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Virtual Iterative Precoding Based LTE POMA Channel Estimation Technique in Dynamic Fading Environments

V.Madhu Kumar, T.V.Ramana

Abstract: A method of channel estimation based on antenna characteristics in angular domain is proposed in this paper. The transmitter and receiver antenna characteristics are sampled with finite sampling frequency and finite bandwidth. The physical channel perceived by the system is a filtered channel, causing the physical channel to lose its strength into multiple taps with dominant channel power, which estimate few unknown subcarriers. These taps in physical channel are analogous to virtual in the discrete-time domain perceived by the system, which draws less gains from the antenna sections. By the proposed work, these virtual channels improves the gain and attenuation of signal transmitted through iterative precoders of Long Term Evolution (LTE) transmitters and receivers set of antennas. An analogy of the above proposed precoding technique is drawn with the time-domain Position-orthogonal multiple access (POMA) path channel model through a filtered channel estimation with infinite temporal resolution of the sampled signal. Proposed model improves the performance of LTE communication system with POMA antennas by providing a perfect channel state information (CSI) including spatial precoding and beamforming. The implementation of the proposed model is simulated in a new dynamic mxn tabs fading scenario path. The comparative results shows a better performance than the existing surveyed methods.

Index Terms: LTE, angular domain, virtual, multiple access, fading

I. INTRODUCTION

The presently work relates generally to LTE communication systems, especially to model the channel to improve the capacity gain of a *massive*-multiple-input and multiple-output (*massive*-MIMO) channel through POMA system. With the existing MIMO channel, the use of correlated POMA system reduces the scattering of antennas by spreading the space between them and improves the representation of channels to provide accurate description of channel behaviour. In conventional channel estimation the modeling of channel is done in array domain ie., antenna-to-antenna channel gains, the channel behaviour is carried between transmit-receive antenna pair and the array-domain model through channel matrix. However these are inaccurate in representing the LTE communication channel, in reality the result analysis is not valid. The modeling of these: channel estimation, channel behaviour and array-domain model, need a larger degree of channel model governed by the number of virtual clusters, each results from scatters and reflectors, in the channel, here each virtual cluster iterates the gain through dynamic bandwidth of the signal transmitted and received to a particular angle of elevation, regardless of the number of antennas employed and hence an accurate improvement in capacity gain with fewer channel matrix elements.

The proposed work provides a method to model the virtual iterative clusters instead of physical, to improve the channel estimation in angular domain with multiple antennas, reflecting the desired antenna pattern in time-domain multi-path channelling, by blind estimating the radiation patterns of POMA antennas with zero-forcing modulation to introduce noise amplification and Omni-directional antenna system is simulated to analyse the statistics of the fading environments.

In this paper, a Virtual Iterative Precoding (*v.i.p*) is proposed to improve the precoder performance and a Channel Estimation Technique (*c.e.t*) is introduced to establish a new channel model in LTE system through simulation. This paper is organized as follows: Section 2 briefly reviews the related LTE and Section 3 introduces the proposed model. In Section 4 present experimental results and discussions and Section 5 concludes the paper.

II. RELATED WORKS

In this section, surveyed research work on LTE is presented. Research in MIMO has widen [1] the LTE works in to vast implementation to deal with the challenges in communication systems [2]. For high gain and high spatial multiplexing gains, to reach optimal performance [1], zero-forcing (ZF) and minimum mean square error (MMSE) methods are used. To achieve this, in these methods, a large number of antennas are used at the base station, results in excessive hardware cost. The large number of antennas exploit multiple antenna systems, using radio frequency (RF) chains at the precoder stage through digital-to-analog (D/A) converters, mixers, and power amplifiers to improve the gain and beam width of array signals. These multiple arrays form *massive*-MIMO structures causing the variables RF phase shifters and RF chains to improve the gain and reduce the cost of the precoders design. RF phase shifters are exploited as phase-only [3], to control the phases of traditional precoders, the introduction of hybrid precoding scheme have changed the RF precoding to implement the spectral efficiency of single-antenna for *massive*-MIMO systems. Simplified transmit precoding/receive combining design is performed, with these hybrid methods are further implemented [4] and [5] in millimetre wave (mmWave) MIMO systems through orthogonal matching pursuit to optimize the SVD (singular value decomposition). To reduce the searching complexity in [5], a [6] greedy precoding method is proposed to searching complexity is reduced. To reduce the number of RF chains [7] has introduced a limited feedback hybrid precoding and number of phase shifters are reduced in [8] to limit the interference cancellation. For multiple users situation orthogonal channel is correlated to result a finite dimensional channel model, but obtained a poor scattering channel environment compared to [9], obtaining low path loss at high frequency, even in spatially correlated *massive*-MIMO systems. However these do not consider the hybrid precoders under fully structured to improve the capacity performance in the large antenna systems.

Spatially correlated and multiplexed MIMO systems with deterministic line-of-sight (LoS) path and a stochastic non-line-of-sight (NLoS) component. *massive*-MIMO reforms in time-division duplex (TDD) mode and attains CSI by up-link (UL) pilot signaling and estimators of channel parameters [10], correlates with down-link (DL) transmit precoding. Through channel estimates, spectral efficiency (SE) can be improved through either spatially uncorrelated [11] or spatially correlated [10], [12] Rayleigh fading channels. These fading characteristics are analysed in [13], were derived in UL and DL SE for single-cell analysis. However the fading characteristics SE is uncorrelated and having scattering clusters.

Despite the above limitations, *massive*-MIMO systems have new challenges in high-resolution analog-to-digital convertors (ADCs) in precoders. At millimeter wave (mmWave) [14], [15] frequency band these challenges becomes more severe under large bandwidths [16], causing high absorption of the antennas signal. Steering antenna designs [17] are introduced to limit these challenges. However the quantization of ADCs degrades the channel estimation performance among the quantization schemes.

This paper provides a way to POMA *c.e.t*, to model the MIMO systems to large in angular domain, by incorporating radiation patterns of the transmitter and receiver antenna in a iterative channel. Proposed technique refers to gain and bandwidth, estimating the antenna patterns through virtual clusters, result in low attenuation of the antenna signals, making channel estimation to improve.

v.i.p is introduced in this paper and compared with quantized feedback technique [16], Weighted-Graph-Coloring [17] for analysis, by proposing a angular-domain channel estimation, by adopting POMA as the main design. The *v.i.p* can be applied to inaccurate channel models in any dynamic fading environments.

III. PROPOSED LTE POMA CHANNEL ESTIMATION TECHNIQUE

In this section, the addressed problem solutions through proposed model is illustrated. *v.i.p* based on virtual clusters allows high gain and high bandwidth of the MIMO system for multi-antenna system through POMA structure. This paper access the SE and gain on the problems stated for different precoders techniques.

A. Contributions

In this paper, improvements in LTE channel estimation through *v.i.p* design in MIMO based POMA structure is performed. The proposed LTE *c.e.t* enhance the RF precoders by adopting virtual clusters, which helps hybrid precoder limitations to eliminate. So far the RF phase shifters and RF chains are in implementation with hybrid precoders, proposed technique through *v.i.p* design overcome and replace the MIMO RF chain antenna structure with POMA offering good improvement in SE, gain and bandwidth of LTE antenna arrays. Proposed work contributions towards the LTE system are summarized below:

a) For virtual clusters design, the beam of each antenna is scattered and reflected with an angle of departure, having a dependence among the pair-wise gains of each transmitter and receiver. The number of virtual clusters is limited to virtual channel created and antennas are designed independent to improve the channel estimation. This design alternatively reduces the number of antennas employed in-turn reduces channel matrix elements.
b) *v.i.p* is introduced through space frequency coding system, by transmitting the training sequence through a window tap, each window tap is performed with Least Squares (LS) method, known sequence is iterated at a time while the unknown sequence is iterated during the non-idle state of channel diagonal matrix elements. This design reduces the idle time of the beam and causing a narrow high gain beam formation.
c) *c.e.t* is proposed through iterative channel matrix for angular domain in a linear antenna array to develop virtual iterative RF structures. This technique is used as initial channel estimator and being iterative reduces the channel power by extracting the channel data instantaneously.
d) For LTE POMA, a fully-structured hybrid precoder is designed, to overcome the number of RF section limitations in hybrid precoder in every iterative positioned channel. This POMA structure enhances the MIMO antenna structures through narrow beam formation by improving the antenna gains.
e) With the proposed work, precoder design through LTE POMA technique is simulated by taking advantage of MATLAB simulation environment in dynamic Rayleigh fading environments with 8x8 tabs.

Thus, proposed precoder technique simulation results establish the effective usage of MIMO based POMA technique applicable in antenna based interference channels to reduce the overlapping of beam angle-of-departure and angle-of-arrivals.

B. Problem Formulation

Angular domain model includes radiation pattern, antenna characteristics and angular directions, formulated as:

$$e_{xy} = e_x\left(\frac{(0,2\pi](y-1)}{S}\right) \tag{1}$$

where e_{xy} is the channel y^{-th} signal of $e_{xy}(\theta)$, $e_{xy}(\theta)$ is the antenna radiation pattern of the x^{-th} element and S is the signal samples acquired at the antenna elements. To improve the radiation pattern of the antenna elements, Eq.(1) has to model using power-angle-matrix channel, whose $(x,y)^{-th}$ element represent the antenna channel power from the y^{-th} transmit beam to the x^{-th} receive beam, which draws a constant channel estimation profile.

The fully-structured precoder is formulated as:

$$\underset{P_{RF},P_{BB}=\sum_{k=0}^{K-1}}{minimize} \quad \left|\left|P^k{}_{opt} - P_{RF}P_{BB}^{H}{}^{k} \quad \right|\right|_P^2 \tag{2}$$

$$subject\ to \begin{cases} F_{RF} \in A \\ \left\|P_{RF}P_{BB}^{H}{}^{k} \quad \right\|_P^2 = N_s \end{cases}$$

where P_{RF} and P_{BB} are the POMA precoder RF and baseband chains, k is the antenna elements, P_{opt} is the position optimisation parameter, p represents the number of positions F_{RF} is the RF sections of partial structures and Ns is the non-zero singular values. To improve the position of MIMO precoder variation, Eq.(2) has to model the precoder to modify both the amplitudes and phases of complex symbols and to control phases of the RF channel elements, to draw large antenna array gains by the *massive*-MIMO antenna systems.

For channel estimation, the received signal at x^{-th} receive antenna is formulated as:

$$r_{x,c} = \sum_{z=1}^{m} \frac{f_{x,y,c} p_{y,c}}{t_{y,c}} + G_{x,c} \quad (3)$$

where $f_{x,y,c}$ is the frequency response, channel subcarrier is c, x and y are the transmit and receive antenna and $G_{x,c}$ represents Gaussian mixture noise with mean=0 and variance= $\sigma_n^2/2$ per antenna element length. Eq.(3) has to model the received stream as a liner combination of transmitted stream by iterating the pilot symbols by masking the non-iterative stream too zero and use of preamble structure to track the speed of received symbols at channel order sequence.

C. *Virtual Iterative Precoding*

To improve Eq.(2), perform positioned RF precoding according to:

$$P_{RF} = P_{RF(x,y)} = \frac{1}{\sqrt[y]{N_r} * \sqrt[x]{N_t}} e^{j\varphi_{x,y}} \quad (4)$$

where $j\varphi_{x,y}$ is the RF chain phase of the (x,y) antenna elements, N is the number of antennas and r and t are the receive and transmit antenna. Here the perfect channel estimation through hybrid structure and by the selection of frequency are made with low-dimensional virtual iterations as:

$$V = P_{opt}^{H} (P_{RF} P_{BB}^{H})^{-1} \Delta \quad (5)$$

where Δ is channel matrix representing diagonal antenna position values. With the virtual iteration scheme, to support continuous symbol streams, to reduce the RF chains hardware complexity, where positioned RF shifters and chains are needed to adjust the amplitudes and phases of complex symbols, as compared to N_t required hybrid precoders is to be replaced by the full-dimensional *v.i.p*.

In practical implementations, the RF phase shifters are quantized with variable phase shifters according to

$$P_{RF} \int_{p}^{2} \varphi_{x,y} = arg \underset{\varphi \epsilon \{0,..,2^b-1\}}{min} \left| F_{RF} \varphi^{p} \frac{\Delta P_{RF}}{\Delta P_{BB}} - \frac{(0,2\pi n]}{2^b} \right|_{p}^{2} \quad (6)$$

where p is the antenna position, b is the symbol stream n is the number of phase entries for each position iteration and $F_{RF}\varphi^{p}$ is the unquantized position phase obtained from virtual iterations to control the RF channel phases and improve the antenna array gains. Thus the *v.i.p* is computed by Eq.(6) with the quantized P_{RF}.

Eq.(6) with Eq.(1) domain is modelled as:

$$P_{RF} \int_{p}^{2} e_{x,y} = \left| G_{x,c} \delta^{p} \frac{\Delta A_t}{\Delta A_r} - \sum_{b=1}^{M} e_x(\varphi) f_{x,y,c} \right|_{p}^{2} \quad (7)$$

where $G_{x,c} \delta^{p} \frac{\Delta A_t}{\Delta A_r}$ is the power-angle-matrix channel model, here At is transmitter antenna pattern matrix, Ar is receiver antenna pattern matrix, δ is power-angle-iteration matrix, where (x,y)$^{-th}$ represents the channel powers. Thus the power-angle-matrix channel approach draws a constant channel estimation profile through Eq.(7).

The drawn channel matrix Eq.(7) is estimated through Eq.(3) is modelled as:

$$T_{data} = \frac{SP \left| P_{RF_p}[z] \right|^2}{SP \sum \left| P_{RF_p}[z] \right|^2 + \frac{\Delta P_{RF}}{\Delta P_{BB}}} \quad (8)$$

where T_{data} is the transmitted pilot symbol data and SP is signal power. From Eq.(8) the received data is represented as:

$$P_{RF} \int_{p}^{2} r_{x,y,c} = \sum_{p}^{2} SP \left| P_{RF_p}[z] \right|^2 + \left| r_{x,c}{}^{p} \frac{\Delta A_t}{\Delta A_r} - \right.$$
$$b{=}1Mex(\varphi)fx{,}y{,}cp2{+}Tdata \quad (9)$$

where R.H.S of Eq.(9) represented as l+m+n, denoting l as the linear combination of transmitted stream power, m as channel preamble estimators and n as pilot symbols in an iterative order scheme, representing the POMA *c.e.t.*

With the virtual iteration of channel estimation, solution to Eq.(1), Eq.(2) and Eq.(3) is presented in this section. Simulation results are provided in this paper to support the above, by demonstrating the efficiency of POMA, compared with surveyed estimators, Eq.(9) is characterised in dynamic fading environments through simulation, shown in Section 4.

IV. SIMULATION RESULTS AND COMPARISON

In this section, simulation results are presented to verify the precoder design. Data streams are sent from a transmitter with Nt=200 to a receiver with Nr=50 antennas, with the channel parameters N_{cl}=8 clusters, number of rays N_{ray}=15 rays, the average power of each cluster is 1, the azimuth and elevation angles of departure and arrival is 10 degrees, the antenna spacing is 0.25 wavelength, and the distribution is [0, 2π).

The simulation was developed using the MatLab in order to implement proposed technique, applying calculations of gain, the services to users in the area under study. The process of developing the simulation based on the objectives:

i. Analysis of Relay Antennas
ii. Analysis of Resolution
iii. Analysis of Rate gap
iv. Analysis of Cumulative Distribution Function (CDF)

A. *Numerical Comparisons*

This work investigates the following evaluations comparatively, with the number of RF chains is equal to the data streams i.e., $N^{t}_{RF}=N^{r}_{RF}=N_s$.

B. *Relay Antennas*

In this case, as shown in figure 1 and figure 2, the proposed exact and analytical result achieves significant higher sum achievable rate than the existing Monte-Carlo work as in [16] and [17]. On the performance, proposed precoder achieves good performance over the exact and approximate range considered.

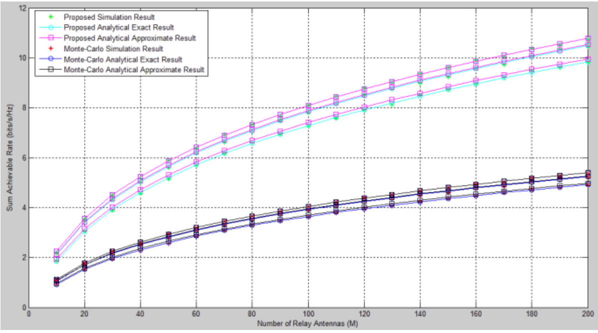

Figure 1: Sum Achievable Rate vs Number of Relay Antennas to illustrate the performance of analytical analysis in Rayleigh fading with 8x8 tabs.

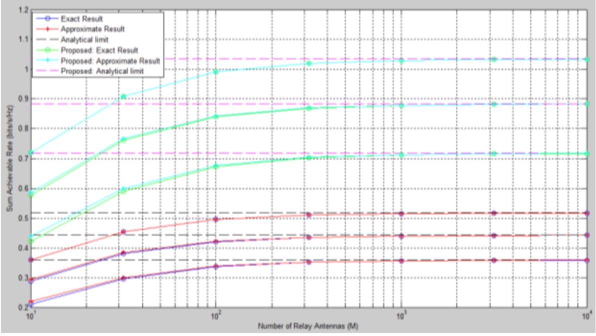

Figure 2: Sum Achievable Rate vs Number of Relay Antennas to illustrate the performance of approximate results in Rayleigh fading with 8x8 tabs.

C. Resolution

With the quantization bits set to 11, the energy efficiency is around 1.6 Mbits per J, the M_o varies 0 to 128. The analysis has taken for low resolution and precoder energy consumption is calculated as in [16] and [17]. Figure 3 shows the simulation of quantization bits with energy efficiency, Figure 4 shows the simulation of AoD quantization bits with Per-user rate.

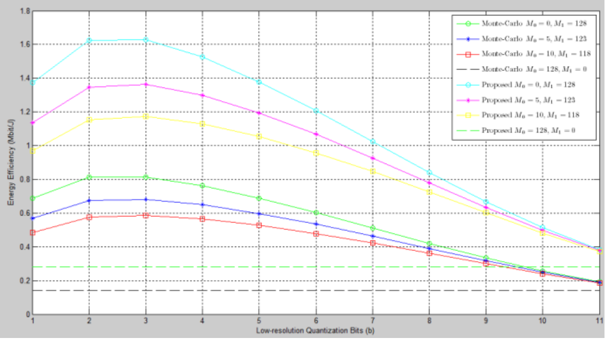

Figure 3: The simulation of precoder energy efficiency with number of quantization bits through proposed precoder technique.

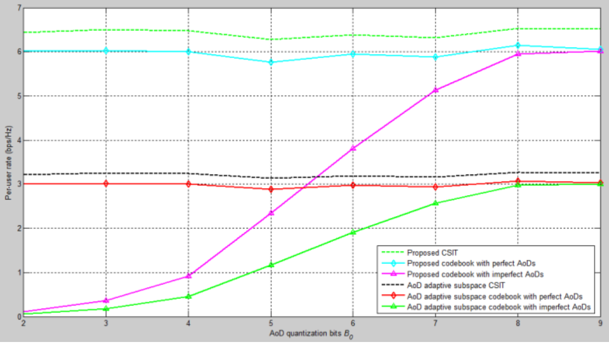

Figure 4: The simulation of AoD quantization bits with different Per-user rate through proposed precoder technique.

D. Rate gap

To evaluate the rate gap of proposed POMA technique, considered three types of constraints for the system design, they are analog and, digital channel feedback and BS antennas as in [16] and [17]. Figure 5 and figure 6 shows the rate gap simulation among proposed and [17], between analog and digital channels for a single cell system. It is observed from the figures that, the rate gap is more in simulation and theoretical analysis.

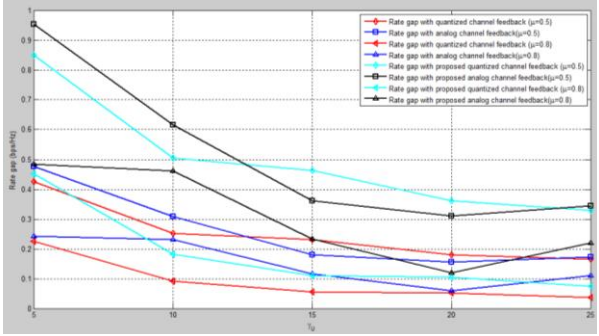

Figure:5: The rate gap with analog and digital channel analysis for channel feedback in Rayleigh fading with 8x8 tabs.

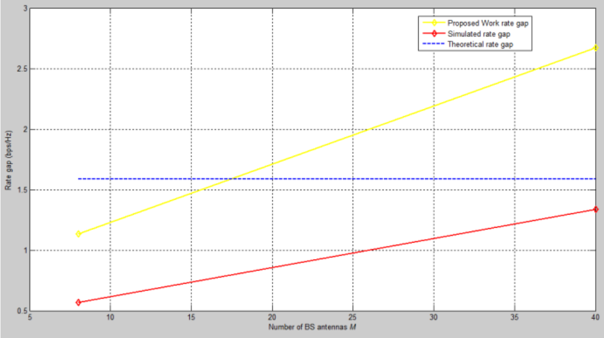

Figure:6: The rate gap with analog and digital channel analysis for BS antennas

E. CDF

As comparison, POMA under achievable rates, WIG-PD scheme is analysed as in [16] and [17]. It is shown in figure 7, proposed POMA technique is even CDF achieving under maximum achievable rate and have achieved performance in user UL transmission rate.

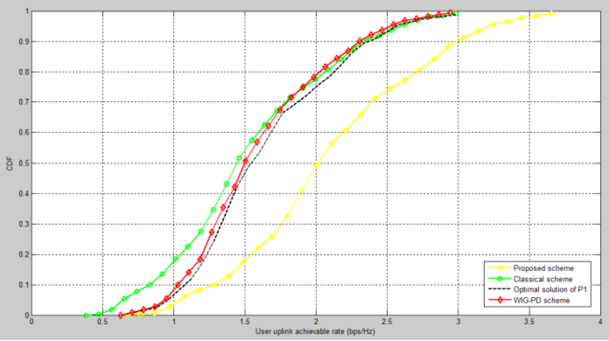

Figure:7: User UL achievable rate and its CDF value analogues to WIG-PD scheme in Rayleigh fading with 8x8 tabs.

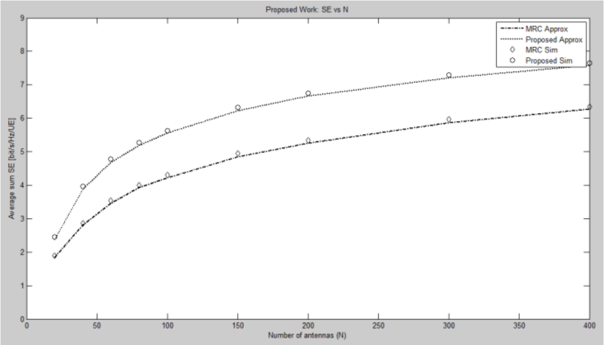

Figure 8: Proposed technique SE variation with the number of BS antennas in Rayleigh fading with 8x8 tabs.

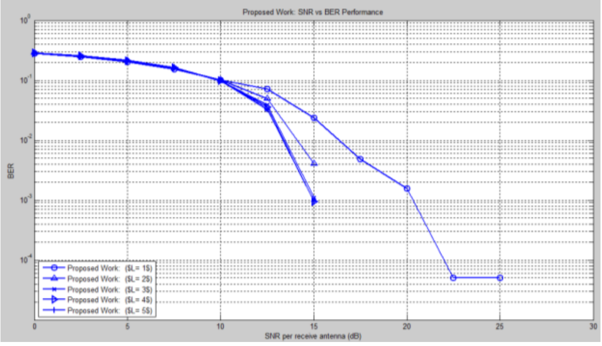

Figure 9: Proposed work SNR performance for varying BER values in Rayleigh fading with *8x8* tabs.

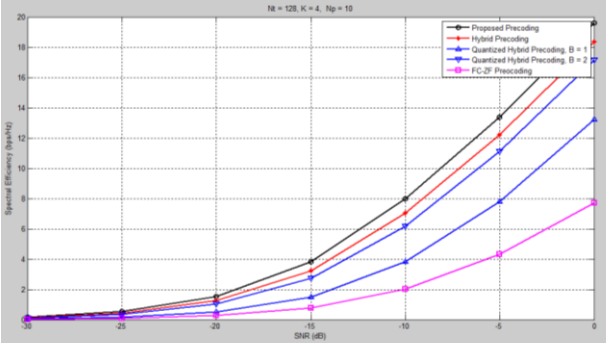

Figure 10: Proposed SNR values with its SE among other hybrid precoding methods in Rayleigh fading with 8x8 tabs.

Figure 8 and figure 9 compares SE variations under proposed POMA technique with the same channel parameters. Compared proposed technique with studies Hybrid precoding [4], Quantized Hybrid Precoding [16] and FC-ZF Precoding [1], through the same SE values applicable to both uplink and downlink is illustrated in figure 10. From the results, the proposed POMA *c.e.t* performs better compare to survey techniques by improving the performance in attenuation and gain for resource allocation.

V. CONCLUSIONS

In this paper, proposed precoder is simulated under practical RF shifters. This paper proposed an approach to MIMO technique, with low-complex POMA system. On the LTE system, the POMA RF precoder is designed, in this paper *v.i.p* is designed for hybrid precoder in *massive*-MIMO systems through POMA. The following important conclusions have been drawn with regard to the proposed work.

1. An angular-domain modelling method for LTE communication system is proposed.
2. For precoding, this paper has proposed *v.i.p* technique to improve the resolution of ADCs.
3. The analysis of signal along antenna arrays under in Rayleigh fading are made through clusters.
4. Demonstrated channel estimation mathematical analysis reduces the cost of hardware requirements and increases the gain of the LTE system.

Finally, *v.i.p* performance has been analysed in a closed form and simulated in dynamic fading environment and mmWave channels. Comparative results show the *v.i.p* is a variable quantized scheme and the SNR, BER and SE results are still better than the surveyed precoding schemes.

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AUTHORS PROFILE

T. Venkata Ramana, as a diligent scholar has excelled in studies from his child hood. His dare to dream, to work smart and strive for nothing less than excellence and to enjoy the journey every step of the way made him to scale greater heights. He has obtained his Bachelor's Degree in Electronics & Communications Engineering from Nagarjuna University. He has completed his Masters in Systems and Control Engineering from Osmania University. He has completed his Doctoral program Ph.D. in the area Satellite Communications from the Andhra University. He took up academic pursuit and served in an array of designations like Associate professor & Coordinator for M. Tech (Evening programs) of GITAM University. He also involved himself in teaching and research tasks. Above all he took up a mission to ignite the young minds so as to nurture the students with the potential to reach greater horizons.

V.Madhu Kumar, is a Research Scholar at GITAM University , Visakhapatnam and currently working as Assistant Professor in JITS (Autonomous), Narsampet, Warangal. He has completed his Masters in DSCE from JNTU Hyderabad. He is the Member of IEEE and Life Member of ISTE. His research area are Wireless Communication and Signal Process-ing. His research topics are published in several National & International Journals.

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