

Blade root bending moments estimation through accelerometer readings and other already available measurements

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Aim

At this point of my research, I am focused on the online estimation of the blade root bending moments using accelerometers readings (positioned in the cavity along the blade) and other measurements already available from the wind turbine (rotor speed, generator torque and pitch angle). Since the accelerometers are placed inside the blade, it makes also possible to retrofit this technology on existing turbines.

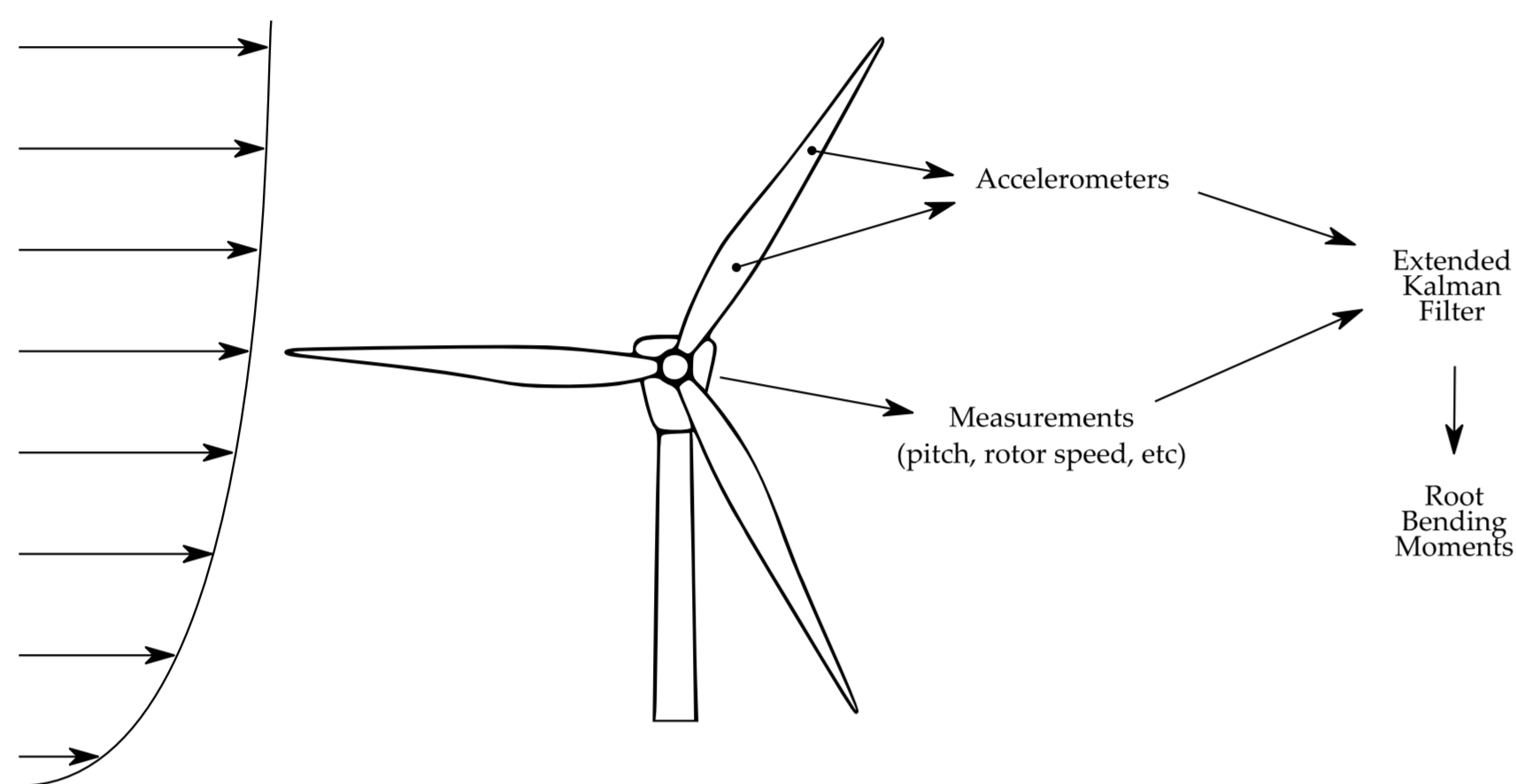


Figure 1: Figure illustrating the concept for the estimation of root bending moments.

Model

In order to better estimate the blade root bending moments, the EKF needs to include an accurate model of the blade dynamics, namely the lumped parameters blade model (see Fig. 3).

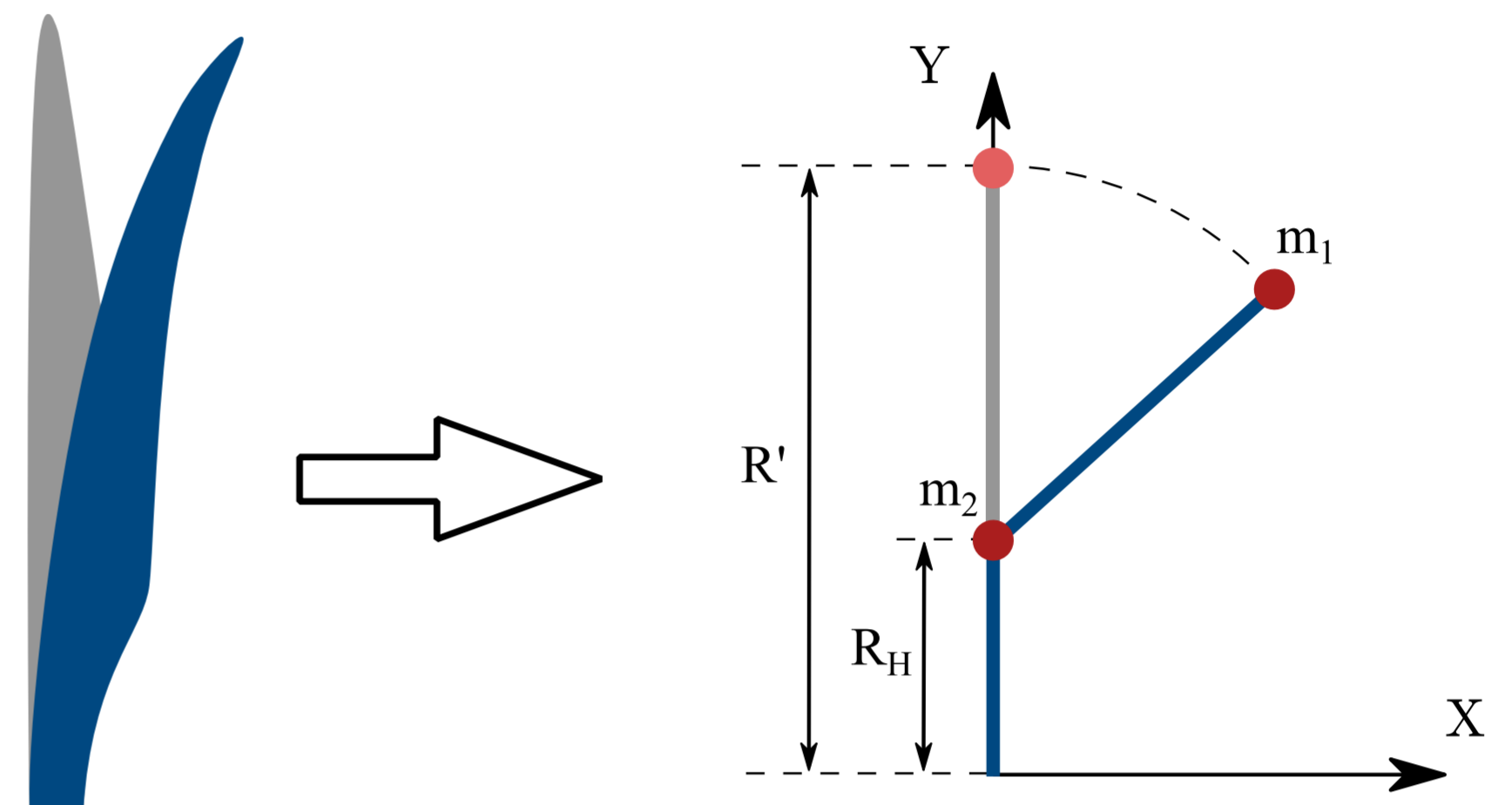


Figure 3: Representation of a blade through the lumped parameters model

Because the accelerometer is rotating with the blade itself, its readings must be corrected to take into account pitch and azimuth angular displacements. This is accomplished shifting between different frames of reference in the wind turbine (see Fig. 4).

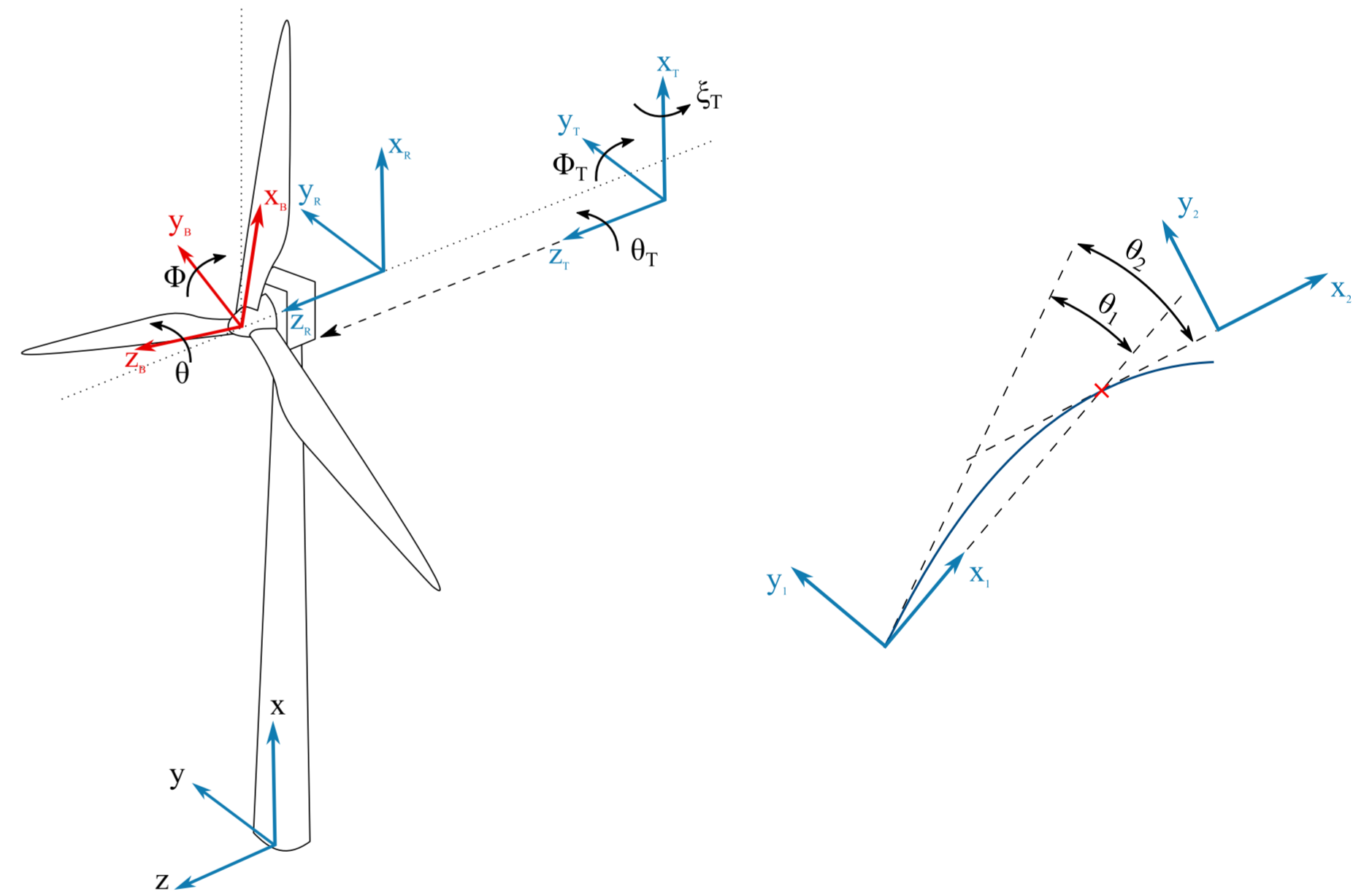


Figure 4: Reference frames in a wind turbine

EKF

The estimation in real time is achieved using an algorithm called Extended Kalman Filter (abbreviated EKF). This numerical tool is used in different applications (such as GPS, target tracking, imaging methods etc.), one of those being the effective wind speed estimation in a wind turbine for control purposes (see Fig. 2).

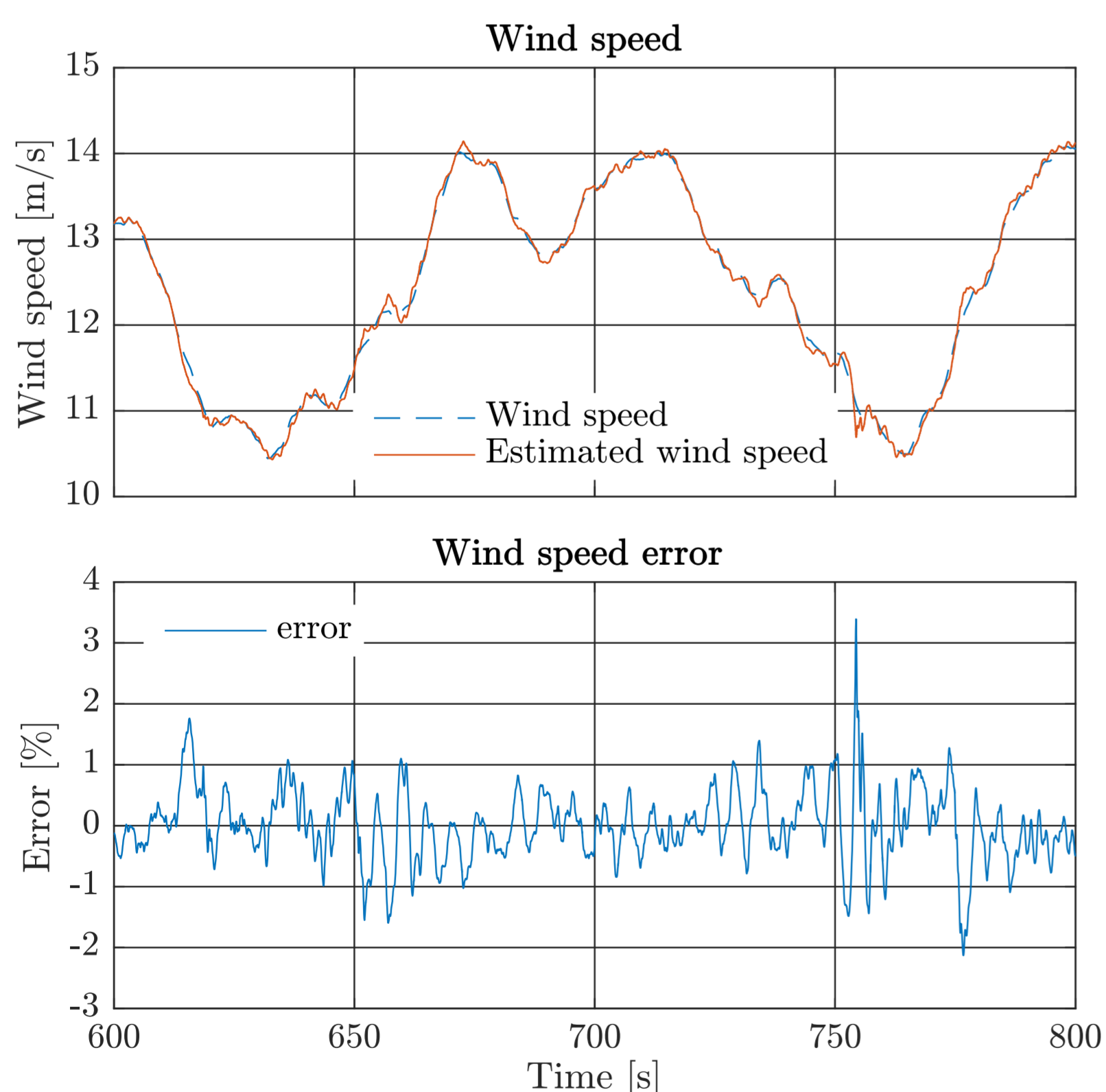


Figure 2: Effective wind speed estimation using an Extended Kalman Filter

References

- Y. Bar-Shalom, X. R. Li, and T. Kirubarajan, Estimation with applications to tracking and navigation, vol. 9. John Wiley & Sons, 2004.
- V.W. Neilson, "Individual Blade Control for Fatigue Load Reduction of Large-scaled Wind Turbines: Theory and Modelling," University of Strathclyde, 2010.