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EXPERIMENTAL DESIGN AND ANALYSIS OF LENS ANTENNA FOR MASSIVE MIMO COMMUNICATIONS

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ABSTRACT

Since from last decade, the lens antenna technology gained significant attention from researchers for various applications. Kinds of lenses introduced to enhance efficiency and gain regardless of end-user applications. The millimetre-wave beamspace communications are future communication technology introduced for improving the data rate and user capacity. However, the current solutions required the dedicated radio frequency channel which leads to extra overhead of energy consumption and cost efforts. Lens antenna technology has been proven an effective technique for Massive MIMO communications to improve the data rate and user capacity while achieving energy and spectral efficiency. In this paper, we present the scheme and experimental examination of the lens antenna based on Massive MIMO. The design of the lens antenna is performed by using the magnifying glass. The transceiver model of Massive MIMO consists of 60 lens antennas. This paper presents the complete design methodology of lens antenna for wireless communications and their experimental validations.

Keywords: lens antenna, beamspace, millimetre-wave communications, massive mimo, spectral efficiency, energy efficiency.

1. INTRODUCTION

Lens antennas are a fundamental candidate for the modification of outside wave extinction. Being a subset of dielectric antennas (such as dielectric resonators, switches, and horns), lenses can be partitioned into different divisions based on their constitutive elements and state. Fresnel zone plate lenses are a general example of such an antenna created from an inhomogeneous substance since the lens is constructed with dielectric bands that each has several permittivity rates. The different inhomogeneous lens is the Luneburg lens, where the refraction formula contracts from the essence. Despite this, most treatments make usage of homogeneous lenses, frequently connected with a type of anti-reflection coating when the element dielectric constant passes a particular advantage. In the duration of the aperture outline, lenses can either be formed or canonical. Shaped lenses are typically planned to construct the aspired radiation model, which is different from a prime source.

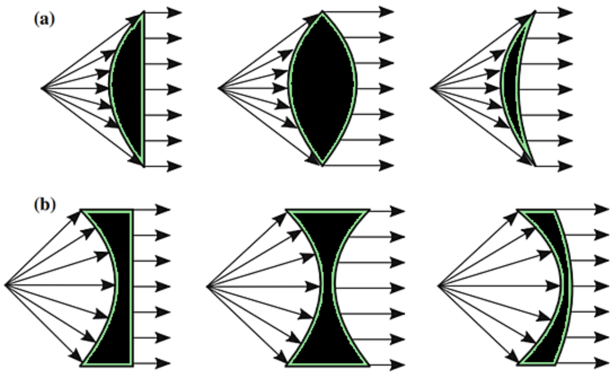

Figure-1. Lens Configuration with a refraction indices n>1, n<1 and b.

It is likewise conceivable to make multi-shaft antennas with worthy off-hub execution. Rotman has exhibited this with an aplanatic-zoned lens, and Peebles achieved comparable outcomes with a dielectric bifocal lens. At millimetre wavelengths (and in certain reports, sub-millimetre wavelengths), sanctioned. The medullary part of our centring gadget is a cumbersome dielectric lens, which, without loss of consensus, we consider as drenched in air. Light encroaches over the level surface of the lens, and the exit round surface has a short sweep R>0, whose inside is set at a given point CC, as delineated in Figure-1. Here we consider that RR stays in the size of the wavelength, even though our methodology isn't carefully confined to such a system. In specific situations, this plan empowers a high-gap centring of light rising out of the curved surface of the lens. From the geometrical perspective, the optical force is conveyed constantly surface of the thick lens described by a paraxial central length.

$$f = \frac{R}{1-n} \tag{1}$$

Where n indicates the refractive file of the lens. If n>1 as happens in common dielectric materials, the lens is disparate with negative central length, f<0, crippling to concentrate light behind the curved surface, as represented in Figure-1(a). In this way, centring is just accessible with a refractive file beneath the solidarity, which can be accomplished by utilizing metamaterials. In the particular instance of epsilon-close to zero metamaterials, setting n=0, light is engaged at the focal point of ebb and flow of the inward leave surface, as appeared in Figure-1(b]. This game plan has as of late been shown tentatively in microwave frequencies and presents interesting attributes, for example, decreased abnormalities in arrangements with numerical gaps near solidarity. An expanded numerical

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opening may be accomplished utilizing negative-list Plano-sunken lenses, as appeared in Figure-1(c). In any case, thick negative-list metamaterials in the close infrared and noticeable recurrence run show an insufficient exhibition primarily because of material Ohmic misfortunes and in homogeneities dissipating Figure-1. Schematics are dependent on optical beams of the centring activity of Plano-inward dielectric lenses. (a) Straightforward dielectrics with a record of refraction higher than solidarity lead to a separating setup. An epsilon-almost zero metamaterial empowers us to concentrate light at the focal point of the shape of the inward surface. (b) An expanded numerical opening is accomplished by utilizing negative-list metamaterials. Our proposition was dependent on coupled metal coatings set at the passageway and leave surfaces of a straightforward dielectric thick lens. An engaged light emission angle Ω will be created by going through the inclination list level metasurface. The uniting wave field proliferating inside the lens will be pulled together at F' utilizing the dynamic bent metal covering, having an expanded semi aperture angle Ω' .

A Rotman lens is regularly utilized in millimetre-wave beamforming applications. While it doesn't offer the wide bandwidth or enormous output angles of different kinds of beamforming lenses, it gives a trade-off in execution and performs well as far as sweep go sidelobe levels, and effectiveness. The structure includes an equal plate locale, with waveguide ports put around the edges of the plate areas, as appeared in Figure-2. These ports are then taken care of by a variety of switches, each associated with a transmitting component. Force contribution to a specific central port will deliver a shaft in a provided guidance and directing is accomplished electronically by exchanging the. Research takes a shot at the Rotman lens radio wire began route in 1963 when Rotman and Turner distributed their exploration work. This work remains the benchmark for scientists right now. The lens parameters are characterized as appeared in Figure-2.

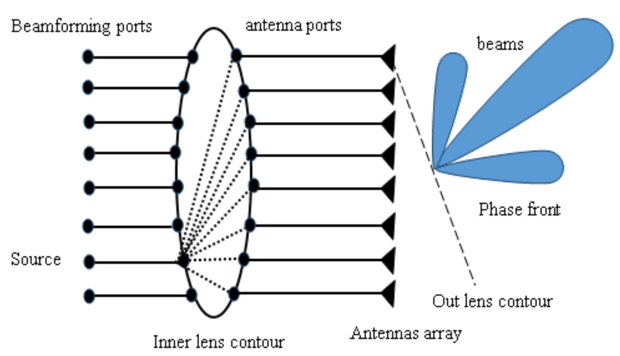

Figure-2. Principle of operation for a Rotman lens.

The central curve finds taking care of components which are named as the shaft port or the pillar form. The internal lens shape finds the accepting components and the external lens form or the exhibit port finds the transmitting cluster components. For the bar form structure, three central focuses were utilized: two off-hub central focuses (receiving wire port and internal lens shape) which were even and one on-hub point of convergence Source. The state of the central bend was picked as around. In contrast to different sorts of lenses, including the Ruze model for which the parameters Y (the - arrange of a subjective point on the inward lens shape) and (the organize of a transmitting exhibit component associated with the accepting component situating at P(X, Y)) was held equivalent to one another; Rotman lens permitted Y and N to appear as something else. This gave more degrees of opportunity in the plan. To infer structure conditions for the lens shape, optical way length balance and the lens geometry were utilized.

Radio wire is a transducer, which changes over electrical power into electromagnetic waves and the other way around. A Reception apparatus can be utilized either as a transmitting receiving wire or an accepting radio wire. A transmitting radio wire is one, which changes over electrical signs into electromagnetic waves and emanates them. An accepting receiving wire is one, which changes over electromagnetic waves from the got bar into electrical signals as appeared in figure 3. In two-manner correspondence, a similar radio wire can be utilized for both transmission and gathering. The receiving wire can likewise be named as an Aeronautical. Its plural is receiving wires or antennas. These days, antennas have experienced numerous changes, following their size and shape. There are numerous kinds of antennas relying on their wide assortment of uses. Right now, I introduced the plan and test examination of lens radio wire-based Massive MIMO. Section II presents a brief review of related works recently presented for the lens antenna. Section III presents the proposed design methodology with configuration and algorithmic parameters for lens antenna. Section IV presents the experimental results. Section V presents the conclusion based on the outcomes.

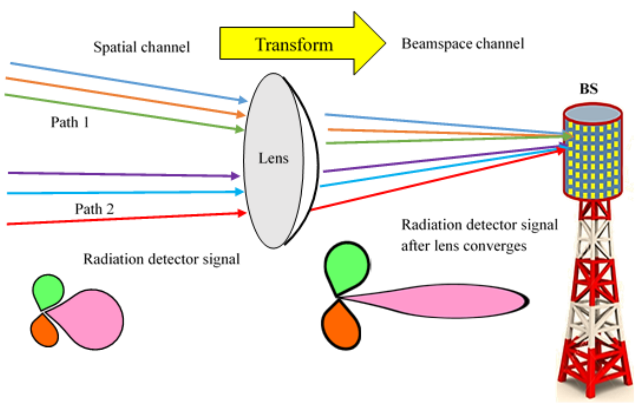

Figure-3. Transmitter and receiver lens antenna.

2. RELATED WORKS

The mm-Wave communications with BS MIMO-NOMA such as 5G networks. In [1], gives a starting book on electrostatic optics, and is joined by a plate containing a program for the IBM PC. A suite of PC programs (LENSES for MSDOS) proposed for down to earth use in the plan and examination of frameworks utilizing round lenses with gaps barrel-shaped components. The LENSES program has been extended to incorporate the count of the coefficients chromatic deviation and the Petzwal basic.

In [2], the proposed transmit-exhibit lens was completely considered, with engineering conversation and choice, just as the plan, assembling, and approval of everything the comprising components of that lens (transmitting components, device circuits, and advances). Inevitably, a total model of the transmit-cluster lens is amassed and radiation design estimations in the anechoic chamber.

In [3], presented and introduced significantly fused 77 GHz time territory multiplex (TDM) MIMO radiolocation. The sensor was reasonable for the bleeding-edge course of appearance (DOA) assessment in azimuth and tallness. For profitable and superb estimations, a fragmentary n staged bolted circle (PLL) with facilitated waveform generator, enabling twitter and frequency tempered constant waveform (FMCW) guidelines, was realized. Spatial beamforming was done with game plan feed show fix radio wires in the blend in with a dielectric barrel-moulded focal point. For the improvement of the course of appearance (DOA) expectation execution, another focal point based MIMO radar technique was performed.

In [4], arranged and executed a limited and less gathering multifaceted nature of discrete focal point gathering contraption's unit cell which relied upon opening coupled microstrip patches. The transmission time of the unit cell was obliged by using variable-length spaces. The usage of the hole coupling framework discards the drifting radio wire structures in view of the air gap between the focal point gathering mechanical assembly layers. The stage control approach used right now less troublesome appeared differently in relation to the defer lines and metallic vias used in past references. It was believed that this unit cell setup could provoke an insignificant discrete focal point radio wire structure and offer incredible and fundamental control of the stage. For understanding a planar discrete focal point getting wire, a display model of 7x7 parts has been produced and assessed. The transmission transfer speed of the unit cell was restricted and will be overhauled during full display use.

In [5], planned and broke down a proportionate electrical lumped segment displaying of an E-moulded fix level lens receiving wire unit cell. The proposed component model comprises two indistinguishable circuits associated with a coupling transmission. The lumped segment limitation was resolved reliably regarding the physical composition of the unit cell at 4.2 GHz. The circuit continued executed and mimicked utilizing MULTISIMV10 software.

In [6], planned and required the exhibit unit cell to build up the stage alteration. Level lens receiving wire components that depended on opening coupled microstrip patches were introduced. The lens contains 7×7 components with a breadth of 71 mm and works in the X-band frequency run. The lens was tentatively approved and great understandings among re-enactment and estimation results were acquired. The accomplished estimated top increase is 15.85 dB. This gives 6 dB gain improvement for the framework. The reception apparatus 1-dB gain bandwidth and power efficiencies are 7.8% and 58% individually. A generally excellent transmission stage moves of 340° is accomplished with a transmission coefficient of superior to 2.25 dB. Moreover, the deliberate radiation design results show that the reception apparatus framework has great evenness among E and H plane with a half-power beamwidth of 16.2° and 16.6° in E-plane and H-plane separately. Additionally, the proposed lens component utilizes a straightforward and less manufacture unpredictability system for stage move revision.

In [7], a proposed strong help recognition (SD)-based channel estimation plot. Specifically, they proposed to fall apart the hard and fast beamspace channel estimation issue into a movement of subproblems, all of which just contemplates one lacking channel portion. For each channel fragment, the first reliably recognize its help by utilizing the assistant traits of the mmWave beamspace channel. By then, the effect of this channel section was ousted from the total beamspace channel estimation issue. After the backings of all channel parts have been perceived, the nonzero segments of the lacking beamspace channel can be assessed with low pilot overhead.

In [8], proposed lenses for beam focusing of DLBs with high fill factor. Their characteristics of high brilliance and high optical power are particularly useful for penetrating depth into biological tissues. A customized optical arrangement fashioned of collimating and adjusting lenses was intended to deliver the beam directing of high-brightness diode laser bars with a high fill portion for optoacoustic utilization.

In [9], All phased QCTO is a phased array dependent on a wide-angle probe planned and temporally tailored. Activated by similar current changes according to a simple plantar array, the conformal outline in the proximity of the QCTO lens can protect the radiation characteristics similar to a planar array with wide-angle shaft checking and low sidelobe levels (SLL). Larry Plus's position is compatible with the Dirichlet - Newman boundary condition to develop the mapping between virtual and natural spaces. The isotropic lens with a refined file was supported by a building with all-dielectric holes followed by rich parameter estimation.

In [10], author Detected Kramer-Rao Lower Bound (CRLB) at the angle of arrival (AOA) evaluation of an RF lens-implanted radio wire array. They estimate an articulation for the received signal as far as natural lens properties are concerned, using an RF lens-inserted radio wire array. As a difference of AOA, the difference in money found within the RF lens. It routinely separates RF lens-installed receiving wire arrays from the uniform linear array (ULA) external RF glasses. Because of this property, the AOA estimates the next CRLB on the estimate and confirms that the CRLB of the RF lens-inserted reception device array may be more useful than the CRLB for a conventional ULA in a particularly desirable extension.

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In [11], introduced a half and half precoding design for mmWave frameworks and got considerable enthusiasm for both industry and the scholarly world. Be that as it may, the ideal half and half precoding configuration has not been completely seen, particularly for the multi-client MIMO case. This paper was work that straightforwardly addresses the non-convex mixture precoding issue of mmWave multi-client MIMO frameworks (with no guess) by utilizing a penalty dual decomposition (PDD) technique. The proposed PDD strategy has an ensured assembly to KKT arrangements of the crossbreed precoding issue under a mellow presumption.

In [12], proposed models of 28 GHz lens wires for immobile and versatile use as anticipated gadgets for a lens-installed mmWave cross breed beamforming framework. Their estimation and re-enactment based investigations offer understanding into the profitable characteristics of lens antennas of a lot more important increase and directivity contrasted with those in which no lens is utilized. The lens antennas' bar exchanging plausibility is checked by exhibiting the move in the pillar's fundamental direction while improving the initiated port consecutively. The lens antennas' structure effects were additionally recognized by examining the impact of amplifying the lens size. Additionally, this introduced connect level and framework level execution assessments that explain the essential throughput execution of the lens antennas in genuine indoor and open-air situations.

In [13], presents a structure for a metal spectacle framed by twelve metallic loops. The lens has been broken down utilizing trademark modes to assess the presence of the flows on the metallic rings and give substantial knowledge into the lens activity. An open-finished waveguide with a thunderous ring was utilized as the essential provisions for the resounding lens. The hypothesis of trademark modes was utilized to dissect the met material lens, to give an understanding of the radiation attributes of the receiving wire.

3. METHODOLOGY

The problem: is how we can improve the signal between the sender and the receiver

The idea: is to develop antennas used in wireless communications by using a magnifying glass. We used a transceiver, which is composed of 60 antennas.

Antenna Structure: The total framework, shaped by taking care of round waveguide and a solitary layer lens receiving wire. As can be watched, taking care of components is a roundabout opening with a full ring, Keep f away from the single-layer lens in the z-pivot. A metal ring attached to the round gap is used to expand the pickup and limit the cross-polarity level of the feeder. By improving the structure for the intriguing frequency band (9–11.5 GHz), subsequent measurements are with: t = 1 27 mm, dw = 19 35 mm, and df = 33 89 mm, where t is the thickness of the metal ring. And Dove and DF have different in and outdistances.

Considering the previous feeder, the lens has been improved to extend the pick-up and limit the sidelobe level and cross-polarity level of the radio wire. Subsequently, the accompanying measurements are taken: Di = 10 88 mm, Do = 15 58 mm, r = 30 55 mm, Dl = 76 68 mm, and f = 13 85 mm, where Di and Do are the inner and outer widths. , Individually, the metal ring, r is the period of the ring where twelve unit cells are exposed, Dl is the width of the lens, and f is the central length.

Mathematical Principle:

- **Sparsity:**

$$H = [h1, h2, h3, \dots hk] = UH = [Uh1, Uh2, Uhk] \quad (2)$$

Hk With a short estimate of prevailing components, approximately sparse.

- **Beam selection:** Choose a small number of imperative beams

$$Y \cong H_{r^H} P_{r^s} + \text{n},\ H_r = H(l, :) l \in \beta \quad (3)$$

P^r the dimension-reduced precoder.
Only a small number of RF chains

System model

K single-antenna users, BS with N antennas, $N_{RF} = KRF$ chains

$$\mathrm{Y} = \mathrm{H^H x} + \mathrm{n} = \mathrm{H^H Ps} + \mathrm{n},\ \mathrm{H} = [\mathrm{h1}, \mathrm{h2}, ..\mathrm{hk}] \in \mathrm{C^{N \times K}} \quad (4)$$

Saleh-Valenzuela channel model.

$$h_k = \beta_{k^{(0)}} a\left(\varphi_{k^{(0)}}\right) + \sum_{i=1}^{L} \beta_{k^{(i)}} a\left(\varphi_{k^{(0)}}\right) \quad (5)$$

$$a(\varphi) = \frac{1}{N}[e^{-j2\pi\varphi m}] m \epsilon I(N) \quad (6)$$

$$\varphi = \frac{d}{\lambda} sin0 \quad (7)$$

Where

φ: spatial direction and 0: physical direction. Transform the spatial channel into beamspace.
Where.

$$Y = H^H U^H + n = H^H Ps + n,\ U = [a(\varphi 1), a(\varphi 2), .. a(\varphi N)] H \quad (8)$$

Where,

$$\mathrm{I(N)} = \{\mathrm{l} - (\mathrm{N}-1)/2,\ \mathrm{l} == 0,1, \dots, \mathrm{N}-1\}, \varphi_\mathrm{n} = \frac{\mathrm{n} - \frac{\mathrm{N}+1}{2}}{\mathrm{N}}, \mathrm{n} = 1,2, ..\mathrm{N} \quad (9)$$

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- Key parameters:

- AP employs a lens antenna array with 16 elements
- 2 single-antenna users
- Frame structure
- User discovers
- Beam selection (4 out of 16)
- Beam-frequency channel estimation
- Precoding
- Data detection

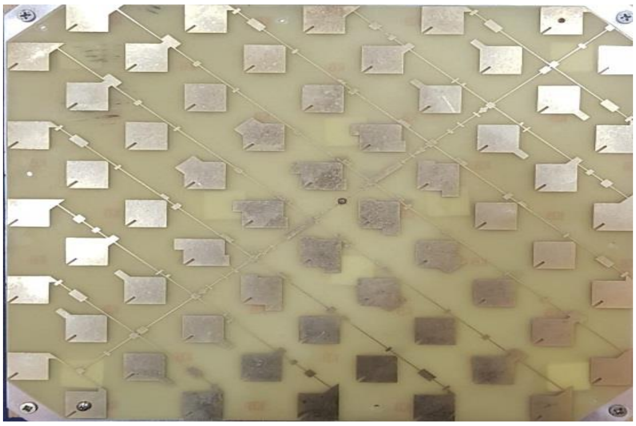

Figure-4. The Mikrotik wireless outdoor access point.

Figure-5. Mikrotik kart device.

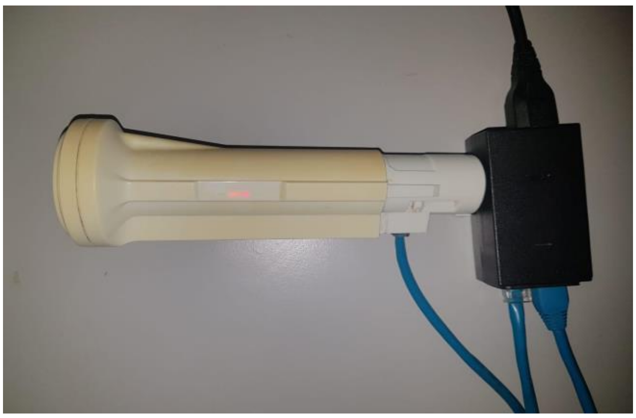

Figure-6. Receiver-type Ubiquiti Power Beam M5-400 / PBE-M5-400 | 5 GHz, 25dBi, Wetter fest, 802.11n, 300Mbit

Beamspace channel estimation: Beam variety challenges the knowledge of the beamspace channel. The channel dimension is great while the amount of RF strings is restricted.

- We cannot sample the beacons on all antennas simultaneously.
- Unaffordable pilot expenses
- Different hardware architecture compared to hybrid precoding.
- Existing current evaluation systems for hybrid precoding cannot be used

Lens Antenna Wire Hybrid Beamforming:

In common phrases, a lens is a refracting gadget that centres on an occurrence of electromagnetic winding. In remote correspondences, a lens container is portrayed as a latent stage shifter that alters the info sign stage as per its occurrence period on the lens gap. Therefore, the lens centres signal vitality to a subset of wires as indicated by the angle-of-departure (AoD) or angle-of-arrival (AoA); this is known as the angle-subordinate vitality centring property [14]. This characteristic adds to the lens receiving wire's large addition and directivity after the bar is engaged in a specific regulation with intense sign energy.

The focused on mmWave lens hybrid beamforming framework to which we, at last, intend to utilize our recommended lens receiving wire. While the baseband and transmitter/beneficiary (T/R) modules' arrangement matches that of a regular composite beamforming framework, for lens receiving wire beamforming, a lens does situate before the N component reception apparatus array to abuse the properties of the lens. The spectacles including the radio wire array, all in all, are alluded upon as that N component lens receiving wire. The angle-subordinate vitality centring property of the lens gives special advantages to the hybrid beamforming framework. To begin with, the framework gets useful and cost-productive when just a subset of antennas is chosen receiving wire determination for signal preparation. Contingent upon the pre-chosen AoD or AoA, a controller ascertains which subset of the array components ought to be turned on to electronically guide the antennas in a particular direction. By supplanting the overwhelming system of stage shifters with the exchanging system with the lens, the sign handling multifaceted nature and RF chain cost is essentially diminished. Besides, the high receiving wire increase of the lens radio wire from directivity makes up for the normal execution corruption of reception apparatus determination which is the inverse to when the lens isn't utilized [17]. Plausibility of Lens Radio Wire Hybrid Beamforming A few investigations concentrated on the hypothetical and estimation based examination of real models of the mmWave lens hybrid beamforming framework. Right now, hypothesis and estimations of such

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a framework. Concerning hypothetical work, the creators in [13] presented discrete lens arrays (DLAs) and receiving wire choice based frameworks to mmWave hybrid beamforming. The lens goes about as a rough spatial Fourier transformer, anticipating signs to the beamspace area which fundamentally decreases the quantity of required RF chains. Multi-way conditions and multiuser situations were likewise assessed [15]. Despite the theoretical work, a couple of examiners investigated the genuine prototyping of mmWave focal point cross breed beamforming structures. In [18], authorities organized a focal point cluster multi-bar MIMO testbed with an Rx focal point module with a restriction of 4 RF chains and a single feed open-completed waveguide Tx. For each RF chain, a subset of 4 feeds was given clarification, and including four switches, one of the arrangements out of the four was investigated each RF chain to build the bar. The focal point was put before the 16-feed cluster. Supporting a multi-customer MIMO (MU-MIMO) OFDM structure course of action results showed that the model had the alternative to disengage the mixed signs beginning from the two Txs. The creators in [19] introduced a two-dimensional (2D) shaft steerable lens radio wire model working at 71-76GHz with a 64 component feed receiving wire array. Bar guiding and - exchanging were executed by just choosing one of the 64 receiving wire components utilizing RF switches incorporated inside the module. In a close-range receiving wire test goes, the most extreme estimated administrative and increases occurred roughly 36.7 dB and 15 dB, with a shaft controlling the scope of ±4◦ ×±17◦. A connection spending investigation indicated 700 Mbps throughput for a transmission length of 55m. Past hypothetical research and prototyping read offer help for the reasonableness and practicality of the mmWave lens beamforming framework. It is indistinct, in any case, how the real lens antennas will act in genuine conditions with genuine blockages including how the microscope aerials' presentation will contrast dependent on their plan. Besides, situations in which a lens isn't utilized likewise must be assessed altogether to completely comprehend the use and properties of a lens receiving wire in beamforming. Consequently, right now, assess various sorts and sizes of lens antennas contrasted with when a lens isn't utilized. We likewise perform their presentation during the connection and framework level examination.

Proposed Adaptive Selecting Network

Adaptive selecting network:

Utilize the 1-bit phase shifter (PS) network to design W

Adaptive: selecting a network for data transmission & combiner for channel estimation.

Q<N, Zk Has full information → sparse signal recovery problem. 1-bit PS → Low energy consumption.

Problem Formulation:

Sparse signal recovery problem: Estimate sparse h_kof size N with a smaller number of measurements Q. Classical CS algorithms can be directly used.

$$z_k = W_{h_k+n_k} \tag{10}$$

Traditional CS Calculations:

Deteriorated performance in the low SNR region.

- Low transmit power at the user side.
- Serious path loss of mmWave signals.
- Lack of beamforming gain

Structural property 1:

Lemma 2. Present h_k as $h_k = \sqrt{N/(L+1)}\sum_{i=0}^{L} C_i$, where $C_i = UC_i$ is the ith carrier element of h_k in the beamspace. Before, when the product of BS wires N goes infinity, any two-channel components C_i and C_j are orthogonal, i.e.,

$$\lim_{n\to\infty} |C_{i^H,}C_j| = 0, \forall\, i, j = 0,1 \dots . L, i \neq j \tag{11}$$

Insights:

The total estimation problem can be decomposed into independent sub-problems. Each sub-problem simply views one inadequate sound ingredient.

Structural property 2:

Lemma 3. Consider the ith direct part C_i in the beamspace, and expect V is an even whole number. At that point, the proportion between the force P_v of V most grounded components of $C_i$and the all-out force $P_T$of $C_i$can be lower-limited by

$$\frac{P_v}{P_r} \geq \frac{2}{N^2}\sum_{i=1}^{\frac{V}{2}}\left(sin^2\left[\frac{(2i-1)\pi^{-1}}{2N}\right]\right) \tag{12}$$

Furthermore, once the location n^* of the most powerful elementC_i is prepared, the other V- 1 most powerful components will regularly be discovered throughout

(a) Hexagonal Glass's Len (b) Circular Glass's Lens

Figure-7. a magnifying (lens) 4 ¼.

Support detection (SD) -founded 2D course evaluation:

Input:

Computation vector: Zk

Combining matrix W

Complete product of course elements $L+1$

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Grasped amount of components for each segment: V

	Elementary:
	$C_i = 0_{N\times 1}$ for $0 \le i \le L,\ Z_k(0) = Z_k$(13)
	For $0 \le i \le L$ (14)
1	Identify the location of the most powerful component of $C_i$as$N_{i^*} = arg\max\ \|w_{n^H}\|z_{k^i}$ is the nth columns of w;
2	Identify sup (C_i) corresponding to 23;
3	LS evaluation of the non-zero components of C_i S $f_i = (W_{i^h}W_i)^{-1}W_{i^h}Z_{k^i}, W_i = W$ (15)
4	Form the approximated $C_{i^{-e}}$ as $C_{i^{-e}}$ (supp(C_i))=f_i
5	Eliminate the attraction of C_i by $z_{k^{(i+1)}} = z_{k^i} - \mathrm{w}c_{i^{-e}}$
6	$i = i + 1$ Edge for
7	$S_T = U_{0<I<L}$ supp(C_i)
8	$f_T = (W_{T^H}W_T)^{-1}W_{T^h}Z_k$, $W_i = W$
9	$h_{k^e} = 0_{N\times 1,} h_{k^e}(S_T) = f_T$
	Product: Expected beamspace current for userk: hke

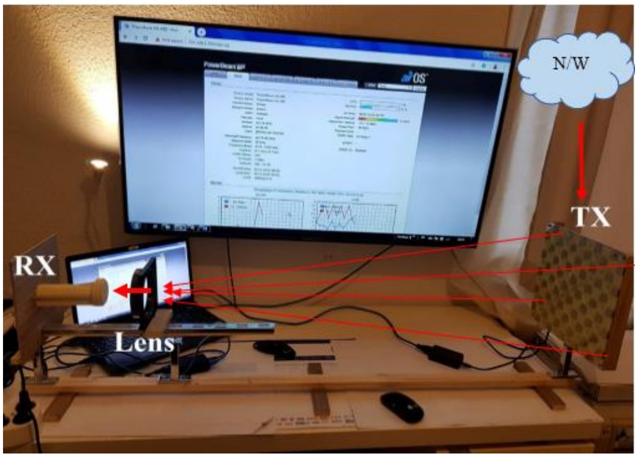

Figure-8. IP Login - https://192.168.20.

Simulation Parameters:

- **MIMO configuration:** $N \times K = 256 \times 16, N_{RF} = K = 16$
- **Total time slots:** (Q=MK=96) M=16
- **Beam selection:** IA beam selection
- **Dimension-reduced digital precoder:** ZF

Channel Parameters:

- **Channel model:** Saleh-Valenzuela model.
- **Antenna array:** ULA at BS, with antenna spacing $d = \frac{\lambda}{2}$
- **Multiple paths:** One Los component and two NLoS components (L=2)
- **LOS component Amplitude:** $\beta_{k^{(0)}} \sim CN(0,1)$Spatial direction: $\varphi_{k^{(0)}} \sim u(-\frac{1}{2}\frac{1}{2})$
- **NLoS components Amplitude:** $\beta_{k^{(0)}} \sim CN(0,1)$ Spatial direction: $\varphi_{k^{(0)}} \sim u\left(-\frac{1}{2}\frac{1}{2}\right), 1 \le i \le L$

4. EXPERIMENTAL RESULTS

The result of the test showed that the lens could increase the signal from (16-18) to (10-11) dBm that result must be better when we choose the Strong lens suitable.

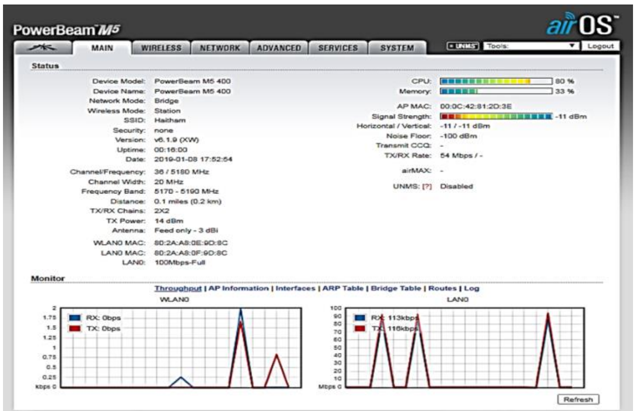

Figure-9. The system with the lens can increase the signal from between (-18 to -11) dBm.

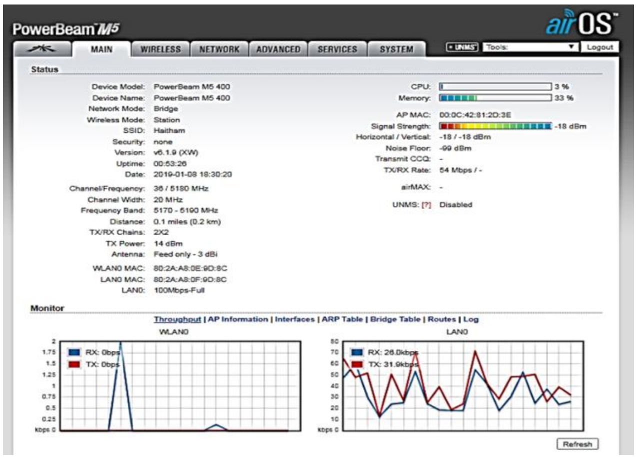

Figure-10. The system without a lens the signal between (-16,-18) dBm.

The measured S11 parameter of the created lens radio wire. As can be watched, estimated and reenacted results are very comparable, with a decent coordinating (S11 ⩽ 10 dB) beginning at 9.5 GHz, roughly, in the two cases. The level of the S11 is kept beneath -10 dB up to 11.5 GHz. The reaction may have been reached out past this upper-frequency limit, be that as it may, as it will be seen later, the addition rots at 11GHz and, thus, it doesn't worth considering a bigger bandwidth. The question is there any effect of the lens of the signal when we used in TX sided. The answer: yes, and that leads to we go to think about the development of the design of the TX.

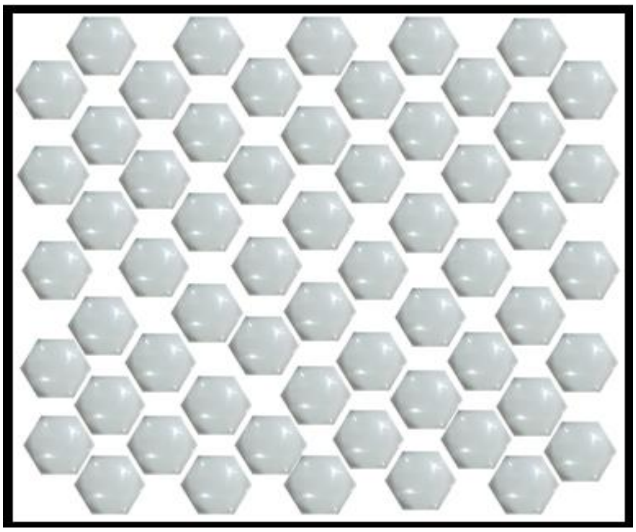

Figure-11. The new design is to use 60 special hexagonal lens front all the lens from this 60 lens.

This means that the cover which it covers the array of antennas is not conventional. Because it contains an array of lenses that correspond to each antenna, which leads to strengthening the signal without the need to increase the energy.

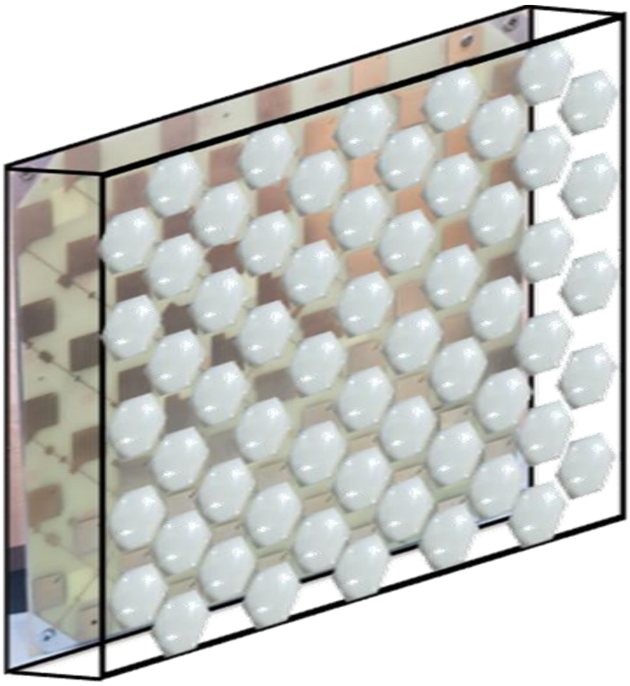

Figure-12. Hexagonal lens cover.

The S-parameters of this fabricated antenna has been measured by practising the vector interface analyzer, Keysight ENA E5071C. The measured diffraction model of the wire at different resonating repetitions for E and H-plane. The distribution original of an antenna at these frequencies has wide beamwidth which suits the primary requirement of mobile antenna applications. Higher gain of the antenna can be attributed to the fact that the effective dielectric constant of the substrate reduces due to negative permeability offered and it also reduces the dielectric losses in the substrate. In addition to this, the conductor loss in the antenna is also reduced because the overall dimension of the patch is relatively smaller than other antennas mentioned in literature operating at these frequencies. Hence, high gain and good isolation characteristics of this antenna make it suitable for wireless communication applications.

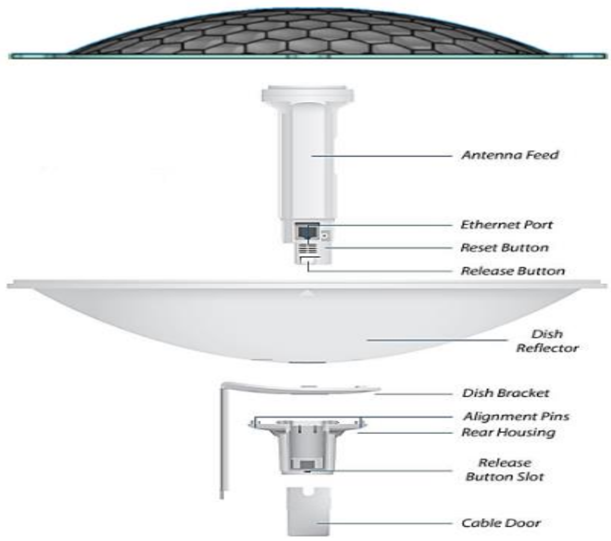

Figure-13. Inner feed technology.

5. CONCLUSION AND FUTURE WORK

In this paper, presented the design and experimental analysis of lens antenna based Massive MIMO. The design of the lens antenna has been performed by using the magnifying glass. The transceiver model of Massive MIMO consists of 60 lens antennas. The lens has moved examined using specific forms to estimate the performance of the tides on the metallic rims and present physical perspicacity into the lens development. The resulting construction increases the highest directivity concerning the feeder along with a wide bandwidth (more than 5 dB) and presents a large cross-polar level which makes this antenna quite suitable for modern wireless communication application.

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