**RASAR**

A lightweight, self-contained radar designed for installation under the wing of UAS for counter-IED and FOPEN missions

The real-time, autonomous, synthetic aperture radar (RASAR) is a quad-polarization, linear chirp pulsed, frequency-modulated SAR designed to be SWAP compatible with deployment on the Shadow-200 UAS. RASAR has been developed as one component of a suite of cooperative sensors designed to enable real-time, cross-modal data fusion.

RASAR is a self-contained system that can be flown in an external pod mounted under the wing of the Shadow or other UAS, minimizing any impact on current ISR payloads. The complete podded system weighs less than 25 lbs and requires less than 150 W of total power. To maximize the system flexibility to the fleet, RASAR has adapted the Naval Research Laboratory’s (NRL’s) Software Reconfigurable Payload (SRP) open architecture design concept, and has been developed as a set of card swappable modules that can be inserted into a standard SRP chassis.

SRP is a USMC Program of Record and supports RF communications and operations across the full spectrum of RF frequencies.

**RASAR RF Components**
- Receiver / Exciter Unit
  - Single c-PCI Card Integrated digital-analog design
  - 12-bit 1600 MHz DAC and ADC drive direct signal synthesis and recording
  - Embedded FPGA performs pulse presumming prior to data transfer for processing
- LNA/PA Unit
  - 25 W peak power amplifier
  - Low-noise amplifier design optimizes to available SWAP

**RASAR Chassis**
- Use existing SRP chassis
- Compact-PCI backplane provides for c-PCI and Ethernet connectivity
  - Ethernet switch resident on backplane
  - 100 MHz system clock and interlocked GPS receiver are resident on chassis backplane
  - Clock and 1-PPS signals routed to all c-PCI slots
  - SRP chassis entered flight testing in April 2011

**RASAR System Hardware**
- RASAR Pod
  - Adapted from another NRL program
  - Pod entered UAS flight testing in Nov 2010

**RASAR Navigation**
- Differential GPS combined with high-accuracy INS provides high-quality navigation solution
- RASAR testbed utilizes Novatel CPT system (DGPS/FOG)
- RASAR UAS system will use Novatel DPGS receiver combined with Honeywell HG1900 IMU

**RASAR Antenna**
- Compact L-band antenna from first RF

**RASAR Data Storage**
- S-FIVE system provides raw and processed data storage and datalink management functions
- All connectivity is via Ethernet
- S-FIVE is mounted centerline or in a second wing-pod

**RASAR Processing and Control Card**
- Combined i7/FPGA card stack
- Performs system command and control, digital spotlighting, navigation processing, and image formation processing
- Additional processing cards enable expanded airborne image formation processing

**RASAR Datalink**
- Any Ethernet-enabled datalink structure can be used
- Current test plan is to use Mini-CDL datalink
- Data link is mounted centerline or in a second wing-pod

RASAR is part of a continuing research program developing compact, autonomous sensing systems compatible with UAS operations and deployments. The sensor development was led by NRL, in conjunction with the Space Dynamics Laboratory (SDL) and SRC, Inc. This research was conducted under the Office of Naval Research (ONR) sponsored Fusion, Exploitation, Algorithms, and Targeting for High-Altitude Reconnaissance (FEATHAR) program and is continuing under the ONR-sponsored Tactical EO/IR/SAR/SIGINT Integrated for Targeting (TEISIT) program.
DATA FLOW AND PROCESS

Mission Operation
Planning: A collection of targets and flight paths is defined prior to take-off and composes a mission. For each leg, the radar mode of operation (HH/VV, Quad Polarization, IFSAR) is set.

Operation: During a flight, the radar automatically turns on and off as it passes the targets defined in the mission. The data is automatically processed and stored or downlinked. Sending a new mission or additional targets in flight is also supported.

Onboard Processing
Pre-processing: Data is captured at 1.6 GHz with 12 bit samples. The raw samples are digitally demodulated into raw baseband IQ data. Normal operational PRF is between 10-20 kHz. Pulses are filtered and pre-summed to knock out returns from outside the antenna beam and provide a boost to the SNR.

Geometry Compression: Given RASAR’s wide beam, the data is further filtered so that only the samples needed to reconstruct the target are kept. Specifically, the data is filtered and decimated so that only the target/beam intersection is kept. Range compression and clipping of unneeded range samples is also performed. Data compression rates of 20x are achieved, which enable transmission of the data down a 8 Mbps datalink.

Onboard Image Formation: Backprojection is performed on an FPGA of a limited target area.

Geometry Compression: The raw data, geometry compressed data, and formed complex images are stored in the sensor’s solid state disk. All can be downlinked to a ground user.

Ground Display
Database Cataloging: Data is received from the datalink or read from the onboard storage and stored into a database.

Image Formation: Backprojection is used on the ground to form images. The algorithm has been optimized to use a GPU to enable near real-time processing of the data as it is downlinked.

Screener Display: Images are displayed to the end user. Change detection, HH/VV subtraction and various other post processing are performed at this stage.

SPECIFICATIONS
• Operating band (extended): 1110–1390 MHz (0.5 m resolution)
• Operating band (primary): 1215–1390 MHz (0.9 m resolution)
• Peak transmit power: 25 W
• System power: 150 W
• Weight: 25 lbs
• MAX Altitude: ≤ 8000 ft, AGL
• Standoff: 500 – 4000 m
• MAX Swath width: ≤ 4 km
• Effective PRF: ≤ 1 kHz
• Beamwidth: 80°
• Navigation solution: DGPS/MEMS
• Polarization: HH, VV, VH, HV
• Processing modes: Real-time onboard back-projection; Full-swath ground-assist back-projection

APPLICATIONS
• Day-night all-weather imaging
• Direct, single pass, thin target detection capability
• Demonstrated performance in counter IED mission
• Provides moderate foliage penetration capability
• Wide Azimuth Beam (WAB) capability
• Mitigates UAS UHF antenna accommodation and spectrum interference issues
• Multi-aperture image enhancement
• Persistent surveillance and area survey operational modes
• Simultaneous HH/VV polarization, quad-polarization
• Change-detection (CD)
• Rapid add-on capability for existing theater assets
• High power, 25,000 ft altitude available with a modest SWAP increase

Scan QR code to download an electronic copy.
© 2018 SRC, Inc. All rights reserved. 20180910