Automatic Fog Detection and Visibility Determination from Camera Images using Deep Learning Features for Aviation Operations Involving Unmanned Aircraft Systems

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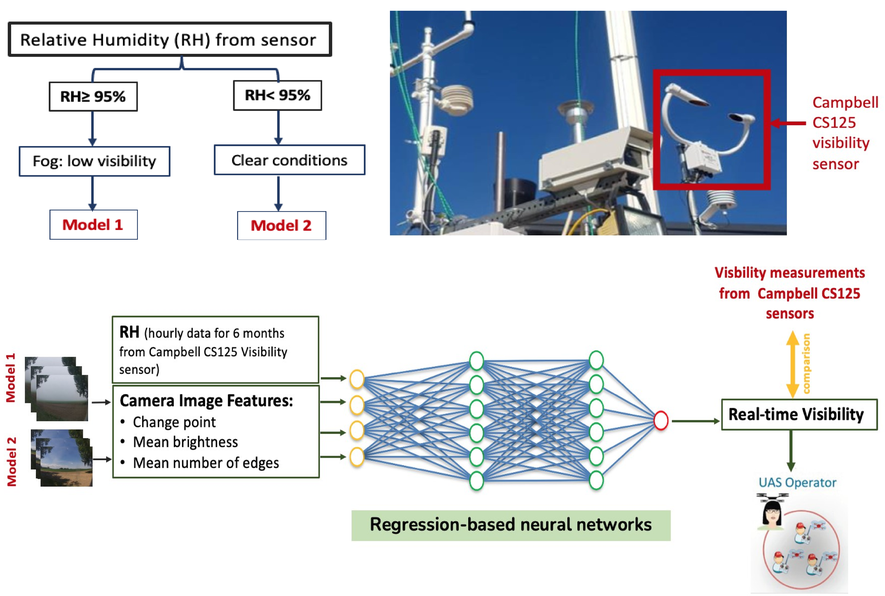
Introduction

- Flying in low visibility from fog reduces Unmanned Aircraft System (UAS) performance.
- Lack of visibility data or the inability to communicate visibility data to UAS operators due to the high cost of existing instruments and the required maintenance.
- Need to increase autonomy of the UAS.
- There exists a high density of low-cost cameras with the potential of providing visibility data.

Objective

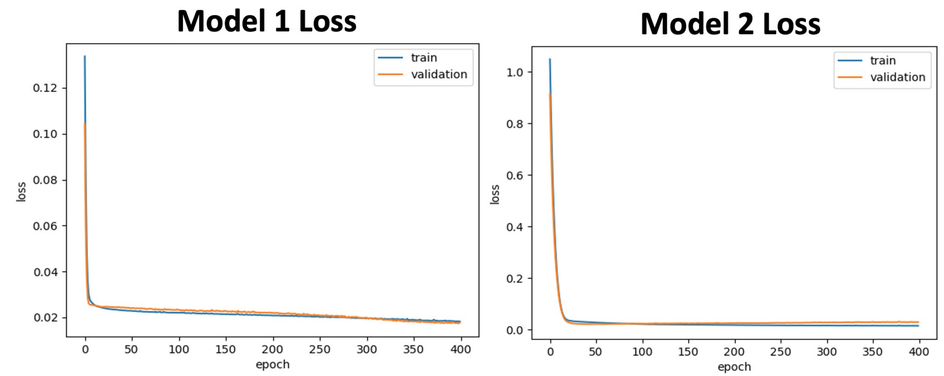
Develop and validate a camera-based deep learning model that provides a real-time visibility estimation and determines the presence of fog over Grand Forks and Fargo, ND and expand it to cover the whole U.S.

Camera-based Real-Time Visibility System

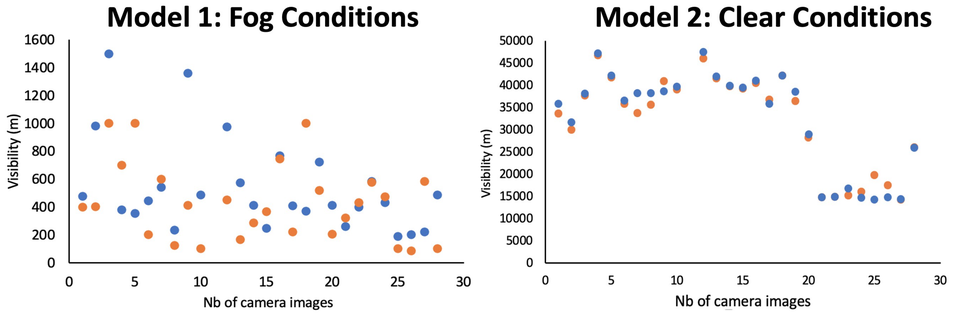


Results

Models' Metrics: Loss function



Models' Evaluation: Comparison to Visibility Sensor Observations



	Mean (m)	Obs (m)	Corr (%)	RMSE (m)	MBE (m)
Visibility from Model 1	428.61	533.48	82	0.57	274.68
Visibility from Model 2	32016.08	32243.33	90	0.05	1255.14

Conclusion

- The Camera-based Real-Time Visibility System estimates the visibility with a reasonable accuracy using camera images from two locations and relative humidity from the Campbell CS125 visibility sensor.
- The two models show a good fit: training and validation loss decrease to a point of stability with a minimal gap between two final loss values.
- Good agreement between the estimated visibility and sensor observation.
- Due to the decreased computational time required and low-cost high density camera, the Camera-based Real-Time Visibility System is suitable for UAS operations that do not want to deploy high cost-instruments.

Future Work

- Train the Camera-based Real-Time Visibility System with dataset over a longer period of time with more fog events.
- Generalize the Camera-based Real-Time Visibility System for deployment over U.S.
- Automatize the Camera-based Real-Time Visibility System to be available for deployment on board of the UAS.