V2X COMMUNICATION AND RANGING TECHNIQUE USING SS TECHNIQUE

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Abstract: The paper proposes a ranging and communication technique where Spread Spectrum is used to find theexact positioning of the nearby vehicles, thus this method can find implementation in autonomous vehicles. Herethe Vehicle can communicate with its immediate surrounding with the help of pseudo noise signals and proper positioning of transmitters and receiver pairs in the vehicles.In the proposed system, The Vehicle-A is expected to generate a simple pseudo noise code (PN) for example a linear binary number stream, which is then transmitted to the receiver's in the nearby vehicles, traffic lights, sidewalks, etc. and then via the transmitters attached to the destination, the modulated signal is then sent back to the source and here the modulated signal is then analyzed by the electronic module of Vehicle-A. This method helps to keep a tab on the locations of the nearby vehicles, helps in lane-keeping and also removes the scope for traffic violations.

I. INTRODUCTION

Autonomous vehicles is the future, thus in the recent years the development of autonomous driven cars has been promoted. Thus the technical working and research of autonomous cars is now happening sooner than what we might have earlier perceived. Some of the immediate applications of this smart and efficient system are:

- Vehicle to Vehicle communication(V2V)
- Ranging and positioning System
- Lane-keeping assist
- Smart traffic operating system

It promotes safe driving, provisions, optimal traffic & control management system, and efficient road management. In numerous systems for ITS, vehicle-to-vehicle communication systems (inter-vehicleCommunication) and ranging systems are essential. A vehicle can mechanically get the material of surrounding vehicles by vehicle-to-vehicle communication systems; it helps to measure distances among their vehicles by ranging systems. It is extremely inefficient from the view of economy and effective use of transmission medium that a vehicle has two systems separately. Therefore, Vehicle-to-Vehicle Communication and Ranging System by means ofSS Technique termed SS Boomerang Transmission System takes been proposed. In this system,a vehicle (Vehicle-1) can know the information of anothervehicle (Vehicle-2) and correspondingly compute the range and the distance between the two vehiclesat the same time. However, Vehicle-1 with the conventional SS Boomerang Transmission System cannot measure the locationof Vehicle-2 because each vehicle has only one pair of receiver and transmitter thus I am altering the position of the transmission and receiver's so as to obtain efficient communication with minimal interferences.

II. LITERATURE REVIEW

In this processa telecommunication signal is commutated and transmitted on a BW which is substantially greater in comparison to the frequency content of the real information. This frequency hopping mechanism is a rudimentary modulation method used in spread spectrum signal broadcast. .In this method direct sequence, frequency hopping, or anamalgam of these, which can be used for multiple access and multiple functions. This technique declines the possible interference to supplementary receivers while procurement privacy. Spread spectrum usually makes use of a sequential noise-like signal structure to spread the normally narrowband information signal over a fairly wideband (radio) band of frequencies. The receiver relates the received signals with the original signal to retrieve the original information signal. Originally there were two motivations: either to repel enemy efforts to jam the communications (anti-jam, or AJ), or to skin the fact that communication was level taking place, occasionally called low probability of intercept (LPI).

III. SPREAD SPECTRUM

Spread spectrum (SS) is a transmissiontechnique via which the data transfer and information accusation can happen. Herein the signal is made to acquire a bandwidth in surplus of the marginalwhich is necessary towire the information: the band spread is adept.This is a modulation method practiced on digitally modulated signals that augments the transmit signal bandwidth to a value much bigger than what is needed to transmit the primitive information bits.

IV. CHANNEL CAPACITY

Channel capacity is directly dependent on bandwidth and the signal to noise ratio (SNR), mathematically

$$\text{Capacity} = \text{Bandwidth} * \log_2 (1 + \text{SNR})$$

Thus, the more the bandwidth, the greater will the signal to noise ratio (SNR) which implies that a greater number of bits per second can be passed via the channel and the medium. However when the signal is feebler than the noise then the value of signal to noise (SNR) is a lot greater than 1.Thus there is a possibility for approximation and the formula can be represented as

$$\text{Capacity} = \text{Bandwidth} * (1.44 * \text{SNR})$$

Thus a proper tradeoff between the signal and the noise is important for the practical application of the above method. So if we can find a proper way of encoding anddecoding the data into a large bandwidth signal range, then only we can obtain an error free way of data transfer and communication.

So for the system to be viable and applicable we must look to realize a method where proper encoding of data is possible. Thus, this in itself is the main reason as to why spread spectrum methods are favored in comparison to other techniques like Amplitude Modulation, Phase modulation, Frequency modulation or a hybrid between them. The advantage can be further explained by using a practical example which also helps us decide for yourself as to why this is the best technique. Let us assume a 3 kHz speech signal which we are interested in transmitting through a channel which possess a noise level which is around 100 times as compared to the signal, let's assume the channel is our normal surroundings for an able visualization. Thus by substituting example values in the above equation wefind out that we get a bandwidth of 208 kHz, which is around 70 times more than the original signal to be transported. This idea of spreading is not only limited to the spread spectrum technique butcan also be seen as the central idea of FM radio. The main advantage of SS technique and FM radio is that produces good sound quality compared to the simpler AM technique. Though this is one of the most important advantage which proves its superiority to other obvious techniques like AM, FM and PM, and allthe hybrid techniques that lie in between.

- Selective Addressing – If we can use optimal techniques to spread the signal and use proper encoding and decoding techniques. Thus by establishing a proper transmitter's code, we can target a specific receiver in a group, which can be predetermined by us which in our case will be a specific vehicle. This specific transmission and selective reception method is termed as Code Division Multiple Access.
- Common Bandwidth Sharing– By proper selection of the modulation code, it is possible to have multiple pairs of transmitters and receivers in the same bandwidth, thereby saving us precious bandwidth range.This is just like operating 50 TV channels at a similar frequency.
- Protection from Prying. It provides an almost idealistic immunity and protection from interception by any third or unwanted receiver. Thus if an eavesdropper who is not aware of the modulation code of the SS transmission, all the interceptors will see is random pseudo noise and not any important data information..
- Insusceptibility to Intervention. The error rates are excellent even with very faint and minimalistic signals. The mechanism is such that whenever a different abnormal signal tries to interfere with the spread spectrum transmission the demodulation mechanism treats it like noise.
- Strain in Discovery. As the spectrum technique causes the link to use much less power per bandwidth than the normal radio link, thus we need sufficiently wider bandwidth, a proper knowledge of the link's code is required for deception and demodulation so signals transmitted by this technique is tremendously hard to detect and decode. This implies that they can co-occur with other more conservative signals deprived of causing calamitous interference to narrowband links.

The above mentioned advantages make the spread spectrum technique a boon to the military community, who are reasonably fearfulbeing intercepted. Thus to develop a better and a more sound understanding it is important to closely examine the multiple options we have for Spread Spectrum designs.

V. MLS SEQUENCE

A maximum length sequence (MLS) is an example of pseudorandom binary sequence. They can be referenced as bit sequences generated using maximal linear feedback shift registers which are so called because they are periodic and imitate every binary sequence (excluding the zero vector) which can be enlightened with the help of shift registers (i.e., for length-m registers they yield a sequence of length 2m − 1). Thus an MLS can also be characterized into n-sequence or an m-sequence, depending on the type of MLS which is present. Generally, MLS's remain spectrally flat, with the exemption of a near-zero DC term.

Spread Spectrum Transmission model

For the application of vehicle to vehicle communication such that autonomous vehicles can become a reality we have assumed a simple SS Transmission model as shown in Fig 1. Here, the Vehicle A is considered as the source for the pseudo noise code and the transmitter attached to it broadcasts it. In simple terms, Vehicle A gives out random pseudo noise codes and the system with which it intends to commute. The destination receiver or the receiver attached to the destination which in this case is the sidewalk, Vehicle B, red light or any such thing receives the PN Code and relies by adding its own information and a specific set of instructions. For example –the Vehicle B returns back the Pseudo noise code adding its own information and when this information is received by Vehicle A it can decode the message and get information regarding the location, range, etc. which are basically all the things required for vehicle to vehicle communication. Similarly the Vehicle A is communicates with the sidewalk and the red-light. The rudimentary principle for this operation is that the phase difference is used to calculate the distance with the side walk. This can also assist us in designing a lane assisting mechanism for automobiles where the need is to basically maintain a constant distance or maintain the same lane throughout.

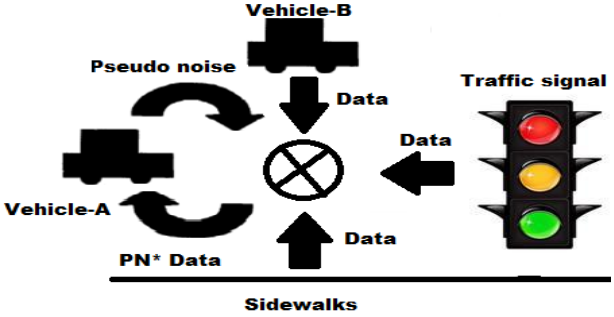

Figure 1.AdvocatedSS Transmission System

VI. THE PROPOSED SYSTEM

The already present systems might be able to give us a sound estimate of the rangeof the vehicles, but the exactness in the location sensing is still missing.Thus in this paper a Vehicle to Vehicle Communication system using Spread Spectrum Mechanism is proposed.Though the scope of the paper is very vast but because of application reasons only Vehicle A to Vehicle B communication is discussed. Since the location of the vehicles aren't fixed thus based on optimal design strategizing we try out three separate methods and their conceptualization are explained. The three positioning mechanisms are shown in Figure 2 and for linearization purposes we assume that at the communicating Vehicle B the positioning of the receiver and the transmitter is done always at the center.

1) Type-A: It consists of one transmitter and two receivers. The transmitters are placed at the center of Vehicle-1 and the two receivers are then placed on the left and the right sides of the vehicle respectively in a symmetrical manner.

2) Type-B: In this particular system there are pairs of receivers andtransmitters and they are placed on either side respectively and each transmitter has its own unique Pseudo Noise code sequence.

3) Type-C: In this particular case also the construction is same as Type-B,that is a pair of receivers and transmitters located at exactly the same points but the difference lies in the code transmitted. Each transmitter here transmits the same code, but there is a particular cycle difference between them. The right Pseudo Noise code is about half cycle behind the left side Pseudo Noise code.

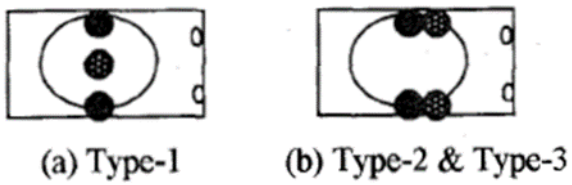

Figure 2 – The positioning of the Transmitter and the Receivers in Source Vehicle which is Vehicle 1

The figure 3 represents the block diagram of Type-Awhere, as explained earlier only one Transmitter is there along with a pair of receivers attached on either side of the vehicle. It also uses a single pseudo noise sequence as compared to Pseudo noise signals compared to Type -B and Type – C which uses PN code sequences. The Vehicle 2obtains the noise signals sent from the transmitter of Vehicle 1 and then its transmitter resends it adding its own trivial information in it.Both the receivers attached on either side of the vehicle recapture the modified signal and decode it to obtain the information sent by Vehicle 2.Since the receivers are located on either side of the vehicles we have a phase difference related to the location of Vehicle 2 which is used to obtain the location of vehicle 2.The phase difference is calculated one. Mathematically, the phase difference is measured by a two-step process, one of them being the distance between the center transmitter of vehicle 1 and its right receiver via the Vehicle 2 (the center transmitter + Vehicle-2 + the right receiver) and another is that between the center transmitter and the left receiver of Vehicle-1 through Vehicle-2 (the center transmitterVehicle-2+the left receiver). Therefore Vehicle- 1 cannot get only the information of Vehicle-2 and the distance between vehicles using the procedure of the conventional SS Boomerang Transmission system but also obtain the location of Vehicle-2 at the same time, which serves our primary motive.

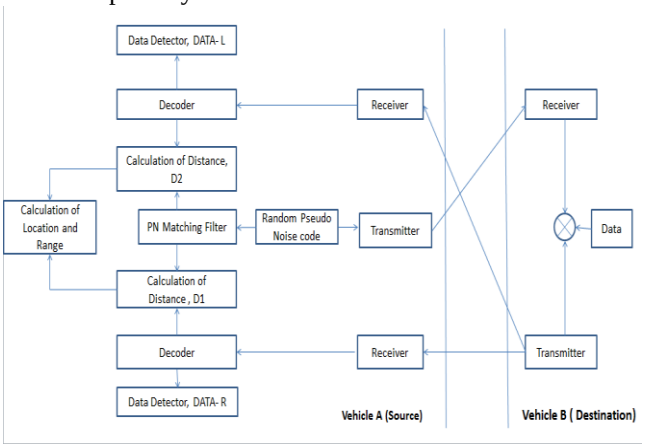

Figure 3: Block mechanism representation for Type 1

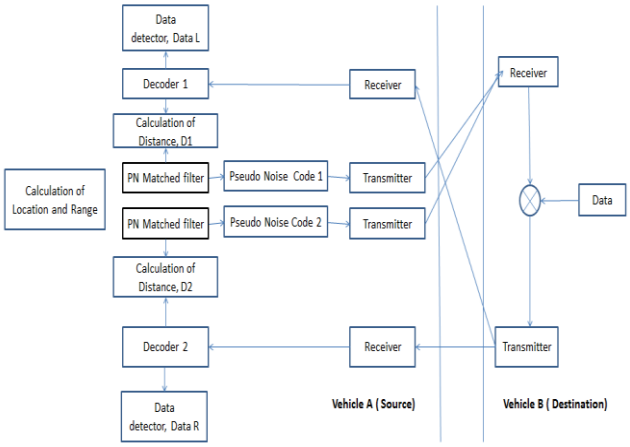

Figure 4: Block mechanism for Type B and Type C

A proper understanding of the working of Type-B and Type-C schematic can be understood via Fig.4.As explained earlier Type-2 and Type-3 contain a two different pairs of transmitter and receiver which are attached to the left and the right side of the Vehicle 1 and unlike the Type 1 configuration here each transmitter generates its own unique Pseudo Noise code in Type-B thus in this mechanism is a tad different from Type 1.In Type-C the positioning of the transmitters and receivers is the same as Type-B but the Pseudo noise code used is the same, but the transmitters are able to generate a particular phase between the cycle and so the PN codes are never synchronous. The Vehicle 2 receives the code from the pair of transmitter attached inVehicle 1 and then it replies to that PN code adding its own Data and sends it back to the Vehicle 1 via its own transmitters. The modulated signals are now demodulated via the data decision and the matched filter which here act as tuning circuits and then with the help of the procedures of the conventional Spread Spectrum Boomerang Transmission system the ranging distance between vehicle 1 and the other vehicle can be calculated.The computation of distance blocks computes two different distances, one of which is the distance between

the right receiver and the right transmitter through vehicle 2 and the other on being the distance between the left transmitter of Vehicle 1 and the left receiver through vehicle 2 and since it is a multi-step process the accuracy of measurement of location of vehicle 2 or any other thing is more favorable as compared to those measured by Type-A.

VII. CONCLUSION

Three different mechanisms have been proposed in this paper and have been studied on a set pattern, whereby vehicle 1 follows vehicle 2. This type of mechanism can also be implemented for any V2X communication wherein the Vehicle 1 will have the chance to communicate almost everything present in the surroundings thereby providing us technology which can find implementation in autonomous or semi-controlled vehicles. We also discuss the advantage of using spread spectrum technique as compared to other methods like PM, FM or AM.

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