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Performance Analysis of Two Different Pulses with SNR for UWB Indoor Localization

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Abstract-Localization is the technique which is commonly employed in wireless network to improve routing and enhance the security. It is the method of determining the position of the object, people, and equipment etc. It has a varieties of applications in different Indoor area system like: In Millitary, Shopping center, Museums, Health care system, In IOT etc. The ultra-wideband (UWB) plays a crucial role in the field of localization for its several features like wide range of frequency (3.1GHz-10.6GHz), ability of penetration to the barriers, ranging accuracy is high (cm), capable of avoiding the multipath fading etc. Indoor positioning system (IPS) using UWB signal provides accurate and real time positioning of the person or any target node device in the area of localization. The UWB transmission scheme proposed two major approaches that are single band approach and multiband approach. For designing the UWB pulses, it is very important to consider the shape of the pulse along with spectral mask which should satisfy the FCC mask spectrum for UWB system. The study of basic pulse shape is very important, because the performance of UWB technology strictly depends on it, like efficient and reliable use of emission power, existing with other radio technology etc. The basic pulses used for simulation of this paper are Gaussian pulse and rectangular pulse. Here in this paper, the two pulses (Gaussian and Rectangular) and SNR values are taken into consideration for IPS. Both these two received pulses undergo the operation of averaging and correlation with that of the original transmitted signal for getting the time of arrival (TOA) data for locating the position of target in the indoor area system.

Keyword- *IPS, Localization, SNR, UWB*

1. Introduction

Now a days the utilization of wireless communication increases rapidly,so the requirement of high data rate also increases,for this there is a need increased data rate capacity, which can satisfy the user's demands fruitfully.The data rate can be increased by increasing the signal bandwidth.The ultra-wideband (UWB) is a type of wireless technology, which plays a vital role in the field of localization for its several features like wide spectrum that is the frequency range is 3.1GHz-10.6GHz, the duty cycle is very less that is maximum on time 5ms to off time 38ms, the ranging accuracy is very high (cm), the pulses used are very small (ns), ability of penetration to the obstacles, capable of avoiding the multipath fading etc. The Federal Communications Commission (FCC) has assigned (In February 2002) the spectrum in range 3.1 GHz - 10.6 GHz as unlicensed indoor UWB application and also defined as this signals having -10 dB bandwidth is higher than 500 MHz [1-4]. Generally the UWB transmitters operate by dispatching billions of pulses through a large spectrum having 7.5GHz wide bandwidth. Modern UWB systems use two technical proposals, one is divide the total of 7.5 GHz spectrum through some 528 MHz bands, which allows the proper execution of bands in definite frequency ranges, on the other hand leaving the rest portions of the spectrum remain unused and other is introducing OFDM modulation scheme and is referred to as UWB-OFDM or multi-band orthogonal frequency division multiplexing (MB-OFDM), which can be contemplated as strong applicant for high-speed WPAN standardization, which come up with high data rate without ICI and ISI technology[5-8]. In this technique, due to the overlapping of sub channels, hence the transmission rate also increases. The requirement of modulators and filters at the transmitter side and similarly the demodulator and complementary filter at the receiver side can be reduced by advanced digital signal processing applications like implementation IFFT and FFT method for modulation and demodulation operation, which make the system more efficient [9]. UWB broadcasts the pulses on through the doors and different obstacles will again reflect the signal with more limited carrier signal through a wide spectrum having number of frequency channels. It causes no interference and the regulatory bodies are active forward deliberately, hence the users having already spectrum allocated are being unaffected. The accuracy of ranging in wireless system is high due to the attributes of UWB system like: immune to multipath, high data rate communication, along with less energy consumption. The Federal Communications Commission (FCC) has allocated (In February 2002) the spectrum in range 3.1 GHz - 10.6 GHz as unlicensed indoor UWB application and also defined as this signals having -10 dB bandwidth is higher than 500 MHz [10-11].The paths of the signal from Transmitter to Receivers are referred as Radio channel. Impulse radio is one of the best choices for the purpose of UWB transmission. Due to the short duration of pulses, the

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spectrum of the UWB signal is several GHz wide. Hence for localization using UWB system the main requirement is consideration of fundamental pulse shape in order to generate the UWB signal. A Gaussian pulse is a most favourable candidate in UWB-IR system. This paper includes the Gaussian pulse and Rectangular pulse with different SNR values are taken into consideration for finding out the channel area for the purpose of localization in Indoor area system.The main objective is to look over the distance value for localization in Indoor area system by considering the Gaussian pulse and Rectangular pulse signal in a typical Indoor area system. The distance of a target is estimated by the time of flight (ToF) calculation that can be obtained from a correlation receiver and use this information to identify the channel type the device is operating in.

2. Literature Survey

The ultra-wide band communication technology acts as an emerging technique for the high data rate, low range wireless communication. The UWB transmission scheme proposed two major approaches that are single band approach and multiband approach. Each approach has some merits and demerits .To nullify the limitations of single band technique the multiband were taken into consideration. In this technique rather than taking the total spectral range of UWB for transmission of the information, divide the UWB band in sub bands. Each of the sub bands takes a range of bandwidth of more than 500 MHz. the information has transmitted through the different sub bands at different instant of time. The main advantage of multiband approach is information has to be operated on a very small range of bandwidth [12-14]. The multi band OFDM UWB proposal given by IEEE802.15.3a standard, the whole spectrum splited into 14 number of sub bands having 528 MHz of bandwidth. All of these sub bands uses OFDM modulation for the transmission of the information. These 14 sub bands are combined in five groups named by group A, B, C, D and E. The 3 initial sub bands with spectrum of 1.8GHz (3.1GHz-4.9 GHz) are called mandatory mode or group A [15-16]. As the MB-OFDM Signal is generated by Rectangular pulse signal, but its spectrum includes the side lobes, which may create interference in IPS. On the other hand Gaussian distribution is a bell shaped and normally distributed with equal number of measurement with respect to its mean value (upper and lower of mean). Its spectrum does not contain any side lobes; hence this signal is immune to interference in the area of localization. It can also be used for clustering, that is a set of data points can be grouped into a cluster and it allows an efficient calculations in statistical analysis. So we simulate here both Rectangular pulse and Gaussian pulses to carry out the operation of localization in Indoor area system. The UWB indoor channel model for wireless PAN is given by the IEEE 802.15.3a standard [17]. The signal that is received undergoes variations can be categorized as path loss, that is fading due to large scale and small scale, shadowing etc. A simple and a reliable channel model are very much essential for UWB Localization in an indoor area system of operation. The model can be categorized into two types that are deterministic channel model and statistic channel model. In between these two models, the statistical channel model is meant for UWB localization, since the deterministic model does not give the site specific data or information regarding topography or specific building etc. On the other hand the statistical channel model is less complex than that of deterministic model for Indoor channel prediction in localization system. The statistical models are generated through the wave propagation for random communication channel. The very much important parameters that it includes are delay dispersion, power delay profile, path loss cluster parameters, fading due to small scale, arrival time of MPCs etc. multipath fading model is main issue of the channel modelling. The UWB communication spectrum is shown in fig. 1 below .The IEEE802.15.3a working group defined four types of indoor channel model such as CM1, CM2, CM3 and CM4.The CM1 defines the LOS environment with distance below 4 meters(between Transmitter and Receiver). The CM2 model is for NLOS environment having same distance as in CM1. The CM3 model is for NLOS environment with separation between 4 to 10 meters and CM4 model is also for NLOS environment having well-built delay dispersion which results a delay spread with 25ns [18-20].

3. Proposed System Model for TOA estimation

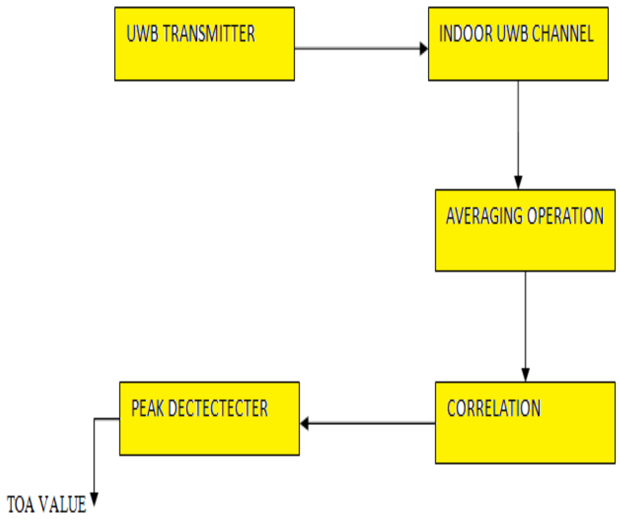

Fig.1 Block diagram for UWB Simulation system [21]

In Fig.1, a UWB transmitter generates very short duration pulses that are passed inside indoor area channel. In Receiver section the UWB receiver finds the transmitted signal along with noise. To remove noise at the receiver side, the average of signal is taken into consideration and it is passed into the correlation block, where the operation of correlation is performed in between the received signal with that of the referenced signal. Now the output is passed through a peak detector, whichdetermines the information about TOA of the UWB signal for Localization in Indoor area system. The UWB simulation parameter values are listed in Table-1. The simulation is done using MATLAB.

4. Simulation result and discussion

The implementation of the systems is done using Matlab Simulation. The different simulation parameters are shown in Table 1.

Table 1: UWB Simulation Parameters

Simulation Parameter for UWB	Value
Light Speed	3×10^{8} m/s
Shape of pulse	Gaussian, Rectangular
SNR	10db, 20db, 30db
Sample rate	60GHz
Pulse width	0.5ns
Number of samples	1000
Variance	0.2

4.1 Simulation result for for Gaussian pulse signal

Now considering the Gaussian pulse and finding out the correlated output, where the correlation occure between the received signal to that of the original transmitted signal at different value of SNRs (10db, 20db, 30db). The simulated output is given below.

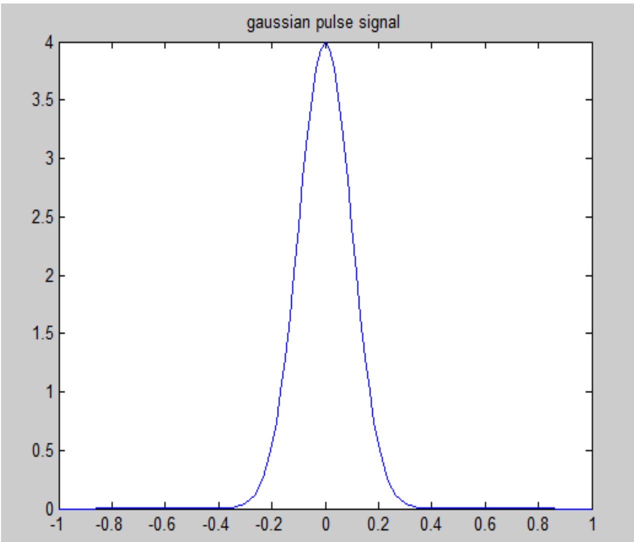

Fig.2 Gaussian Pulse Signal

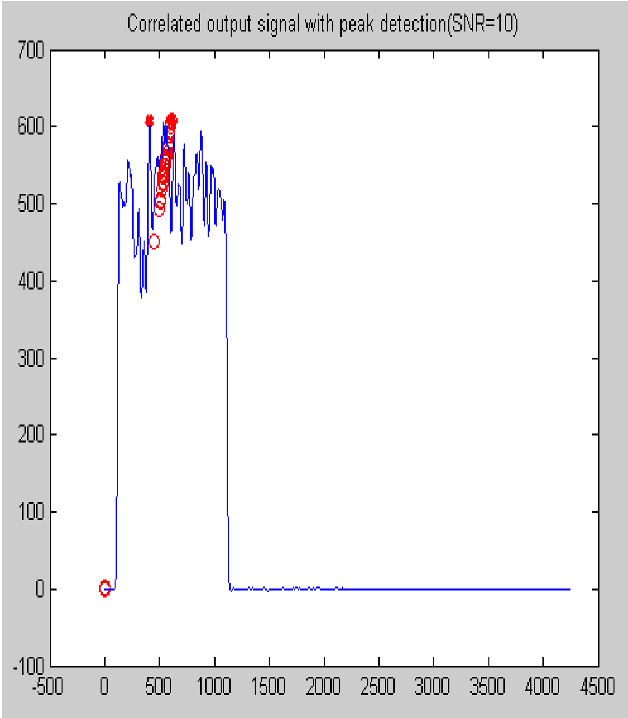

Fig.3 Corelated output signal with peak detection(10db)

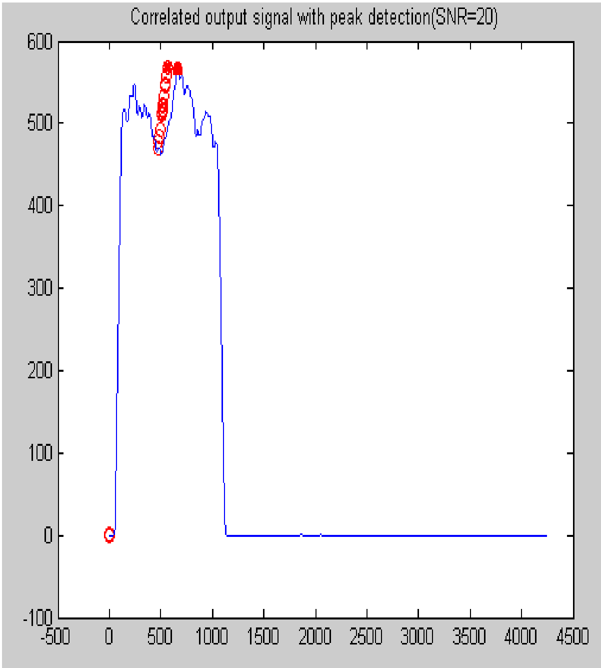

Fig.4 Corelated output signal with peak detection(20db)

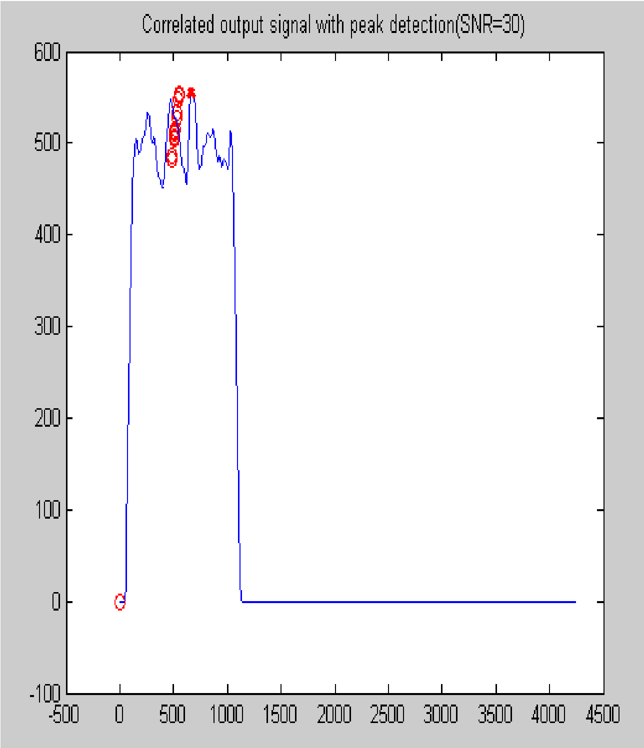

Fig.5 Corelated output signal with peak

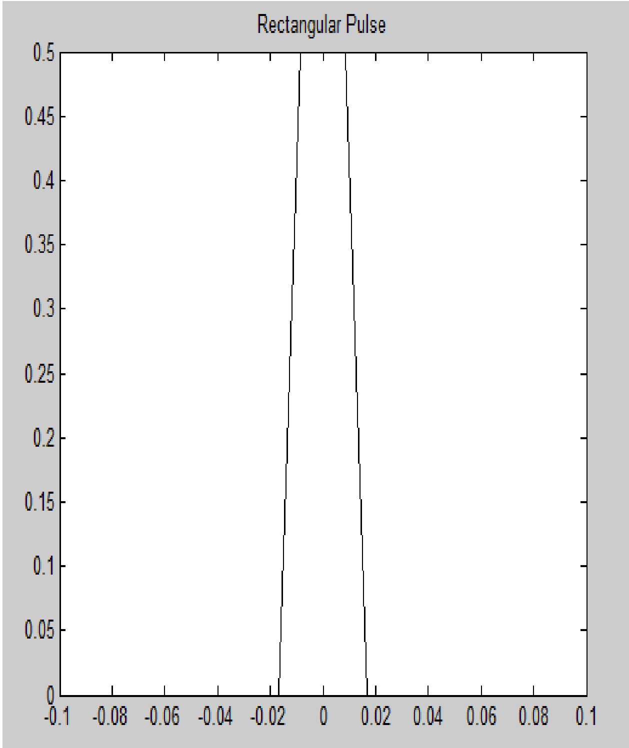

Fig.6 Rectangular pulse signal

Here in Fig.2, it represents the Gaussian pulse simulation. In Fig. 3, the peak detection occurs at 350 numbers of samples for SNR at 10db. Now the corresponding ToA, it includes is 5.83ns with ranging value 2.16m and Channel type is CM2. In Fig. 4, the peak detection occurs at 550 numbers of samples for SNR at 20db. Now the corresponding ToA, it includes is 10ns with ranging value 3.83m and Channel type CM2. In Fig. 5, the peakdetection occurs at 650 numbers of samples for SNR at 30db. Now the corresponding ToA, it includes is 10.83ns with ranging value 4.11m and Channel type is CM3. The ranging information so obtained is used further to locate the coordinate of target unit in the area of localization.

4.2 Simulation Result for Rectangular Pulse Signal

Now considering the Rectangular pulse and finding out the correlated output, where the correlation occure between the received signal to that of the original transmitted signal at different value of SNRs (10db, 20db, 30db). The simulated output is given below.

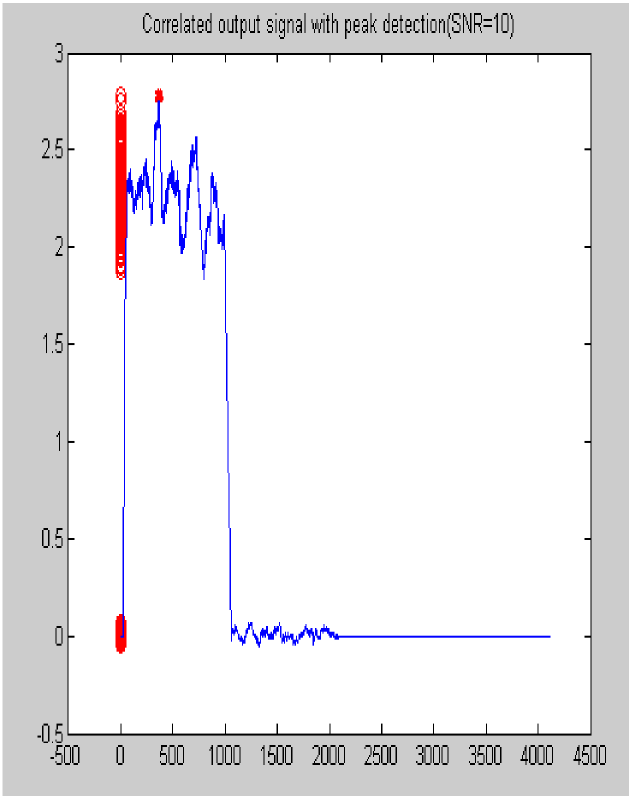

Fig. 7 Corelated O/P for Rectangular signal(10db)

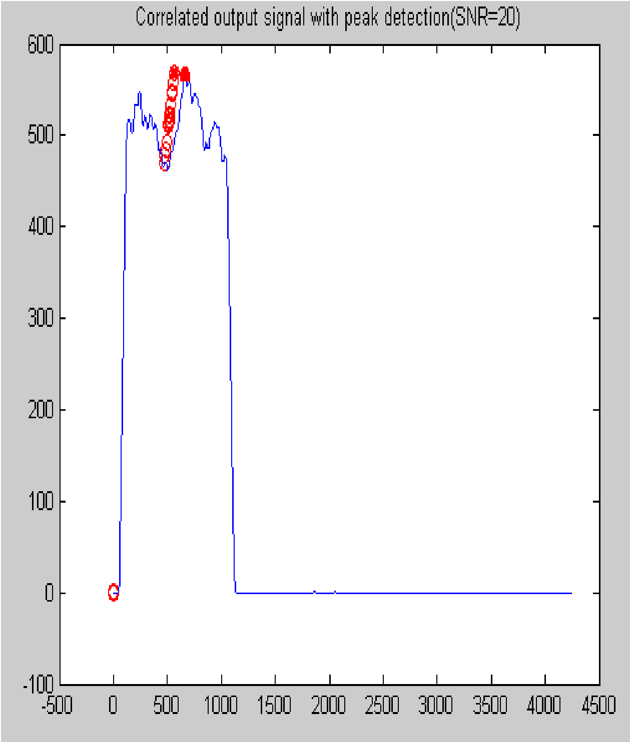

Fig.8 Corelated O/P for Rectangular signal(20db)

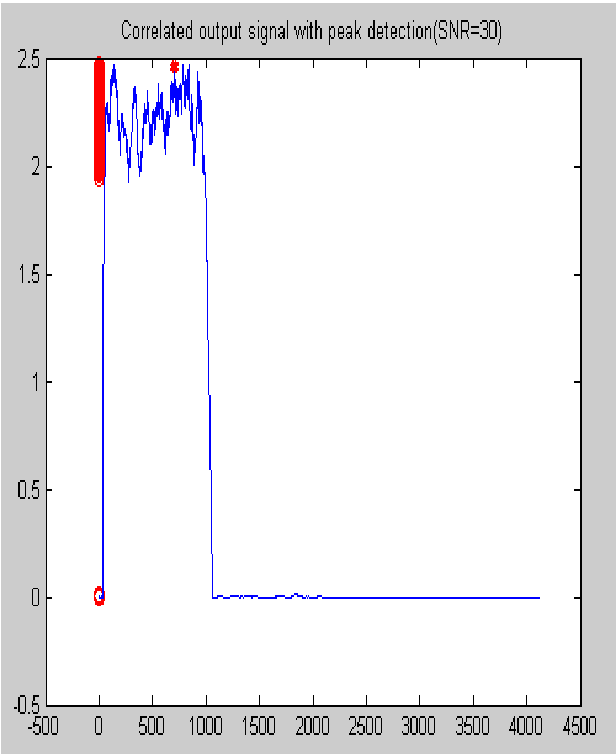

Fig.9 Corelated O/P for Rectangular signal(30db)

Here in Fig.6, it represents the Rectangular pulse simulation. In Fig. 7, the peak detection occurs at 450 numbers of samples for SNR at 10db. Now the corresponding ToA, it includes is 7.5ns with ranging value 2.85m and Channel type is CM2. In Fig. 8, the peak detection occurs at 600 numbers of samples for SNR at 20db. Now the corresponding ToA, it includes is 10ns with ranging value 3.83m and Channel type CM2. In Fig. 9, the peak detection occurs at 800 numbers of samples for SNR at 30db. Now the corresponding ToA, it includes is 13.33ns with ranging value 5.1m and Channel type is CM3. The ranging information so obtained is used further to locate the coordinate of target unit in the area of localization.

5. Conclusion

This paper analyzes the Gaussian signal and Rectangular signal for finding out the time information, which is required for estimating the Indoor area for UWB localization. We investigated the suitability of Gaussian pulse and rectangular pulses for finding out the proper area of localization in indoor area system. From the different output results, it is come to an end with decreasing the SNR, the estimated distance for localization decreases. From the different output results, it is found that the simulated output for Gaussian pulse represents a smooth representation of distance estimation, but the range of area for experimentation is low. On the other hand the estimated distance for localization using Rectangular pulse increases, but its output representations show slightly complex delegation.

The future work is to carry out the localization in indoor area system through these distance values by the application of machine learning techniques.

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Author contributions

I have contributed the analysis and coding parts for this manuscript.

Conflicts of interest

The authors declare no conflicts of interest.

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