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An Improvised Quality Aware PSA Channel Estimation Algorithm Based on S-DCT With Rayleigh Distribution over AWGN Distribution

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Abstract

In order to reduce the noise elements effect, pilot symbol aided (PSA) channel estimation (CE) algorithms based on the transform domain such as DFT, DCT appear attractive owing to their capacity. Here, in this paper we introduced an improved channel estimation algorithm based on shortened DCT (S-DCT) with Rayleigh distribution (RD) to eliminate the energy leakage by using the symmetric property and also compared with the existing channel estimation methods such as Least Square (LS), DFT and mirror weighted DCT even that of S-DCT with additive white Gaussian noise (AWGN) distribution. Simulation results demonstrate that the S-DCT-RD can reduce the energy leakage more efficiently, and performed far better than the existing CE algorithms.

Keywords: *PSA, S-DCT, DFT, S-DCT-RD, AWGN Channel.*

1 INTRODUCTION

Nowadays, in various channel estimation algorithms, pilot-symbol-aided detection (PSAD) channels estimation is a practicable approach. PASD can be divided into two parts: no prior information and prior information of the channel. Owing to the stochastic change of statistical characteristic in real wireless channel, in illusion to high rare data communication, it is difficult to gain prior information for the channel. In channel estimation algorithms of no prior information, least square (LS) is of low-complexity and practical algorithm, but is a low accurate channel estimator. Compared with some conventional algorithms, transformation based domain channel estimators have excellent performance with modest complexity increase, so it will be an important aspect of channel estimation algorithms. The DFT-based channel estimation can achieve theoretically ideal low-pass interpolation. It can improve the accuracy of estimated channel frequency response with low complexity by exploiting FFT algorithm. However the drawback of conventional DFT-based method is that it can't provide the excellent performance when the multi-path fading channel exist any sample-spaced path delay. Reference proposed that windowed DFT based pilot-symbol-aided methods avoid the defect and improve system performance, but reduce effective frequency band utilization. In reference, DCT-based channel estimator's performance excel mirror extension DFT-based channel estimator. In reference, mirror weighted DCT based channel estimator is proposed. Its performance closes to minimum mean square error (MMSE) estimator. In high SNR, it avoids an error floor, but system has poor performance in low SNR. The paper proposes a truncation DCT channel estimation algorithms which base mirror weighted DCT channel estimation and utilizes the characteristic which compress the power to the low frequency reign by DCT. By the result of simulation, it excels previous transformation domain algorithms, and in high SNR has more excellent performance.Most first generations systems were introduced in the mid 1980's, and can be Characterized by the use of analog transmission techniques and the use of simple multiple access techniques such as Frequency Division Multiple Access (FDMA). First generation telecommunications systems such as Advanced Mobile Phone Service (AMPS) only provided voice communications. They also suffered from a low user capacity, and security problems due to the simple radio interface used. Second generation systems were introduced in the early 1990's, and all use digital technology. This provided an increase in the user capacity of around three times. This was achieved by compressing the voice waveforms before transmission. Third generation systems are an extension on the complexity of second-generation systems and are expected to be introduced after the year 2000. The system capacity is expected to be increased to over ten times original first generation systems. This is going to be achieved by using complex multiple access techniques such as Code Division Multiple Access (CDMA), or an extension of TDMA, and by improving flexibility of services available. The telecommunications industry faces the problem of providing telephone services to rural areas, where the customer base is small, but the cost of installing a wired phone network is very high. One method of reducing the high infrastructure cost of a wired system is to use a fixed wireless radio network. The problem with this is that for rural and urban areas, large cell sizes are required to get sufficient coverage.

Fig1.1 shows the evolution of current services and networks to the aim of combining them into a unified third generation network. Many currently separate systems and services such as radio paging, cordless telephony, satellite phones and private radio systems for companies etc, will be combined so that all these services will be provided by third generation telecommunications systems.

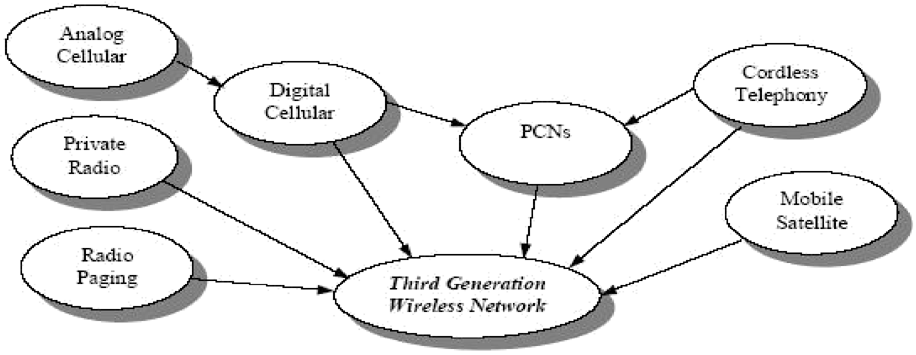


Figure 1.1: The evolution of current networks to the next generation of wireless networks.

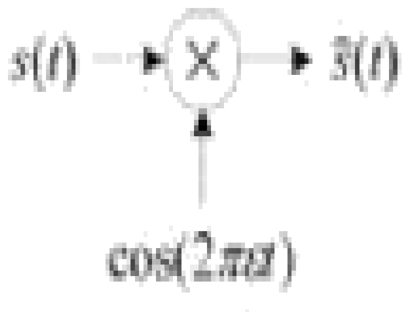
Currently Global System for Mobile telecommunications (GSM) technology is being applied to fixed wireless phone systems in rural areas. However, GSM uses time division multiple access (TDMA), which has a high symbol rate leading to problems with multipath causing inter-symbol interference. Several techniques are under consideration for the next generation of digital phone systems, with the aim of improving cell capacity, multipath immunity, and flexibility. These include CDMA and OFDM. Both these techniques could be applied to providing a fixed wireless system for rural areas. However, each technique as different properties, making it more suited for specific applications.

II.OVERVIEW AND MOTIVATION

In the past decades, there are so many channel estimation schemes have been proposed. Among those, the channel estimations based on PSA will help us to increase data rate. There are two parts in PSA-CE methods, those are: No prior information of channel and Prior information of channel based methods. The authors in [8] and [9], proposes a least squares (LS) approach and Minimum Mean Square Error (MMSE) which are categorized under no prior information of channel. Among those, LS estimator is simplest method and it has lower computational complexity when we compared with the MMSE estimator. But, however the results of MMSE are better than the LS estimator. Different interpolation methods are given in [9] and [10], which will be used in PSACE.Compared with the existing methods, transformation based methods will perform excellent with moderate complexity increase. In [11], the author explained DFT based CE method. It can improve the system efficiency by reducing the computational complexity by exploiting the fast Fourier transform (FFT) algorithm. However, it can’t provide an excellent performance when a sample spaced path delay will be existed by the multi path fading channels. To overcome this drawback, windowed DFT-CE method has been proposed in [12] to improve the performance of the system. But, it reduces the utilization of frequency band. Then after to improve the performance of the system more accurately, the DCT based PSA-CE methods have been proposed in [13], [14] and [15]. These methods have got excellent performance at high SNR region, but at low SNR values it gives very poor performance. In order to improve the system performance even at low SNR values, here in this paper we proposed a novel PSA-CE method based on S-DCT-RD.the proposed algorithm utilizes the DCT characteristics which compresses the power to the low frequency reign. By observing the simulation results, proposed algorithm has dominated the existing PSACE methods with higher SNR and lower bit error rate (BER) values.

2.1 Frequency offset channel

The frequency offset channel introduces a static frequency offset. One possible cause for such a frequency offset is a slow drifting time base, normally a crystal oscillator, in either transmitter or receiver. The frequency offset channel tests the frequency correction circuit in the receiver. The following figure shows the block diagram of the Frequency shift channel.

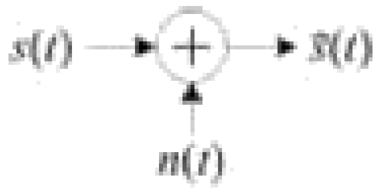


The mathematical model follows as:

$$\tilde{s}(t) = s(t)\cos(2\pi\varepsilon t)$$

2.2 AWGN channel

For the Additional White Gaussian Noise (AWGN) channel the received signal is equal to the transmitted signal with some portion of white Gaussian white noise added. This channel is particularly important for discrete models operating on a restricted number space, because this allows one to optimise the circuits in terms of their noise performance. The block diagram of the AWGN channel is given in the next figure.



$$s(t) = s(t) + n(t)$$

Where n(t) is a sample function of a Gaussian random process. This represents white Gaussian noise.

2.3 Multi path channel: The multipath channel is the last of the static channels. It reflects the fact that electromagnetic waves can travel over various paths from the transmission antenna to the receiver antenna. The receiver antenna sums up all the different signals. Therefore, the mathematical model of the multipath environment creates the received transmission signal by Summing up scaled and delayed versions of the original transmission signal. This superposition of signals causes ISI.

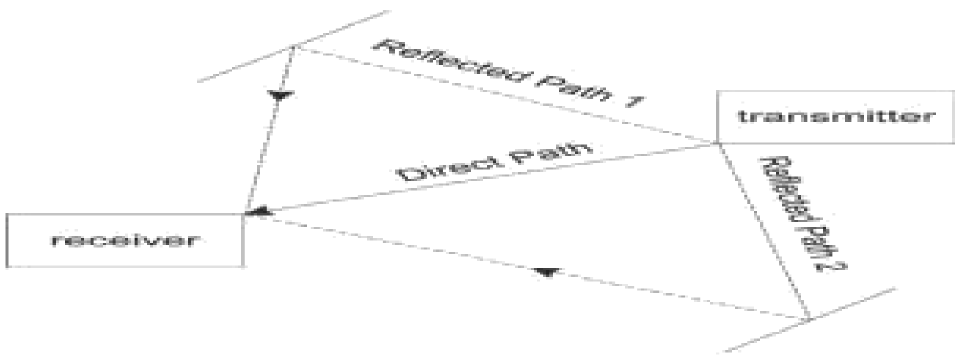
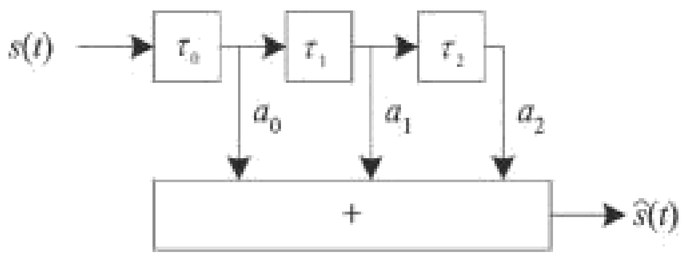


Figure 2.3: A multipath environment



The mathematical model follows as:

$$\hat{s}(t) = \sum_{i=0}^{D-1} a_i \times s(t - d_i)$$

III.PROPOSED WORK (CHANNEL ESTIMATION METHOD)

3.1 DCT-based channel estimation method:

Transformation domain Based channel estimators don't need any statistic of channel. It has low complexity by adopting fast transformation domain method. In DFT method, when the number of sub-carriers is equal to the number of IFFT points, DFT-based channel estimation results will satisfy the desired frequency response of the original signal. However, reference proposed that if isn't a integer, in other words, it is discontinuous between two ends of the N-point data, signal energy's leak will occur. The process will bring aliasing occurring. Firstly,DFT-based channel estimator is described, where after the paper proposes excellent DCT method.On the assumption that M pilot insert uniformly a whole OFDM symbols. Owing to known data in pilot-symbols, the response of frequency can be estimated according to various formulas

3.2 Truncation DCT channel estimation algorithms:

Two channel estimators' algorithms of transformation domain are proposed above. Their homology of DFT/DCT is that padding zeros to transformation domain induce increase of sampling points for improving algorithms' performance. In the formula, AWGN isn't filtered in pilot sequence. The paper proposes an improved DCT-based channel estimator, namely, truncation DCT channel estimation. According to characteristic of DCT, the power of original sequence in frequency domain is condensed to the low frequency reign by DCT, the power in high frequency reign regard as channel noise. Therefore, we adopt a method which setting the threshold to filter redundant noise, and define the threshold as truncation coefficients. Np represents truncation coefficients, and fills following formal.The improved DCT based channel estimator was described above. Compared with DFT, the algorithms can reduce partly channel noise in transformation domain using DCT characteristic which has better power concentration in low frequency region. Thereby it can achieve significant performance without any prior information of the channel.We use simulations to examine the performance of the proposed algorithms. We assume a QPSK OFDM system with a total number of sub-carriers N=128 including 32 comb pilot sequence, and first pilot is put on the first subcarrier. The sampling period is . The channel has 6 paths and the set of delay spread is {0, 3.5, 4, 5.4, 9, 13.2}.We adopt separately LS, DFT, mirror weighted DCT and truncation DCT channel estimator to observe different SER in different SNR.Fig. show SER of LS, FFT, mirror weighted DCT and truncation DCT channel estimator in different SNR. In the figure, two DCT based channel estimators achieve better interpolation performance than the popular DFT-based methods in high SNR. DFT method's SER increases because of non-sample-space path delay in channel. Whereas mirror weighted DCT and truncation DCT channel estimator eliminate aliasing error and avoid an error floor. In low SNR, mirror weighted DCT method has higher SER than truncation DCT channel estimator. Proposed algorithm in the paper has excellent performance compared with other transformation domain channel estimators in any SNR.

IV. EXPERIMENTAL RESULTS

Fig. shows the truncation DCT channel estimator's SER in different SNR and *Np*. In the figure, owing to strong noise in low SNR, the percentage of signal power in the total power is small. Thereby a small change of *Np* can't induce SNR increase. However when SNR exceed 20dB, the length of *Np* is very important, and a small change of *Np* will bring big SNR increase. If the number of truncation is Np+1or Np-1, the algorithm decrease 3-5dB at SNR=35dB. If the number is Np+2 or Np-2, algorithms performance descends rapidly, and the change will result in an error floor. Simulation results indicate that power leakage and rudimental noise affect system performance in high SNR.

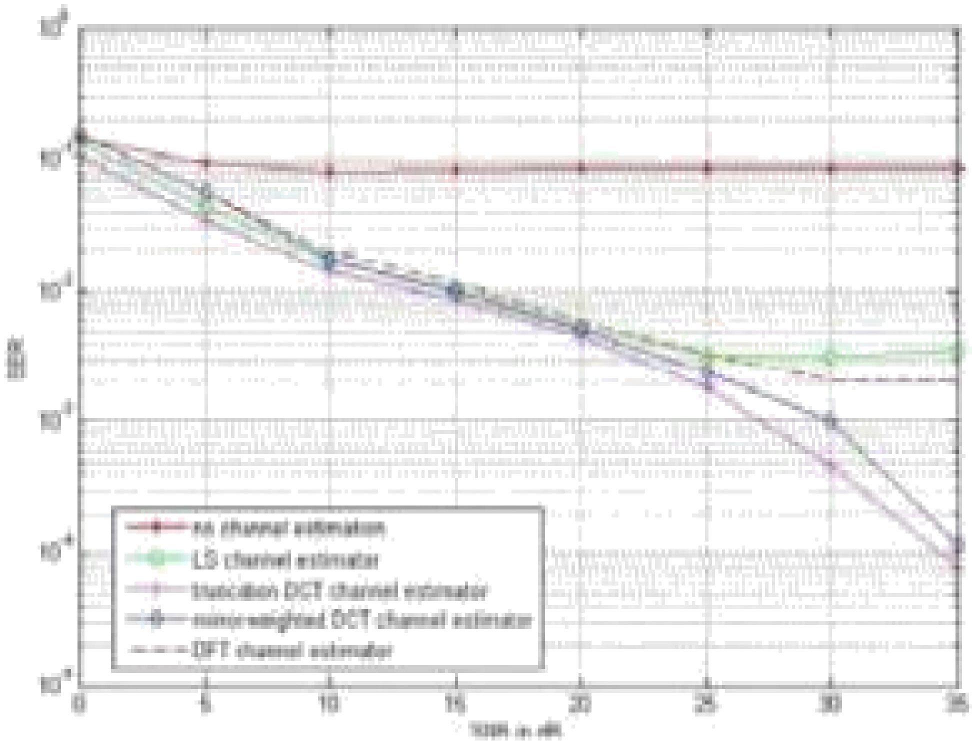


Figure 4.1: SER of channel estimator

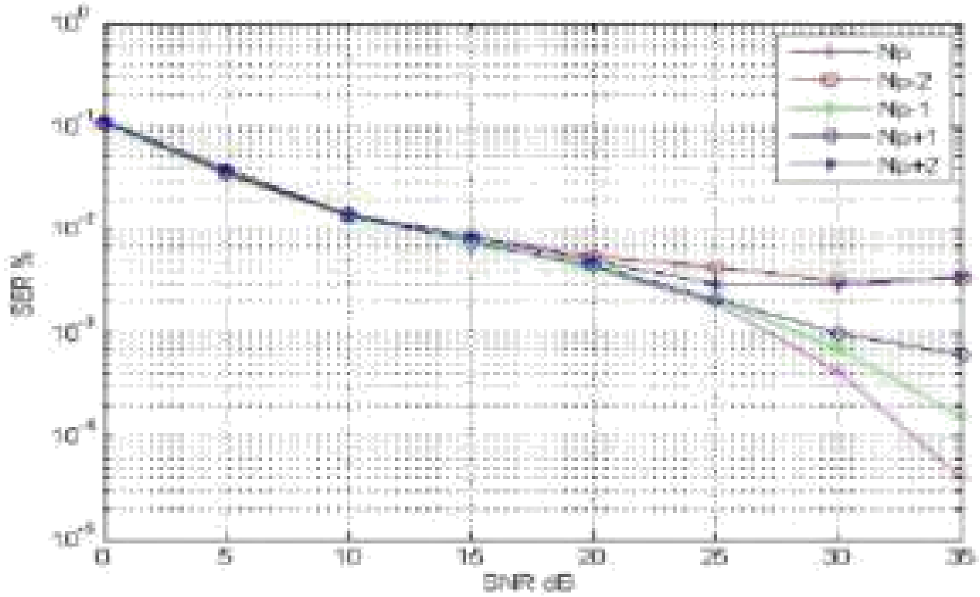
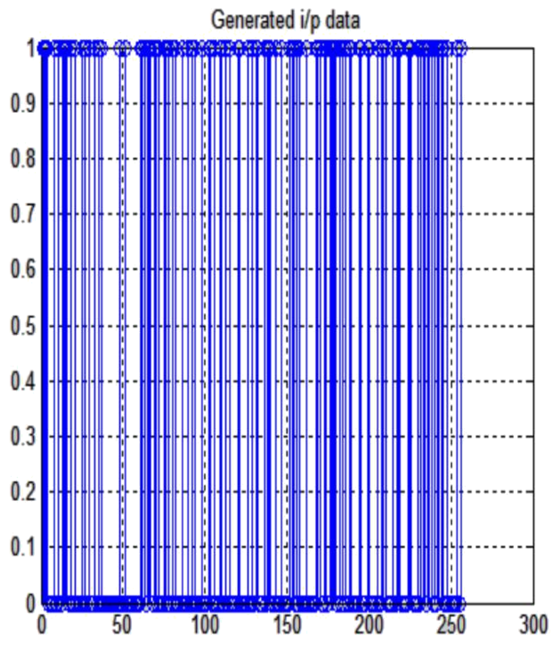


Figure 4.2: SER of different truncation

V. RESULTS AND DISCUSSION

all the experiments have been done in the MATLAB 2014a environment with high speed CPU specifications. We examined all the above discussed algorithms performance and compared with each other. Here, QPSK-OFDM system has considered with a number of sub carriers N=64, 128, 256 512, and so on, which includes 32 pilot sequences. Assumed the SNR is from 1 to 40 dB, path delay 1.0e-2, symbol rate for AWGN =10000sec and for Rayleigh = 20 micro seconds, Doppler frequency=100Hz, power delay = {0, -5, -10} dB are the system specifications for estimating the channel using the proposed and existing CE algorithms. First, randomly generated digital input data has shown in fig6 then the OFDM signal for transmission has shown in fig6.1. Fig6.2 shows that the performance of signal to noise ratio (SNR) to mean squared error (MSE) with the proposed S-DCT and conventional LS, DFT, MW-DCT algorithms. It shows that the proposed CE algorithm with AWGN has the less MSE. Comparison of shortened coefficients in AWGN channel has given in fig6.3. Performance of proposed algorithm with Rayleigh distribution has displayed in fig6.4, which performs even better than the AWGN specifications by reducing the channel noise further with reduced error.



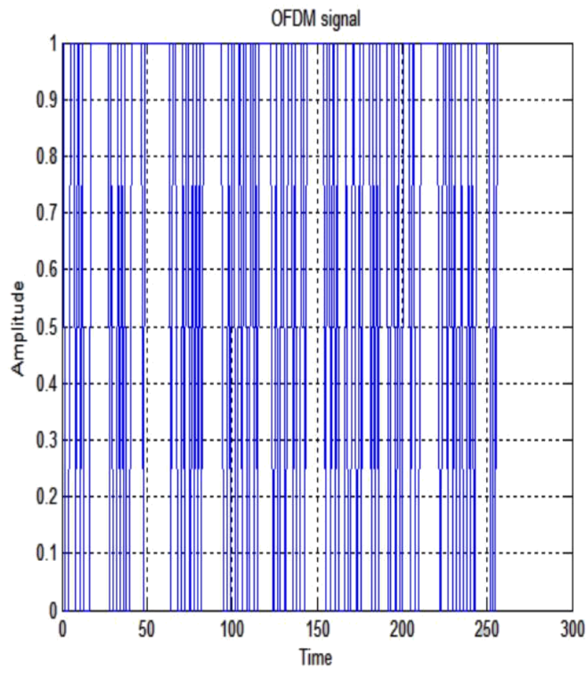


Figure 5.1: Generated input data **Figure 5.2:** OFDM signal for transmission

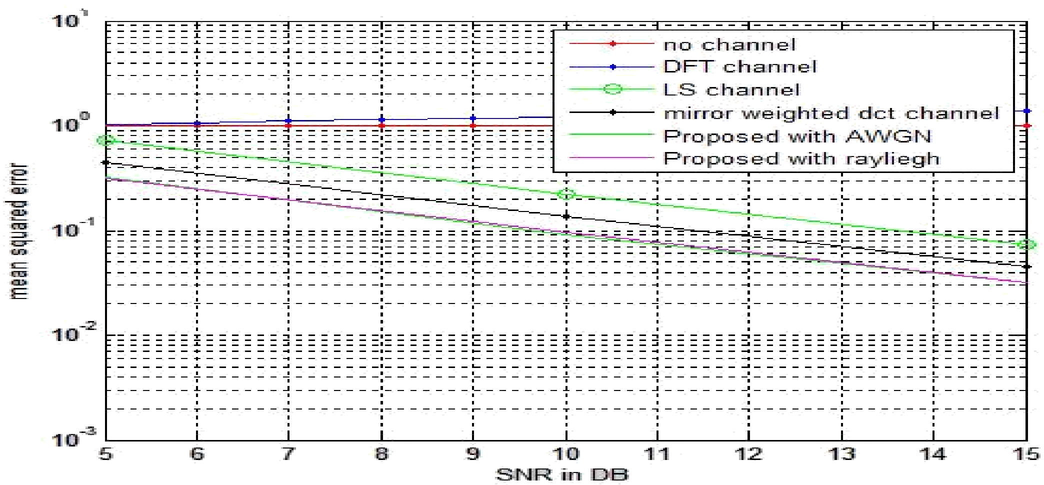


Figure 5.3: Performance of SNR vs. MSE with S-DCT-RD

VI.CONCLUSION AND FUTURE SCOPE

In the multi-path of non-sample-space path delay, the paper proposes the truncation DCT channel estimator which base mirror weighted DCT channel estimation. Simulation results prove the excellent performance of proposed method as compared with conventional method. And the truncation DCT channel estimator can be implemented by mature low-complexity fast algorithms and architectures, which is favorable to matrix-based channel estimator.Here, a novel channel estimator algorithm has been proposed by using S-DCT under the Rayleigh distribution. Also performed the analysis of channel estimator algorithms based on LS, DFT and MW DCT under AWGN channels. Proposed algorithm has been tested with AWGN as well as Rayleigh channel. Simulation results show's that the proposed S-DCT-RD has performed superior to the existing channel estimators in terms of channel noise and mean square.

The mean square error (MSE) to signal to noise ratio (SNR) can be further improved by using more efficient channel estimation techniques, considering all the parameters of the noisy environment channel.SNR can be further improved by limiting the energy leakage caused due to high data rate and attenuation in the channel.

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