ABSTRACT

This thesis analyzes the Doppler spread compensator (DSC) in a thorough manner for a future railway mobile communication system (FRMCS) based high-speed railway signaling communication system. Multiple-input multiple-output (MIMO) technology combined with DSC (MIMO-DSC) is able to support FRMCS for high-speed railway signaling whose operation is analyzed in depth in this thesis. In order to support the implementation of MIMO-DSC in the field, this thesis implements MIMO-DSC without DSC first on a universal software radio peripheral (USRP) and verifies how DSC works with several antennas.

The Doppler effect can be compensated by MIMO-DSC based on the Bessel function by interpolating the signal at a fixed point with respect to the ground for one orthogonal frequency division multiplexing (OFDM) symbol duration. The dominance factor of Rayleigh fading and/or Doppler effect is evaluated with the number of antenna elements K = 2, 4. MIMO is implemented on a laboratory scale using USRP to confirm several types of simulation techniques such as modulation, signal synchronization, and channel estimation in a high-speed railway signaling system.

This thesis successfully: (i) made the implementation of MIMO on USRP B210 as a basis for the development of MIMO-DSC, (ii) analyzed MIMO-DSC with the parameters of the 5th generation (5G) FRMCS technology in Indonesia which resulted in significant improvements (up to about 21 dB), (iii) found the fact that the 5G numerology 0 system without DSC still experiences an error-floor that cannot be improved even at high signal-to-noise power ratio (SNR) levels (above 30 dB) at a speed of 500 km/h, and (iv) found that the use of fewer antennas can reduce the adverse effects of Rayleigh fading. The results of this thesis are expected to contribute to the development of fast train communication systems in Indonesia.
Keywords: signaling systems, 5G FRMCS, DSC, MIMO.