Micro-Doppler Study of an Array of Rotating Spheres
AP-S/USNC-URSI Joint Symposium

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The electromagnetic response of dynamic electromagnetic structures can give rise to micro-Doppler shifts (V. C. Chen, IEEE Trans. Aero., 2006). Radar illumination of helicopter rotor blades (Balanis, IEEE Trans. Ant. Prop., 2001) and windmill blades can introduce harmonics and, thus, distortion of the signal. These micro-Doppler shifts can be attributed to the micro-motion of the target. An aspect of interest to this effort considers this behavior from coherently rotating scatterers (V. Kozlov et al., J. Quant. Spect. & Rad. Trans., 2017). The present work investigates this idea further by considering the generation of discrete frequencies through the rotation of periodic array structures.

This effort examines the generation of micro-Doppler shifts from an array of rotating spheres. Two different array topologies are considered. The first topology assumes synchronized rotational motion of the spheres around a central axis. The second topology assumes asynchronized motion where each sphere orbits with a slightly different phase offset. An example of the asynchronous array of rotating spheres is shown in Fig. 1. The micro-Doppler generation model considers the scattered electromagnetic spectrum from an off-normal incident field exciting the array at multiple rotational positions. The antenna array factor for a periodic array is analyzed at each time step of the rotational motion. Time-frequency techniques are then applied to generate the micro-Doppler response.

Results will be presented for different variations of the synchronous and asynchronous cases, in phase and out of phase, including spheres and blades. A comparison of frequency shifts is made between the synchronized and asynchronized motion. Finally, the unique modulation of asynchronous motion is presented to explore the controlling of phase offset variation.

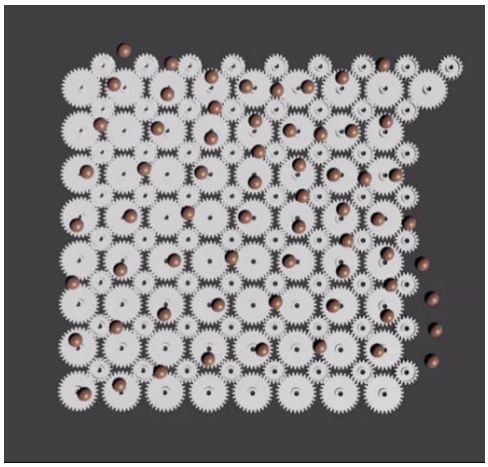

Figure 1. Asynchronous array of rotating spheres