) were highly sensitive to the choice of network structure and in both cases the UKF was superior in terms of estimation RMSE. Figure 6 shows the tracking of $C10$ (conductance of pipe between $Tank1$ and the outside world using UKF together with the events that occurred during a typical simulation. We present a tracking plot for UKF instead of the often superior PFUKF to show that we can track the continuous variables and system faults well using a very low number of particles (300) compared to the number of particles needed using the generic PF (50000) without taking advantage of the computationally more expensive PFUKF.

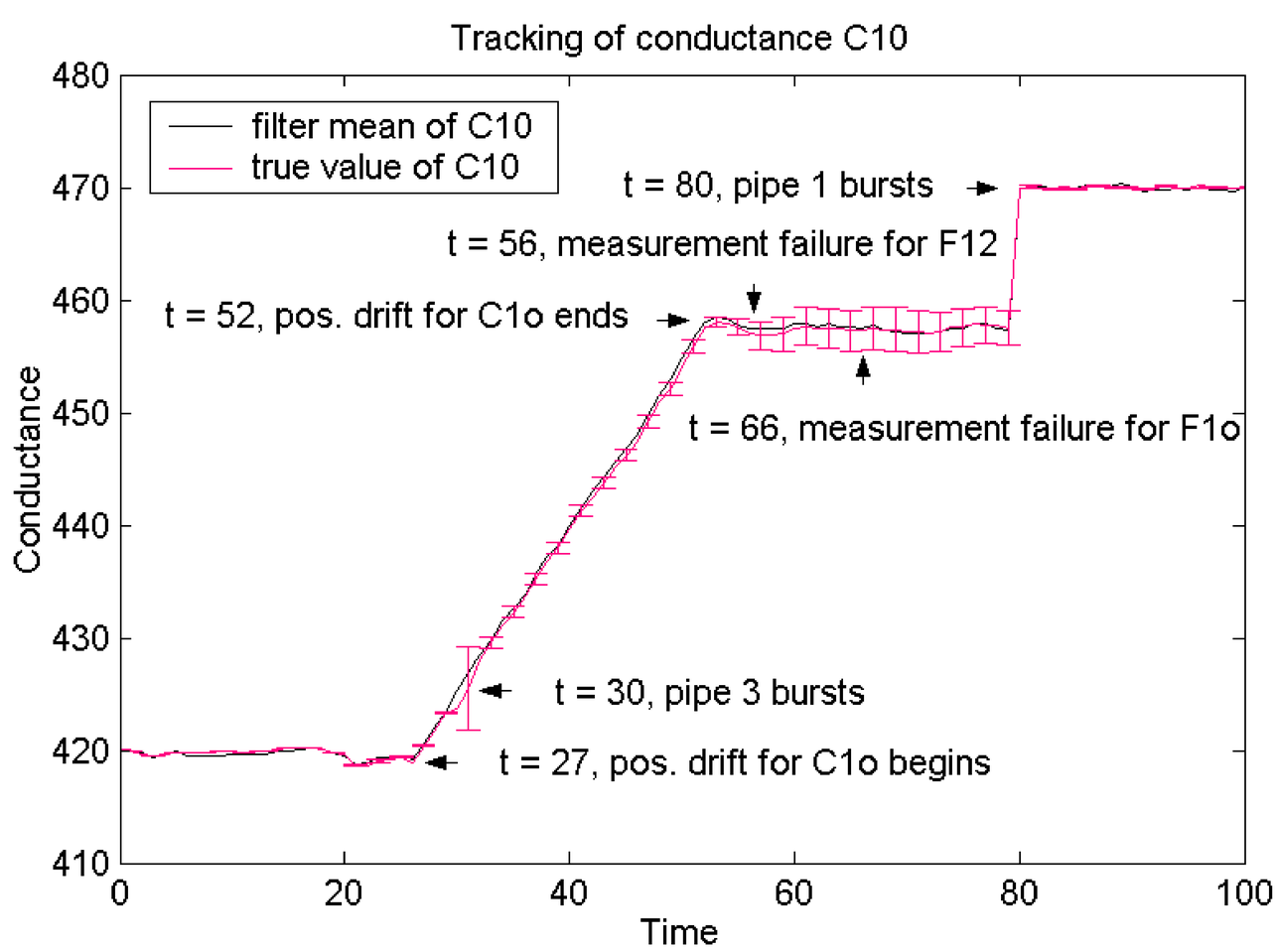

Figure 6

Conclusion

Comparison of a generic PF, the EKF, the UKF and hybrid models using a complex, hybrid 2T-DBN watertank simulation of a fault detection system showed that the UKF made more accurate estimates and was network structure insensitive as opposed to the generic PF and the EKF. Furthermore, the PFUKF was the most reliable algorithm, when we used a false measurement model. Finally, we showed that we were able to track the discrete failure nodes with a low number of particles using UKF. We prefer PFUKF, when the UKF is not able to make reliable estimates (noise, unknown/higher order models) and have the necessary computational time. Otherwise, we settle for the UKF or the generic PF if the assumptions of the UKF are not valid.

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