It is essential to develop a reliable prognostics framework, which can accurately predict the fatigue life of critical metallic components that are subjected to a variety of in-service loading conditions. A novel integrated localization and prognostic model combined with a particle filtering approach, which can accurately localize cracks in aluminum components, is developed. The prognostic model combines a physics-based approach with a data-driven approach to predict the crack growth and the residual useful life. In this approach, particle filtering is used to iteratively combine the measured crack location from a Lamb wave-based localization algorithm with the predicted crack location from the prognostic model to probabilistically estimate a crack location at the next time instant. The localization algorithm accounts for uncertainty in time-of-flight measurements using probabilistic data association. The mean and variance of a future crack location predicted by the prognosis model at each time step are entered into the data association algorithm to be used as a priori (dynamic prior) knowledge to increase the accuracy of the crack location estimation. The prognosis model is first validated using the experimental data obtained through performing fatigue test on Al2024-T351 lug joint. Then, the crack location estimates for a growing fatigue crack with and without using dynamic prior are presented to demonstrate the benefit of using a dynamic prior and particle filter updating to combine prognostic and localization algorithms.

The results indicate that the proposed approach is capable of predicting the crack length with a relative error of less than 5% for majority of the presented cases.

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