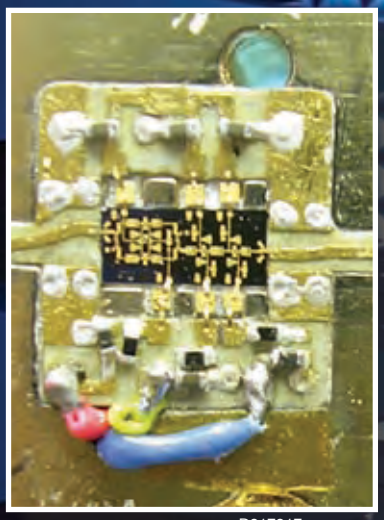
Applied Physics

SwRI is developing innovative metamaterial antennas that are smaller than conventional antennas of the same frequency. We evaluate these antennas in a 14-meter RF anechoic chamber to validate performance and optimize designs.



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digital & analog electronic systems development • RF systems • laser, fiber & electro-optics • sensors mechanical systems & design • acoustics & ultrasonics • reservoir characterization • biometric systems packaging • robotic vehicle evaluations • hardware & component analyses • advanced microelectronics microelectromechanical systems (MEMS) • rapid prototyping • miniaturization technologies

With a diverse staff and a full range of engineering facilities and expertise, Southwest Research Institute creates sophisticated, miniaturized, low-power electronic, sensor and optic systems and devices for a range of applications (applied-physics.swri.org). We also evaluate novel robot systems and develop new algorithms and software programs to collect and process data (advancedelectronics.swri.org).

To optimize reservoir production, petroleum companies rely on sophisticated analyses of geologic formations to assess rock permeability and porosity as well as volume and distribution of fractures, which provide pathways for hydrocarbon pooling and flow. Using existing borehole array processing algorithms, SwRI geophysicists have developed a new method for inverting cross-dipole sonic waveforms. The inversion algorithm quickly and reliably separates and extracts unknowns to accurately predict the number, distribution and direction of formation fractures, providing valuable clues for production-improving strategies, such as directional drilling from the original borehole outward into the formation (reservoirgeophysics.swri.org).

The Institute operates unique facilities to evaluate small unmanned ground robots. We continually expand the capacity and capability of our test bed facilities to keep up with the increasingly diverse and rapidly growing field of ground robotics. Recent additions include walls with a variety of surface features and textures to test climbing robots and a confined space used to evaluate snake-like robots. We also added an elevated arena with a motion capture system to track multiple communications relay robots.

In cooperation with SwRI antenna specialists, we used internal funding to study using metamaterials for radio frequency electromagnetic applications, including antenna and filter improvements. Electromagnetic metamaterials are composed of a host medium with inclusions designed to control electromagnetic radiation properties. To fit in tight spaces, we developed a patch antenna about one-fifth the size of a normal system that offers two resonant frequencies, one characteristic of the patch and one related to the resonance of the enclosed metamaterial. The metamaterial load provides lower frequency resonance and, as the size of the patch is decreased, the lower resonant frequency also decreases (advancedelectronics.swri.org).

Our high-frequency millimeter wave designs draw from multiple disciplines. By applying advanced design methods, including finite element modeling and microwave cascade circuit optimization, in concert with state-of-the-art assembly equipment, we are developing advanced microwave monolithic integrated circuit, or MMIC, designs such as a 35-GHz amplified detector for a passive millimeter-wave imaging system. Staff members also led an internal research project to expand detector capabilities up to 110 GHz in support of current and future program initiatives.

We are developing a unique automated pedestrian system to test the response of autonomous vehicle safety and perception systems without endangering a real person. Using advanced analytical tools to model the dynamics of the system, SwRI is working to achieve stable balancing and to coordinate walking speed with cadence. ❖

Visit applied-physics.swri.org for more information or contact Vice President Ed Moore at (210) 522-2739 or ed.moore@swri.org.

1. *Combining finite element modeling and microwave cascade circuit optimization with advanced design capabilities and state-of-the-art assembly equipment, SwRI developed advanced microwave monolithic integrated circuit designs, including a 35-GHz amplified detector for a passive millimeter-wave imaging system. Using internal funding, we continue to advance our capabilities to create detectors in the 110-GHz range (advancedelectronics.swri.org).*

2. *In 2009, we conducted tests and experiments to evaluate small unmanned ground robots in the extremely challenging environment of the Mojave Desert in California.*

3. *To read the formations surrounding petroleum deposits, SwRI geophysicists have created a new algorithm that uses cross-dipole sonic data to estimate formation properties around boreholes.*