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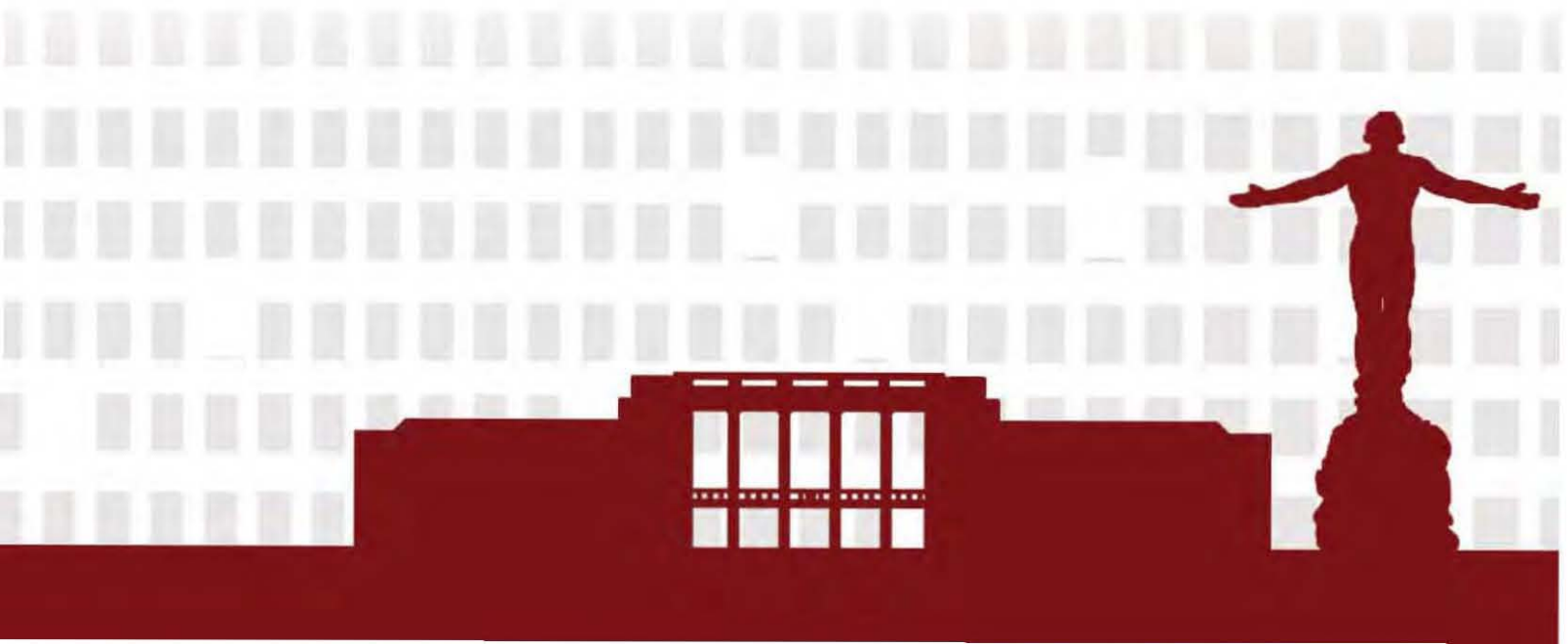

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THE EFFECT OF ROTATIONAL MOTION OF A MOBILE RECEIVER ON THE WIRELESS SIGNAL RECEPTION IN A NON-LINE OF SIGHT INDOOR ENVIRONMENT

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ABSTRACT

This work investigates the characteristics of wireless signals received by a mobile device upon the rotational movement of the receiver. Rotational movements such as arm, head, pitch and roll affects the received signal strength in the azimuth plane. In particular, these motions introduce changes in the antenna's location, orientation, and polarization. The degradation of the received signal caused by these motions contribute to the existing impairments that affect the quality of the communication link. Studying the signal degradation that results from random movement of the device together with other propagation conditions in the communication channel lead to a different analysis of signal impairments.

Through computer simulations, we implemented a model for the rotational movements of the mobile device and the wireless channel. For the receiver antenna, we assume a half-wavelength dipole used in [1] while the transmitter is assumed to be non-mobile, non-rotating and uses a vertically polarized antenna. The rotational motion includes head turning during a call, body twisting or turning while holding the device, and, roll or pitch movement during interactive use. These specific movements were chosen to simplify the behaviour and scenarios. The channel model used for the non-line of sight simulation of the wireless channel is the Saleh and Valenzuela (S&V) model. The S&V is a two-dimensional statistical channel model representing a clustered multipath signal scenario in an indoor environment [2].

The rotational movement of the device is integrated in the wireless communication system before summing the received signal envelopes as shown in Figure 1. These random rotational movements change the location of the receiving antenna as it spins/twists based from the angular velocity. The random rotational movements also vary the radiation pattern of the antenna projected at the azimuthal plane. The effect of the rotational movement on the wireless signal reception changes the propagation characteristic and the envelope of the received signal. These characteristics were described initially by finding the best-fit probability distribution function graphically. It was found that if the axis of rotation is away from the device (head turning or body twisting/spinning) the measured histogram of the magnitude of the received complex envelope resembles a Nakagami probability distribution curve, as shown in figure 2(a). It was also found that the magnitude of the received signals' behavior during the on-axis rotation (roll or pitch) is best fitted to the probability distribution function of Weibull, as shown in figure 2(b).

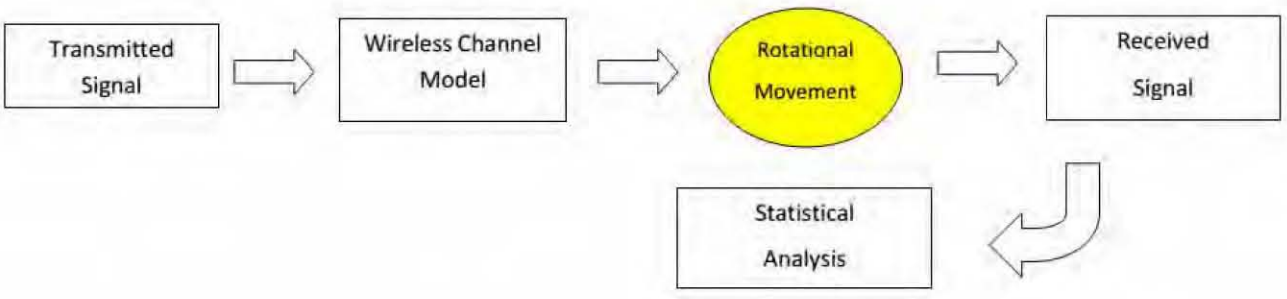
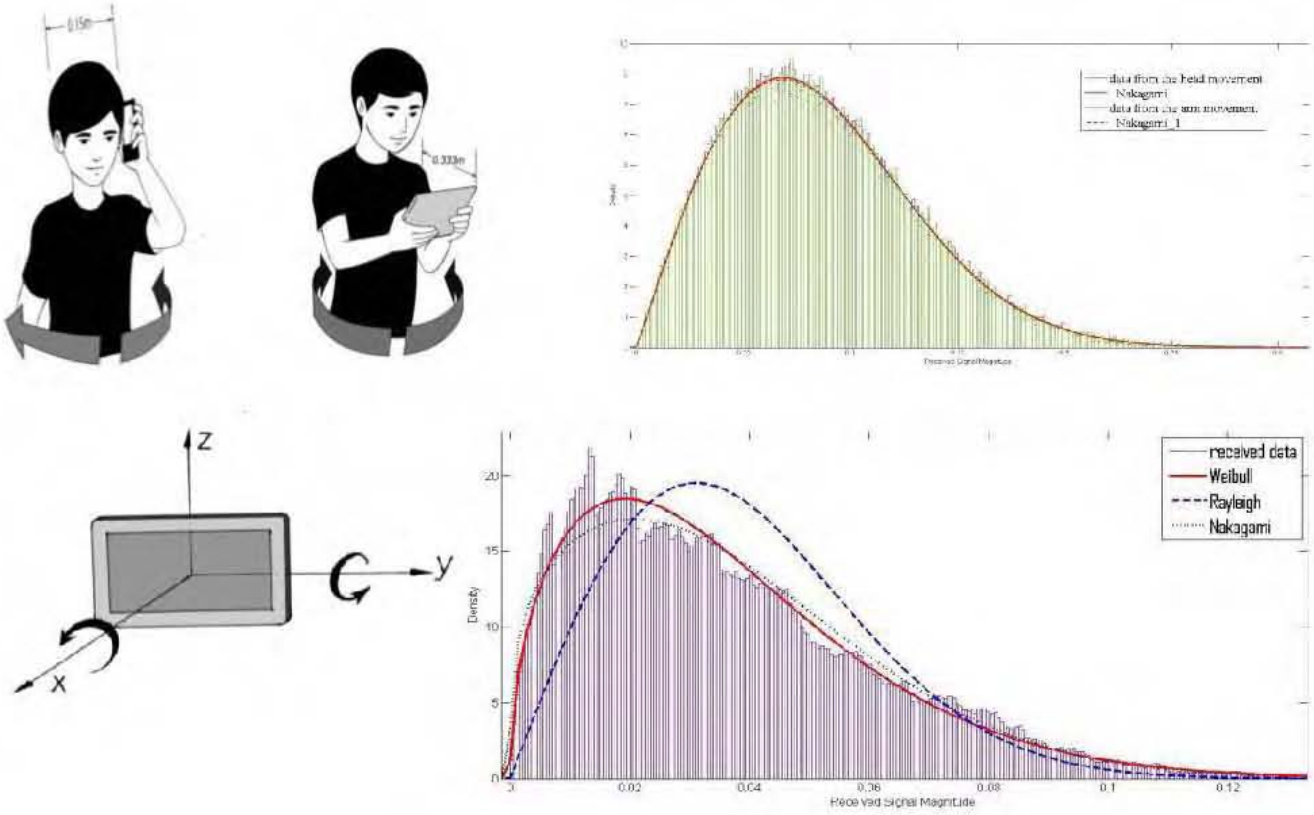


Figure 1. System block diagram.



(b)

Figure 2. Rotational movement (left) and the histogram of received signal magnitude that undergoes rotation whose axis is (a) away from the device (b) on the device.

Keywords: rotational motion, Rayleigh, Saleh and Valenzuela, Weibull.

References

1] S. Jaeckel, et al., "A Geometric Polarization Rotation Model for 3D Spatial Channel Model," IEEE Transactions on Antennas and Propagation, Vol. 60, No. 12, 2012, pp. 5966 - 5977.

[2] Q. H. Spencer, et al., "A Statistical Model for Angle of Arrival in Indoor Multipath Propagation," *IEEE 47th Vehicular Technology Conference*, May 1997, pp. 1415 - 1419.