Large Area Wind Turbine Inspection

Principal Investigator:
Christopher Niezrecki, University of Massachusetts Lowell

Co-Principal Investigator:
Robert GIles, University of Massachusetts Lowell

Student Researcher:
Robert Martin, University of Massachusetts Lowell

IAB Mentor:
Rahul Yarala, MassCEC

Collaborators:
Christopher Baird, University of Massachusetts Lowell
Andrew Schoenberg, CERL

During the manufacture of wind turbine blades, internal defects can form which negatively affect their structural integrity and can lead to premature failure. These defects are often not detected before the final installation of the blades onto wind turbines in the field. There is a growing need for non-destructive inspection (NDI) techniques that can examine utility-scale wind turbine blades for defects during post-manufacture. These techniques must be able to scan large areas quickly, inexpensively, and effectively.

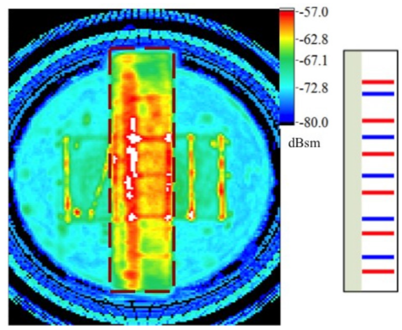
Due to their promising performance during year one, terahertz radar and infrared imaging techniques continued to be investigated into year two. New fiberglass samples with well-defined defects were fabricated for additional testing. The techniques and their post-processing algorithms were be optimized for fiberglass NDI and their effectiveness were quantified.

An x-ray imaging technique was also tested during year one. Despite being very effective at detecting nearly all the embedded fiberglass defects, investigations into x-ray imaging as an NDI technique did not continue into year two due to high equipment costs and safety concerns.

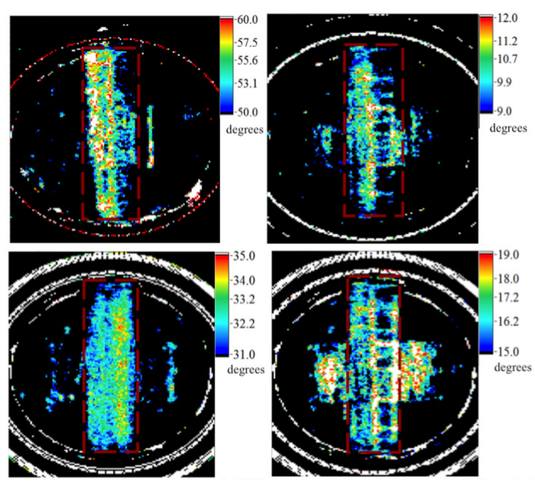
The data from the terahertz Inverse Synthetic-Aperture Radar (ISAR) scans were reprocessed using more comprehensive data processing algorithms during year two. The fully polarimetric data collected during year one was used to create ISAR images for the four traditional polarization states, and for the Euler parameters determination. A contrast quantification algorithm was used to evaluate each of the ISAR images proving that the m Euler parameter produced the best contrast between defect and defect-free regions. The year-two results show that the technique is promising for shallow, large defects, but has difficulty imaging deeper defects.

Further investigations into infrared thermography were also conducted. The new samples fabricated by the Composites Engineering Research Laboratory (CERL) were tested by heating them up and recording the cool-down surface temperatures using a Forward looking infrared (FLIR) camera. In addition, a section of a 9-meter turbine blade was also inspected using these techniques. Preliminary results indicate that the technique is reasonably effective for out-of-plane wave defects, but no other defects have been detected.

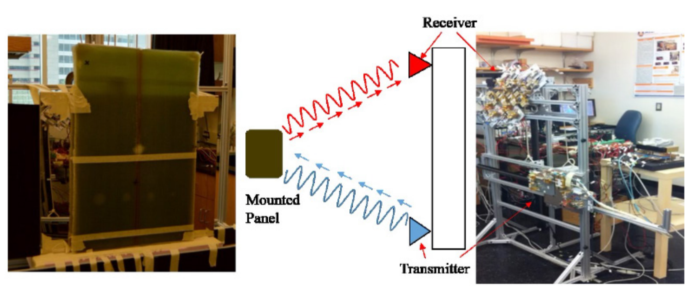
Finally, in collaboration with Northeastern University, a millimeter wave inspection technique was tested. The new CERL samples were imaged using a ~73GHz system performing synthetic aperture radar (SAR). The preliminary data was not fully processed, however initial analysis generated results that did not correlate well with the damage in the panels.



Composite m parameter ISAR image for Sample Y1-3 at 30 degrees elevation (left), as well as defect schematic (bottom right) of the sample. In the ISAR image, the sample is outlined with a brown dash.



Composite ISAR images of sample Y1-3 at 30 degree elevation for y (top-left), v (top-right), w (bottom-left, r (bottom-right), Dashed brown boxes indicate the location of sample Y1-3 in each of these images.



Photographs of sample Y-2 mounted (left) and the millimeter wave radar system used to image the sample (right). A diagram (center(shows how the transmitter is directed at the mounted sample, and the receiver picks up the reflected radiation.