iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VII **Month of publication:** July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36953

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Implementation of Hybrid Precoding for MIMO System Using Kalman Approach

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Abstract: ***Multiple antenna system in communication is a main role to serve a multiple users at a time simultaneously in future wireless communication system. The MIMO specifically refers to practical method for sending and receiving the data more than one signal at a time over the same radio frequency channel by exploring the multipath propagation. MIMO is fundamentally a special form smart antenna system modified to enhance the performance of a data signal, such as Beamforming / Precoding and diversity. In millimeter wave 60 GHz band requires a large no of antenna arrays at two sides of transmitter and receiver terminals to beam forming gains, in a way to counteract the high path loss. There are many Precoding methods existing, like Zero Forcing (ZF) method, Branch and Bound (B&B) method and Hybrid method. In the form of fully digital method it's not possible to do with more no of antenna arrays due to hardware complexity at such ranges, while coming to purely analog also suffers the bad performance circumstances. Hence we propose a Hybrid Precoding method in Digital/Analog in the multi user scenario based on the Kalman approach. To mainly reduce the errors between transmitted data to estimated data. Simulation results validates that immense improvement and better performance is achieved compared to existing precoding methods in terms of BER and spectral efficiency.***

Keywords: Millimeter wave (mm wave), ***Multiple-input and Multiple-output (MIMO), Zero Forcing (ZF), Branch and Bound (B&B)***

I. INTRODUCTION

Multiple-input and Multiple-output (MIMO) communication systems notably in short vary wireless communications with an occasional path loss, to boot the converters become a vital issue of system value. It's known that digital to analog converters (DAC's) have a lower energy consumption compared to analog-to-digital converters (ADC's) with constant clock speed and backbone. As an example, once considering the device mix given and assumptive that the energy consumption of a DAC or ADC doubles with every more little bit of resolution, the DAC consumes only 30 minutes of the energy consumption of the ADC with constant parameters. For this reason, the DAC is often neglected inside the optimization of communications systems. MIMO is sub-divided into three main categories; Precoding, spatial multiplexing (SM), and selection committal to writing.

Precoding is multi-stream beamforming, inside the narrowest definition. In further general terms, it's thought of to be all spatial method that happens at the transmitter. In (single-stream) beamforming, constant signal is emitted from each of the transmitter antennas with applicable section and gain weight such that the signal power is maximized at the receiver input. wherever from the Precoding is obtaining a particular disadvantage in separate solutions throughout this regard, linear precoding ways, like maximal-ratio transmission and zeroforcing ways that are followed by division square measure. At constant time a nonlinear approach has been studied. where the precoding vector is obtained supported associate optimization methodology. The Precoding disadvantage is optimization that's resolved by utterly completely different methodology in precoding, such as in zeroforce precoding, branch and positive precoding and Hybrid precoding.

The Zero-Forcing are referred to as null-steering Precoding may even be technique of spatial signal method by that a multiple antenna transmitter will null the multi user interference really terribly multi-user MIMO wireless communication system. Once the channel state knowledge is dead it is known at the transmitter. If the transmitter is tuned in to the down link channel state knowledge (CSI) dead, ZF Precoding can do nearly the system capability once the quantity of users is massive. On the choice hand, with restricted channel state knowledge at the transmitter (CSIT) the performance of ZF Precoding decreases depending on the accuracy of CSIT. ZF-Precoding wishes the varied feedback overhead with affiliation signal-to-noise-ratio (SNR) so on succeed the entire multiplexing gain. we have AN inclination to later offer numerical results describing the performance of normal Zero-Forcing precoding, that outperforms pure zero-forcing at low SNR however is resembling Zero-Forcing at asymptotically high SNR.

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The Branch-and-Bound (B&B) algorithmic framework has been used successfully to go looking out actual solutions for an oversized array of optimization problems. B&B uses a tree search strategy to implicitly enumerate all potential solutions to a given disadvantage, applying pruning rules to eliminate regions of the search house that cannot cause a stronger answer. There unit three algorithmic parts in B&B which will be such by the user to fine-tune the behavior of the rule. These parts unit the search strategy, the branching strategy, and thus the pruning rules, Branch associated positive could be a rule vogue for separate optimization problems. The Hybrid beamforming, on the other hand, splits the overall precoding into the bottom band and RF stages, thus in turn cuts down the required vary of data converters and RF chains, and, hence, improves energy efficiency. the knowledge converters with huge system of measurement than ever before, that unit notably necessary in millimetre Wave communications, want exponentially increasing power consumption for whole range number of resolution bits. In Hybrid Precoding methodology in Digital/Analog inside the multi-user scenario supported by the Kalman approach which results in the reduction of errors between transmitted data to countable data.

II. METHODOLOGY

The Hybrid precoding method is divided into two precoding stages, the precoding stages are RF precoder and BB precoder, while performing the fully digital hybrid method are not possible to do with more no of antenna arrays due to hardware complexity at such ranges, while coming to purely analog one is also suffers the bad performance circumstances. We propose a Hybrid Precoding method in Digital/Analog in the multi user scenario based on the Kalman approach. Then, a two step procedure is to perform: first, the RF analog precoding/combining step is performed and then an iterative Kalman-based approach is applied to estimate the digital baseband precoder at the BS in order to reduce inter-user interference.

We devise a Kalman-based hybrid precoding/combining theme for the invention innovate multi-user millimeter Wave huge MIMO systems, wherever the precoding baseband matrix is taken into account of the state matrix within the Kalman formulation. We outline the error between transmitted and calculable information as a operate solely of the precoding, combining and channel matrices. we have a tendency to show comparative simulation results each in terms of spectral efficiency and BER performance, that ensure that the planned approach performs higher than different existing ways. The number of RF chains could also be abundant under the quantity of antennas in hybrid solutions, so reducing the signal process complexness and therefore the energy consumption of RF chains. The spec could be a millimeter Wave-based huge MIMO cellular system wherever the BS is causing No of bit streams through No of base station antennas and No of transmittal RF chains for serving M mobile stations (MS), every with No of MS antennas and one RF chain at the MS. This assumption is even since the implementation of user devices is influenced by the requirement for low complexness, cost, and power consumption. On the opposite hand, the BS could have a lot of refined digital signal process (DSP) capability to support multiple coinciding information streams.

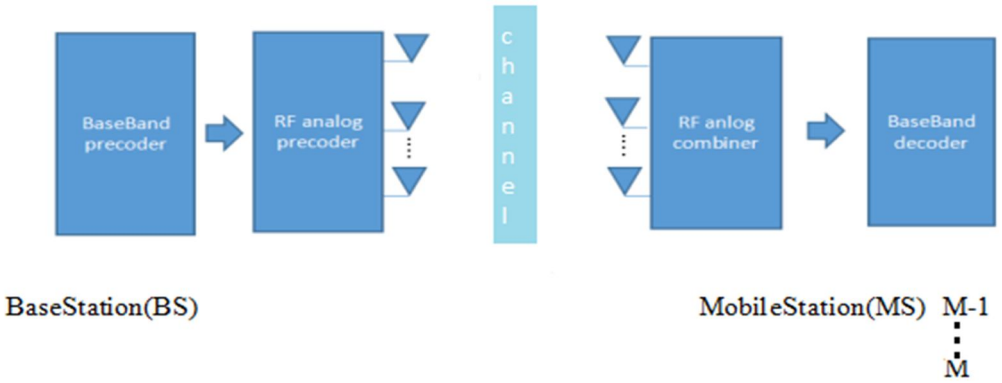


Fig. 1 MU-User MIMO system with Digital/Analog Hybrid precoding using kalman approach.

At the downlink, the base station sends a synchronization message applying both the baseband precoder with the size number of transmitted antenna into number of bits and the analog precoder with the size number of base station antenna into number of transmitted antenna, so that the sampled transmitted signal is x is equal to product of Baseband precoder, RF precoder, No of bits into one transmitted symbol vector (s). For simplicity we adopt a narrowband block fading channel. Then the received signal get the signal along with the Gaussian noise vector. Since the MS employ only RF analog combining after the combining process, the estimated symbol can be formed. On the uplink, the signal model is similar to downlink but the role of the precoders and combiners are exchanged.

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A. *Precoding and Combining with Kalman Formulation*

Kalman filter be a powerful tool that has been exploited for many physical layer applications, like carrier frequency synchronization and part recovery. The Kalman filter may be a wide applied conception in time series analysis employed in fields such as signal process. We tend to next formulate the beamforming/combining downside employing a Kalman filter-based approach. The system design consists of a hybrid analog/digital precoder at the BS, and easy MS devices with RF analog combining solely. The BS sends the preamble messages, and also the calculable signal at the MS represents the observation vector. The Kalman filter formula minimizes the sum-MSE of the coaching vector, outlined because the square distinction between the signal transmitted by the BS on totally different beams and also the calculable signal at the MSs, that's the gathering of all the estimates. Then we tend to formulate the n- th Kalman iteration .We contemplate the baseband precoding matrix of the Kalman filter state, whereas the analog precoder is computed.

B. *Hybrid Precoding Based on Kalman Approach*

In the hybrid multiuser MIMO system, we compute the analog combining matrix for each mobile station and the Hybrid analog and digital precoding RF precoder **F**RF and Base Band **F**BB matrices at the BS.

1) *The Optimization Formulation of Hybrid Precoding Supported Kalman Approach:* We presently aim to vogue the hybrid millimeter Wave precoding matrix through the Kalman-based approach by minimizing the error. The defination of the minimizing error is formed as a results of the minimize of Baseband precoder and RF precoder is developed is adequate error(E) mode sq. of transmitted signal minus calculable signal. The first condition less than equal to P in refers to power constraint, whereas the alternative is to limit the look for the columns of the RF precoder inside a gaggle of L basis vectors . These basis vectors is chosen from the transmit array response vectors at the angle of departure (AoD) of the millimeter Wave channel, below the hypothesis of fantastic AoD knowledge at the transmitter, or from a codebook F of amount RF precoding vectors. The optimization formulation is not include any mind of transmission /estimation. however solely the precoding/combining matrices. Then the gathering of RF combining vector contained in He matrix, that's the equivalent channel matrix is He. They represents the effective downlink channel to Mobile station-mean. The problem is nonconvex because of the multiplication of the variables FRF , FBB, and combining matrix. However, if we have a tendency to tend to tend to repair FRF and combining matrix, we have a tendency to area unit reaching to solve the improvement draw back and calculate FBB. Specifically, we have a tendency to tend to tend to 1st vogue the RF beamforming and mixing matrices then we have a tendency to tend to tend to reckon the digital precoding FBB through the repetitive Kalman procedure.
2) *RF Analog Precoding and RF Analog Combining:* We determine first the RF beamforming/combining matrices for each BS-MS link independently and then continue with the baseband precoding to reduce the multi-user interference. In the first step, the BS and each MS-*m* calculate the RF beamforming and combining vectors, by maximizing the signal power for the MS-*m*.Existing single-user RF beamforming solutions can be used on this purpose in order to design the RF beamforming/combining vectors without explicit channel estimation and maintain a low training overhead. Once the combining vectorsare determined for all MSs, as well as the the analog precoder FRFat the BS, the digital baseband precoder FBB is computed in the Baseband precoding based on kalman approach.
3) *Kalman Baseband Precoding:* At this step, the BS utilizes the effective channels. The each effective channel vector has dimension M × 1, which is much lower than the original channel matrix with size No of mobile station into No of Base Station. Each mobile station -mean uses a codebook to quantize its effective channel output, and sends the index of the quantized channel vector to the Base Station. As the last step, the Base Station designs its Kalman-based digital precoder FBB based on the quantized channels. The sparse mm Wave channels and the narrow beamforming ensure that the effective MIMO channel is well-conditioned. This allows the Kalman-based digital beamforming approach to achieve near-optimal performance as shown in the results in section 3.

III. RESULTS

There are various designs in precoding, while taking into consideration of precoding method we have N number of method like Hybrid tree search, Hybrid MM, MMSE Hybrid Precoding, ZF Precoding this all the methods under the design of precoding method. Day to day we have to move for a new and modified and which is gives a better performance methods. Simulations are performed in Matlab the results are shown below.

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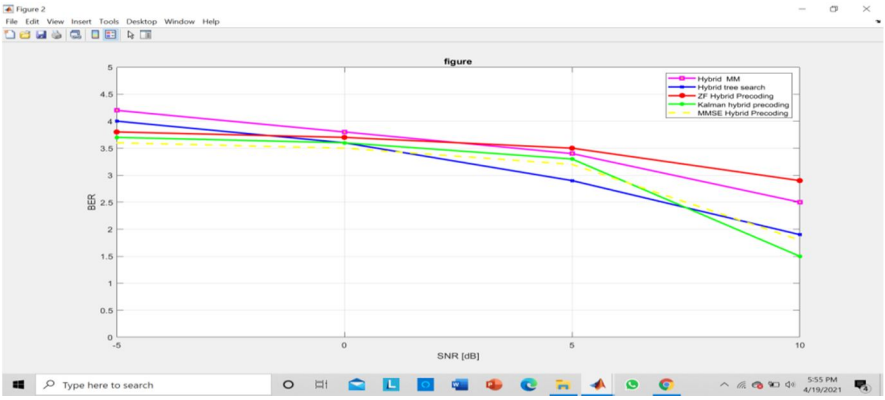


Fig. 2 Simulation results of BER vs SNR

Fig 2 Compares BER performance of different schemes in the simulation results. The schemes are Hybrid tree search method, maximum magnitude (MM), ZF precoding. The proposed Kalman solution shows the best performance compare to existing hybrid solution and the BER evaluation with number of BS antennas is 64, number of MS antennas is 4, number of users is 4.

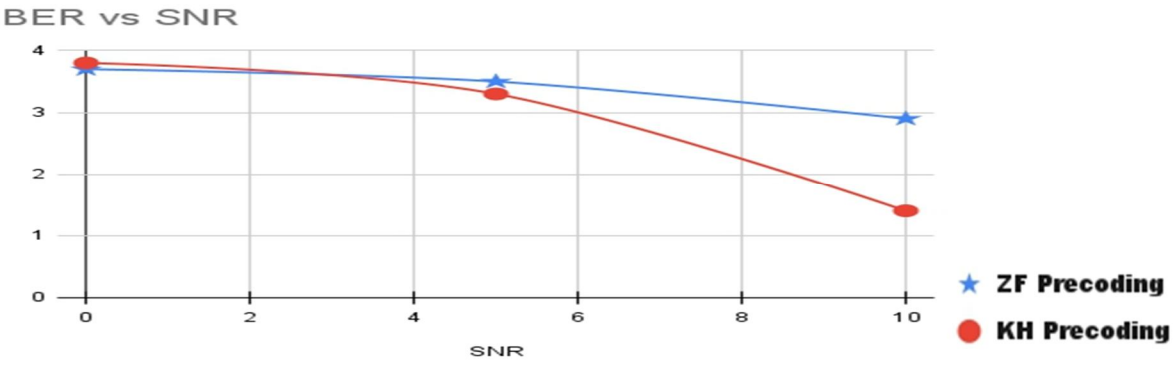


Fig. 3 BER vs SNR

In Figure 3 By the simulation results we compared the proposed Kalman Hybrid Precoding method which gives a better performance compared with existing precoding method such has ZF Precoding in terms of BER.

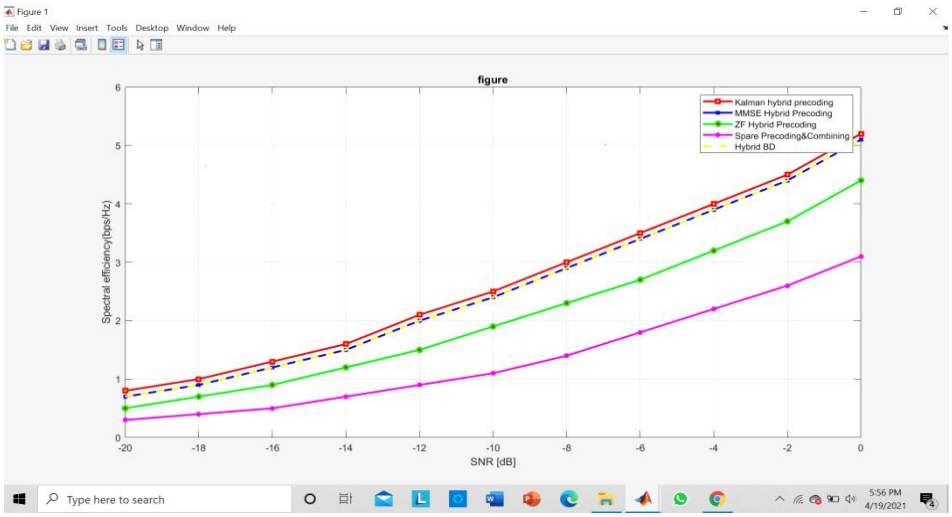


Fig. 4 Simulation results of Spectral efficiency vs SNR

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In Fig 4 The Hybrid Precoding method comparision among the Spectral efficiency varying SNR with no.of Base station antennas is 256, no of MS antennas is 64, no of users *M is* 8. Compares Spectral efficiency performance of different schemes in the simulation results. The different schems are Hybrid tree search method,maximum magnitude (MM) ,sparse precoding and combinig, ZF precoding.

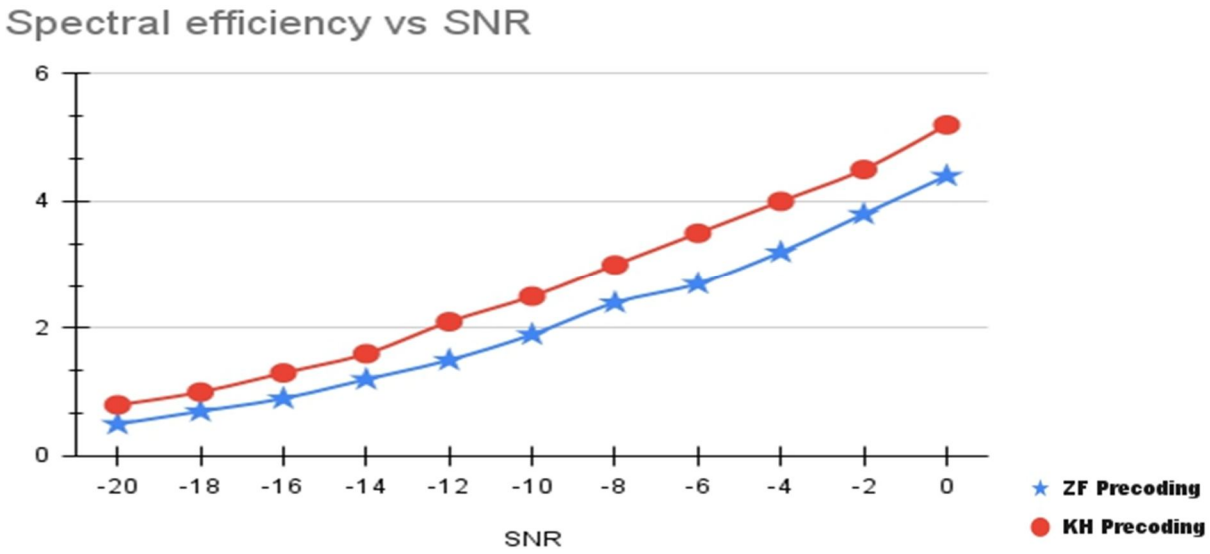


Fig. 5 Spectral efficiency vs SNR

In Fig.5 By the stimulation results we compared the proposed Kalman Hybrid Precoding method which gives a better performance compared with existing precoding method such has ZF Precoding in terms of Spectral eeficiency.

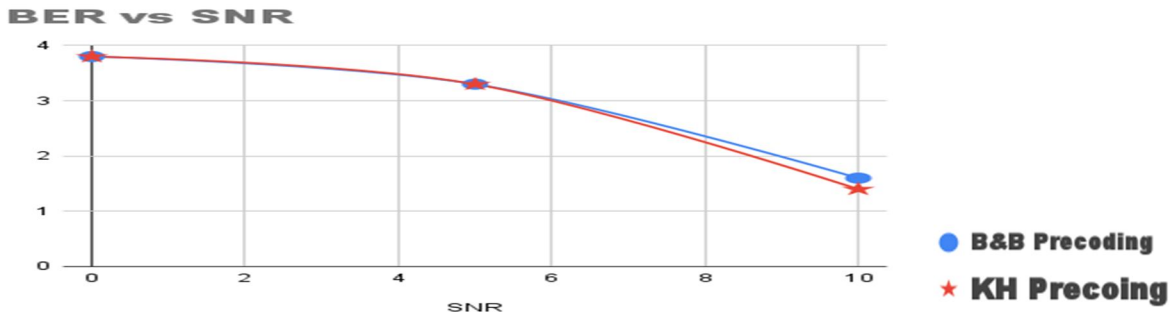


Fig. 6 Comparision of Kalman Hybrid Precoding with existing Branch and Bound Precoding method

In Fig 6 We have compared the method Kalman Hybrid precoding with existing one Branch and Bound precoding method were m=10. By the performance of both simulation we have notice that the proposed method of Kalman Hybrid Precoding method gives a closely best performance with respect to BER vs SNR.

IV. CONCLUSION

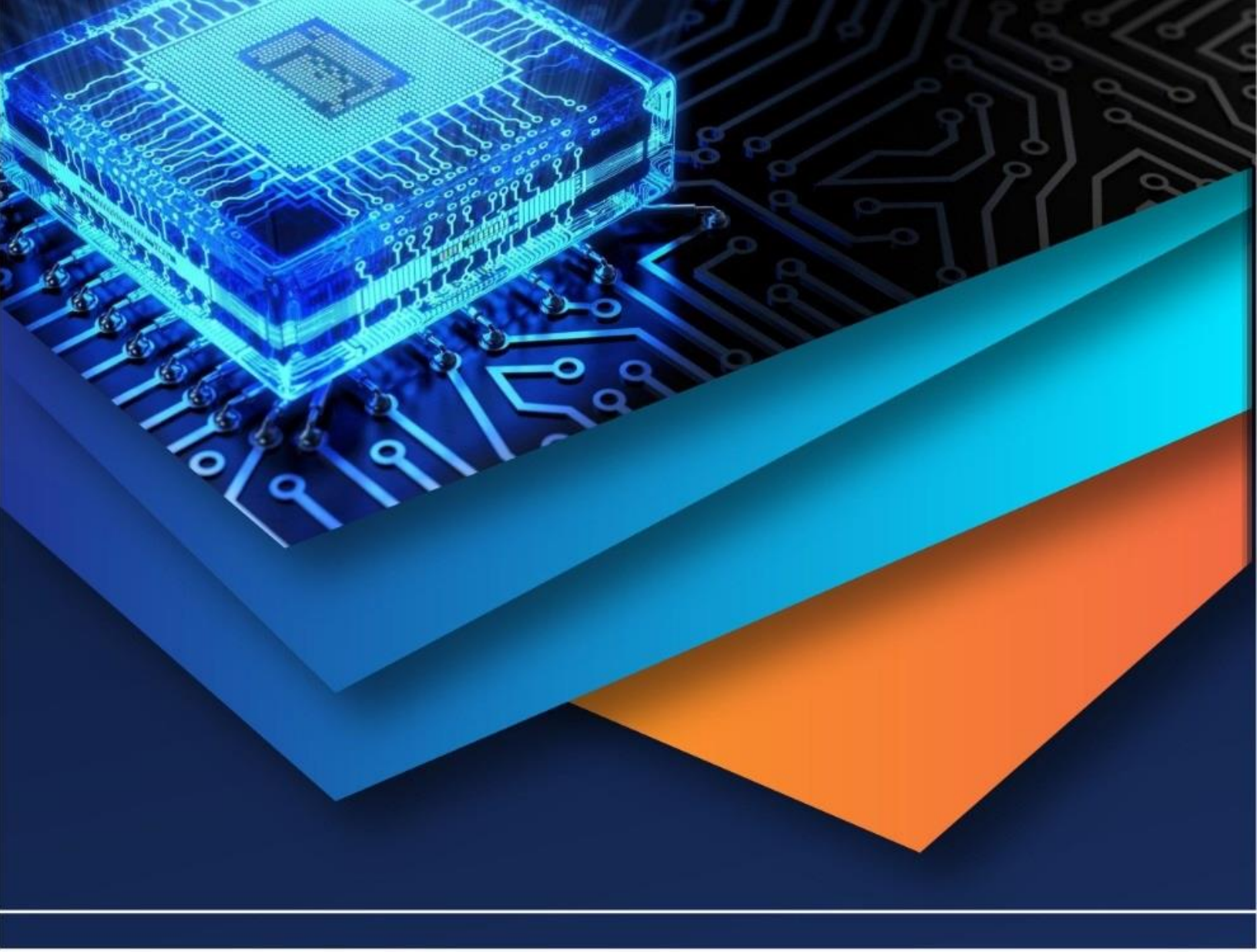
From the simulation results the proposed kalman hybrid precoding gives a best performance compared with existing hybrid solution in terms of BER and Spectral efficiency. The design critertion describes by minimizing the error between the transmitted and estimated data. The method uses a particularly designed formulation of the error, and the approach of kalman procedure is taken out in two steps. The first step perform the RF precoding/combining matrix, and then design the digital baseband precoder at the Base Sation. Simulation results shows the performance in in terms of BER and Spectral efficiency and the proposed method we also compared with Branch and Bound precoding method, Then the proposed method which gives closely best results compared to Branch and Bound method in terms of BER.

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