11.13 DEEP LEARNING FRAMEWORK FOR PRECIPITATION RETRIEVALS FROM COMMUNICATION SATELLITES

AHMAD GHARANJIK[1], KUMAR VIJAY MISHRA[2], M. R. BHAVANI SHANKAR[1], BJÖRN OTTERSTEN[1]

[1] Interdisciplinary Centre for Security, Reliability and Trust (SnT), University of Luxembourg, Luxembourg

[2] IIHR Hydroscience & Engineering, The University of Iowa, Iowa City, USA

ahmad.gharanjik@ext.uni.lu

Opportunistic use of communication satellite links has been shown to provide valuable precipitation information in the regions that are beyond the coverage of conventional ground-based weather radars. Deployment of additional weather radars is expensive while there are overwhelmingly many ground satellite terminals spread across the world. The link conditions of these terminals are available at a central location (gateway station) in real-time making the entire setup usable in practice. The operation of satellites at Ka-band implies strong attenuation of link signals in the rain medium. The carrier-to-noise-ratio (C/N) measurements of the link are directly related to the specific attenuation A so that rain rate R can be computed using a nearly linear R-A relationship at Ka-band during moderate and heavy rain storms.

Nonetheless, this approach cannot be directly exploited for the satellite link primarily because, in the absence of measurements such as reflectivity, Doppler velocity and dual-polarimetric variables, the link cannot differentiate between storm types and intensities. Our previous work [Gharanjik et al. 2018. Centralized rainfall estimation using carrier-to-noise of satellite communication links, IEEE Journal on Selected Areas in Communications, in press] has shown that machine learning (ML) methods help in overcoming such disadvantages by recognizing wet and dry link conditions when trained with the rain gauge data.

In this work, we investigate deep learning (DL) in the specific context of rainfall estimation using the data from single-polarized passive receivers of ground terminals. Our goal is to show that advanced DL networks can learn to recognize rain intensities (no/dry/moderate/heavy) and storm types (stratiform/convective). This information is highly beneficial to correctly apply the R-A algorithm. We compare our results with the observations from the rain gauges and the nearest German weather service Deutscher Wetterdienst (DWD) radars. To the best of our knowledge, this is the first work that employs advanced learning techniques for the passive satellite links to generate rainfall estimates.