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Research Article
Bit Error Rate Performance of RFID Signal in SDR Communication

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Abstract
In this atudy, the Software Defined Radio (SDR) based radio frequency identification (RFID) simulation model under different modulation techniques is developed. The model productively assesses the execution of multi-array Phase Shift Keying (PSK), Pilot Symbol Assisted Modulation (PSAM) and high data rate Quadrature Amplitude Modulation (QAM) techniques. The performance of these modulation techniques is assessed when the framework is subjected to various clients and in addition to noise level and the channel impairments. The simulation of Additive White Gaussian Noise (AWGN) and multipath Rayleigh fading was considered based on bit error rate for selected channel utilization. The system is investigated by means of bit error rate and different signal-to-noise ratios. The simulation results are showing a possible solution for future software defined radio in various wireless communication systems. The experimental results showed that the PSAM transceiver achieved a high level of data transmission accurately. The performance of the SDR is analyzed by comparing the input and output waveforms using Bit error rate, which demonstrates the effectiveness of the system.

Key words: Radio frequency identification, software defined radio, modulation, bit error rate, signal to noise ratio, additive white gaussian noise

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INTRODUCTION

Currently, the world has become a wireless based system. One of the hottest technologies in the wireless application area is the RFID. Its unique advantages-data transmission with extremely low power or even without power in a tag-can be of good value for goods management. The RFID devices are being developed and improved continuously. The devices are getting smaller and the reading ranges are getting longer. This reinforces the vision of the disappearing computer and a totally digitalized environment. The rapid growth in RFID communication has proven that wireless communication is viable for data services. Earliest mobile gadgets are intended to convey a solitary correspondence administration utilizing a specific standard. Be that as it may, with the enduring development of new remote administrations and benchmarks, single reason gadgets with devoted equipment assets can no more address the client's issues. It is likewise costly to overhaul and keep up a remote framework because of the consistent change in advancement. These sorts of issues have prodded an assortment of exploration subjects including shrewd radio outline, which permits for sign recognition abilities as well as streamlining of radio parameters such as bandwidth, bit error rates, filtering, etc. (Han *et al*., 2007).

The SDR offers a flexible radio architecture that allows for upgrading and the addition of features to the radio that are easily implemented through the software. For instance, security features and support for different data-transmission standards or RFID data types can be easily added by altering the software. Additionally, advanced signal processing techniques involving multiple antennas and PSK, QAM and PSAM techniques can easily be implemented without necessitating major hardware changes in the RFID transceiver. The major factors that are expected to create a wider acceptance of reconfigurable radios are limited bandwidth, multi-functionality, global mobility, compactness and power efficiency, ease of manufacture and ease of upgrade (Tuttlebee, 2002).

Regulated envelope; QAM signals are utilized to enhance power proficiency, with included gadget cost for exceedingly straight speakers. With standard QAM, images are situated to frame a square cross section in the mind boggling plane. The star grouping structures of symbols with equal energy that are evenly distributed about the origin of the normalized unit circle in the complex plane. The QAM modulated signals are utilized to enhance power productivity with included devices cost for very straight intensifiers. With standard QAM, symbols are situated to shape a square grid in the unpredictable plane. The group of stars structures of both of these signals lend themselves to ambiguity in phase and has limited bandwidth to adapt in dynamic environments (Simoneau and Pearson, 2009; Subramaniam *et al*., 2000; Shen *et al*., 2005).

The rapid growth in mobile communications has given rise to an increasing demand for channel capacity using limited bandwidth. The QAM yields high spectral efficiency due to its use of amplitude and phase modulation and along these lines, is a viable procedure for accomplishing high channel limit (Xia and Wang, 2005; Digham and Alouini, 2003). Phase adjustment and along these rapid fading in the transmission lines, is a compelling system for accomplishing high channel limit thus requiring high quality channel estimation and equalization. Many researchers have studied PSAM to compensate for the fading effects at the receiver (Kim *et al*., 1997).

Different communication techniques are used to provide a considerable amount of flexibility while maintaining performance (Blech *et al*., 2009). In SDR, modulation and demodulation of radio signals are performed exclusively by software. Thus, it reduces the peripheral hardware of the RFID communication devices. The communication link of SDR mainly consists of a transmitter, channel and receiver. The transmitter processes an information signal to produce the signal that is well defined on the way to pass dependably and effectively through the channel to the receiver (Haghighat, 2002; Simoneau and Pearson, 2009).

In this study, SDR-based wireless communication systems are reviewed. The system model used for SDR is discussed on a reconfigurable platform, in which the process of modulation and demodulation of system to the radio signals is performed solely by programming. In the majority of the systems proposed in the literature, inflexible frequency and limited bandwidth are used for channel capacity due to channel availability, the spectrum to convey information and the cost. Software defined radio-based RFID transceivers require unlimited bandwidth to communicate the reliability and integrity of the data from source to sink, which can be accomplished by searching for low cost alternatives to the existing SDR. The solution should be accomplished with an acceptable processing of modulation and demodulation with a limitless bandwidth channel.

This study addresses an SDR-based digital signal processing technique to process an RFID signal and provides an evaluation of the system performance by comparing sign to noise is proportional with bit error rate of the signal utilizing multi-adjustment systems.

MATERIALS AND METHODS

SDR model: The RFID is a basic piece of our life and the term authored for short-range radio innovation used to impart principally advanced data between a stationary area and a movement objects. The SDR is utilized to build profitability and comfort of these RFID correspondences.

Figure 1 demonstrates software characterized radio system, in which the info channel is a band pass channel, which tests the advanced sign at a rate of in any event double the got recurrence. The inspected advanced signs are then changed over to simple sign by means of a wideband DAC and afterward conceivably up-changed over from moderate recurrence (IF) to radio recurrence (RF). Adjustment procedure then changes the RF bearer signs of a tag to pass on the data to the recipient through channel. An additive white Gaussian noise channel is being decided for RFID information transmission.

The receiver utilizes a wideband ADC that catches the greater part of the channels of the radio software hub. The recipient then concentrates down-changed over the signal and demodulates the channel waveform utilizing programming on a processor. In the receiver, the RF front end deciphers the received signal from its bearer recurrence to an IF signal to baseband. Then again, in the transmitter, the RF front end interprets the transmit signal from IF or baseband to the craved bearer recurrence. The yield of ADC is examined at a rate in any event double the transfer speed of the baseband signal. The yield channel is a low pass channel, which band restricts the digital signal.

In conclusion, an assessment of the original signal is created at the input in the receiver side. The recovered signal is then contrasted with the data signal for assessment. A few measurements are considered to assess an interchange join execution, concerning sample the received BER on account of computerized signals.

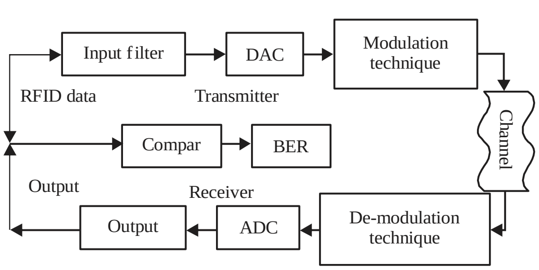

Fig. 1: SDR model for RFID signal transmission

Modulation techniques: Modulated signal can be characterized as the procedure whereby the frequency or phase of the carrier is fluctuated as per the digital data to be transmitted. There are quantities of balance systems, relies on upon simple sinusoid components, for example, amplitude, phase or frequency stage. The carrier of the signal is adjusted into digital data by Amplitude Shift Keying (ASK), PSK or Frequency Shift Keying (FSK), modulation. In SDR, the balance strategies give a lot of adaptability while looking after execution (Digham and Alouini, 2003; Kim *et al*., 1997). The proposed SDR framework is developed using PSK and QAM modulation techniques for RFID signal transmission.

Phase shift keying: Phase shift keying is an adjustment procedure in which the period of the carrier wave is altered in light of what symbol is being sent (Shen *et al*., 2005). It is a system to guide information symbol to comparing stage status. The Binary phase shift keying (BPSK) signal is presented in Eq. 1, when the initial phase is zero:

$$S_{PSK}(t)=\begin{cases} S_1 = A\cos\omega t & 0\le t\le T_b \text{(for binary 1)} \\ S_2 = -A\cos\omega_c t & 0\le t\le T_b \text{(for binary 0)} \end{cases} \tag{1}$$

Any amount of phases may be utilized to develop a PSK group rather than 8-PSK which was generally considered the most unusual request PSK group of leads sent. Hence, the simulation was done based on RFID environment.

Quadrature Amplitude Modulation (QAM): The QAM could be represented as a mixture of ASKS and PSK that implies the advanced data is conveyed in both the stage and the amplitude of the carrier. The QAM is a system for sending two separate channels of information (Kim *et al*., 1997).

The carrier is generated to make two carriers to be particular the sine and cosine variants. The yields of both modulators are mathematically represented in Eq. 2, the results of which are a single signal to be transmitted, containing the in-phase, I and quadrature, Q information:

$$S_m(t)=A_m^I\, g(t)\cos(2\pi f_c t)-A_m^Q\, g(t)\sin(2\pi f_c t) \tag{2}$$

Pulse Symbol Assisted Modulation (PSAM): In PSAM, the radio waveforms in the transmitter, channel and receiver are defined by the SDR program. Pilot symbol assisted modulation regulation is utilized to decrease the impact of direct fading for the channel in mobile communication. It tests the channel by network embedding's known pilot symbol into the information stream. The recipient utilizes these pilot symbols to decide the channel state data (Digham and Alouini, 2003). A standout amongst the essential parts of this system is the technique utilized by the receiver to find the timing position of the pilot symbols. Therefore, with the noise, the received signal can be expressed in Eq. 3 as:

$$r(t) = c(t)\times s(t)+n(t) \quad (3)$$

where, r(t) is the received signal, c(t) indicates the multiplicative fading problem, its envelope has a Rayleigh dissemination, s(t) is the transmitted received signal and n(t) is the added noise additive white Gaussian noise with zero mean.

These algorithms are used in the transmission from source to sink RFID signal transmission application.

RESULTS AND DISCUSSION

In this section, experimental results for the SDR-based RFID model (proposed in the sections above) are presented. The results are simulated and analyzed based on the effect of the performance via various modulations introduced in Simoneau and Pearson (2009), Subramaniam *et al*. (2000), Shen *et al*. (2005) and Xia and Wang (2005). In Suwadi *et al*. (2009), the transmission performance is calculated based on fixed distance while in this study the performance is calculated for wireless signal. The RFID limitation based SDR framework is intended for PSK and QAM modulation. This is because of the easiness and reduces the marginal equipment that utilized for RFID devices. The performed results demonstrated that QAM has the best execution as far as BER versus SNR in the middle of PSK and QAM balances through AWGN channel. It can be seen from the literature that the SNR at 6 dB or more, the execution of QAM is superior to correlate with PSK i.e., the QAM has best likelihood coordinated well with the info error probability. Along with these lines, it can be acknowledged that higher the SNR, higher the BER degradation. Accordingly, RFID transmission capacity is increased.

PSK-based modulation schemes convey data via radio frequency by changing the phase of the radio carrier wave. A predetermined amount of phases is used to characterize the digital data. In the urban area, there are many objects between the transmitter and receiver as the receiver moves in the area, creating a phenomenon named as the multipath fading environment. Other schemes also covered in this study

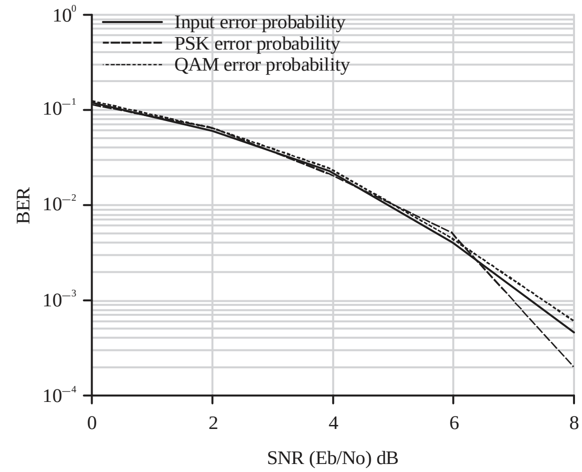

Fig. 2: BER vs. SNR of an RFID system via QAM and PSK modulation

are QAM and PSAM, which were discussed below. The trend is toward finding a modulation scheme that uses more bits to represent a symbol to achieve a higher data rate while maintaining a low BER at a little power. In PSK, the signal was transmitted accurately as verified by comparing the input and output bit error rate of the signal. As shown in Fig. 2, the degradation of the output signal decreased after 6 dB because the time delay and noise interference in the channel, which did not occur in the QAM and PSAM.

The performance of the QAM technique provides an estimate of the time and exhibits small fluctuations about the actual value. When studying the influence of the parameter estimation errors on the detection process, these variation given intensification to BER degradation as compared to perfect synchronization and reduce the performance. Therefore, it is essential to know this BER corruption as far as the exactness of the evaluations defined by the synchronizer so that t can be intended to yield target BER degradation. Figure 2 shows the performance of QAM in term of BER versus E_bN_o.

In PSAM technique, the nature and shape of the transmitted and received signals are the same. The SDR-based BER performance degradation of the PSAM modulation technique provides an approximation that shows small variations compared to the input value as exposed in Fig. 3, due to the synchronization noise in the channel and the filter effect on the magnitude of the signal variation. However, the overall transmission is very accurate concerning of input and output degradation.

The results attained from the simulations output of the PSK, QAM and PSAM modulation systems evaluated under AWGN and Rayleigh fading channels are documented in this

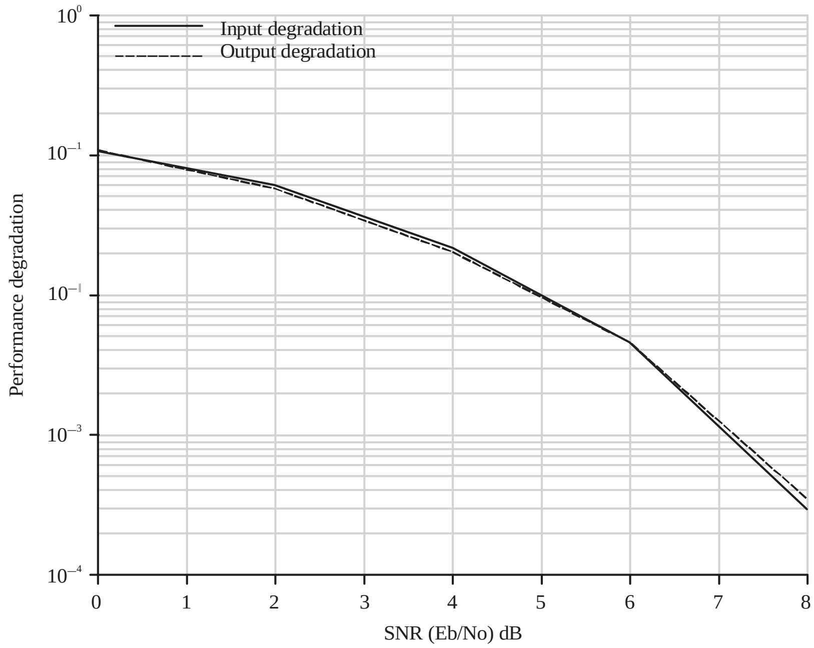

Fig. 3: BER degradation using SDR under PSAM

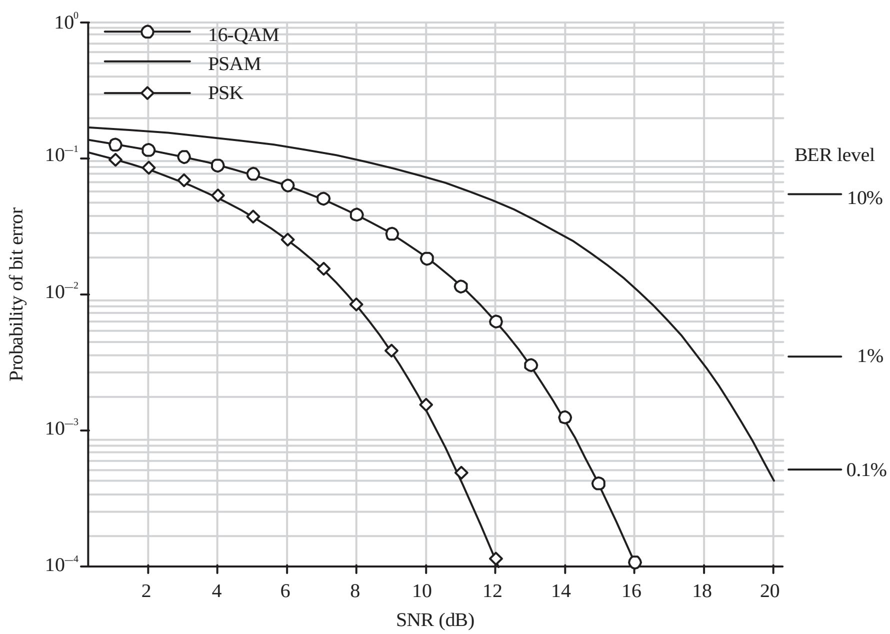

Fig. 4: BER performance of RFID transceiver in adaptive modulations

study. As shown in Fig. 4, at any target error rate, there are significant gaps between these modulation schemes. Such as, at a target error rate of 0.1%, PSK requires 11 dB of SNR. When the channel SNR is at that value, the modulation will achieve 0.1% BER. However, for all values of 11 dB and 12 dB, the modulation will use PSK and achieve 0.1% BER. Only when the channel reaches 12 dB and the modulation scheme switches to QAM will the BER return to the target. Thus, the performance will tend to be better than the target as shown in Fig. 4, except when the SNR is below the value needed for PSK to achieve the goal.

The performance execution of the BER and their error are shown by shifting the SNR from 0-25 as appeared in Table 1. It is seen that with the increment of SNR, the execution of the framework is debasing regarding BER and synchronizing error of the PSK QAM and PSAM modulation

Table 1: Evaluation of PSK and QAM modulation concerning of BER and synchronizing error by varying SNR

SNR	PSK error	PSK BER	QAM error	QAM BER	PSAM error	PSAM BER
0	9	0.35	6	0.25	5	0.23
5	7	0.295	5	0.20833	5	0.2007
10	6	0.266	4	0.16666	4	0.1555
15	5	0.213	3	0.125	3	0.113
20	4	0.016	2	0.08333	2	0.0680
25	3	0.125	1	0.04166	1	0.0088

techniques, respectively. Table 1 also obtains regarding the synchronizing error and BER rate of PSAM scheme are better performance comparing with PSK and QAM modulation schemes.

The tainted execution of modulation techniques for BER and their error are acquired by shifting the SNR from 0-25 as appeared in Table 1. Shows the increasing of SNR, the execution of the framework is degrading based on BER and synchronizing error of the QAM and PSK modulation, respectively. Table 1 similarly demonstrates that synchronizing error and BER debasement of QAM plan are a bit better contrast comparing with PSK adjustment plan.

CONCLUSION

Software defind radio model was developed for RFID signals. In this framework, data were generated by a source and then modulated and coded into symbols to be transmitted by the transmitter. Signals passed through the channel, where fading and noise were introduced. Transmitted bits were detected at receiver and sent to the output, where the BER result was calculated. This development resulted in a framework that allowed the RFID signal to be modulated with a constellation that was most appropriate for the channel conditions between the source and destination at the point in time when the signal was transmitted. The result is an intelligent reader that reads any tag to upgrade the system at different frequencies. Therefore, the effects of fading amplitude and phase estimation error on the BER of M-QAM over flat Rayleigh fading and AWGN channels were summarized. The results were obtained by averaging the SNR. Based on the simulation results shown in section V, we propose that QAM has best performance at 16 dB concerning of BER versus SNR in the AWGN channel. Therefore, it is concluded that when the bit transmission rate is a high requirement, QAM and PSAM can be used as the modulation scheme for better transmission performance.

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