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Optimization Spectrum Efficiency of MIMO Systems Based Planer Array with Quantizer Designs

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ABSTRACT: The fifth generation of mobile communication systems (5G) promises unprecedented levels of connectivity and quality of service (QoS) to satisfy the incessant growth in the number of mobile smart devices and the huge increase in data demand. One of the primary ways 5G network technology will be accomplished is through network densification, namely increasing the number of antennas per site and deploying smaller and smaller cells. Massive MIMO, where MIMO stands for multiple-input multiple-output, is widely expected to be a key enabler of 5G. This technology leverages an aggressive spatial multiplexing, from using a large number of transmitting/receiving antennas, to multiply the capacity of a wireless channel. In order to overcome the above effects, the work focuses on the QR-RLS based channel estimation method for Massive MIMO systems with different modulation scheme. To deploy many antennas in reasonable form factors, base stations are expected to employ antenna arrays in both horizontal and vertical dimensions, which is known as full-dimensional (FD) MIMO. The most popular two-dimensional array is the uniform planar array (UPA), where antennas are placed in a grid pattern. To exploit the full benefit of massive MIMO in frequency division duplexing, the downlink channel state information (CSI) should be estimated, quantized, and fed back from the receiver to the transmitter. However, it is difficult to accurately quantize the channel in a computationally efficient manner due to the high dimensionality of the massive MIMO channel.

KEYWORDS: Massive MIMO, Channel State Information, Square Root-Recursive Least Square (QR-RLS), QAM Modulation, Quantizer, Uniform Planar Array

I. INTRODUCTION

MIMO technology has been a topic of interest for the past two decades and MU-MIMO has made its way into standards such as 4G LTE and IEEE 802.11 (WiFi). Massive MIMO is a variant of MU-MIMO with the potential to offer significantly higher spectral and energy efficiencies at low computational complexities, making it one of the enabling technologies for 5G communication systems. Nowadays, wireless communication plays a central role in the industrial production process. Ubiquitous coverage, low latency, ultra-reliable communication, and resilience are key for wireless communications in a factory environment. In this respect, "cell-free" Massive MIMO, with its flexible distributed architecture, with its macro-diversity gain and inherent ability to suppress interference, is suitable to cope with the challenging industrial indoor scenario [2]. Also, a radio stripe deployment may integrate additional sensors/actuators such as temperature sensors, microphones, miniature speakers, vibration sensors, etc., and provide additional important features, e.g., fire alarm, burglar alarm, earthquake warning, indoor positioning, climate monitoring and control.

An antenna is a vital element of a wireless system because it acts as the input and the output interface for wireless tools. In modern wireless systems, characteristics like bandwidth, channel capacity rate, the speed of data transfer, the reliability of data, interference between two signals, cost as well as the size of device etc. plays a significant role. An antenna is used as a conducting element while transmitting and receiving electromagnetic waves in wireless applications. Since the antenna is a resonating structure, its tuning according to applications plays an important role. Enrichment in multimedia applications can be done to offer higher data rates. Shanon's channel capacity theorem is used to enhance channel capacity by increasing either signal to noise ratio or by a wide range of bandwidth. Due to various regulatory laws and cost involved in buying bandwidth in the crowded spectrum, it is difficult to achieve above metrics. The data rate of the system at the transmitter as well as at the receiver can be enhanced by using multiple radiating elements. In Multiple Input Multiple Output (MIMO) technology, multiple antennas operate in different modes based on characteristics of the different channel.

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II. CHANNEL ESTIMATION

In order to achieve the benefits of a large antenna array, accurate and timely acquisition of Channel State Information (CSI) is needed at the BS. The need for CSI is to process the received signal at BS as well as to design a precoder for optimal selection of a group of users who are served on the same time-frequency resources. The acquisition of CSI at the BS can be done either through feedback or channel reciprocity schemes based on Time Division Duplex (TDD) or Frequency Division Duplex (FDD) system. The procedure for acquiring CSI and data transmission for both systems is explained in the subsequent sections.

Channel Estimation and Data Transmission in FDD System

In FDD system, the signals are transmitted at different frequency band for uplink and downlink transmission. Therefore, CSI for the uplink and downlink channels are not reciprocal. Hence, to generate precoding/beamforming vector for each user, BS transmits a pilot signal to all users in the cell and then all users' feedback estimated CSI of the downlink channels to the BS as shown in Fig. 1. During uplink transmission, BS needs CSI to decode the signal transmitted by the users. To detect the signal transmitted by the user, CSI is acquired by sending pilot signal in the uplink transmission.

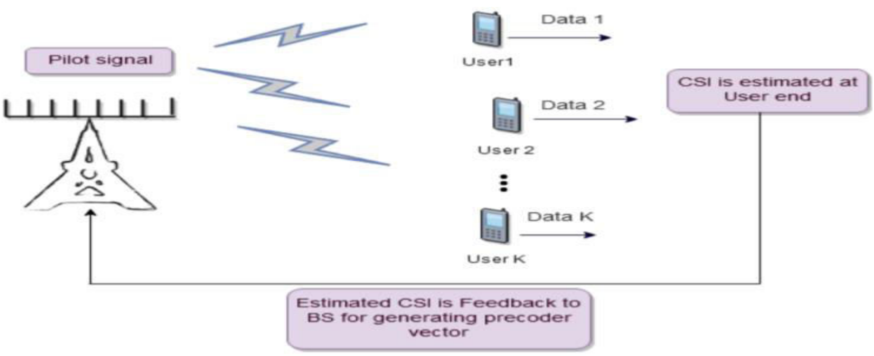

Figure 1: Downlink transmission in an FDD Massive MIMO system

III. PROPOSED METHODOLOGY

The MIMO-OFDM device modified into applied with the useful resource of MATLAB/SIMULINK. The execution device is binary facts this is modulated the use of QAM and mapped into the constellation elements.

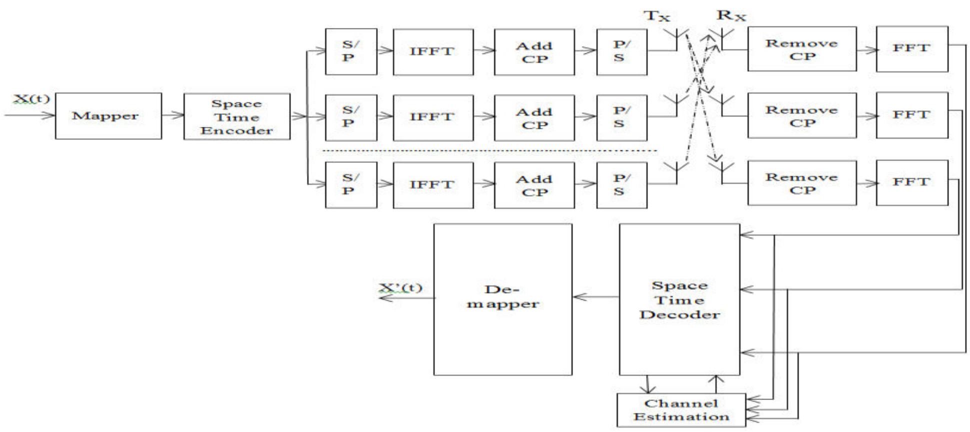

Figure 2: Massive MIMO System Models with Channel Estimation Technique

The virtual modulation scheme will transmit the records in parallel by means of manner of assigning symbols to every sub channel and the modulation scheme will determine the phase mapping of sub-channels thru a complex I-Q mapping vector show in figure 2. The complicated parallel facts stream must be converted into an analogue signal this is suitable to the transmission channel.

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The complicated parallel facts stream has to be transformed into an analogue sign that is suitable to the transmission channel. It is performed to the cyclic prefix add to the baseband modulation signal because the baseband signal is not overlap. After than the signal is splitter the two or more part according to the requirement.

Square Root Recursive Least Square (QR-RLS) Algorithm

A QR-RLS based MIMO-OFDM channel estimation is proposed. Which uses givens rotation based QR factorization for estimator updating. Channel estimation is a center issue for recipient plan in remote correspondences frameworks. Since it is unimaginable to expect to quantify each remote direct in the field, it is critical to utilize preparing arrangements to appraise channel parameters, for example, constrictions and deferrals of the proliferation way. Since in most UWB recipients associate the got flag with corresponded a predefined format flag, an earlier learning of the remote channel parameters is important to foresee the state of the layout flag that matches the got flag.

Mathematical Equation

Be that as it may, because of the wide data transfer capacity and diminished flag vitality, UWB beats experience extreme heartbeat twisting.

Consider the received signal at q^{th} receive antenna represented in matrix form as

$$Y(n) = (U(n).H(n)) + V(n) \tag{1}$$

The posteriori error is given by the difference between the received preamble symbol and its corresponding estimate at time n on q^{th} receiving antenna

$$e(q,n) = y(q,n) - \tilde{y}(q,n)$$

(2)

$$e(q,n) = y(q,n) - X_{pre}(n)\tilde{H}_q$$

(3)

Where $\tilde{H}$ has the same dimensionality as H. The weighted Square-root error at time n is given by

$$e(q,n) = \sum_{i=0}^{n} \lambda^{n-i} (|e(q,i)|)^2$$

(4)

Where λ is weigh factor, whose value lies between (0, 1) depending on channel fading conditions is present. Solution of the above equation gives the optimum value for the estimated channel coefficients H at time n. The optimum solution

$$H_q(n) = R^{-1}{}_X(n) \times R_{Yqx}(n)$$

(5)

Where $R_{Yqx}(n)$ is the autocorrelation matrix of the preamble signal, $R^{-1}{}_X(n)$ is the cross correlation matrix between received signal and the preamble signal at time n.

Different Modulation Technique:-

Binary Phase Shift Keying (BPSK) is a two phase modulation scheme, where the 0's and 1's in a binary message are represented by two different phase states in the carrier signal: θ=0° for binary 1 and θ=180° for binary 0.

Quadrature Amplitude Modulation (QAM)

Many data transmission systems migrate between the different orders of QAM, 16-QAM, 32-QAM and 64-QAM, dependent upon the link conditions. If there is a good margin, higher orders of QAM can be used to gain a faster data rate, but if the link deteriorates, lower orders are used to preserve the noise margin and ensure that a low bit error rate is preserved.

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As the QAM order increases, so the distance between the different points on the constellation diagram decreases and there is a higher possibility of data errors being introduced. To utilize the high order QAM formats, the link must have a very good E_b/No otherwise data errors will be present. When the E_b/No deteriorate, then other the power level must be increased, or the QAM order reduced if the bit error rate is to be preserved.

MODULATION	BITS PER SYMBOL	SYMBOL RATE
BPSK	1	1 x bit rate
16QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64QAM	6	1/6 bit rate

Uniform Planer Array:-

In MIMO technique transmission and reception of signal is done by multiple antenna elements which leads to increased data rate, reliability, and efficiency of wireless systems. But attenuation of the signal over some bands is observed due to fading effect which reduces the quality of data transmission. Fading reduces signal power due to multi-path propagation. As errors in transmitting data increases, the effective throughput of the system decreases which deteriorates the channel capacity of a RF transmitter [1]. Use of diversity technique decreases the fading effect by discovering different signal paths for communication. Time and frequency diversity techniques play a major role in this regard. An advanced technique such as space diversity is used to reduce multi-path propagation. Multiple antennas are used at the transmitter as well as at the receiver to increase channel capacity by reducing the fading effect.

Quantizer Design:-

In the recent years of cellular communication, Dielectric resonator as a radiator is one of the most celebrating antenna structure because of the several reasons such as low metallic loss, high radiation efficiency, no surface wave losses and low dissipation at higher frequency [1]. First time, S.A. Long with his colleagues, McAllister and Shen developed dielectric resonator as an antenna in 1983 [2]. They did his research on cylindrical shaped dielectric resonator antenna (CDRA). However, dielectric resonator is available in different shapes like hemispherical, rectangular, pentagon, tetrahedral but cylindrical shape is widely used by number of researchers. It is due to the two important reasons: (i) ease of commercial availability; (ii) formation of three diverse modes (TE_{mnp}, TM_{mnp}, HEM_{mnp}) for radiating purpose. Recently, ring shape DRA (by creating cavity in CDRA) is widely used because it has lesser quality factor than CDRA. Dual band circularly polarized radiator is one of the most fascinating topics for research due to the following reasons: (i) solo radiator can work for different wireless applications; (ii) multipath fading will be reduced; (iii) transmitter/ receiver become alignment free [3]. In open literature, different procedures are offered to create multiband features such as pentagon shaped aperture coupled CDRA, microstrip line fed CDRA along with C-shaped parasitic slot, moon shaped DGS loaded ring DRA and composite aperture fed CDRA [4-7]. Similarly, some research articles are also available on circularly polarized DRA like chamfered rectangular DRA, grooved rectangular DRA, hybrid Z-shaped CDRA and aperture coupled dual notch loaded cylindrical dielectric resonator antenna.

Analysis and design of dual-band circularly polarized ring dielectric resonator antenna is investigated in this communication. Reformed square shaped aperture is not only used to stimulate the ring DRA but also behave as a radiator. Reformed square shaped slot and annular microstrip line creates orthogonal modes and creates CP wave in upper frequency band

IV. SIMULATION RESULT

MATLAB simulations are performed for various combinations of transmitted and received antenna in massive MIMO system. Simulation experiments are conducted to evaluate the SNR verse bit error rate (BER) performance of the proposed QR-RLS based channel estimation with different modulation technique i.e. QAM-16, QAM-32 and QAM-64 for 8×8 system is shown in figure 3. For different value of SNR, the implemented QR-RLS based channel estimation for 8×8 system shows BER reduction performance.

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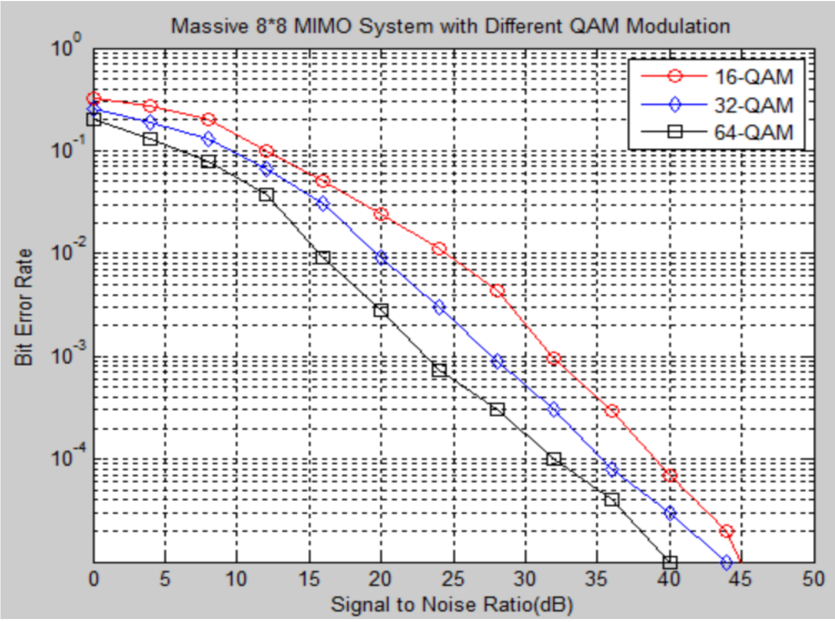

Figure 3: BER vs SNR for Massive 8×8 System with QR-RLS based Channel Estimation Technique

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed algorithm 16×16 system is shown in figure 4.

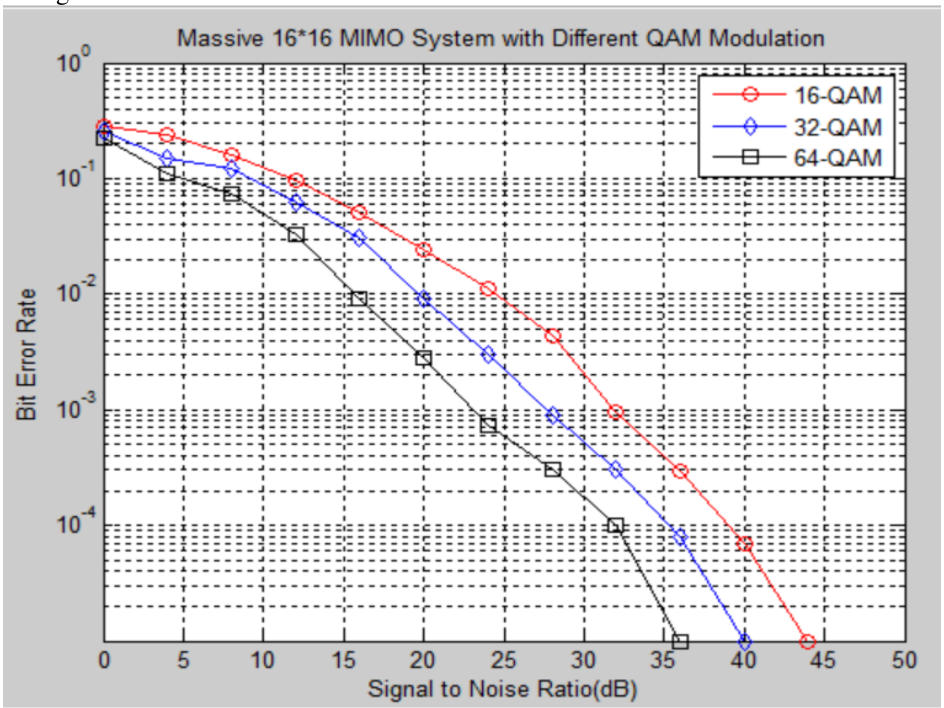

Figure 4: BER vs SNR for Massive 16×16 System with QR-RLS based Channel Estimation Technique

Simulation experiments are conducted to evaluate the SNR VS BER performance of the proposed algorithm 32×32 system is shown in figure 5.

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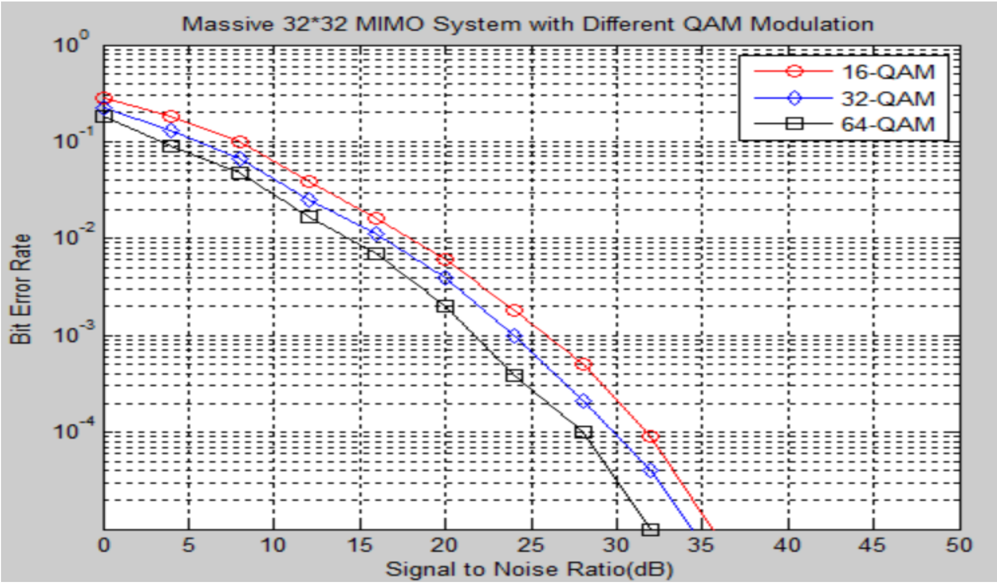

Figure 5: BER vs SNR for Massive 32×32 System with QR-RLS based Channel Estimation Technique

Simulation experiments are conducted to evaluate the SNR verse spectrum efficiency performance of the proposed QR-RLS based channel estimation with different modulation technique i.e. QAM-16, QAM-32 and QAM-64 for 8×8 system is shown in figure 6.

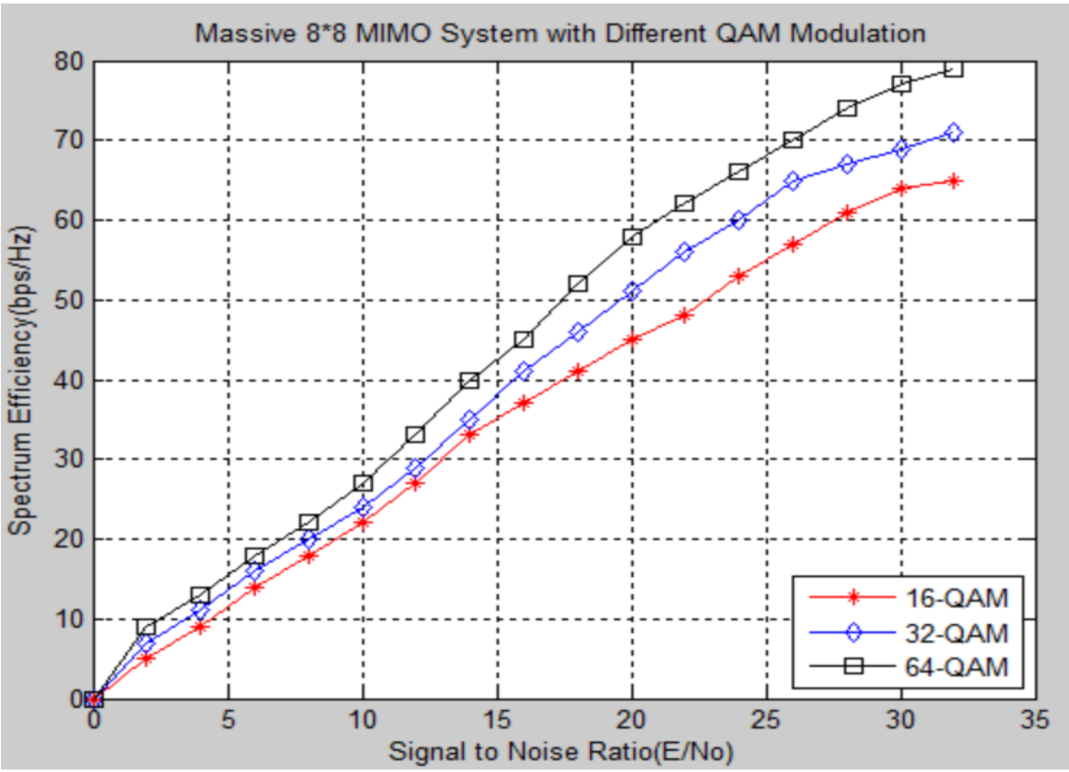

Figure 6: Spectrum Efficiency vs SNR for Massive 8×8 System with QR-RLS based Channel Estimation Technique

V. CONCLUSION

We have developed a method for tracking the error for receiver side with knowing the transmit pre-coder or data. The proposed method is particularly useful in minimize the error in receiver side. The proposed QR-RLS based channel

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estimation technique with different QAM modulation technique is applied for different transmitter and receiver antenna and calculated bit error rate (BER) and spectrum efficiency with respect to signal to noise ratio (SNR). Simulation result is clear that the 32×32 transmitter and receiver antenna is best performance compared to 16×16, 8×8 transmitter and receiver antenna.

To detect and quantize beams properly, we also developed a multi-round beam search approach that scans both vertical and horizontal domains jointly under the moderate computational complexity. To reduce total feedback overhead, we also proposed a wideband quantizer that utilizes the correlated information between multiple frequency tones. Numerical simulations verified that the proposed narrowband quantizer gives better quantization performance than previous CSI quantization techniques, and the proposed wideband quantizer further improves the quantization performance with less feedback overhead compared to the narrowband quantizer in wideband settings.

REFERENCES

[1] Jiho Song, Junil Choi, Taeyoung Kim, and David J. Love, “Advanced Quantizer Designs for FDD-Based FD-MIMO Systems Using Uniform Planar Arrays”, IEEE Transactions on Signal Processing, Vol. 66, No. 14, July 15, 2018.

[2] H. Q. Ngo A. Ashikhmin H. Yang E. G. Larsson T. L. Marzetta "Cell-free massive MIMO versus small cells" IEEE Trans. Wireless Commun. vol. 16 no. 3 pp. 1834-1850 Mar. 2017.

[3] Huang A. Burr "Compute-and-forward in cell-free massive MIMO: Great performance with low backhaul load" Proc. IEEE Int. Conf. Commun. (ICC) pp. 601-606 May 2017.

[4] Q. Huang A. Burr "Compute-and-forward in cell-free massive MIMO: Great performance with low backhaul load" Proc. IEEE Int. Conf. Commun. (ICC) pp. 601-606 May 2017.

[5] H. Q. Ngo A. Ashikhmin H. Yang E. G. Larsson T. L. Marzetta "Cell-free massive MIMO: Uniformly great service for everyone" Proc. IEEE Int. Workshop Signal Process. Adv. Wireless Commun. (SPAWC) pp. 201-205 Jun. 2015

[6] E. Nayebi A. Ashikhmin T. L. Marzetta H. Yang "Cell-free massive MIMO systems" Proc. 49th Asilomar Conf. Signals Syst. Comput. pp. 695-699 Nov. 2015.

[7] F. Rusek, D. Persson, B. K. Lau, E. G. Larsson, T. L. Marzetta, O. Edfors, and F. Tufvesson, “Scaling up mimo: Opportunities and challenges with very large arrays,” IEEE Signal Process. Mag., vol. 30, no. 1, pp. 40–60, Jan 2013.

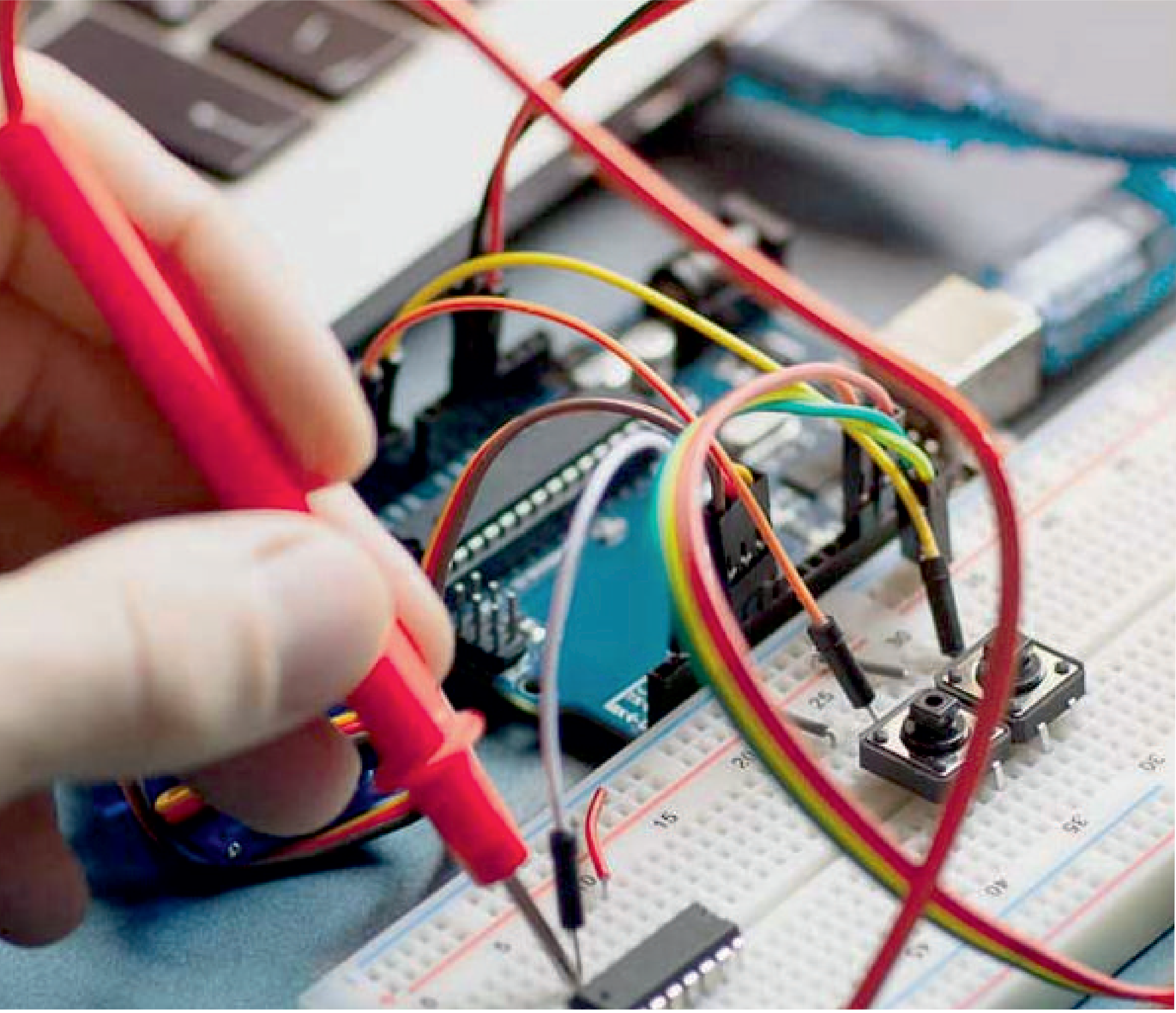
[8] L. Lu, G. Y. Li, A. L. Swindlehurst, A. Ashikhmin, and R. Zhang, “An overview of massive MIMO: Benefits and challenges,” EEE J. Sel. Topics Signal Process., vol. 8, no. 5, pp. 742–758, Oct 2014.

[9] S. Payami and F. Tufvesson, “Channel measurements and analysis for very large array systems at 2.6 ghz,” Proc. 6th Eur. Conf. on Antennas and Propag. (EUCAP), pp. 433–437, March 2012.

[10] A. F. Molisch, V. V. Ratnam, S. Han, Z. Li, S. L. H. Nguyen, L. Li, and K. Haneda, “Hybrid beamforming for massive MIMO: A survey,” IEEE Comm. Mag., vol. 55, no. 9, pp. 134–141, 2017.

[11] F. Sohrabi and W. Yu, “Hybrid digital and analog beamforming design for large-scale antenna arrays,” IEEE Journal of Selected Topics in Signal Processing, vol. 10, no. 3, pp. 501–513, April 2016.

[12] O. E. Ayach, S. Rajagopal, S. Abu-Surra, Z. Pi, and R. W. Heath, “Spatially sparse precoding in millimeter wave MIMO systems,” IEEE Transactions on Wireless Communications, vol. 13, no. 3, pp. 1499–1513, March 2014.



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