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HEXAGONAL LENSES WITH BEAMSPACE MILLIMETRE WAVE MASSIVE MIMO

Haitham Al Fatli and NorshidahKatiran
Faculty of Electrical and Electronic Engineering, Wireless and Radio Science Center, Universiti Tun Hussein Onn Malaysia Parit Raja, Batu Pahat, Johor, Malaysia
E-Mail: haithamalfatli@gmail.com

ABSTRACT

In this paper, we propose using a Hexagonal lens with Massive beamspace MIMO. It can significantly reduce the number of the (RF) chains, which leads to reduce the energy of the Radiofrequency. The proposed expected for future wireless communication systems. Therefore, we required channel links without loss of performance in the system. In this research, we discuss the Loss of energy from the beam problem. There is an essential issue in this paper to discuss; which is the angle of departures (AoD) for channel paths cannot precisely map on spatial specimen points. Consequently, it degrades the sum rate and energy efficiency of the system. We present the deploying energy-efficient for phase shifter and zero-forcing (EE-PS-ZF). To get a more efficient performance EE and SE, by use in mm Wave Massive MIMO and support by the Hexagonal lens antennas array. The benefit of PS is that it uses a phase shifter to the transformer. Which it can choose various beams by applying a single, but, in traditional precoder, each can choose only one pole. Simulation results show that proposed algorithms perform better by developing method spectral and energy efficiency as opposed to conventional algorithms. The effects also prove this proposed systematic formulation is better than the traditional method.

Keywords: hexagonal lenses, mm wave, RF chain, ZF, and PS.

INTRODUCTION

However, these methods are designed principally to any few numbers regarding antennas [1] [2]. We can consider the Massive MIMO and mmWave is the benchmark technology for the wireless communication network in the future [3]. The first face in this technology, for example, the Bandwidth(BW), is significant. The reason, providing more amount of transmission and data rate increases to energy efficiency (EE).Furthermore, it is appropriate for different cellular networks such as microcell, picocell. Due to these properties, it had got more attention from the industrial communities and also from the researchers [4]. The main challenging is the rapid increase in the application of different devices such as in smartphones, notebooks which there require higher mobile data traffic. It is possible to go beyond the new devices to 50 billion such as IoT, cloud sensors from the different surveys which stated In more research. Therefore if we look in the existing technology, Are not enough for a high increase demand of 1000 X in data traffic in the future [5]. Therefore to solve this problem is proposed to use the concept of massive MIMO with the mm-Wave, which uses spectrum range between 30-300GHz [3] [4]. The spectrums used by incorporating mm-Wave, which underutilised with massive MIMO technology. Therefore the system performance can be much better. However, the problem of concern for this proposed. Any antenna in the system needs to own dedicated RF_{ch}. That leads to consuming more energy. The spectrums used by incorporating mm-Wave, which underutilised with massive MIMO technology. Therefore we can get system performance much better. Any antenna in the system needs to own dedicated RF_{CH}. That leads to an increase in budget requirements and consuming more energy. Therefore this problem leads to degrades energy efficiency and throughput system. Merge beamspace with MIMO This proposal mentioned in different researches which merge the energy for channel beams on different antennas. Therefore we can change the conventional spatial channel into the beamspace channel.In Figure-1. Show transformation of a conventional path Passes through the Hexagonal Lens antenna array and beamspace MIMO.

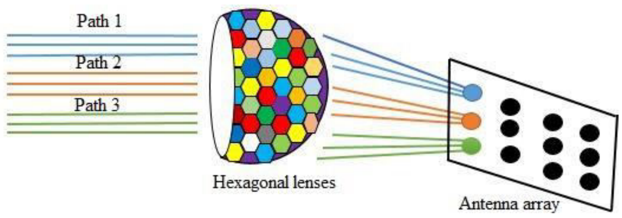

Figure-1. Beamspace MIMO hexagonal lens antenna array for energy concentration.

We used the beamspace technique to reduce the required number of RF_{ch} because the properties of mm Wave channels are limited, dispersed, and for this reason, it shows a beamspace channel dispersed structure installation. That led to display beamspace channel in sparse installation, which is the fundamental RF_{ch} Reduction. So the existing research does not work on loss energy, which leads to deterioration of the system performance. That because the Hexagonal Lens antenna array has a different spatial point (SP), [6] but the angle of departure (AoD) is distributed continuously for various channel paths. That means that AoD channel paths cannot be precisely mapped to the SP, resulting in the inevitable power of one beam in different other beams, respectively. The author papers [7] [8] rely on traditional encoding of the MIMO beam distance. Each beam is chosen for a single path, making a one-to-one agreement [7]. Therefore, the smaller fraction from the channel energy package is managed, which means a significant SNR loss. That is an undesirable but straightforward idea for this problem is to deploy radio frequencies that can receive single channel path loss energy [9]. This method can certainly eliminate the problem of loss. But it requires a large number of radio frequencies because each antenna in the mm Wave Massive MIMO system requires its own RF_{ch}, which significantly increases power consumption requirements and system complexity. We propose a new approach to deploy an energy-saving phase switching (PS), and zero effect (ZF) to overcome the problem of lost energy and increase spectral and system efficiency. The main difference in the proposed and conventional algorithms is that the proposed PS uses phase converters (PSs) that can select multiple beams for a single RF_{ch} radio that can receive most of the loss beam power, whereas a conventional scheme can only select one beam per RF_{ch}.Therefore, this proposed using to perform the ZF coding to improve an SNR and EE of the system as well as the PS. The Simulation results showed. That the proposed can efficiently improve an energy loss problem in the mm Wave MIMO package to achieve optimal amount sum rate and EE, sequentially. The results showed that the suggested charts could achieve much better performance than traditional mark-up charts. This remaining paper organised as follows: Section II describes the model of the proposed system described in the analytical formulation. The simulation results presented in section III. Section IV concludes the paper.

SYSTEM MODEL

In this paper, we focus on to use massive beamspace MIMO with amm Wave frequency when the base station (BS) provides, a large number of an antenna array. The BS has associated with several amounts of hexagonal lenses, which cover the overall shape of the lens. The hexagonal lenses are mead from glass or polyethene material. At the same time, the system considered using several numbers of RF_{ch}which serves several numbers of users. We present y as signal vectors of the received, and y ∈ $\mathbb{C}^{Kx1}$ as received signal vectors for all k users. We can express this relationship.

y=H̃^H x+n (1)

Where

Beam space channel matrix denotes are$\widetilde{H} = [\widetilde{h1}, \widetilde{h2}, \widetilde{h3}, ... \widetilde{hk}] \in \mathbb{C}^{NxK}$, in BSthe transmitted signal indicated $x \in \mathbb{C}^{Nx1}$ for all the user K, also in BS the channel beamspace among all the user k_{th} are denotes$\tilde{h}_k \in \mathbb{C}^{Nx1}$. Finally the noise vector following distribution $\mathbb{C}N(0, \sigma^2 I_k)$and k_{th} user, $n \in \mathbb{C}^{kx1}$ $where\ \sigma^2$Noise energy. To energy constraint criterion, the condition: $\|\times\| \leq E_T$, is a matrix of order N x N the rows at the BS the total maximum transmitted energy can be express E_T. The hexagonal lens antenna as a unitary place discrete Fourier transform (DFT) the Non-orthogonal steering vector can express as:

$$\cup = \left[a(\widetilde{\Phi 1}), a(\widetilde{\Phi 2}), a(\widetilde{\Phi 3}), \ldots, a(\widetilde{\Phi N})\right]^H \quad (2)$$

If the vector array steering spatial direction is,$a(\Phi) \in \mathbb{C}^{N\times 1}$ which is obtain from

$$\widetilde{\Phi\iota} = \frac{1}{\sqrt{N}}[\mathrm{i} - \frac{N+1}{2}] \quad (3)$$

If the (i = 0, 1, 2…. N) Is a group of the indicator which covering all the space. We can expect the relationship among a beamspace and the spatial channel matrix by

$$\widetilde{H} = UH = Uh_{1,}Uh_2, \ldots, Uh_k = \left[\tilde{h}_1, \tilde{h}_2, \ldots \ldots \tilde{h}_k\right] \quad (4)$$

Where,$h_k \in \mathbb{C}^{N\times 1}$,$k_{th}$ user spatial channel vector.

MM WAVE SPATIAL CHANNEL MODEL

We first review the deployed for the proposed mm Wave channel model by using the Saleh Valenzuela channel model of which used for this purpose [10]. We can be expressed of the conventional spatial channel by:

$$h_k = \sqrt{\frac{N_{uk}}{N_{cl}^k N_p^{(k,l)}}} \sum_{l=0}^{N_{cl}^k} \sum_{l=0}^{N_p^{(k,l)}} ß_{k,l}^i \ a(\Phi_{k,l}^i) \quad (5)$$

Where the large scale fading factor is theu_k of the k_{th} user, the number of clusters for the k_{th} user is the N_{cl}^k, the number of paths within the l_{th} cluster of the k_{th} user is $N_p^{(k,l)}$, the complex gain for the i_{th} way in the l_{th} cluster of the k_{th}user is $ß_{k,l}^i$, is the angle of departure (AoD) to the i_{th} path on l_{th} cluster of k_{th}user is $\Phi_{k,l}^i$, which distributed within a particular cluster for all *I* as:

$$\left[\Phi_{k,l} - \frac{\tau_{k,l}}{2}, \Phi_{k,l} + \frac{\tau_{k,l}}{2}\right] \quad (6)$$

Than the average angular spread and is the average AoD in the l_{th} cluster of the k_{th} respectively is the$\Phi_{k,l}$. We can be obtained of the steering vector when considering to the N model antenna elements uniform linear array (ULA) by:

$$\alpha(\Phi) = \frac{1}{\sqrt{N}}[e^{-j2\pi\Phi m}] \mathrm{m} \epsilon I(N)$$

Where$I(N) = \left[l - \frac{N-1}{2}, l = 0,1,2, \ldots, \mathrm{N} - 1\right]$ this set for pointers of Φ corresponding set centred around zero there is the spatial direction which it an acquired by$\Phi = \frac{d}{\lambda} sin\theta$the signal physical direction is a θ; the wavelength of the signal is a λ. And the separation or spacing of antenna elements is a d which satisfy half-wave condition ($d = \frac{\lambda}{2}$) at the proposed mm-wave frequencies.

LOSS OF ENERGY PROBLEM

Some problems are facing the hexagonal lens antenna array, such as losing the energy in beamspace

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MIMO. While in the case of the current channel path, AoD distribution is automatic and continuous. Therefore, by AoD method of one channel [11]. We cannot determine the goal accurately by use SP. That leads to loss of the energy for one channel beam to set of channel beams, which causes deterioration performance of the system. Besides that, the energy loss for the multiple paths, it is overlaid on a narrow range of $[\Phi_{k,l} - \frac{\tau_{k,l}}{2}, \Phi_{k,l} + \frac{\tau_{k,l}}{2}]$ and that lead to an increase in the problem of losing energy, we can illustrate that in Figure-2. There is no loss of energy in Figure-2(a), because there is an accurate diagram of the AoD and the lens with SP. But in Figure-2(b) there is worst loss energy because a path of AoD Located in the middle of two from SP. Therefor in Figure-2(c) we can see the slight loss of energy when a minor mismatch occurs between the AoD path and SP. From the results of this study, we determine the loss of energy quantum. Therefore, the single path was being a consideration of the worst loss of energy in Figure-2(b). Therefore, we selected only one beam which has the highest energy. Then we can be writing the ratio of lost energy to total energy by:

$$\ddot{\eta} = 1 - \frac{1}{2\sum_{i=1}^{\frac{N}{2}} \frac{\sin^2(\frac{\pi}{2N})}{\sin^2\left((2i-1)\frac{\pi}{2N}\right)}} \qquad (6)$$

From equation (6), It becomes clear that a single path idea of how the loss energy is severe. That means there is a certain amount of SNR loss which needs improvement. The results from this equation shown how much energy lost from the total energy of the beam.

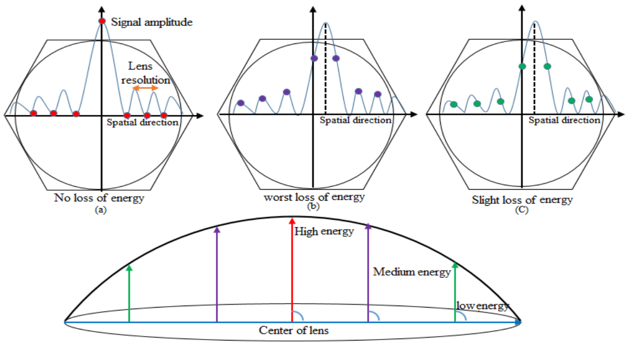

Figure-2. Loss of strength of Hexagonal Lens antenna array.

PHASE SHIFTER

In the beamspace MIMO system, there is three-way to precoding Shown that in Figure-4.

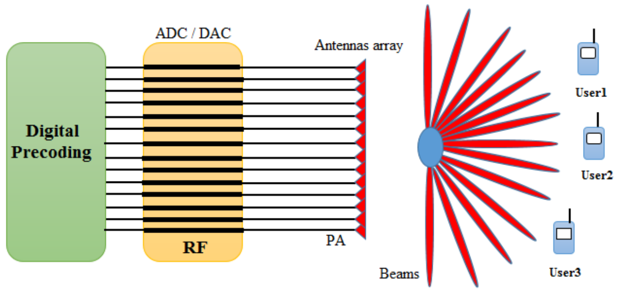

Figure-3(a). Conventional precoding which the number of RF is equal the number of antennae.

Therefore, only one single beam we can choose from one single RF_{ch} to one user. Therefore the single beam is precoding, and the consumption of energy is given by [12].

$$E_{sB} = E_T + E_{BB} + E_{RF}K + NKE_{sw} \qquad (7)$$

Where, $E_{BB}$is the baseband energy, E_{RF} is the RF_{ch}energy, $E_{SW,}$ Switching energy. In Figure-3(b) show the precoding method deploys with a small number of RF, which it deploys lower energy consume. But in the equation (6) the single beam precoding has a loss in SNR and to solve this problem is implementing several RF to get a much more of beams energy as shown in the Figure-3(b)

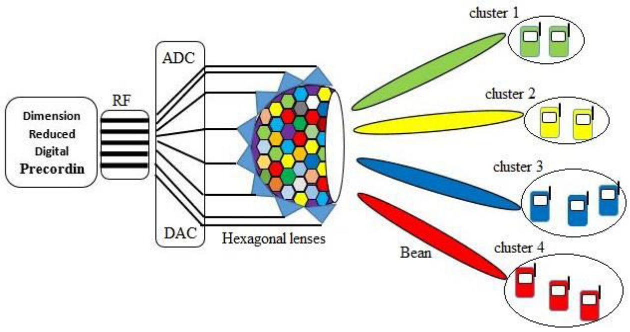

Figure-3(b). Multiple-beams with multiple RF_{ch}precoding.

The precoding, in this case, is called multiple beams radio frequency chain ($MBRF_{ch}$) and the energy consumptions we can express by this equation:

$$E_{MBMRF} = E_T + E_{BB} + E_{RF}B_T + NE_{SW}B_T \qquad (8)$$

Where the total number of selected beams is $B_T = \sum_k B_K$, the name of beams chosen for the k_{th}user is B_k, in the equation (7) we can collect all the loss of energy, but this hurdle needs to more amount of RF_{ch}. We can understand this case by assuming there are 80 users(K) to use with a total number of beams 4 (B_T), which required a lot of RF_{ch}.Therefore, the higher energy consumption will be 4x80=160, which means higher energy consumption. So that leads to higher hardware complexity and more cost. Therefore, to solve this problem, we

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propose the PS precoding, as shown in Figure-3(c) to address the loss energy problem.

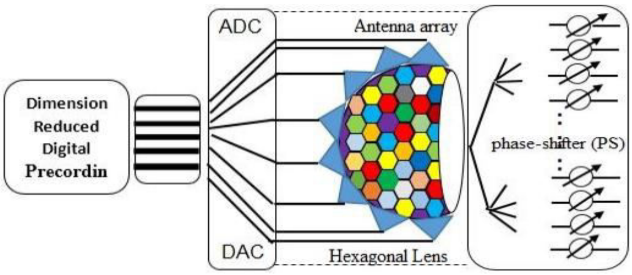

Figure-3(c). Used hexagonal lens-antenna arraywith phase shifter networkprecoding.

his algorithm explains the single RF_{ch} which it can select more beams by using the analogue PS. The RF_{ch}. It is connected to an arbitrary subset from all number of antennas by using a switch network. That means can connect the single antenna with oneRF_{ch}. Moreover, the PS is sitting on each antenna connected to rotate in signals way. Therefore, the total number for the PS is express N, which is not a large number. Then we can present the PS precoding energy consumption by:

$$E_{PSN} = E_T + E_{BB} + E_{RF}\,K + E_{sw}\,NK + E_{ps}B_T \qquad (9)$$

If the phase shifter energy consumption is PS. Then the channel signal for the PS algorithm can express by:

$$x = E_{RF}E_{BB}\,S \qquad (10)$$

Where $E_{RF} = \left[E_{RF}^1, E_{RF}^2, E_{RF}^3, \ldots, E_{RF}^{N_{RF}}\right] \in \mathbb{C}^{NxN_{RF}}$, RF precoder. And the $S \in \mathbb{C}^{kx1}$ There is a signal vector of the source. Therefore the E_{RF} in practice, is E_{RF} realised via the PS and switches,

$$\left|[E_{RF}^1]_j\right| = \left\{\frac{1}{\sqrt{B_i}}, j \in B_i\right\} \qquad (11)$$

When the B_i selected the beams for a set of indicator to the $i_{th}user$. It is not easy to deploy the PS algorithm for beamspace MIMO conventional.

HEXAGONAL LENS ANTENNA ARRAY

As shown in Figure-2 in this paper the proposed hexagonal lens shape the distance between the centre of the hexagon shape to each of the six heads is equal to the radius of the circle(R) an around it and is identical to the length of one side of this shape. Then if we compare this hexagonal lens shape with square lens shape lentil in terms of distance, we find some of the spaces in the rectangular shape are equal to and some equal to$\sqrt{2}R$. Therefor is no doubt that the same distance between the centre of the lens and its perimeter as it is hexagonal leads to a more uniform and more straightforward distribution of analysis [13]. To prove that of geometric calculations method, we find that the areas of overlapping energy ($E_{overlap}$) in the field of the circle in the square lens is equal to:

$$E_{\text{overlap}} = \frac{\pi R^2 - 2R^2}{\pi R^2} = 1 - \frac{2}{\pi} = 0{,}173$$

While in the hexagonal lens, the fields of interfering energy (interference) from the circumference of the circle are equal as:

$$E_{\text{overlap}} = \frac{\pi R^2 - \frac{3\sqrt{3}}{2}R^2}{\pi R^2} = 1 - \frac{3\sqrt{3}}{\pi 2} = 0363$$

As shown in the Figure-2, the high-energy and low-energy zones shown in the hexagonal lenses. Then the distance between two adjacent hexagonal lenses shape centre is equal $\sqrt{3}R$, and between Square lenses, the shape is$\sqrt{2}R$. Therefore we chose the hexagonal lens shape for the current study.

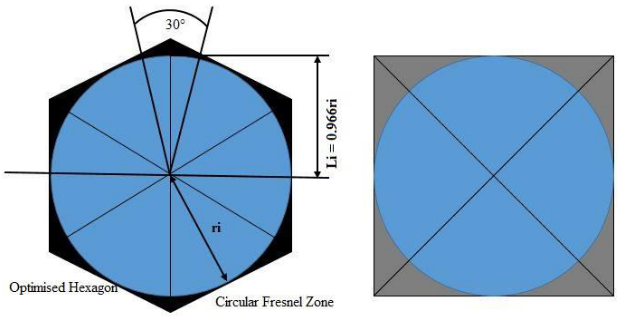

Figure-4. Compact between hexagonal lens with square lens.

ZF PRECODING

To determine the performance of the system, we use zero-forcing precoder to the PS algorithm, which based on a matched filter (MF). To reduce the required number of RF_{ch} We connected the MF to the hybrid analogue precoding structure [14]. We can explain the simulation parameters for ZF precoding in Table-1.

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Table-1. ZF algorithm parameters for PS.

	Parameter	Symbol	Value
1	Hexagonal lens antennas Number at BS	N	256
2	No. user antenna	K	3
3	No. clusters	N_{cl}^{K}	1
4	No. paths in each cluster	$N_P^{(k,l)}$	8
5	Number of RF_{ch} per user	N_{RF}	1
6	Signal To Noise Ratio	SNR	30dB

SIMULATION RESULTS

In this section, we see in Figure-5 the simulation results from the comparison between the sum rates in three cases. The first conventional algorithms (fully), second PS algorithm (phase-shifters), and third Hexagonal Lens-antenna array (lens) into the number of channel beams. We can see the practical results by using Table-2to find the relationship between the SNR different number of the beam, for example (1,2,4,8, and 16 beams) .

Table-2. Sum rate to the number of beams.

No. of beam	SNR = 30		
	Lens	Phase-shifters	Fully
1 beam	1.535853	1.535853	1.535853
2 beam	3.313529	3.313529	3.313529
4 beam	7.774255	8.096839	8.096839
8 beam	17.1916	17.46898	17.46898
16 beam	30.21097	0.190291	0.190291

The RF regularly chooses just one beam to a specific user when having single-beam. In the case of multiple beams, there are some changes in the both PS algorithm and RF single algorithm. Therefore, the PS algorithm can be achieving more sum rate when compared with single RF to any user. It is additionally that every sum-rate among the PS and RF single algorithm becomes extra sufficient if the amount of beams increases. Moreover, the precoding system can achieve optimal performance from a fully digital (FD). Which intends that the system package effectively optimise the waste energy point in the recommended beamspace massive MIMO.

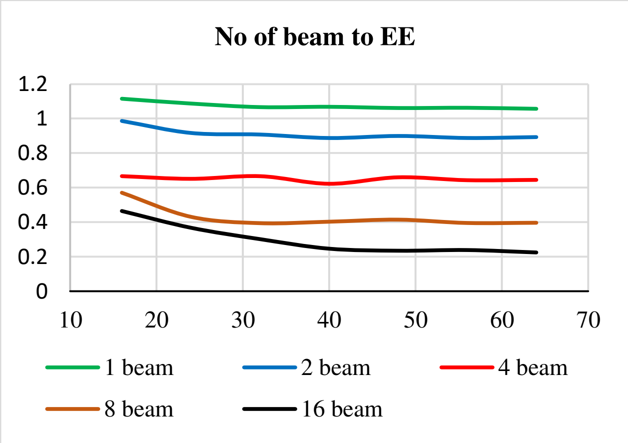

Figure-5. Number of the beam to SNR sum rate (bit/s/Hz).

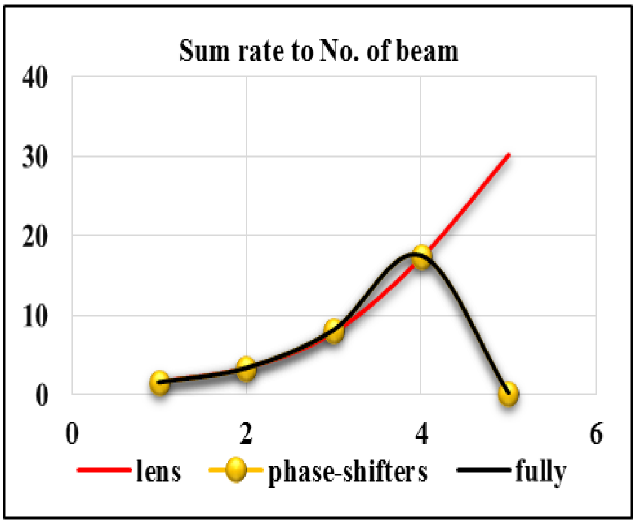

Figure-6. No of the beam to EE.

Table-3. Number of the beam to energy efficiency.

No.	No of users	No.of beam				
		1 beam	2 beam	4 beam	8 beam	16 beam
1	16	1.11486727	0.986201	0.6668151	0.57074	0.465074
2	24	1.08702985	0.916844	0.65129781	0.431495	0.368247
3	32	1.06627763	0.907653	0.66665707	0.394733	0.302331
4	40	1.06828267	0.887472	0.62266683	0.403261	0.24708

5	48	1.06117664	0.899444	0.66013933	0.415167	0.235307
6	56	1.0624814	0.887619	0.64331306	0.39576	0.239157
7	64	1.05659369	0.892844	0.64526648	0.397114	0.225259

There is some comparison of the EE of the PS algorithm with the conventional methods on the number of beams in Figure-6. It is necessary to remark that as the FD/MB_{RF} Therefore, the system has a more generous sum rate when seeing to Figure-5. In the case of using the lens and at the same time we can see decreased the EE. That is further lower than the RF single, which is not acceptable because of the FD/MB_{RF} Precoding extends a large number of energy-consuming. Though it has decreased EE in Figure-6, which is further lower than the RF single, which is not acceptable. It is because of the FD/MB_{RF}, that a large number of energy-consuming moreover, PS gives the most suitable EE production than conventional systems. To PS system employs a small amount of PS converter, to get the low energy-consuming. For this reason, it assumed that the proposed methods are suitable for both SE and EE optimisation. In Figure-7, a comparison between a sum rate of a PS, ZF with the conventional methods on a signal to noise ratio (SNR) is presented. We can see visible in Figure-7 that the PS ZF algorithm can achieve best a sum-rate production. The single RF, and single-beam which is also near to the optimal FD.

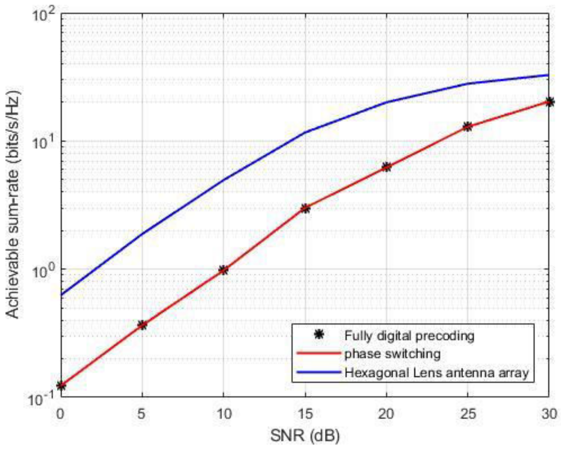

Figure-7. SNR to Sum-rate in three cases fully, PS and lens.

Therefore, the sum rate ratio between the PS precoding and RF precoding increased if the values of SNR are increasing. That means PS precoding can implement best in SNR than the conventional systems. Figure-7 represents the example of the PS, ZF precoding, including the perfect precoding in EE. The suggested system can perform close rendering, together with the quixotic precoding design, which gives it correctly of a working system.

CONCLUSIONS

The main idea in this research, how to deploy a single RF, which can choose many beams into various PS. Also, we study the wasted of energy delivery and the required number of RF_{ch} in the mm waves with massive beamspace MIMO. We use the ZF precoding system with the proposed PS to enhance the problem of wasted energy delivery. To a combination of the preponderance of the wasted energy in the beamspace channel. MF use with the ZF precoding because of it based on then. It also is used to analyse a performance system in SNR. Show the results of Simulation that the algorithms which we proposed can get effective energy better. That means the optimise of a concerned loss energy problem beamspace massive MIMO. That leads to increases in the overall performance of the system, which it can find from the results. We can show the results of the sum rate of SE and EE increased by using PS proposed and ZF. Precoding. Finally, the future research work in this paper. The researchers can continue to how can using multiple users in one beam with multiple user antennas and using different channel models and also can use a different design of hexagonal lens antenna array.

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