Development of the digital receiver for wind profiler radar using software defined radio technique

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It is important to observe atmospheric turbulence in order to clarify developing processes of the atmospheric boundary layer. However, it is not so easy to observe the atmospheric turbulence. In FY2003, the MU radar was equipped with a ultra-multi-channel system, which enabled us to observe three dimensional structures of the atmospheric turbulence by means of radar imaging techniques. Limitation of the MU radar is that it cannot observe the lower part of the atmosphere below 2 km. Therefore we have developed digital receivers which can receive the signal from multiple antennas of the 1.3-GHz wind profiler radar (LQ7) for observing the atmospheric boundary layer (see Figure 1).

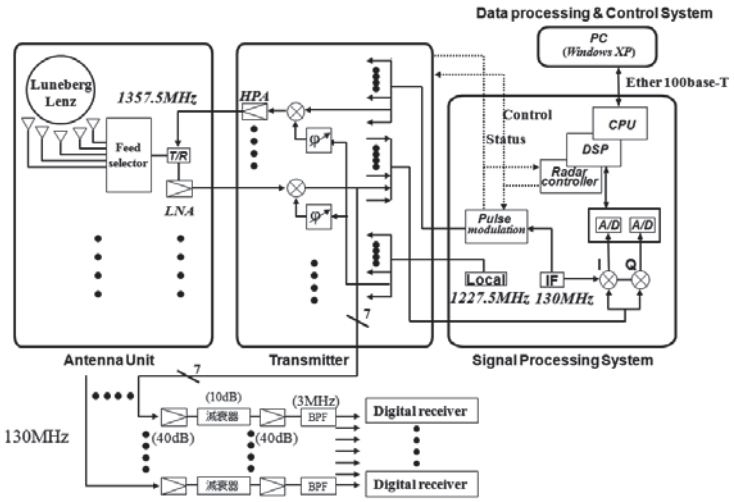

Figure 1. Block diagram of an LQ7 wind profiler radar and developed digital receivers.

The purpose of this study is to develop the digital receivers which can be used in multi-frequency and multi-channel modes. Thereby, range and spatial resolutions will be improved by observations of frequency domain interferometry (FDI) and spaced domain interferometry (SDI). In this study, we used software defined radio receiver, USRP2, for the development of the digital receiver. First, we developed receiver using a GNU Radio software library to control USRP2. We developed techniques to synchronize the receiver with the transmission of LQ7 and for data acquisition. We conducted test observations using a developed receiver and LQ7, and evaluated the capability of the receiver from the observation results of Doppler spectra and velocities. We confirmed that the developed receiver correctly operates and has equal performance with LQ7. However, we found an unavoidable problem regarding the synchronization among plural receivers. In order to solve this problem, we developed a new receiver with Universal Hardware Driver (UHD) which is a driver provided from the manufacturer company of USRP2. The receiver with UHD enables us to synchronize several receivers by using GPS clock. We developed techniques to synchronize the receiver with the transmission of LQ7 and for data acquisition, and conducted the test observations. As shown in Figure 2, we confirmed that the developed receiver correctly operated.

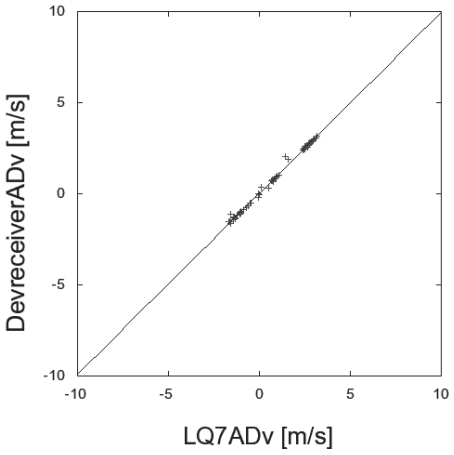

Figure 2. Scatter plot of radial Doppler velocities obtained by LQ7 itself (horizontal axis) and the developed digital receiver (vertical axis).