P12R.3 ADVANCED WEATHER SURVEILLANCE ALGORITHMS AND TECHNIQUES USING A RAPID SCANNING X-BAND RADAR – FIRST RESULTS

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The Naval Post Graduate School's Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) in collaboration with ProSensing Inc., recently modified a phased array X-band tactical radar system to add a weather surveillance mode. The modified system, reconfigured for mobile operation from a heavy duty truck, is shown in Figure 1.

Figure 1 MWR-05XP installed on a heavy-duty truck. The 1.2 m phased array antenna provides electronic beam scanning in elevation and combines electronic back-scanning with mechanical scanning in azimuth.

The new system was named **MWR-05XP** (**M**obile **W**eather **R**adar, 20**05** **X**-band, **P**hased Array) and is the first mobile electronically scanned phased array radar developed for weather sensing applications. The most important feature of the MWR-05XP is its ability to electronically scan the antenna beam in both elevation (73° scanning sector) and azimuth (8° scanning sector). The system is also able to mechanically rotate the antenna in azimuth at variable speeds. The MWR-05XP rapid scanning radar's key system parameters are summarized in Table 1.

This weather radar serves both as a mobile weather research instrument and as a test-bed for exploration of the integration of weather display modes into tactical military radars. The rapid scan capability of this radar presents new challenges with regards to calibration, clutter removal, radar control and data processing.

As part of the modification, ProSensing developed a state-of-the-art PC-based Weather Radar Processor (WRP), which provides radar control, data acquisition and signal processing for 3-D weather radar measurements. The WRP system consists of a data acquisition subsystem and auxiliary hardware necessary for controlling the electronic scanning features of the radar.

Initial experiments with the mobile radar system were carried out in March, 2005 in Marina, CA. A typical RHI scan from this experiment, shown in Figure 2, demonstrates the ability of the radar to detect light rain at ranges from 1-30 km. Longer ranges are possible at a reduced pulse repetition frequency. The rapid scanning capability of the radar system allowed this sector scan of 0-55° in elevation and 4° in azimuth at one degree steps (220 beams) to be sampled in 70 milliseconds.

•Table 1. Key system parameters for the MWR-05XP.

Parameter	Value
Transmit frequency	X-Band
Transmit power	23 kW
PRF	10 kHz (max)
Transmitted pulse width	1 μs
Antenna type	Mechanically rotated electronically scanned phased array
Azimuth BW	1.8°
Azimuth Scan	360°, 30 RPM
Elevation BW	2.0°
Elevation Scan	-18° to 55° relative to the horizon
Range Resolution	150 m
Receiver IF frequency	98 MHz

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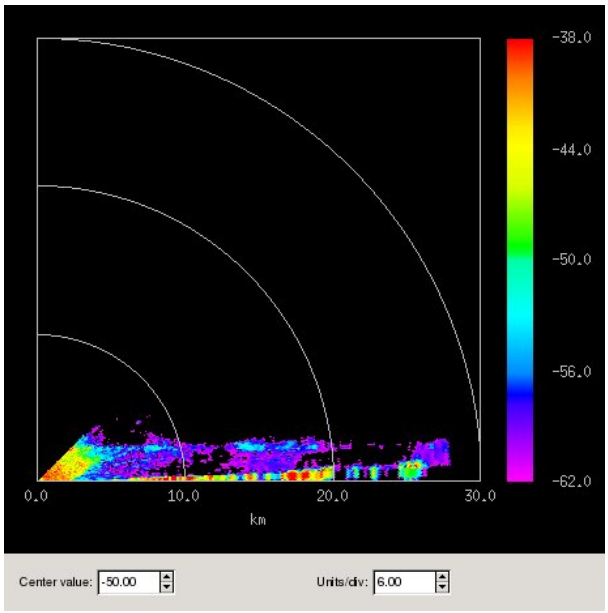

Figure 2 Real-time RHI display from the MWR-05XP

Future work with the MWR-05XP will focus on system calibration, development of optimal scanning schemes for various data products, and development of the ground clutter rejection filters for improved detection of weather features. Planned hardware improvements include implementation of a new computer controlled azimuth antenna positioning system that will allow for mechanical sector scanning in azimuth. The new scanning system will significantly improve the sensitivity of the system by allowing the MWR-05XP to dwell longer in the area of interest. Future missions will include imaging super-cells in the Great Plains and monitoring hurricane landfall on the Atlantic coast and the Gulf of Mexico.