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Research Article

Performance comparison of Jakes & Gausian doppler spectrum in Wireless Communication Channel

Anis Suliman Ali Bakouri[Å]*

[A]Om-Alaranb College of Science & Technology, Libya

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Abstract

The wireless communications channel constitutes the basic physical link between the transmitter and the receiver antennas. Its modelling has been and continues to be a tantalizing issue, while being one of the most fundamental components based on which transmitters and receivers are designed and optimized. The ultimate performance limits of any communication system are determined by the channel and their operating environment like fading, multipath propagation, type of terrains, and mobility (Doppler shift). Realistic channel models are thus of utmost importance for system design and testing. In this paper an effort has been made to compare the performance of mobile wireless communication channel between Jakes and Doppler Spectrum.

Keywords: *Channel modeling, number of taps mobile Velocity and Doppler Spectrum.*

1. Introduction

A wireless network is a rising new technology that will permit users to access services and information by electronic means, irrespective of their geographic location. Wireless networks can be divided in two kinds: infrastructure network and Infrastructure less (ad hoc) networks. Infrastructure wireless network is a network with fixed and wired gateways. A mobile host interrelates with base station within its communication radius. The mobile device move frequently when it is communicating with other mobile devices. As radio waves propagate through space, multiple corruptions due to morphology, temperature and humidity of the environment through which they are traveling can occur. As a consequence, mobile radio transmissions usually suffer large fluctuations in both time and space. A major limitation on the performance of a mobile communications system is the attenuation undergone by the signal as it travels from the transmitter to the receiver. The path (from the transmitter to the receiver) taken by the signal can follow the Line-of- Sight (LOS) in which the signal loss may not be severe. In typical operational surroundings, indirect paths also exist and the signal reaches the receiver through the processes of reflection, diffraction, refraction, and scattering from buildings, structures, and other obstructions in the path. These are examples of Non-Line-of-Sight (NLOS) propagation.

*Corresponding author's ORCID ID: 0000-0000-0000-0000
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The ultimate performance limits of any communication system are determined by the channel modeling [1]. Realistic channel models are thus of utmost importance for system design and testing. In addition to exponential power path-loss, wireless channels suffer from stochastic short term fading (STF) due to multipath, and stochastic long term fading (LTF) due to shadowing depending on the geographical area. STF corresponds to severe signal envelope fluctuations and occurs in densely built-up areas filled with lots of objects like buildings, vehicles, etc. On the other hand, LTF corresponds to less severe mean signal envelope fluctuations, and occurs in sparsely populated or suburban areas [2-4]. In general, LTF and STF are considered as superimposed and may be treated separately [4]. However, the mobile radio channel places fundamental limitations on the performance of mobile wireless networks. In the mobile radio environment, fading due to multipath delay spread impairs received signals. Movement of the receiver causes the multipath components as well as their phase and propagation delays to vary with time, and the speed of motion impacts how rapidly the signal level fades. Reliable operation of a wireless communications system is dependent upon the propagation channel over which the system operates as the channel is the primary contributor to many of the problems and limitations that plague wireless communications systems [5]. This has prompted a need for a deeper understanding of the wireless channel characteristics. Such an understanding will lead to developing viable solutions to such problems as dropped or lost packets, interference, and coverage

The focus of channel modeling in this paper is studied based on the following physical phenomena like multipath propagation, type of terrains, and Doppler shift due to motion of the mobile. The purpose this paper is to evaluate the performance of a radio channel model and examine the effect of various parameters on the channel behavior that is representative of environments in which mobile wireless networks operate

2.0 Wireless channel characteristics

Reliable operation of a wireless communications system is dependent upon the propagation channel over which the system operates.

2.1 Operating environment

The operating environment of wireless communications usually encompasses indoor or outdoor forms where a radio transmitter or receiver is capable of moving.

1. Types of Terrain

Propagation characteristics differ with the environment through and over which the radio waves travel. Depending on the type of environment, the signal will be reflected or absorbed by the obstacles it encounters. The above-mentioned parameters are important considerations in a operating environment, e.g., a command vehicle carrying mobile command posts moving through an area where the radio wave could be reflected by any kind of obstacle, such as a mountain or building. In this paper, there are Two models urban areas and hilly terrain widely used for evaluation of channel characteristic

2. Multipath propagation

For most practical channels, where signal propagation takes place in the atmosphere and near the ground, the free-space propagation model is inadequate to describe the channel .In a wireless mobile communications system, a signal can travel from the transmitter to the receiver over multiple reflective paths; this phenomenon is known as multipath propagation. This effect can cause fluctuations in the received signal's amplitude, phase, and angle of arrival, known as multipath fading. Fading is caused by interference between two or more versions of the transmitted signal that arrive at the receiver at slightly different times there are two main types of fading effects that characterize mobile communications, large-scale fading and small-scale fading. A mobile radio roaming over a large area must process signals that experience both types of fading, small-scale fading superimposed on large-scale fading.

3. Effects of weather

For most practical channels in which the signal propagates through the atmosphere, the free-space propagation channel assumption is usually not enough. The first effect that must be included is the atmosphere, which causes absorption, refraction and scattering. Signal attenuation through the atmosphere is mainly due to molecular absorption by oxygen for frequencies ranging between 60 and 118 GHz and due to water vapor in the 22, 183 and 325-GHz bands .Rain has the most significant impact since the size of the rain drops is on the order of the wavelength of the transmitted signal. It results in energy absorption by the rain drops themselves, and as a secondary effect, energy is scattered by the drops.

4.Additive White Gaussian Noise

In addition to the impairments experienced by the signal as a result of the multipath propagation phenomena, a channel can also be affected by Additive White Gaussian Noise (AWGN). It can be considered one of the limiting factors in a communications system's performance. AWGN affects each transmitted symbol independently. The term "additive" means that the noise is superimposed or added to the signal and there are no multiplicative mechanisms involved

3.0 Simulation Parameters

The key to successful channel characterization depends on whether the chosen parameters are closely related to the performance of the system under consideration. Therefore, a number of choices and considerations must be taken into account when building the model. In general, for a TDL model, the following parameters and functions must be specified: the number of taps, the Doppler spectrum of each tap, the Ricean factor K, and the power distribution of each tap. Simulations were conducted for five different sets of parameters values consisting of number of taps, velocity in miles per hour (mph), frequency in GHz, terrain and the power spectrum as given in Table 1.0. For scenario, the Doppler spectrum were plotted.

The simulation is performed by using the network simulator MATLAB for evaluating the performance of channel characteristic of mobile wireless network.

Table.1 Simulation parameter

Taps No.	Velocity	Frequency (GHz)	Terrain	Power spectrum
12	30 and 80	2.4	Urban and Hilly	Jakes/Gaussian
18	30 and 80	2.4	Urban and Hilly	Jakes/Gaussian
26	30 and 80	2.4	Urban and Hilly	Jakes/Gaussian
34	30 and 80	2.4	Urban and Hilly	Jakes/Gaussian

4. Result and Discussions

4.1 Doppler spectrum

Figure 4.1.(A) shows the Jakes spectrum at a carrier frequency of 2.4 GHz and a mobile speed at 30 mph. Two related representations of flat and Gaussian spectra were also implemented in the simulation and are shown in Figures 4.1(B), for the carrier frequency of 2.4 GHz and a mobile speed at 30 mph. Note that as the Jakes spectrum suppresses the low frequencies, the Gaussian spectrum is predominantly low frequency in nature.

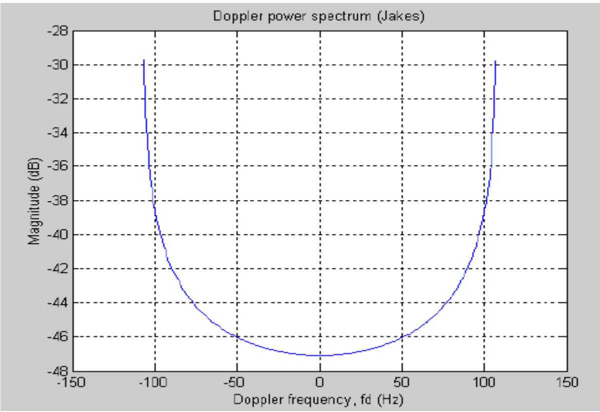


Figure 4.1(a) Jakes Doppler power spectrum at a mobile speed of 30 mph and a carrier frequency of 2.4 GHz.

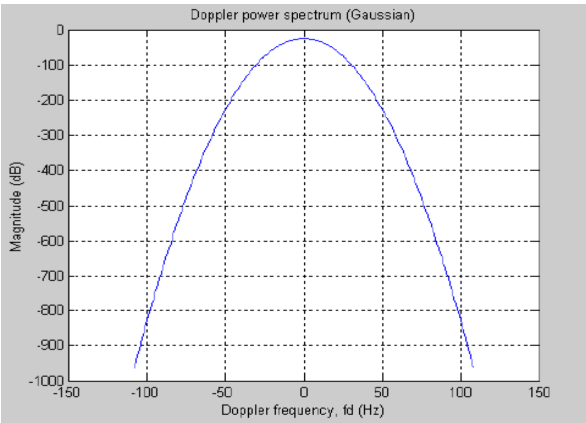


Figure 4.1(b) Gaussian Doppler spectrum at a mobile speed of 30 mph and a carrier frequency of 2.4 GHz.

The simulation results also showed that the flat spectrum is not suitable for both operating environments of urban and hilly terrains, and it suffers the most distortion. The Jakes spectrum was found to be suitable for the high-speed urban areas, and the Gaussian spectrum was appropriate for the low-speed urban areas and the hilly terrain.

4.2 Number of Taps

Simulations were performed assuming an urban environment, a carrier frequency of 2.4 GHz, keeping the velocity at 30 mph and varying the number of filter-taps. The effect of 12, 18, 26 and 34-taps were studied. The filter-taps are computed for the three different Doppler spectra: Jakes, flat and Gaussian. The PSD at the filter output using the Jakes spectrum is shown in Figure 4.2(a). Depending on the type of power spectrum used, it can be seen that the envelope corresponds to the shape of the respective power spectrum used. Figure 4.2(b) show the PSD at the filter output for the flat and the Gaussian spectrum, respectively; the shape of both differs considerably from that of Jakes.

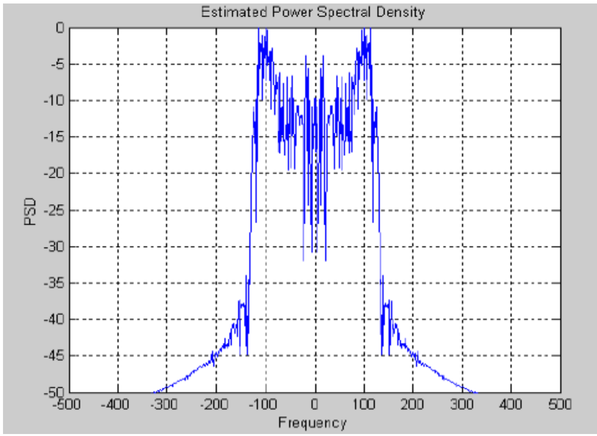


Figure 4.2(a) PSD at the filter output using Jakes spectrum.

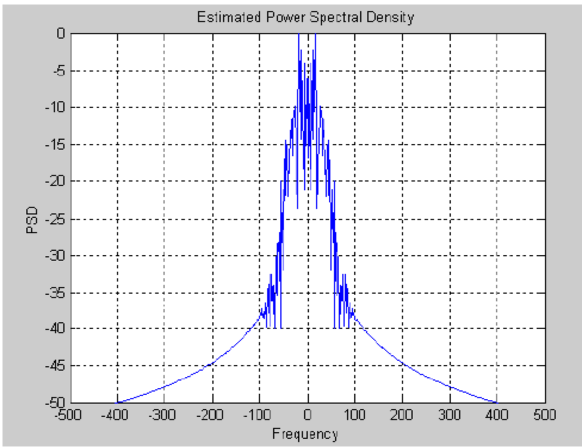


Figure 4.2(c) PSD at the filter output using Gaussian spectrum

4.3 Mobile Velocity and Doppler Spectrum

In this simulation, the carrier frequency is set at 2.4 GHz and, from the previous section, the number of taps for the TDL model was chosen to be 8.

(A)Velocity at 30 mph

The signal constellation plots for a mobile traveling at a speed of 30 mph are shown in Figures shows the transmitted signal through a channel with a shaping filter using the Jakes spectrum, Figure 4.3(a) shows the result of passing the signal through a channel with a shaping filter Fig4.3(b) shows the result of passing the signal through a channel with a shaping filter using a Gaussian spectrum.

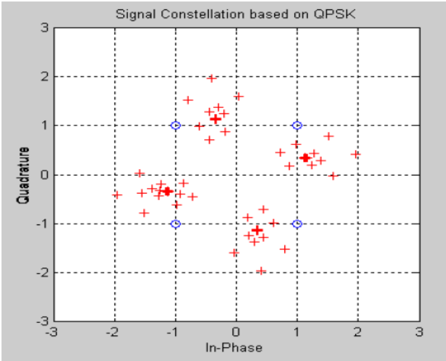
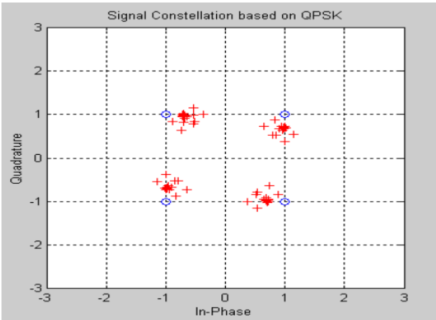


Figure 4.3 (a) Signal constellation for a Channel model with the following parameter settings: 2.4 GHz, 30 mph, urban area, and Jakes spectrum.



4..3 (b) Signal constellation for a Channel model with the following parameter settings: 2.4 GHz, 30 mph, urban area, and Gaussian spectrum.

(B)Velocity at 80 mph

When the velocity of the mobile is increased, the Doppler frequency is higher. The fact that the mobile unit is now moving at a higher speed caused the channel to change accordingly. The constellation plots for a mobile traveling at a speed of 80 mph are shown in Figures 4.3(c,d),,for different Doppler spectra

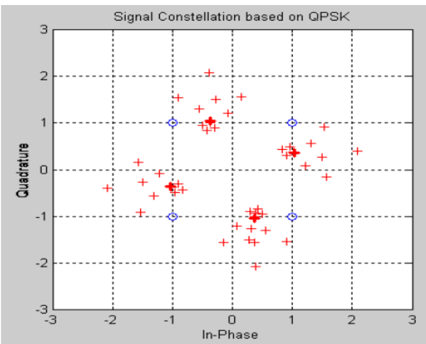


Figure 4.3 (c). Signal constellation for a channel model with the following parameter settings: 2.4 GHz, 80 mph, urban area, and Jakes spectrum.

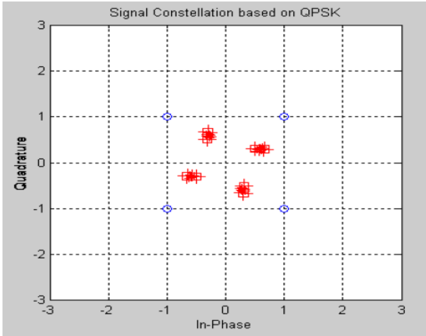


Figure 4.3 (d) Signal constellation for a channel model with the following parameter settings: 2.4 GHz, 80 mph, urban area, and Gaussian spectrum**.**

The simulations results indicate that the number of tap gains of the TDL channel model should generally be small since higher-order tap gain values are not significant. In addition, it was noticed that the results obtained for carrier frequencies of 2.4 GHz As Doppler shift is directly proportional to speed, two different mobile speeds of 30 mph and 80 mph were used in the simulation, representing a low and a high mobility scenario, respectively. The simulation results indicate that the Gaussian and Jakes are more suitable Doppler spectra for mobile radio channels than the flat spectrum.

Lastly, two types of environments (i.e., urban and hilly terrain) were considered in this work. The Jakes Doppler spectrum should be used in urban environments with high mobility; the Gaussian Doppler spectrum is the choice for low mobility urban environments and for the hilly terrain under both low and high mobility

Conclusion

- The simulation results indicate that the Gaussian and Jakes are more suitable Doppler spectra for mobile radio channels than the flat spectrum.
- The simulation results also showed that the flat spectrum is not suitable for both operating environments of urban and hilly terrains, and it suffers the most distortion. The Jakes spectrum was found to be suitable for the high-speed urban areas, and the Gaussian spectrum was appropriate for the low-speed urban areas and the hilly terrain
- The Jakes Doppler spectrum should be used in urban environments with high mobility; the Gaussian Doppler spectrum is the choice for low mobility urban environments and for the hilly terrain under both low and high mobility

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