A New Generation Tracking and Exploitation System

Cyclops Technologies

**Principal Investigator:** David Breville

**Area of Interest:** Location, Tracking and Communication Technologies.

**Capability Description:**

A new generation miniature collection and precision geolocation platform for body worn and micro UAS deployment. Ideally suited to be implemented as a 10 ounce payload requiring minimal power for detection, precision geolocation, and collection of wireless signals. System provides ability to capture signals over 250 MHz instantaneous bandwidth with the ability to stitch together frequency bands eliminating white space between bands. Allows for collection of cellular signals operating in three bands such as upper and lower GSM bands and UMTS simultaneously. System is TDOA ready allowing for precision geolocation. Experiment is to verify collection ability and the ability to reproduce frequency spectrum and play back accurately on spectrum display post mission. Experiment will also include basic signal detector and determine geolocation accuracy of cellular signals in GPS denied environment using trilateration with combination of high performance and basic signal detectors.

**Experiment Objective/Hypothesis:**

Objective is to determine basic geolocation accuracy and verify ability to accurately play back spectrum signature of area using combinations of frequency bands.

**Experiment Plan / Data Collection Plan:**

The measurement of the results will be from different sensor placement around the airfield with and without a UAS deployed sensor to determine accuracy over variety of sensor placements.
Collection activity will be for cellular phones to determine the relative distance required to perform accurate reproducible collection.

**Measures of Performance & Effectiveness:**

Effectiveness and performance will be determined from data collected using several different antennas, different frequency bands and various signal types. Results will be analyzed for several different cellular formats and will include evaluation of geolocation accuracy of push to talk radios in the 136-174 MHz band.

**What new capability does this represent?**

The system tested is (to our knowledge) the first of its kind with the ability to utilize direct frequency conversion greatly reducing sensor cost, power, size, and weight. Additionally the heat dissipation is a fraction of typical scanning receivers greatly reducing exposure because of heat signature. Objectives also include to determine effectiveness to replace systems such as "Wolfhound" with a low profile system that is more cost effective, smaller, and ability to geolocate and prosecute other signal types.

**What capability gap does this address?**

The technology gap filled is to provide a truly body worn system with small footprint that can operate as an unattended sensor transforming the warrior into an "intelligent" sensor. The technology gap also is to provide a subpound SIGINT payload that may be utilized in micro UAVs such as the InstantEye as a single UAS or swarm UAS deployment to provide wide area surveillance.
“Mini Roadrunner” Digitizer/Recorder
Preliminary Technical Datasheet

FEATURES

- Digitize/records/playback a selected radio band up to 100 MHz bandwidth
- Available internal bands include VHF PTT through WIMAX
- Available with 16 bit resolution to 500 MHz and/or 12 bit resolution to 2.7 GHz
- 92 db AGC range, 1 db steps
- Internal FFT provides <20 KHz resolution on realtime, record, playback signals
- Free running or triggered FFT
- Separate RF input and output ports
- Internal clock (optional external)
- Data recorded to removable SSD
- Miniature, lightweight, low power

APPLICATIONS

- Ideal for small UAVs
- Integrate into portable equipment
- Cellular SIGINT systems
- Test equipment (playback recorded stimulus signal or record sample signals for later comparison/analysis)

DESCRIPTION

The Mini-Roadrunner is a unique digital spectrum analyzer and spectrum recorder/player for the VHF/UHF spectrum that can be specifically tailored to push-to-talk, telecommunications uplink and ISM bands. Using the latest in advanced high-speed ADC technology, the digitizer applies the antenna signal through a proprietary analog preprocessing subsystem (patent applied for) and directly to the ADC input without the need for mixers, converters, or synthesizers. Steep response RF filters for each of the bands provide strong signal rejection of adjacent band signals (i.e., cellular downlink signals). Very fast response time digital RF attenuators provide automatic or manual gain control. The clock frequency is tailored to the selected band and provides the needed sample frequency. Multiple ADCs may be driven by a common clock for FDOA or TDOA operations. Optional time stamping is also available.

The Mini-Roadrunner has three primary functions: digitizing the selected band, outputting an FFT spectrum to a USB port, and optionally writing/recording the digital sample stream to a solid state drive (SSD). The FFT may be used without the SSD to function as a simple spectrum analyzer, or as a spectrum analyzer to view the SSD’s write or read data stream. An external USB display (PC, tablet, smartphone, etc.) and application (sample application available from Softronics) is required to view the FFT spectral data output. A second USB port controls the variable clock.

Using the triggered mode for search and warning applications, the power consumption and heat dissipation may be minimized. In this mode of operation, the FPGA is disabled while the ADC collects samples, then the ADC is disabled while the enable FPGA computes and outputs the FFT, and finally both the ADC and FPGA are disabled until triggered into the next FFT epoch.

An application is available for downloading recorded digital data to an external device.
The digitizer is packaged in a small shielded case with SMA RF input and output connectors, and USB data and control port. The digitizer operates from +6 to 24 Vdc primary power. A user-provided LiPo or NiMH battery pack may be used to power the MiniRoadrunner.
**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>DIGITIZER PARAMETERS</th>
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<tbody>
<tr>
<td><strong>Frequency range</strong></td>
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<tr>
<td>(Contact Wireless Innovations for custom band schemes)</td>
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<tr>
<td><strong>Standard bands</strong></td>
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| **Resolution, digitizer/recorder** | 12-bits, 2700 MHz upper freq limit |
| (One or both ADCs can be factory installed) | 16 bits, 500 MHz upper freq limit |
| **Resolution, playback** | 14-bits, 2700 MHz upper freq limit |
| **Noise figure** | 18 db (typical) |
| **AGC dynamic range** | 92 dB, 1 db steps |
| **IIP3 (no AGC)** | +5 dbm (typical) |
| **Spurious free dynamic range** | 70 db (12-bit, typical) |
| **Antenna** | External (user selected) |
| **Input impedance** | 50 ohms |

<table>
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<tr>
<th>DATA/CONTROL CHARACTERISTICS</th>
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<tbody>
<tr>
<td><strong>Remote control/FFT port</strong></td>
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<tr>
<td><strong>Clock control port</strong></td>
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<tr>
<td><strong>Required setup data</strong></td>
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<tr>
<td><strong>FFT output</strong></td>
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<tr>
<td><strong>Power management</strong></td>
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<tr>
<td><strong>SSD capacity</strong></td>
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<tr>
<td><strong>Record time</strong></td>
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<table>
<thead>
<tr>
<th>PHYSICAL/ENVIRONMENTAL CHARACTERISTICS</th>
</tr>
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<tbody>
<tr>
<td><strong>Power input</strong></td>
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<tr>
<td><strong>Power consumption</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
</tr>
<tr>
<td><strong>Module size</strong></td>
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<tr>
<td><strong>Connectors</strong></td>
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<tr>
<td><strong>Operating temperature range</strong></td>
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<tr>
<td><strong>Non-operating temperature range</strong></td>
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<tr>
<td><strong>Operating altitude</strong></td>
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<tr>
<td><strong>Operating humidity</strong></td>
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Specifications are subject to change without notice as we continuously strive to improve our products.
**Arf Miniature Wireless Detector**

**FEATURES**

- Detects all cell phone transmissions (GSM, UMTS) with Wi-Fi, ISM, Mobile SATCOM, Push to talk radios, and customized frequency bands.

- Multiple configurations: OEM board, Integrated into Android phone, body worn sensor, UAV payload, unattended ground sensor, and as part of an integrated sensor network.

- Exceptionally low false detection rate using specialized filtering – prevents false alarms from nearby cell tower down links.

- Internal non-volatile logging function to log all signal activity on 10 frequency bands with time stamp and GPS locations (when integrated into Android phone).

- Integrated automatic reporting option to central facility.

- Miniature size allows concealment/embedding.

- Ideal for use with micro UAVs.

**DESCRIPTION**

The Arf cell detector provides the ability to detect, with an unprecedented low false alarm rate, any cell phone or wireless transmission in a room. The Arf uses an innovative design to scan and identify any cellular activity over the 450 MHz to 3 GHz frequency bands for both the US and international market. The unit scans 10 independent frequency bands, with each having a settable threshold level allowing for calibration to a specific room environment. Specialized software is built-in to automatically determine the threshold settings and attenuation level for each frequency band, allowing for easy installation. This auto-calibration routine determines the background spectrum statistics and sets the detection thresholds accordingly. Coupled with selective filters with exceptionally high out of band frequency rejection, these statistics, assure a very low false alarm rate.

The Arf logs up to 512 Mbytes of data to internal nonvolatile memory (band, power, time/date, optional GPS location). The log and control/alarm functions may also be accessed via built-in USB or serial port, or by use of a wireless data link with one of those ports. Additionally, an option for power and data over internet provides the ability to provide power and transport data over an Ethernet cable.

The Arf may be configured in a room or at a portal with a directional antenna, to allow the detector to be placed in a location that points away from a storage area of cell phones “checked in” prior to entering a secure area. The installation includes calibration to insure a phone placed in this storage area will not cause a false positive indication. A network of units may be placed in a room or facility with new patent pending DF Power Triangulation software to accurately locate the phone within a conference room or facility.

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APPLICATIONS

- Detection of cell phones in restricted areas – automatic recording, logging, locating, etc.
- Perimeter security and force protection
- Detecting and locating wireless contraband in prisons and correctional institutions
- Wireless monitoring and automatic reporting in secure conference rooms and facilities
- Site survey of signals present in remote areas
- Determination of wireless formats utilized for military or law enforcement mission planning (micro UAV deployed)
- Detection of potential interference sources
- Integrated into other platforms for signals situational awareness
- Integrated into large network of sensors (body worn, UAV payload, vehicle mounted, unattended ground sensors) for detection and precision geolocation of suspect emitters
- Counter IED

SPECIFICATIONS

RECEIVER PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
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<tbody>
<tr>
<td>Frequency range</td>
<td>30 MHz to 3000 MHz (6000 MHz optionally)</td>
</tr>
<tr>
<td>Bands</td>
<td>10 bands, factory configurable</td>
</tr>
<tr>
<td>Selectivity</td>
<td>Set by filters (&gt;80 dB out of band rejection)</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>-80 dBm noise floor (typical)</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>60 dB</td>
</tr>
<tr>
<td>AGC range</td>
<td>Selectable 1/2/5/10/20/50/100 channels/second max</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>Antenna</td>
<td>User-supplied, Optional integrated antenna for frequency bands from 700 MHz-3 GHz</td>
</tr>
<tr>
<td>External power</td>
<td>4-36 vdc, 50 ma, via solder terminals or mini-USB connector (stand. +5V USB power), inc. cell phone USB power</td>
</tr>
<tr>
<td>Weight</td>
<td>approximately 2 ounces (uncased)</td>
</tr>
<tr>
<td>Size</td>
<td>approximately 1.25x5.2x0.3 inches</td>
</tr>
<tr>
<td>Connectors</td>
<td>U.FL (antenna), Micro-USB, RS232 header</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>-20 to +55°C</td>
</tr>
<tr>
<td>Non-operating temperature range</td>
<td>-40 to +70°C</td>
</tr>
<tr>
<td>Operating humidity</td>
<td>10 to 90% non-condensing</td>
</tr>
</tbody>
</table>

SAMPLE OF INTERNATIONAL FREQUENCY BANDS (MAY BE CUSTOMIZED)

<table>
<thead>
<tr>
<th>Channel</th>
<th>Frequency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1710-1785 MHz (Cell)</td>
<td>GSM 1800</td>
</tr>
<tr>
<td>2</td>
<td>2400-2483 MHz (Cell)</td>
<td>Wi-Fi</td>
</tr>
<tr>
<td>3</td>
<td>880-915 MHz (Cell)</td>
<td>GSM 900</td>
</tr>
<tr>
<td>4</td>
<td>410-470 MHz (Land Mobile)</td>
<td>Land Mobile</td>
</tr>
<tr>
<td>5</td>
<td>1600-1660 MHz</td>
<td>Mobile SATCOM</td>
</tr>
<tr>
<td>6</td>
<td>Customer defined</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1920-1980 MHz (Cell,3G)</td>
<td>UMTS</td>
</tr>
<tr>
<td>8</td>
<td>824-849 MHz (Cell,3G)</td>
<td>GSM 800</td>
</tr>
<tr>
<td>9</td>
<td>1850-1910 MHz (Cell)</td>
<td>GSM1900</td>
</tr>
<tr>
<td>10</td>
<td>Field Configurable</td>
<td></td>
</tr>
</tbody>
</table>

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