Avian Surveillance and Warning System

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Introduction

- SRC has developed an advanced L-band avian radar called *BSTAR*™ for deployment to U.S. civilian airports and military airfields

BSTAR™ Radar: Unique Technology

- **Solid state 3D radar**
- Provides **automatic detection, location, tracking and classification** of small, low, slow-moving birds
- **Fully coherent pulse Doppler processing suppresses stationary** clutter
- Enables detection and **altitude-based tracking** of avian targets **over areas of high ground clutter**, where most other avian radars fail to perform
- L-band design significantly reduces interference caused by weather and other small airborne objects, such as insects
- High reliability and low lifecycle cost – no moving parts

***BSTAR* offers unique technology that allows for actionable "sense and avoid" alerts on bird activity.**

What is *BSTAR*™?

- **Avian radar subsystem(s)**
  - Modern military radar technology
  - Avian optimized waveforms
  - Avian optimized tracker
  - State-of-the-art target classification
- **3D display subsystem**
  - Google earth-based 3D Display
  - Wireless remote connectivity
- **Data management subsystem**
  - Real-time playback capabilities
  - Warning region situational awareness toolset
  - *BSTAT*™ trend analysis/data mining toolset
- **Thermal/visual imager subsystem(s)**
  - Integrated camera subsystem
- **Hazard assessment subsystem**
  - Real-time hazard warning system
  - Hazard analysis toolset
- **Network services**
  - TCP/IP integration for display at airports, FAA and CEAT
  - Wireless PDA/laptop services

An integrated System of Systems

What Does *BSTAR*™ Do?

- **Scans:** electronically 360º in azimuth (or sectors if desired)
- **Detects moving targets:** pulse Doppler processing and multi-dimensional clutter map eliminates non-moving returns
- **Locates detection:** in range, azimuth, elevation and range-rate
- **Auto-tracker:** associates detections in 4-space to existing tracks and automatically updates tracks
- **Auto-classifier:** examines attributes of the track and assigns estimated target type (bird, plane, ground vehicle or unknown)
- **3D display:** depicts color-coded tracks (and detections if desired)
- **Hazard alert:** issued if conditions dictate in a user-defined warning region
- **Data management subsystem collects all data:** into a database for later analysis
- ***BSTAT* Avian Analyzer:** provides database query tools for analysis
- **Integrated thermal/visual camera:** (optional) subsystem automatically slews-to-radar-cue for operator confirmation of target classification

L-band Advantages

- **Weather immunity**
  - No appreciable backscatter or attenuation from rain
  - Birds remain detectable in rain
  - Reference: Sauvageot, Radar Meteorology
- **Insect detection is negligible**
  - No issue in mistaking insects for birds
  - Reference: Vaughn, Proc IEEE, 73-2
- **Avian radar signature**
  - Peak radar cross section ("Maximum average RCS") near L-band
  - Reference: Pollon, IEEE Transactions, AES-8

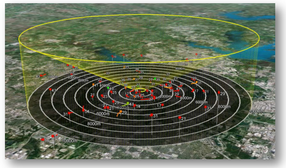
360° L-band solid-state, 3D electronic scan

Detects, tracks and classifies small, slow-moving birds

Suppresses stationary ground clutter

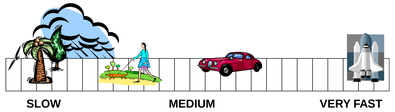
Electronically Steered Antenna

- Radar electronically scans 360 degrees in azimuth
- Programmable scan volume to focus on areas of interest with higher update rates
- Stationary antenna provides excellent reliability



Pulse Doppler Filtering

- Luckily most targets of interest are moving and most clutter (buildings, mountains, trees) are not. We use the shift in frequency due to Doppler to pick out targets from clutter
- Doppler processing separates signals into "bins" depending on Doppler frequency. By doing so it can not only separate moving from non-moving, but it can also distinguish between different relative velocities
- Doppler processing is done using a series of different filters, each tuned to a specific Doppler frequency



***BSTAR*'s ability to track small, low, slow-moving birds in the presence of heavy ground clutter is unsurpassed and no other avian radar comes close to *BSTAR* in this arena.**

3D Display

- **Integrated Google Earth 3D display**
- **User configurable**
- **Provides radar control and status**
- **User defined and savable views and perspectives**
- **Pop-up windows provide detailed, real-time track information**
- **Playback of archived data**
- **Real-time avian situational awareness**
- **Geographical display of *BSTAT* queries**

*Birds are color-coded according to estimated **biomass***
Red – larger birds
Green – smaller birds
Aircraft are colored blue

The *BSTAR*™ display provides an advanced feature-rich 3D situational awareness including avian biomass and covering the airports full region of interest.

Hazard Assessment Subsystem

- Real-time system displays estimated biomass for each bird track that along with location, altitude and speed indicate potential avian hazard levels
- Hazard level metrics such as avian/aircraft miss distance monitoring developed
- Hazard Assessment Subsystem highlights the regions of significant bird activity, based on user defined risk levels
- *BSTAR* enables the user to identify the high threat areas, or hot spots
- System display highlights those locations where birds congregate or may have entered a region of concern

Miss distance monitor detects an actual near-miss of bird and aircraft

These algorithms and metrics are designed to detect and predict avian hazard situations.

All-weather coverage without insect detection

BSTAT software suite catalogs and quantifies avian behavior

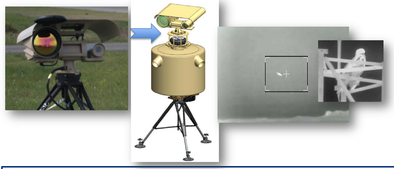
BSTAT: Data Management Subsystem and Avian Analyzer Software

- Collects, archives, catalogs, analyzes and quantifies radar data for all target types
- Automatic data management system logs all target movements and parameters (3D position, time, velocity, altitude and biomass of avian targets)
- Evaluates hazardous wildlife attractants and bird behavior patterns
- Estimates trends with respect to location, hour, day, season and year
- Automated custom reports
- Selectable playback times
- Evaluates bird behavior patterns and trends to identify potential hazards

BSTAT is a turnkey solution that provides the user the desired data when he/she wants it.

Optional Integrated Electro-Optical/Infrared Camera

- Offers user **bird verification, size estimation, species identification, bird count and more**
- **Thermal imager allows for enhanced day and night observation**
- **Automated slew-to-radar-cue and video auto tracking** provides for continuous in-flight observation of birds
- Can be used to verify potential avian hazards, saving wildlife or operations personnel from responding to false alarms



Our integrated radar/camera system offers unique opportunities for the users to actually see and identify the birds in flight.

BSTAR™ Operational Evaluation

- SRC has been conducting engineering trials and demonstrations of *BSTAR* at various sites
- Working with the
  - University of Illinois Center of Excellence in Airport Technology (CEAT) on behalf of the
  - FAA Airport Technology Research & Development Branch and with the
  - USN BASH PM and his associates
- The FAA, CEAT and the USN have all been involved in cooperative R&D efforts aimed at assessing radar technology for use at airports as a tool to detect and track avian targets for many years.
- The FAA and CEAT are conducting a 2-year Stage 3 Operational Evaluation of *BSTAR* at Dallas Fort Worth International Airport
- Evaluation started in October 2011
- No hardware issues of any kind since emplacement

BSTAR deployed at Dallas-Ft Worth International Airport

High Reliability and Low Lifecycle Cost

- Electronic phased array with no moving parts and solid state for reliable operation
- Hardware is military qualified (Mil Std 810F, EMI 460E, etc.)
- Rated to withstand 120 knot winds
- **High mean-time between failures based on fielded data**
- **Low maintenance and operational cost**
- **Full integrated logistics support including remote monitoring**
- Specifications
  - Requires 110/220 VAC, 2650W
  - Unattended remote operation over IP network
  - System weight and size
    - 400 lb
    - 4 ft diameter by 4 ft high

Summary

- *BSTAR* has the most advanced signal processor, target tracker and target classifier in the avian radar arena
- Designed and built by a highly experienced military radar house
- Software variant of US Army's Lightweight Counter Mortar Radar with over 700 fielded
- 3D coverage with 0 to 30 deg elevation
- Excels at tracking low, slow bird targets
  - 10-km (6NM) range on FAA standard avian target (crow)
- Simultaneously detect and track in three dimensions and classify birds from aircraft
- Low cost of acquisition and sustainment

***BSTAR* provides unique avian real-time situational awareness.**

PR 12-2751

BSTAR exploits the best of field-proven, modern military technology to enhance aviation safety