The BYU Interferometric SAR (YINSAR)

David G. Long
BYU Center for Remote Sensing, Microwave Earth Remote Sensing Laboratory
Brigham Young University
459 Clyde Building, Provo, UT 84602
long@ee.byu.edu (801) 422-4393

With NASA funding BYU has successfully demonstrated the feasibility of a low-cost, compact interferometric SAR. The Brigham Young University Interferometric SAR (YINSAR) has been successfully collecting interferometric SAR image data over several sites in Utah and Colorado to support archeology and geologic studies. In particular, the low flight costs of YINSAR have made it possible to frequently (every two or three weeks) over-fly study areas. Sample YINSAR data is available for viewing at http://www.ee.byu.edu/ee/mers/ under the “SAR Research” topic.

YINSAR instrument has been developed to fly on a small, six passenger aircraft. It includes a differential GPS correction system, an inertial motion sensing unit (IMU), and A/D boards which allow streaming of the 500 MHz dual channel receive data directly to disk. We have developed our own SAR image and motion compensation processing software along with a new phase gradient-based focusing algorithm.
A block diagram of the YINSAR system is shown in Fig. 1 with photographs of the hardware and aircraft shown in Fig. 2. YINSAR operates with a 200 MHz bandwidth at a 9.9 GHz center frequency. By operating the aircraft at low altitude (typically 1000-1500 feet), a low-cost, low-power transmitter can be used. Costs are minimized by using a double sideband (DSB) transmit chirp and an all-digital final IF. The DSB chirp doubles the effective bandwidth of the transmit signal with only a small SNR loss due to reduced carrier suppression. The entire system is phase-locked to a 100 MHz stable local oscillator (STALO). The bi-static IFSAR
The antenna system consists of three identical waveguide-fed horn antennas, see Fig. 2. The two receive antennas are separated by a baseline length of approximately 1 m. Mounted in place of the passenger seats in a six passenger small aircraft, YINSAR is controlled from the co-pilot’s seat using a laptop computer. Aircraft attitude and motion data is sampled using both a kinematic GPS (at 10 Hz) and the IMU (at 500 Hz). Coupled with our processing software, antenna position and pointing information accurate to within a few centimeters is determined during a data take in order to compensate for aircraft motion in the processing.

For most of our studies YINSAR has been operated from a 6 passenger Cessna 337M. This twin engine push/pull plane is particularly well-suited for remote sensing. Owned by Utah State University (USU), the aircraft has been modified for our use by replacing the center seats with a rack to mount the YINSAR electronics and permanent mounting of the six GPS antennas and the three X-band YINSAR antennas. The aircraft costs $250/hr to operate, including the pilot, and thus can support multiple flights over the study areas at very low cost. We recently added a low frequency (2 GHz) channel to YINSAR, but have not done flight testing of the new channel.

![Figure 4. SAR image draped over topography inferred from SAR data.](image)

**Selected Publications**


**Related Student Theses**


