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Visibility Nowcasting For UAS Operations using Deep Learning

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Unmanned Aircraft System (UAS) operations have spread rapidly worldwide performing a variety of military and civilian applications. The ability and performance of UAS to carry out these applications are strongly affected by poor weather conditions. Fog is one of the critical issues that threaten the safety of UAS missions by altering visibility. Therefore, the mission planning based on accurate visibility nowcasts prior to Beyond Visual Line Of Sight (BVLOS) UAS missions will be mandatory to ensure safer UAS operations.

Two types of models are generally considered for visibility nowcasting: physics-based or data-driven models. However, physics-based visibility forecasts remain expensive and difficult to use operationally. Recently, with the increase of the number of available historical data, data-driven models, especially those using deep learning approaches in particular, have attracted increasing attention in weather forecasting and have proven themselves as a powerful prediction tool.

This study aims at developing a Visibility Nowcasting System (VNS) that improves the performance and the capability of nowcasting the visibility using deep learning over the U.S.. To that end, a deep neural network, called an encoder-decoder convolutional neural network (CNN), is used to demonstrate specifically how basic NWP fields such as temperature, wind speed, relative humidity, etc. and visibility from surface observations can provide accurate visibility nowcasts. The VNS will be then tested in different geographical environments where UAS flights are deployed (for example, over North Dakota) since it can learn the time and space correlation according to the historical data.

To train the network, we created a labeled data set from available METAR reports and hourly reanalysis data from the High-Resolution Rapid Refresh (HRRR) model. This dataset will be also used to test the CNN and evaluate their nowcasting performance. The model will be then evaluated in operational use cases and compared to other available visibility observations during fog events.