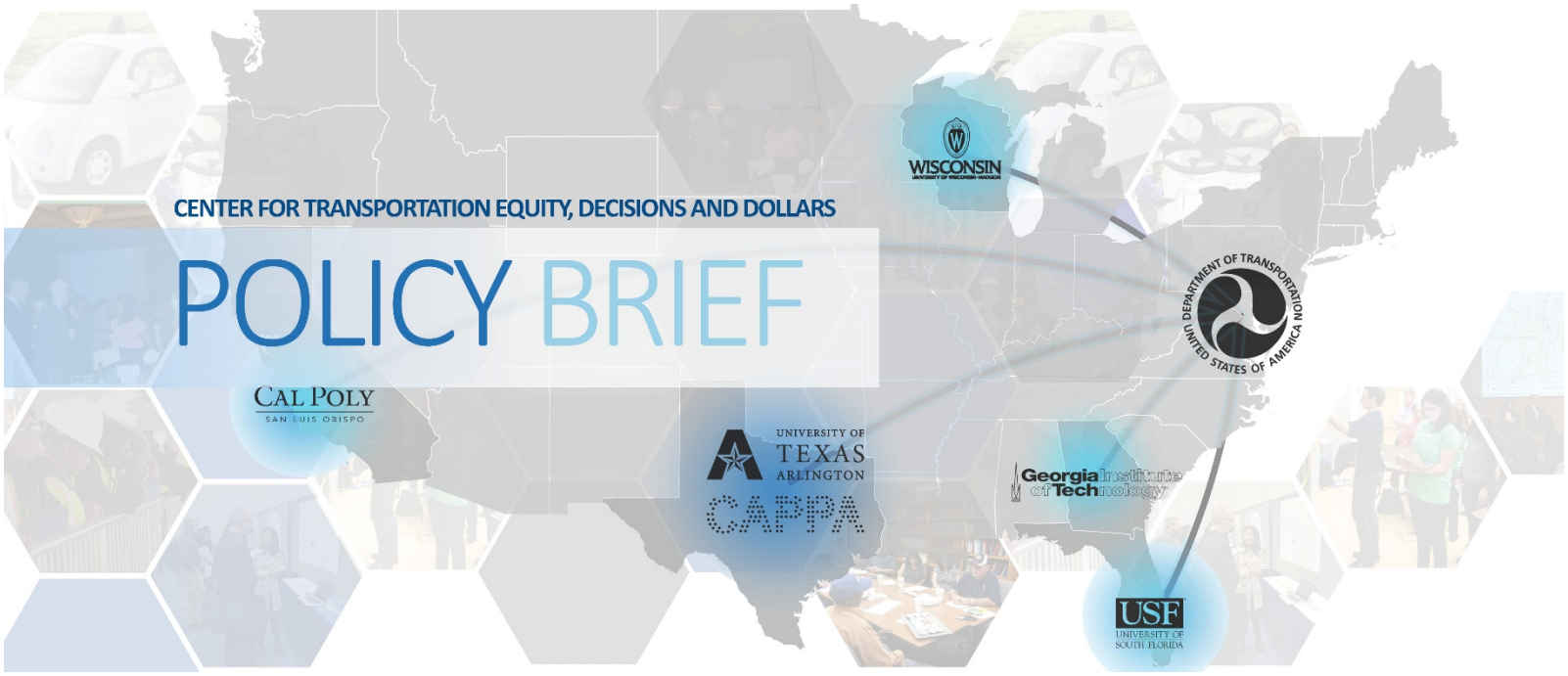

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TRANSPORTATION COMMUNICATION TOWER INSPECTION USING NOVEL UAV TECHNOLOGIES

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Executive Summary:

This proposed research employs UAV systems integrated with the close-range photogrammetry (CRP) technology and machine learning techniques for transportation tower infrastructure condition assessments. To achieve the above objectives of this study, UAVs were used to capture various elements of the tower structures in their existing field conditions. These images were further used for quantitative and qualitative assessments of the tower. For quantitative assessments, the aerial images were georeferenced and processed using photogrammetry techniques to build three-dimensional models that facilitate contactless surficial assessments of the tower features. Typical three-dimensional mapping products for the vertical structures include dense point cloud, mesh model, and orthomosaic. The tower condition can be further inspected, at the comfort of the office desk, by viewing it from multiple angles offered by its digital replica. For qualitative analysis, different machine learning techniques such as object detection and instance segmentation were evaluated to understand the feasibility of automating the identification of tower features. Machine learning-based neural network models were trained using the annotations of tower features in hundreds of aerial images and video-frames collected using UAVs. The majority of the annotations were performed on the frames extracted from the high-quality videos of the tower collected using a UAV. The annotation of tower features varies for both types of classifications, hence two sets of annotations were performed to feed into the respective classifier model. First object detection was evaluated, and based on the experience gained, instance segmentation classifiers were built subsequently. The developed classifiers were fine-tuned by varying the learning rate, epochs, and other model parameters to identify the optimal performance based on the performance indicators. Once the classifiers were built, they were tested on the same set of images that were not used for training the models. After validation of the models, they were also applied to each of the frames and overlaid on the videos. Overall, the framework adopted in this study is expected to benefit agencies in efficiently monitoring and maintaining the assets.

Scope of Problem:

The current multi-disciplinary study involves civil, aerospace, and computer science engineering fields. The scope of this study involves two tasks: the quantitative evaluation of the tower features and the qualitative identification of a set of tower features, discussed in the later sections of this report, using machine learning techniques. For this purpose, the research team used photogrammetry techniques for the former task and two machine learning techniques for object localization and classification in images and videos to accomplish the latter task. Structural deformations of the tower were also examined by building three-dimensional models of the tower using photogrammetric techniques.

Policy Alternatives:

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Policy Recommendations:

Agencies may start recruiting FAA certified drone pilots or provide training to the inspection staff