Integrated Lens Antennas for Multi-Pixel Receivers

This integrated lens antenna could enable high-resolution, three-dimensional imaging radar for homeland security applications.

NASA's Jet Propulsion Laboratory, Pasadena, California

Future astrophysics and planetary experiments are expected to require large focal plane arrays with thousands of detectors. Feedhorns have excellent performance, but their mass, size, fabrication challenges, and expense become prohibitive for very large focal plane arrays. Most planar antenna designs produce broad beam patterns, and therefore require additional elements for efficient coupling to the telescope optics, such as substrate lenses or micromachined horns.

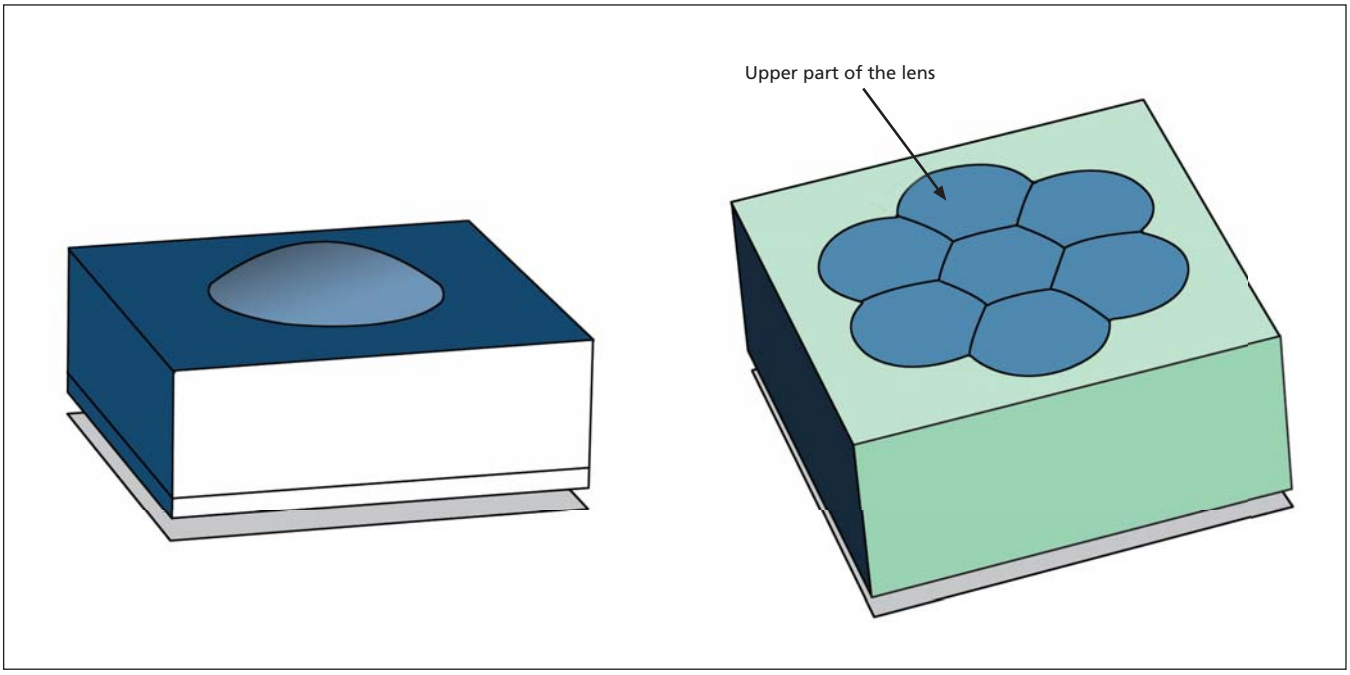
An antenna array with integrated silicon microlenses that can be fabricated photolithographically effectively addresses these issues. This approach eliminates manual assembly of arrays of lenses and reduces assembly errors and tolerances. Moreover, an antenna array without metallic horns will reduce mass of any planetary instrument significantly.

The design has a monolithic array of lens-coupled, leaky-wave antennas operating in the millimeter- and submillimeter-wave frequencies. Electromagnetic simulations show that the electromagnetic fields in such lens-coupled antennas are mostly confined in approximately 12–15°. This means that one needs to design a small-angle sector lens that is much easier to fabricate using standard lithographic techniques, instead of a full hyper-hemispherical lens. Moreover, this small-angle sector lens can be easily integrated with the antennas in an array for multi-pixel imager and receiver implementation. The leaky antenna is designed using double-slot irises and fed with TE10 waveguide mode. The lens implementation starts with a silicon substrate. Photoresist with appropriate thickness (optimized for the lens size) is spun on the substrate and then reflowed to get the desired lens structure.

An antenna array integrated with individual lenses for higher directivity and excellent beam profile will go a long way in realizing multi-pixel arrays and imagers. This technology will enable a new generation of compact, low-mass, and highly efficient antenna arrays for use in multi-pixel receivers and imagers for future planetary and astronomical instruments. These antenna arrays can also be used in radars and imagers for contraband detection at stand-off distances.

This will be enabling technology for future balloon-borne, smaller explorer class mission (SMEX), and other missions, and for a wide range of proposed planetary sounders and radars for planetary bodies.

This work was done by Choonsup Lee and Goutam Chattopadhyay of Caltech and Nuria Llombart Juan for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.



The **Dielectric Silicon Micro Lens** (left) is shown with a possible array concept (right).