Characterization of Unpaved Road Condition
Through the Use of Remote Sensing:
Data Processing Results and Outreach

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In support of a Cooperative Agreement between the USDOT Research and Innovative Technology Administration (RITA) and Michigan Technological University, the USDOT-RITA is assisting the Michigan Tech team to design and develop a Remote Sensing system which promises to extend the available Commercial Remote Sensing & Spatial Information tools to enhance an unpaved road assessment system.

Data Collection to derive Unpaved Road Condition
Aerial images are required in order to derive road condition metrics. Traditional 1″ – 6” per pixel aerial photography does not have the spatial resolution to ‘see’ distresses such as potholes, washboard and ruts on the road. To acquire imagery of sufficient resolution, radio controlled aircraft (a Bergen Hexacopter) equipped to carry a Nikon D800 camera (center) are employed to fly over segments of unpaved roads to collect imagery of the road at a resolution high enough to detect distresses on the road.

Road condition data were collected from a radio controlled aircraft flown at 25-30 meters above the ground. The Ground Sample Distance (GSD) of the imagery collected is approximately 2mm. The image data were then processed through a custom application that assesses structure from motion to extract a 3D model of the road surface.

Distress Detection – 3D Reconstruction
A Structure From Motion algorithm is used to derive a densified point cloud from overlapping imagery. Each point in the point cloud has an RGB value from the imagery. The road surface is isolated from the background using a windowed entropy filter. Since the road is relatively smoother than the surrounding fields, the unpaved road can be extracted as a mask. Other algorithms such as a Gabor filter for ruts and washboarding and Canny Edge Detection for potholes are then applied to detect and classify distresses.

Remote Sensing System Performance
The performance of the system that was developed to meet the requirements set at the beginning of the project has been evaluated. Data was collected at a total of 8 different sites in Southeast Michigan over a period of two years. No single site had all the distresses required for assessment. Algorithm performance was evaluated by comparing the result of manual scoring of distresses to the algorithm. When the image quality was within specifications, the height maps that are the basis for subsequent distress characterizations met resolution requirements. Detection of distresses is above 93% when height map resolution requirements are met.

As part of the effort to make local and regional transportation agencies aware of the research, MTRI personnel traveled to Sioux Falls SD to demonstrate the Unsurfaced Roads Condition Assessment System (URCAS) to the 29th Annual Regional Local Road Conference sponsored by the SDSU South Dakota Local Transportation Assistance Program. Representatives from the MTRI team discussed the system developed for unpaved road assessment and flew live demos of the UAVs used to collect data.