Vertically Integrated Research in Reconfigurable Liquid-Metal RF Devices

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The University of Hawaii is a charter member of the Vertically Integrated Projects (VIP) Program Consortium, established in 2014 to reform STEM education. In the VIP Program, faculty work on research projects with student teams that are *vertically integrated*. That is, the faculty mentor the graduate students, who in turn mentor the seniors and juniors, who in turn mentor the sophomores and freshmen. Participating undergraduates receive academic credit, and are required to remain with a project through graduation. As a student rises in maturity to the senior level, the depth of knowledge should be approximately the same as that of a first-year graduate student.

Given the appeal and proliferation of wireless devices among students, one VIP team at the University of Hawaii is focused on reconfigurable RF devices that may play an increased role in future wireless technologies. The interest level among students is heightened even more since this group focuses on liquid metal to create dynamic shape-shifting RF components. Senior design projects have included liquid-metal monopole, helical, spiral, and Yagi antennas. Graduate students in this group have also demonstrated liquid-metal filters, phase shifters, baluns, tuners, and amplifiers. Most of these proof-of-concept devices were demonstrated with pressure actuation, but this method isn't the most compatible for integration with RF devices.

This research group has had recent success with electrical actuation, which not only enables easier integration with modern RF architectures than pressure-driven techniques, but also consumes relatively low power and uses low-voltage signals to manipulate the liquid metal to tune RF performance. This presentation discusses two types of electrical actuation methods to create liquid-metal RF devices: (1) a technique that alters the liquid metal's surface tension to control its position within a fluidic channel, and (2) a controllable means for deforming an anchored liquid-metal tuning element. Both methods are low-voltage, low-power-consumption solutions for realizing reconfigurable liquid-metal devices.

The presentation will be made by a student who started participating in the VIP Program as a freshman, and is currently working on a liquid-metal RF switch as a sophomore.