Analysis of UWB Systems for Synchronization and Fine Timing

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Abstract: Ultra-Wide Band (UWB) technology due to its high speed, data rate and multipath immune characteristics is one of the promising solutions for communication systems. There have been awesome studies efforts to apply extremely-huge bandwidth using Ultra Wide band (UWB) technology to the military and government sectors. In UWB technology challenging task is synchronization and fine timing performance for the specified application. This paper explores the different types of UWB receivers which are Transmitted Reference (TR) UWB Receivers and Frequency Shifted Reference (FSR) UWB Receiver focusing on the synchronization and timing performance of the specified application. In order to identify these issues, the existing researches carried out in the domain of synchronization and timing performance of UWB from existing literatures. Through the review of existing literatures certain research gap are identified which are all stated in the research gap.

Keywords*: *impulse radio, synchronization, multipath interference, Bit error rate-BER performance, frequency-shifted reference.

I. INTRODUCTION

Ultra-Wide Band (UWB) technology is one of the most promising technology with features like high-speed, data transfer rate and terrific immunity to multipath interference. In last few years, the UWB technology playing an important role in various areas like radar, remote sensing and military communications [23]. Ultra-Wideband (UWB) era has been particularly used for radar-based programs until now [6], due to the wideband nature of the signal that outcome in very correct and accurate timing information. Compared to other "narrowband" or "wideband" systems, firstly the features are very promising in terms of a very high bandwidth which is more than 1.5 GHz and undoubtedly this bandwidth is lots extra than the bandwidth used by any modern-day technology in the field of communications. Secondly, UWB is carrier free. Conventional "narrowband" and "wideband" schemes use Radio Frequency (RF) carriers for transmission of signal. Here UWB implementations modulate an "impulse" that has a very fine timing, therefore resulting in a waveform that occupies bandwidth in the range of GHz [4].

II. BACKGROUND

There had been extremely good research efforts to apply ultra-wide band (UWB) technology to the military and authorities sectors. Some of them are already accomplished and a few are intended for future. These applications are especially labeled into 3 components: communications and sensors, position location and monitoring, and radar [5]. However, because of latest traits in high-speed switching systems, UWB is turning into greater attractive for low cost consumer communications applications. Ultra-Wide band (UWB) technology does help to split this generation from greater traditional "narrowband" systems as well as newer "wideband" structures typically stated in the literature.

III.IR-UWB RECEIVERS

The UWB device-wide bandwidth makes the receiver's model very much challenging in regular UWB systems that makes use of pulse-position modulation or antipodal with very short duration pulses [8]. Digitization of the complete signal bandwidth was far feasible in conversion technology that is analogue-to-digital (A / D) for basic low-power receivers of UWB. In the front-end RAKE receiver-style architecture, most UWB receivers which are mostly digital include a variety of analog correlators to capture signal power. Since many resolvable approaches within the conventional fading environment, energy efficient selection explained here might be costly and will pose problems in terms of channel evaluation, even though it is acceptable from the point of circuit complexity. These problems of implementation were a motivating factor for the industry to move to the UWB multiband method from traditional impulsive UWB for the applications of short-range high-data [7].

A significant prerequisite is the capacity to independently handle transmitted spectrum as it is preferred to select a methodology which is best way to prevent interference from other communication systems; providing better data rates and output ranges while being resilient to multipath. A detailed description of the IR-UWB receivers was given in this section. The two important receivers that is Frequency-Shifted Reference (FSR) systems and Transmit-Reference (TR) and their techniques were studied and simulated in the subsections [9] .

A.Transmitted Reference (TR) UWB Systems

The performance of UWB systems depends heavily on the timing criteria, predominantly due to strict power constraints and limited pulse periods. It is hard to design these receivers if the system requires simple low cost, then the local references calculate the channel and collect enough energy for accurate detection of UWB data.

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The UWB wireless communication systems of Transmitted Reference (TR) may settle down the difficult UWB timing criteria and offer a simple receiver which collects energy from the several solvable multi-path elements [25]. TR receiver is an alternative to RAKE receivers with low difficulty [24].

TR signalling can be described as a signalling mechanism that donates a part of the transmitted energy to measuring channels [11]. For transmitting signals, the TR system operates, and it is consist of separable data. it links the parts of random time-varying channels of communication [11]. The receiver compares the information and the reference sections of the received signal to construct a decision variable [11]. Such pulse sequences could be modulated by PAM or PPM [13], [8]. BPSK is only used with coherent receivers in conjunction, and the performance was better than PPM because it's format is an antipodal modulation [15]. For TR-UWB systems, the frame interval is described as $T_{f,}$ and the symbol interval is described as $T_{s.}$ Every frame interval has an impulse for UWB and $Ts=N_fT_f$, $N_f \gg 1$ [26]. The transmitted signal in the typical TR-UWB device during the l^{th} period of symbol. It is described as follows,

$$x_{TR}(t) = \sum_{k=0}^{N_{f-1}} \left(\sqrt{\frac{E_s}{2}} p\left(t - lT_s - kT_f\right) + b_l \sqrt{\frac{E_s}{2}} p\left(t - lT_s - kT_f - D\right) \right)$$

Where,

E_s - Per symbol period of transmission energy

$b_l \in \{-1, +1\}$ - During the l^{th} symbol period, information bit to be transmitted.

p (.) - Normalized shape of UWB pulses

D - The delay between the data pulse and the reference

In Transmitted Reference, the reference pulse will be first transmitted to the known fixed position; then data pulse is transmitted where the position of the information bit is determined [15]. The received signal at the receiver is multiplied as shown in Fig 2 with a delayed version of itself [15]. It is possible to remove the requirement for a locally generated reference (LGR) and the LGR synchronization difficult problem by transmitting a reference together with the information. Whereas the TR system uses the position of available power for the signal reference portion of the signal, the removal and complexity of LGR come at the cost of reduced data transmission capacity [11].

The properties of TR-UWB architecture from [25]:

1. Due to the transmission of the reference pulse signal throughout the same channel as the data pulse signal, it offers an ideal model for matching the information pulse without precise channel approximation, however with noise distortion, it causes the receiver to degrade at some point of the demodulation process [11].

2. Simple timing retrieval could be accomplished by repeating $S_i(t)$ (same number of times per symbol) as needed and integrating the receiver over these multiple frames. Timing is therefore only necessary at the symbol level, that can be a significant gain in applications with low data levels, where often $T_s \gg T_f$ [25].

3. Data pulse and reference pulse are transferred in one frame, and over the time of the frame, the channel only needs to be constant. This could be important for systems that operate in an extremely mobile environment [25]. Before the correlation, it is important for the receiver to utilize a low-pass filter to minimize the noise. In [16], several doublets per chip have been identified to maximize the range and to the low the applications of data rate. In realistic systems, the polarization of the first reference pulse should be randomized, thus reducing spectral lines [16]

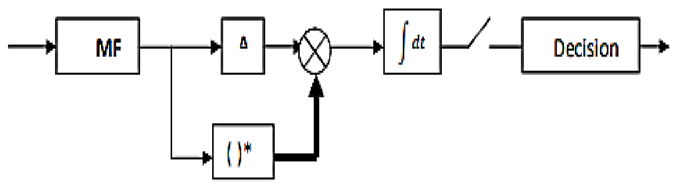

Figure 2: Block Diagram of a transmitted-reference receiver

B. Frequency Shifted Reference (FSR) UWB Systems

The TR technique was introduced as an intelligent solution for the design problem for the UWB receiver, which permits use of multi-access (MA) UWB, particularly for applications with low data rates [17]. TR-UWB system, distinguish a time difference between the data bearing pulse and reference bearing pulse and change the data pulses with antipodal bits. Through identical channel both the reference signal and the data signal travel and can act as a model for the distorted channel of data signal, the receiver compares obtained the data signal and a time delayed version of itself to absorb entire data signal energy [11]. In spite of the evident simplicity of the TR-UWB receiver's architecture, It's not a simple task to make an incredibly wide-band delay component accurately [18]. To neglect the receiver's wideband delay element [7] [28], the slightly frequency-shifted reference (FSR) UWB model was used.

Implementing a wide band frequency translation is much easier than delaying the signal in time domain, the technique taken into consideration to apply the selected frequency-translated reference pretty cautiously; in other manner, the reference is transformed to the data-bearing signal in frequency as opposed to time being orthogonal, consequently avoids the delay part. It isn't always important to enforce the information signal and orthogonality of the reference over each frame period, instead over a symbol duration.

A frequency offset is therefore encouraged between both, data impulse train and the reference impulse train, which is the opposite of the symbol period. This frequency shift is a ways under the channel's reliability degree, and therefore it acts as an accurate approximation for the data-bearing pulse. [7].Because the facts pulse has to travel roughly the identical channel because the reference pulse, the orthogonal frequency obtained by means of definitely transferring the data pulse is vain, for the reason that frequency difference between pulses exceeded the channel's coherence frequency of any sensible fading channel. Therefore, a method is tried to acquire an orthogonal reference with a mixer.

In FSR-UWB method, a template of basic signal could be described as $x(t)$ that contains N_f unmodulated UWB pulses with a standard pulse shape, as

$$x(t) = \sum_{k=0}^{N_{f-1}} p(t - kT_f).$$

The data waveform is defined as a frequency-shifted variant of such a signal which is roughly orthogonal over the large N_f symbol interval [7]. Determining $f_0 = {}^{1}/_{T_s}$ as the data signal frequency shift comparative to the reference, [26], the transmitted signal during the l^{th} symbol period could be expressed as

$$x_{FSR}(t) = \sum_{k=0}^{N_{f-1}} \left(\sqrt{\frac{E_s}{2}} p(t - lT_s - kT_f) + b_l \sqrt{E_s} p(t - lT_s - kT_f) \cos(2\pi f_0 t) \right)$$

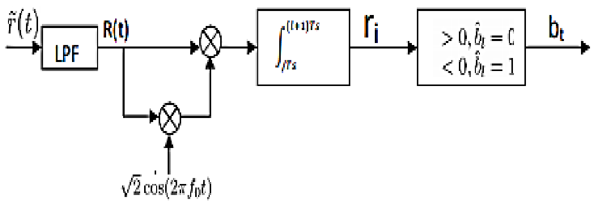

Figure 1: Frequency-Shifted Reference UWB Receiver

Fig. 3 shows the suggested receiver for FSR system. A full description of the receiver of FSRUWB is given in [7]. Not only does this method foresee the requirement for the delay line in the TR-UWB scheme, but also it is focused on low-data rate application area. The FSRUWB system, which hires many carriers, was shown in [28], and This offers a substantial improvement in performance relative to the FSR-UWB standard, whereas the receiver does not need a delay line. [9].

IV.RELATED WORK

A.Fine Synchronization in UWB

In [19] a synchronization scheme for ad hoc network, in which a disbursed synchronization approach based on the convergence of nodes clock parameters to an average reference using diffusion technique is presented. Using the pulse modulation technique, which finds out delays and drift values, the protocol measures the time of arrival (TOA) of localization technique. It introduces a distributed algorithm for global convergence of the synchronization in an ad hoc network. Under particular constraints, the scheme tend to show that the use of the local clocks as references for other localization applications can be feasible. The major drawback with the scheme is the local unpredictability of the algorithm speed convergence due to the dependency of the second eigenvalue of C on the global network topology.

In [20] a Maximum Likelihood Sequence Estimator (MLSE) used to replace bulky synchronization algorithms on the cost of slight performance losses. A promising MLSE technique furnished here, that is operating at the output of an analog energy detector frontend. The MLSE has a very less or no CSI. Depending at the specific MLSE realization, the defined method is capable of cancel robust ISI which spreads uniformly over several BPPM half frames. For slight ISI, additionally supplied simplified MLSEs cancel ISI correctly. It is definitely a profitable technique for sturdy and very ISI. Lastly , it have become verified that complicated synchronization algorithms can be overlooked with the aid of using one of the proposed easy MLSEs by having reduced BER performance.

A work by [21] presents an analogue timing synchronization implementation in UWB impulse radio scheme. In the research, a two-step synchronization system was studied for impulse radio UWB systems. This approach was proposed to synchronize UWB receivers in the analog domain for high-speed timing. The appropriate timing resolution is calculated, and the methodology is validated by system-level simulations. This two-step analog domain synchronization system provides a cost-effective, realistic solution for CMOS implementation. The analog synchronization system detects the timing details from the UWB pulses (received) and syncs the LO signal with a precision of ±12.5ps. The results of the system-level simulations were provided for verifying two-step analog synchronizer operations.

A novel algorithm for pulses amplitude modulation (PAM) UWB structures developed in [27]. Here Pilot and information symbols are simultaneously transmitted by using orthogonal code division multiplexing (OCDM) scheme. For coherent detector, the timing offset for Multipath Interference (MI) is calculated using a scheme based on minimal average error probability (MAEP). The proposed scheme is tested for mean-Square-error (MSE) and the bit-Error -Rate (BER) performances. It concluded that the proposed scheme outperforms the Maximum Correlated Output (MCO) based algorithm in multipath channels. In [27] an unique data-aided synchronization algorithm for pulses amplitude modulation (PAM) UWB systems in which Pilot and data symbols are simultaneously transmitted with the help of an orthogonal code division multiplexing (OCDM) method. In the receiver, the timing offset is estimated using an algorithm based totally on minimum average error probability (MAEP) of the coherent detector. The calculation of timing offset is considered here using multipath interference (MI). The method shows that the explained algorithm is completely better than the algorithm based on the maximum correlated output (MCO) in multipath channels.

A synchronization scheme for ultra-wideband (UWB) structures using direct-sequence (DS) codes is presented in [29]. The explained method avoids channel estimation and exploits in advance, the information of DS codes.

The acquisition of the signal in real-time is accomplished using integrate-and-dump (I&D) filter process. Both the speed and the efficient synchronization is achieved due to pseudo random and periodic features of DS codes. A lower bound on the acquisition of the explained method is also derived. Simulation results shows overall enhancement in the performance of the defined scheme compared to present options in terms of probability of acquisition, normalized mean square error (NMSE), and bit error rate (BER). By using previous information, a feature just like the Dirac delta function is set up, and particular most value of its takes place at the appropriate timing. A frame level synchronization may be acquired through the selection of the objective function.

[30] Suggested a first-rate timing algorithm for synchronization of Ultra-Wideband (UWB) signals using pulse position modulation (PPM). With this scheme, the timing algorithms in both data-aided (DA) and non-data-aided (NDA) modes are evaluated. The explained scheme functions in two steps. The first step is of a coarse synchronization based on the dirty templates (TDT) acquisition scheme. In the second step, we look into a new high-quality synchronization algorithms which offers a progressed estimate of timing offset. Simulations results confirm overall performance development of defined method of timing synchronization as compared to the regular TDT algorithm.

An unbiased block synchronization algorithm that makes use of the structure of the cyclic prefix, the presence of pilot tones in the OFDM block, and an estimation of channel time impulse response is proposed in [31]. This method provides fast and effective way of synchronization on UWB multipath fading channels. To improve the effectiveness of the block synchronization method, the start of frame mean square error used. With numerical results from simulations, shows that the defined algorithm has an edge over other defined algorithms. Due to the inclusion of channel impulse response into the correlation of the pilot signal, a significant performance development observed in both schemes. Though the channel identification step is required, it has been additionally explored that the degradation (of less than 50%) is observed because of approximate channel estimation. This technique can be utilized where identification of a channel and synchronization are combined to result appropriate start of block estimations because of improvement in channel identification with proper synchronization in phase.

B. Timing in UWB

A technique for modelling propagation of ultrawideband (UWB) signals in indoor or outdoor environments which based on positioning structures based on round-trip-time (RTT) measurements and on a particle filter are Presented [1]. RTT measurements can be impacted with non-Gaussian noise with the assumption of transmission of non linear pulses in an additive white Gaussian noise channel and are detected using a threshold-type receiver. Here RTT noise properties are studied, alongwith the effect of non-Gaussian noise on RTT-based positioning systems are analyzed. To this motive, in the presence of the modelled noise, a classical least-squares estimator, an extended Kalman filter , and a particle filter are compared whilst used to locate a slowly moving target . It is proven that, a particle filter can be an effective solution in a practical indoor environment, with high computational complexity.

[3] Evaluated an RTLS focusing at the performance of finding a mobile tag with 3 and 4 anchors based totally on the DW1000 IC underneath indoor scenarios. Also executed experiments with distinctive settings for the RTLS, The RTLS evaluation kit tested in this text showed a promising capacity for micro-location applications. However, observed a few boundaries inside the overall performance of UWB RTLS in both 2D and 3-D cases. On common the 2D accuracy is inside the sub-meter level, however the 3-D accuracy will be worse up to a few-meter level. A variety of guidelines for deploying the UWB RTLS nicely to gain a terrific localization performance are pointed out, consisting of wherein the anchors should be hooked up and the ideal region the tag ought to be within. Also improvement accuracy alongside the z-axis is likewise a crucial issue to be investigated in addition in the future.

[14] provided a sensor-to-time transmitter based Ultra-Wideband (UWB) having an RC interface, and an ultra-low-power pulse generator is explained. The information to be sensed and transmitted is recovered and transmitted in the time domain, exploring sharp time-domain resolution UWB pulses. This technique removes the need of ADC and sensor tags and reveals energy saving aspects to limit the number of bits to be transmitted. According to sensor variations, the discharging time of the RC time constant in proportion to the sensor variations is measured here. The UWB pulses are having with intervals of RC discharging time, without modulations. The circuit prototype is applied in a trendy 0.18 μm CMOS method.

C. Review of loop algorithms in UWB

An impulse-radio ultra-wideband (IR-UWB) communications suggested in [32]; even small timing errors would result in severe degradation in overall performance of a system. Thus, to resolve this problem, a novel approach is explained here for a hybrid synchronous sampling is time lock loop (TLL). Based on the ML estimation approach, Timing error detector (TED), the important part of TLL, is obtained first. At low SNR, an improved performance of the explained TLL scheme is achieved, using simulations on S-Curve and timing errors variance. The hybrid TTL scheme, is not only allowed with reduced sampling rates but also with the benefits of like low power consumption and are highly reliable. Thus the explained TLL scheme, permits a nice trade-off between the entire implementation cost and overall performance.

A delay-locked loop (DLL) technique to minimize the timing errors and preserve fine synchronization are explained in [33]. In this method the structure is modified through internal model control (IMC). The simulated performance shows that the advised approach capable of providing accurate tracking and best results even in the presence of Doppler Effect. In addition, the presented DLL approach is having higher transient response in comparison with the conventional approach. But the transient performance is disappointing and tracking performance faces the issues from Doppler Effect. A DLL circuit is applied in [34] to match the clock frequency and the estimated clock frequency, of both the responder and the initiator respectively. But, a DLL won't be suitable scheme, because of the responder and the initiator needs for different clock frequencies [35].

A novel dual closed-loop automatic gain control (AGC) algorithm is presented in [2] which has an adjustable gain over a wide range and fast convergence in comparison with the conventional AGC algorithm. The coarse tuning is achieved using the AGC loop prior to synchronization block. To approximate the reference power, the symbol power within the preamble is calculated using the loop after synchronization block. This is fine-tuning. The simulation results shows that the proposed algorithm able to enhance the adjustable range, along with improvement in convergence speed. In accordance with frame based wireless receiver, a double closed-loop AGC scheme is also presented. The first loop controls the acquired signal that might be efficiently synchronized. The SNR is improved using the second loop. The quick and accurate gain adjustment is achieved and also the distortions caused due to ADC saturation are removed efficaciously. Simulation results also shows improvement in the receiver stability.

D.Studies related to TR-UWB, coded reference UWB and FSR-UWB Systems

From previous available literature few of the researcher, advised that general UWB structures (eg. Antipodal structures) allows the same overall performance loss as that determined within the TR-UWB machine whilst mistakes inside the channel estimates required to figure out the coefficient combining for the rake receiver are considered [36]. However, Simple in architecture but implementation of the TR-UWB receiver, may be daunting. In specific, the delay element, which is dealing with wideband analog signal, is tough to design within the low-power included style desirable for the TRUWB receiver. Also, a few of the extended versions of the TR-UWB scheme described in the literature [37].

Transmitted-reference structure of UWB scheme is proposed in [7] wherein the separation among reference pulse and data, rather than being a time delay, is a slow rotation over the symbol time. This highlights a frequency-translated reference that is orthogonal to the data pulse. An exact analysis of the presented scheme is studied, and numerical results suggest that the described system structure not only achieves the intention of achieving a less complex receiver structure but also it suggests an efficient improvement to the traditional TR-UWB system.

A coded-reference (CR) UWB systems are offered in [38]. First, they have taken into consideration a typical non-coherent pulse-position modulated system. Then, an optical receiver in line with the Bayes rule is derived for CR UWB systems. Also the asymptotic optimality features of the traditional CR UWB receivers are investigated. The experimentation results are provided to examine the capability of the most reliable and traditional CR UWB receivers.

To convey the good aspects of TR UWB systems without an analog delay line, slightly frequency-shifted reference (FSR) UWB systems are presented where data and reference pulses are shifted in the frequency domain rather than in time domain [7]. But the major problem of the orthogonality between the data and reference pulses cannot be maintained at the receiver for high data rate systems [26].

A research through [12] offered a transmitted reference pulse cluster (TRPC) signalling and implemented for non-coherent UWB systems. Here, a realistic pass-band TRPC-UWB device is developed and analysed to address the carrier frequency offset, phase offset and section noise present in voltage controlled oscillators (VCO) of the transmitter and the receiver sections. Based on a standard version of VCO with noise and allowing few affordable assumptions, an analogous linear time-invariant (LTI) analytical version is acquired to allow bit error rate (BER) computations. The analysis carried from the simulation results indicates that both the consistent carrier frequency and the phase offset may be eliminated using the pass band transmitter and the non-coherent receiver. Furthermore, an impact of phase noise on the system noise performance is explored using BER expression. The expression validated through Simulation effects suggesting that TRPC is extra robust to the impact of phase noise than conventional receivers.

A new transmitted reference pulse cluster (TRPC) system explained in [39] where a set of uniformly spaced short duration reference and data pulses are used for transmission. This receiver proposes a simple, robust and sensible auto-correlation detector to be applied. It controls the foremost hurdle of having the long wide band delay line to the practical implementation of traditional transmitted reference receivers. TRPC is also well suited with the signal layout proposed in the IEEE 802.15.4a Working Group for coherent and non-coherent systems. The effectiveness of the defined receiver and non-coherent pulse position modulation (NC-PPM) with energy detection are analysed and compared. The experimental results show that TRPC is much better than the traditional TR, NC-PPM, the dual pulse scheme and the frequency-shifted reference system.

To overcome the associated delay issues of TR, a frequency shifted TR was proposed in [40]. Recently, authors in [7] proposed a frequency-shifted reference (FSR) scheme to keep away from the use of delay lines within the conventional TR machine. In [41], a dual pulse (DP) scheme proposed which are used contiguous pulses to transmit data and also only desires Tp long delay lines. due to closely spaced reference and information pulses the major problem of ISI and hence low performance in comparison to the traditional TR systems. It became proposed in [41] to mitigate IPI by using analog averaging over a couple of obtained DP frames before autocorrelation, or to completely take away IPI by using the IDP scheme. However, either solution required long delay lines as in the conventional TR scheme, except that in DP the frame period may be half the frame duration in TR, i.e., Tf, DP > Tm. Therefore, the delay line issue is handled at the cost of low performance or long delay lines frame are essential to attain the same overall results as TR [39].

A research by [43] supplied a mixed binary pulse position modulation (BPPM)/code-multiplexed transmitted-reference (CM-TR) UWB system. Since only one half of the energy is used for transmission of reference pulses at low-to-medium data rates, it suffers from very high multi-user interference (MUI) and inter-frame interference (IFI). Maintaining the same data rate , the blended BPPM/CM-TR UWB schemes allows 3 dB much less energy per bit in comparison to the CM-TR system and achieves noticeably longer silent intervals among the pulses, which not best mitigate the IFI however also reduction in the MUI because of less number of collisions with other asynchronous users.

The multiuser BPPM/CMTR scheme performs well when simulated, in a very high SNR conditions, where impact of IFI and MUI strongly degrades the bit-error-rates (BER) performance. The development is achieved without growing the receiver complexity.

A study by [44] presented a synchronization technique for multiuser transmit-reference ultra-wideband (TR-UWB) structures. The presented method, promises a fine resolution data packet offset estimate. By exploring the fact that, a time domain shift corresponds to a frequency shift, the algorithm complexity is extensively reduced. In the simulations the complete transceiver chain is taken into consideration contemplating measured channel impulse responses in an average university area. The overall degradation in performance of the algorithm is observed with increased number of users. This problem can be solved by using user codes, having low cross-correlation properties for any code offset.

A research by [45] provided a compact ultra-wideband (UWB) antenna incorporated with sharp notches with a detailed evaluation of the mutual coupling of the multiple notch resonators. By using complementary split-ring resonators (CSRR) on the radiating semi-round patch, without growing the antenna size authors achieved the sharp notch-filtering of diverse bands within the UWB band. Also frequency shifts are estimated from the coupling of the nearby CSRRs, a detailed study of the coupling from various notch resonators is accomplished, and constructed the equivalent model. The time-domain behaviour of the proposed antenna is carried out to highlight its validity on various applications. With proper simulations and calculations, the frequency response of the input port measured. The radiation pattern of the carried out quad-notched UWB antenna is almost omnidirectional in the allowed frequency band.

A work via [28] proposed a multi-differential FSR-UWB device, where a single reference carrier and multiple data carriers used. This change importantly allows more number of (differential) levels for signalling in the architecture. Along with maximum degrees of freedom with little improvement in bandwidth can be achieved using the scheme presented in comparison to SD FSR-UWB, and also having less error in high data rates applications. Unlike similar improvements to traditional TR-UWB systems, the advantage is bigger than that acquired by means of genuinely amortizing the reference signal energy over a multiple data symbols. Moreover, by means of using Mary signalling, the presented scheme allows effective narrowband interference suppression.

V.CONCLUSION

Through the analysis of existing literature certain research limitations are examined and identified which put forth the further research domain. The review of existing literature is carried under three major criteria based on review of ultra-wideband technology, synchronization performance of UWB and timing performance of UWB for specific applications. In review of UWB it is observed that [10] concentrates on positioning of UWB for specific application alone this research does not concentrates on challenges related to UWB application. Research carried out by [46], and [22] focus on parameters associated with UWB technology does not provide the in-depth analysis of related factors in UWB technology. In review of synchronization performance of UWB research gap identified in existing research is synchronization for various modulation techniques is not identified by [30]. Another research carried out by [20] focuses on synchronization in channel model, and [19] does not provide the clear review about specific applications. To overcome the problem of synchronization [31] and [29] developed a model but it does not concentrate on specific application. The review carried out by [1], [3] and [14] focuses on VLSI specific application alone and evaluated under certain factors like noise performance and propagation time on VLSI. Due to the above mentioned drawback it put the significant research domain for specific application for communication system.

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