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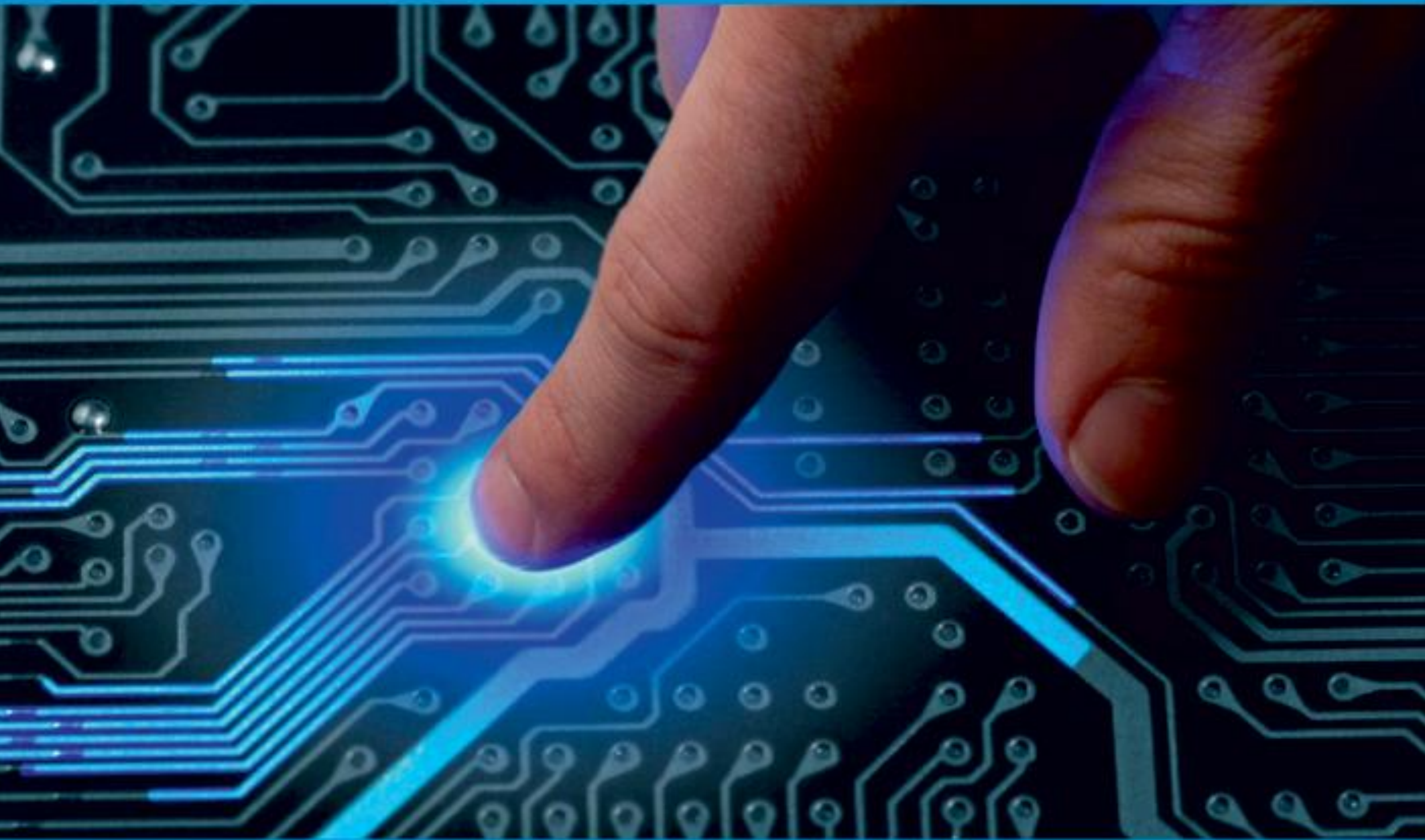

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# A SRS-Based 5G NR Uplink Channel Estimation

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**ABSTRACT:** The precise channel estimation is a prerequisite to acquire beamforming performance that the massive multi-input and multi-output (MIMO) system guarantees.Channel Estimation (CE) is one of the key technologies in mobile communication system and also important in Sounding Reference Signal (SRS) that is used to detected channel quality information in 5G-NR uplink. According to the latest 5G-NR specification, the pilot aided CE algorithms for 5G-NR uplink are researched in this paper. To improve the performance and decrease the complexity of traditional channel estimation methods, here we propose a novel Pilot-Aided channel estimation algorithm – Conjugate Cancel (CC) channel estimation, after LS, MMSE and SRS are introduced. The goal of the method is to reduce the computational complexity and restrain the interference of noise. Stimulation shows that the improved method is prior to the traditional algorithms respectively while achieving the purpose of Channel Estimation.

**KEYWORD:** Sounding reference signal, 5G New Radio, Channel estimation, sub-6 GHz, conjugate channel.

## I. INTRODUCTION

With the rapid development of mobile communication, the evolution about wireless network technology has been transformed from audio service to data service gradually; it is obvious about the superiority of data service pursing the broadband, the requirements should be satisfied by the provider. To achieve this goal and keep continuing competitiveness in the field of communication, the Third Generation Partnership Program (3GPP) members started a feasibility study on the enhancement of the Universal Terrestrial Radio Access (UTRA) and this project was called Long Term Evolution (5G-NR). As evolution system of 3G, 5G-NR which bases on orthogonal frequency division multiplexing (OFDM), and combines multiple input multiple output (MIMO) and flexible time frequency domain resource scheduling and so on, forms thoroughly new air-interface technology which is different from code division multiple access of 3G. 5G-NR can be known as 4G standard technology and becomes the trend of future mobile communication system. However, wireless channel environment is very complexity, so the channel estimation is important in order to recover the original signal accurately. Channel estimation issuch process that gets channel transfer function (CTF) usingcertain principle according to parameters of channel modeand received signals.

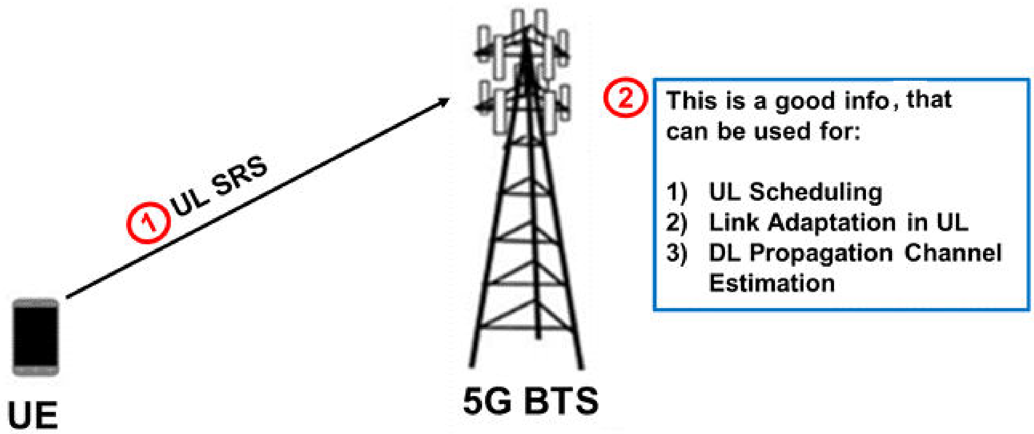


**Figure 1:** Sounding reference signal in 5G-NR uplink

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We study mainly Pilot-Aided channel estimation algorithms in this paper. In uplink, Sounding Reference Signal is used to estimate channel quality so that User Equipment (UE) can be assigned to transmit signal in high quality channel. At present, the usual Pilot-Aided channel estimations are Least-Square (LS) and Minimum Mean- Square Error (MMSE). After analysis these traditional algorithms, we introduce a novel method in this paper. The algorithm aiming at channel estimation of Sounding Reference Signal (SRS) position decreases the complexity of these traditional methods.

## II. MATERIAL AND METHODS

In General, SRS is a reference signal transmitted by the UE, and is measured by the BTS to estimate UL channel propagation, and this in general can be used for many others functions, which will be cover in this article, The below summarizes the main characteristic of 5G SRS.

- The UE transmits the Sounding Reference Signal(SRS) according to the instructions provided by the BTS, and is used by the BTS to measure the UL propagation channel from the SRS.
- An SRS Transmission can occupy 1, 2, or 4 symbols in the time domain; these symbols can be located at the last 6 symbols of a UL Slot.
- An SRS Transmission can occupy up to 272 RBs in the frequency domain, but an individual UE does not transmit the SRS on every subcarrier but select specific SCs based on transmission comb type(TC).
- NR SRS are more flexible compared to 4G, for example 4G SRS were occupying one symbol and was using transmission comb type 2 only , while NR occupy up to 4 symbols and is using transmission comb type 2 or 4.

Figure 2 explain transmission comb type but it is mainly control how many SCS will be used by the UE within RB during SRS transmission.We know that SRS is generated from base sequences which stem from ZC sequence through cyclic shift which is to maintain the orthogonal of different users. So we can take advantage of the property of orthogonal of received signals from different users to estimate channel transfer function. To analyze the process in detail, we assume that two users transmit signal in SRS allocation and the SRS are multiplexed by code division multiple access. Then, according to 5G-NR protocol, the RSR in transmitter are:

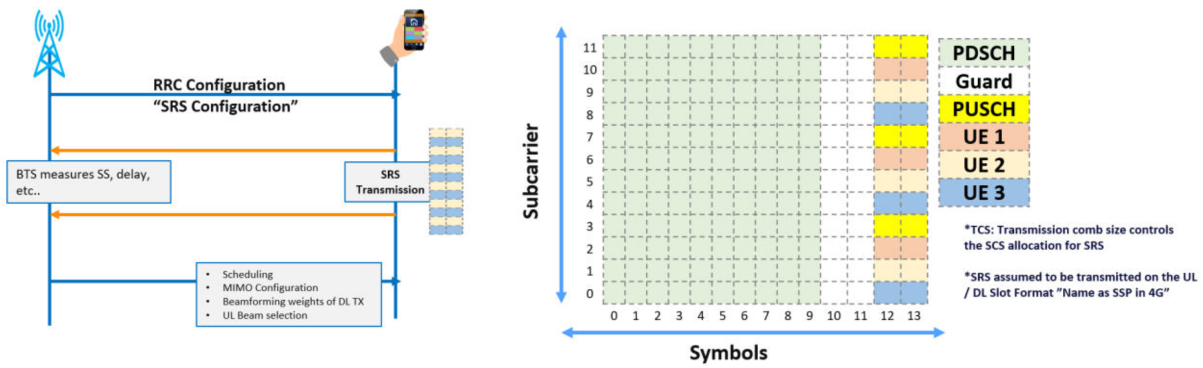


**Figure 2:**Explain comb type transmission

$$S_1, S_2 = S_1[e^{j\pi} \quad e^{j2\pi} \quad \dots \quad e^{jN_{sc}\pi}] \tag{1}$$

First, extracted received signal $Y$ multiply the conjugate original RSR sequence, we obtain $\bar{Y}$ , and it is:

$$\bar{Y} = \begin{bmatrix} \bar{Y}_1 \\ \bar{Y}_2 \\ \bar{Y}_3 \\ \vdots \\ \bar{Y}_{N_{SC}} \end{bmatrix} = Y \times \bar{S}_1 = \begin{bmatrix} H_{11} + jH_{21} \\ H_{12} + jH_{22} \\ H_{13} + jH_{23} \\ \vdots \\ H_{N_{SC}} + jH_{2N_{SC}} \end{bmatrix} \tag{2}$$

Next, we add the adjacent rows to cancel the other user's information. Given that the channel transfer function of adjacent subcarrier is similar, so we can get the CTF value for each subcarrier after this step. As well, user2's channel

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transfer function can be gotten by the same way. Note that we don't consider effect from noise when we compute the channel transfer function, so the performance of the method is low. In order to improve the performance of this algorithm, we deal with the channel transfer function value further as follows:

• Step 1: we covert the estimated value into time domain through IFFT:
• Step 2: using the threshold comparison which is introduced in [6] to deal with the signal of time domain for purpose of decreasing interference.
• Step 3: the signal is transformed into frequency domain again.

Through these steps, the precision of conjugate cancel estimation is improved. Figure 1 shows the whole process of conjugate cancel estimation.

Fig.1. Conjugate Cancel Estimation

After all above steps, the precise CTF of every data subchannel can be otained by different interpolation methods such as [7] [8], according to Channel FrequecnyResponse of adjacent pilots symbol.

## III. SIMULATION RESULTS

UE and SRS Configuration: Set the key parameters of the simulation. These include:

- The bandwidth in resource blocks (12 subcarriers per resource block)
- Subcarrier spacing: 15, 30, 60, 120, 240 (kHz)
- Cyclic prefix length: normal or extended
- Number of transmit and receive antennas: 1, 2 or 4.
- Number of layers. It must be lower than or equal to the number of transmit and receive antennas.

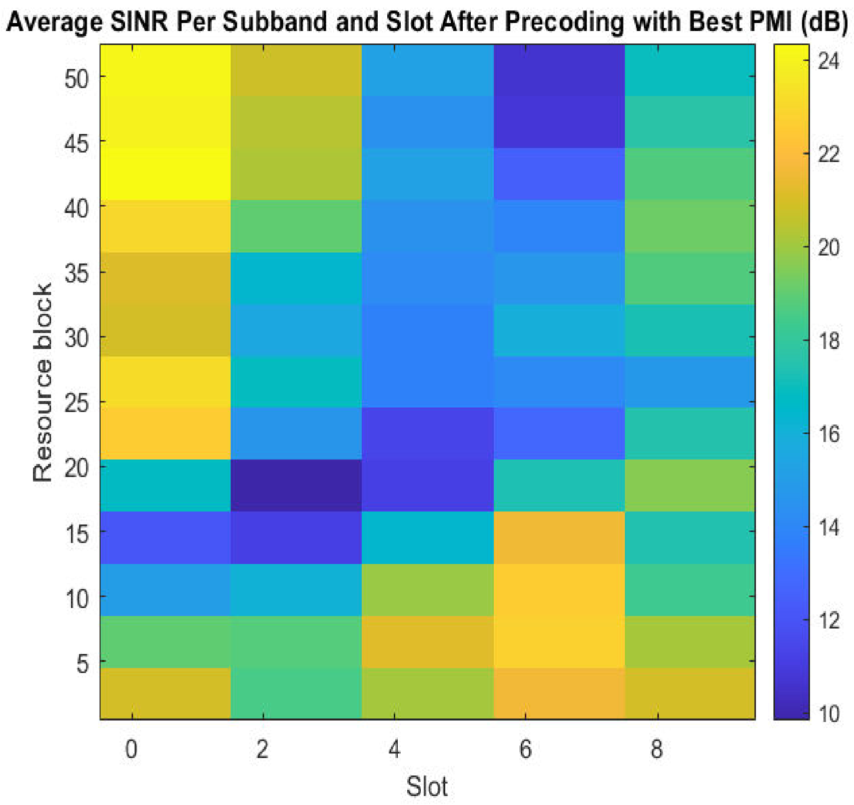


**Figure 3:**Display the SINR per slot and RB obtained after precoding with the PMI that maximizes the SINR per subband.

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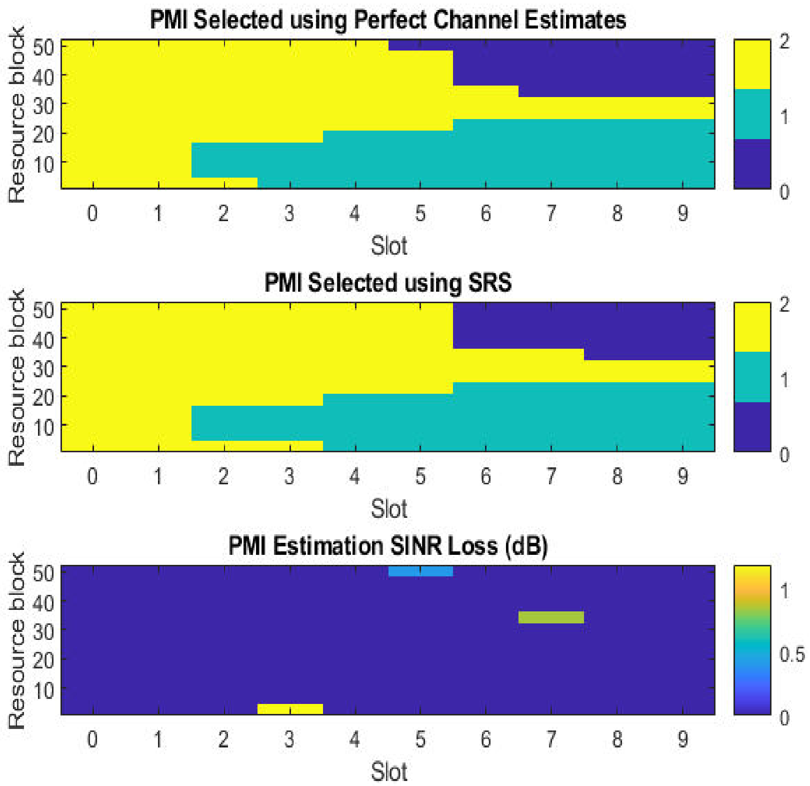


**Figure 4:**Display the selected PMI using perfect and practical channel estimate.

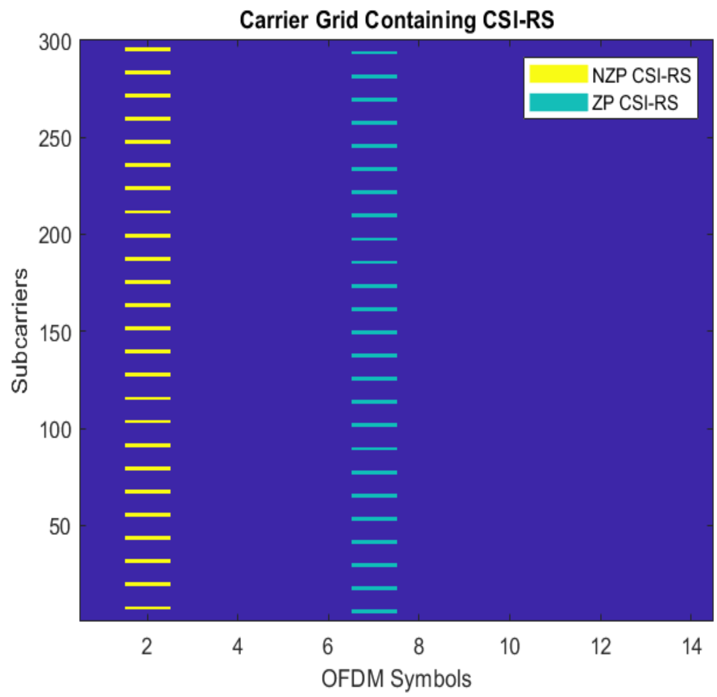


**Figure 5:**Plot the locations of the CSI-RS (both ZP and NZP) in the grid.

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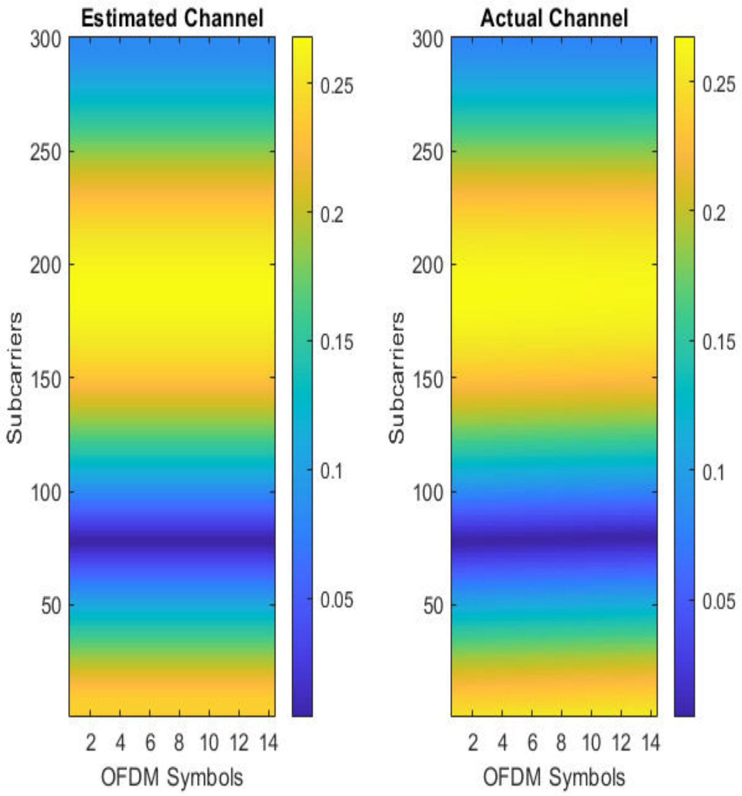


**Figure 6:**Plot the estimated channel and actual channel between first transmitting antenna and first receiving antenna.

The SRS parameters specified include:

- Number of SRS antenna ports: 1,2,4
- Number of OFDM symbols allocated for SRS per slot: 1,2,4
- Starting OFDM symbol of the SRS transmission within a slot. It must be (8...13) for normal CP and (6...11) for extended CP.
- Starting position of the SRS in frequency specified in RBs
- Bandwidth and frequency hopping configuration CSRS, BSRS, and BHop. Set BHop>= BSRS to disable frequency hopping.
- Transmission comb to specify the SRS frequency density in subcarriers: 2,4.
- Number of repeated SRS symbols within a slot. It disables frequency hopping in blocks of Repetition symbols. Set Repetition = 1 for no repetition.
- Periodicity and offset of the SRS in slots.
- Resource type can be 'periodic', 'semi-persistent', and 'aperiodic'. The frequency hopping pattern is reset for aperiodic SRS resource types in every slot.

## IV. CONCLUSION

With the frequency resource becoming less and less, channel estimation and frequency domain scheduling are becoming hot technologies nowadays. In this paper we propose a novel method for the purpose of reducing the complexity of traditional methods to estimate channeltransfer function. We use the properties of equally spaced cyclic shifts from the mother ZC sequence to make Pilot- Aided channel estimation. Through conjugate multiply and user cancel and threshold, we obtain the channel transfer function. The simulation shows that the scheme we provide in this paper estimates the channel transfer function accurately while it reduces the computational complexity, at the same time, we use threshold to decrease the interference of noise and this method achieves better performance of channel estimation.

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