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An Improved Adaptive Beamforming Algorithm for 5G Interference-Coexistence Communication

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ABSTRACT

In a 5G network, coexisting wireless technologies could cause interference, which would impair the performance of the received signal. This work proposes a novel approach for handling interference-coexistence communication in antenna array processing. We use the Linearly Constrained Minimum Variance (LCMV) filter, a linear filter. We apply a log-sum penalty to the coefficients and incorporate it into the traditional single linearly constrained least mean square cost function (LC-LMS). Iterative filter weights are calculated using a formula. Using simulations in an antenna environment with a signal of interest, noise, and interferences, we show that the novel method's convergence rate is quicker than the conventional one. The mean-square-error (MSE) of the suggested approach is also confirmed. The results show that our method has a lower MSE than the conventional LC-LMS algorithm. In order to handle the coexistence of signals and interference in a 5G system, the suggested adaptive beam forming method can be implemented.

KEYWORDS : Interference-coexistence, LC-LMS, Log-Sum Penalty.

1. INTRODUCTION

Electrocardiography (ECG)

Five-generation (5G) connectivity has begun to be widely deployed in a few nations worldwide. Therefore, in order to properly build the architecture by which such signals are accurately transmitted and received, comprehensive studies on channel modelling and signal measurements with respect to the fundamentals of physics are required. Utilizing such technology is encouraged by its promise of increased data rates and improved network performance over already used networks. This is frequently accomplished by taking use of larger bandwidths in higher frequency bands, such as 30 Gigahertz (GHz) [3]. For instance, across a bandwidth of roughly 270 Megabits per second (Mbps), millimetre wave (mmWave) communication offers up to 10 Terabits of data rates and spectral efficiency (SE) of about 100 bps/Hz (30–300 GHz frequency band).

These methods allow for significant signal gains and may expand the signal's range, but they also result in larger and more complex antenna designs for both transmitters and receivers. The study, which found that performance degradation is inversely correlated with antenna size, serves as support for this. The study has also brought to light a few technological difficulties that scientists should be aware of before tackling the technology. While beamforming extends the use of massive MIMO and cell-free technologies by utilizing a wide range of antenna elements to provide high security, enhanced energy efficiency (EE), good communication reliability, and low signal processing complexity, these technologies are regarded as some of the most exciting innovations for the 5G communication paradigm.

Beam Forming

The goal is to address the work being done by some researchers on beamforming techniques that improve network performance by reducing radiation in all directions. Following is a summary of the contributions, a better knowledge of interference in 5G communication and interference-reducing beamforming techniques (i.e. green communication). A concise but effective exposition of the key 5G channel modelling models. The comparisons of various interference mitigation methods help to clarify the efficacy of beamforming approaches. The presentation of numerous studies on this topic encourages the study to serve as a benchmark for beamforming in upcoming 5G systems. In their simplest form, all signals fade and suffer significant channel losses.

Hybrid Beam Forming

In this context, the work described in provided a hybrid beamforming strategy that can make use of the channel state information to create a beamsteering map codebook. The method makes an effort to reduce interference between the sub-bands brought on by the orthogonal frequency division multiplexing's carrier offsets (OFDM). Despite the appearance of complexity, a digital beamformer with controlled channel inversion was utilised to simplify the design. According to, a 5G-IOT smart virtual antenna array is created to effectively direct the generalised frequency division multiplexing (GFDM) beams towards the desired angles. This eliminates interference. Despite the interference being reduced, the performance is only mildly concerning because there are few higher frequency channel models available.

Time Division Multiple Access (TDMA)

Any beam can be selected at any time by the antenna. Other methods, such as time division multiple access (TDMA) approaches in or zero-forcing (ZF) of can be utilised to reduce interference with the aid of smart antennas. A dual beam antenna that uses the 28 GHz frequency spectrum is suggested in. In order to provide a larger beam with a high gain, the design depends on merging two separate radiating parts. Wider beams are produced using microstrip patches on the azimuth plane, and a wave-guide aperture is used to produce a greater gain on the elevation plane. In addition to having a smaller antenna, the antenna can reduce interference in a useful way by maximising the radiation from its two radiating components.

2. 5G COMMUNICATION

The rapid, unprecedented network growth and rising network demands that drove the development of the 5G system prompted researchers to examine the 4G communication systems' limits as a foundation for the new 5G system specifications and services. Figure shows how the network has expanded to serve many different types of communications (e.g. agricultural monitoring services, medical services. Because so much information is shared in these settings, sophisticated systems are needed to handle it. A significant issue is the relationship between frequency and data rate, as low frequencies won't be able to meet these needs and high frequencies can't provide greater coverages.

Numerous studies came to the conclusion that, in addition to the demands of newly emerging services like cloud computing, smart homes, drone systems, multimedia streaming, point-to-point communication, etc., which have already been exceeded, traffic is expected to increase to 24.3 Exabytes per month by 2019. Therefore, the 5G communication system is the wireless communication revolution that supports spectacular applications, extraordinary data rates, and top-notch performance. Fundamental modifications to the communication infrastructure are required, as well as creative performance realisation. The subsections that follow include descriptions of some of the significant 5G issues, applications, and services.

In order to satisfy the predicted demands for data transmission in the coming decade, the deployment and commercial operation of 5G networks are accelerating.

In recent years, there has been a lot of interest in 5G networks, which are emerging intelligent systems that apply enhanced signal processing, D2D, internet of things (IOT), edge computing, and wireless access technologies. The coexistence of several wireless technologies in a 5G network may result in interference in the same frequency range, which would degrade the received signal. In the network, anti-interference communication will continue to be crucial. The use of adaptive beamforming technology in antenna processing to tackle interference issues has always been crucial. The system incorporates the direction information into the sent signal, which is subsequently mixed with noise, interference, and signal of interest (SOI) at the receiving end. In actuality, SOI's Direction of Arrival (DOA) differs from existing.

3. RELATED WORKS

In, the hybrid beamforming architecture in mm Wave bands is shown. Radically new air interface technologies must be developed to accommodate this new paradigm shift in mobile communication. Inter-cell interference, brought on by the anticipated considerable cell densification required to enable the required 10-fold increase in spectral efficiency, is one of the major issues the mobile industry will confront. The creation of signal, DOA, and blind beamforming may all be included in the beamforming algorithm based on the beam reference signal. Based on the beam reference signal: The transmission end of such a system requires a known training sequence or pilot sequence, but it is not necessary to know or estimate the users' degrees of availability (DOA).

The LMS, RLS, direct matrix inversion, and other more traditional algorithms. Such a robust approach will work better if the system synchronizes in a state that is close to ideal. Based on DOA beamforming: An algorithm may determine this information without knowing who sent the reference signal, but it has to know how to estimate DOA. The portion of the predicted weight value that is adjusted based on the DOA and its components. The traditional method of estimating DOA uses ESPRIT, MUSIC, and a number of enhanced algorithms built on two techniques.

Blind beamforming

By changing the weighting vector of the blind beamforming array antenna, the blind algorithm obtains a beam pattern that meets the criteria. Widrow and Hoff put forth the earliest least-mean-square (LMS) algorithm. It has drawn curiosity from all across the world and is renowned for its simplicity. However, the steady state error and convergence rate are not as pleasing. The issues have been somewhat resolved by the LMS derivations. Since the LMS adjustment is directly inversely proportional to the input vector, the approach experiences gradient noise amplification issues when the input is sufficiently large. The problem has been successfully solved by the Normalized LMS method, which uses the squared Euclidean norm of the input vector at each adaptation. Additionally, variable-step LMS have significantly increased convergence rate. The mean-square-error (MSE) between the estimation signal and the intended signal is minimized by all of the aforementioned derivations.

The Minimum-Mean-Square-Error (MMSE) criterion, which uses MSE as the cost function, is employed in the derivation. It should be noted that the solution has not received any new restrictions. The author of introduces two distinct penalties on the cost function based on LMS in MMSE. The method with penalty outperforms LC-LMS in results for convergence.

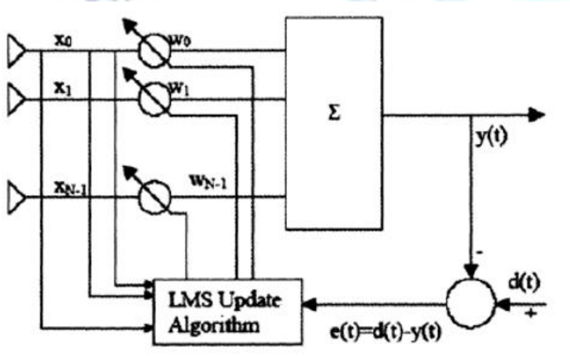
Many adaptive beamforming methods employ the update technique. The majority of algorithms can be divided into two groups, Non-Blind Adaptive and Blind Adaptive, depending on whether or not a training signal is used. In our study, we used non-blind algorithms.

4. PROPOSED METHOD

In this study, we provide novel LCMV algorithms. The output power is used as the cost function in the LCMV criterion. Frost made the first suggestion. Additionally, it performs well in anti-interference. However, the convergence rate runs counter to steady state. The method has been significantly improved by other academics. To advance it, however, further work is still required. In response to, we provide a novel approach built on the LCMV framework. The cost function is subject to the log-sum penalty. Through mathematical derivation, we arrive to the ultimate formulation. Simulations are run to demonstrate the novel method's superiority to the conventional singly linearly constrained LMS. The method performs better in steady state and convergence rate than other methods.

Least-mean-square (LMS) algorithms are frequently employed in adaptive filtering applications for modelling, equalisation, control, echo cancellation, and beamforming. These algorithms have shown to be both reliable and simple to implement methods for on-line estimate of time-varying system parameters [7]. The antenna array pattern is optimised to have the maximum possible gain in the direction of the desired signal and nulls in the direction of interferers, as shown in Fig., which illustrates a generic adaptive beamforming system that requires a reference signal. The outputs of the individual sensors are linearly combined after being scaled using corresponding weights.

Consider an adaptive beamforming system that includes a uniform linear array (ULA) with N isotropic elements. It is depicted in the picture below.



The LMS technique will be used to calculate the weights here based on the Minimum Squared Error (MSE) criterion. As a result, the spatial filtering problem entails signal estimation from the received signal (i.e., the array output) by minimising the error between the reference signal d(t), which closely matches or exhibits some degree of correlation with the desired signal estimate, and the beamformer output y(t) (equal to wx(t)). This is a typical Weiner filtering problem, and the LMS algorithm can be used to find the answer iteratively. The coefficients in a weight vector w (series of amplitude and phase coefficients) are multiplied by the signal x(t) received by various antenna elements in order to change the phase and amplitude of the incoming signal appropriately.

We impose a log-sum penalty on the coefficients and add it to the cost function on the foundation of conventional single linearly constrained least mean square (LC-LMS). We arrive at the filter weights' iterative formula. Through computer simulations of an antenna environment with an interesting signal, noise, and interferences. In this section, we provide the new algorithm's precise derivations. The recently proposed algorithm bases its object function on the LC-LMS and adds a log-sum penalty to it.

$$\min P_{out} = \min E\left[|y(n)|^2\right]$$
$$\text{s.t.} \begin{cases} \mathbf{s}^H \mathbf{w} = z \\ \sum_{i=1}^{M} \log(1+ \mid w_i \mid /\varepsilon') = t \end{cases}$$

$$\begin{aligned} \mathbf{w}(n+1) = & \mathbf{P}\left\{\mathbf{I} + \frac{\text{sign}[\mathbf{w}(n)]\,\text{sign}^H[\mathbf{w}(n)]\mathbf{sH}}{MQ(n)}\right\}\mathbf{w}(n) \\ & - \mathbf{P}\left\{\mathbf{I} - \frac{\text{sign}[\mathbf{w}(n)]\text{sign}^H[\mathbf{w}(n)]}{MQ(n)}\mathbf{P}\right\}\mu\mathbf{R}\mathbf{w}(n) \\ & + \mathbf{P}\frac{\text{sign}[\mathbf{w}(n)]}{MQ(n)} e_L(n) \end{aligned}$$

where

$$\mathbf{P} = \mathbf{I} - \mathbf{sH}$$
$$Q(n) = 1 - \frac{1}{TM}\text{sign}^H[\mathbf{w}(n)]\mathbf{sHB}$$

5. SIMULATION RESULTS

The comparison of Convergence Rate (mu) at different mold of the vector. The convergence rate (mu) should be better for a better results. The output at receiver's side will converge more if the convergence rate is higher.

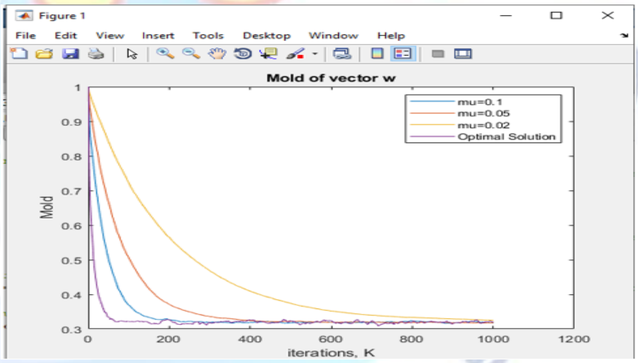


Fig 1 Convergence Rate for different Molds of Vector

From the results, we can say that at higher convergence values the output has converged better with the receiver's output and not perfectly converged at low convergence values. This shows that higher the convergence value the better the convergence rate at receiver's side but, it doesn't mean that the higher value can go upwards for a maximum value, it also have a final limits that means the optimal solution.

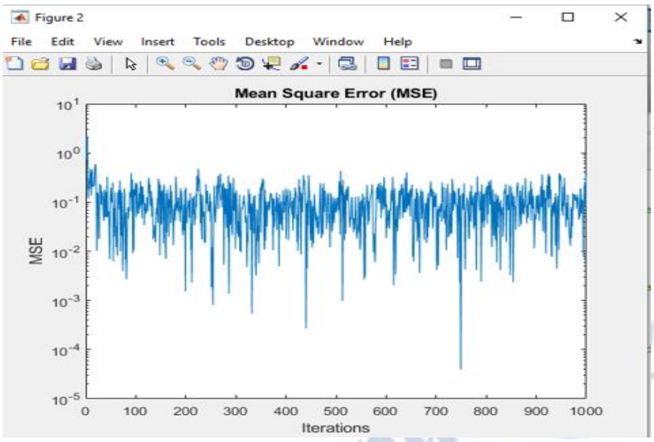


Fig 2 Mean Square Error (MSE) of the Signals

The above results shows the mean square error of the signals. The LMS algorithm always aims at taking the signal with low mean square error. That means the minimum the error value maximum the convergence at output or receiver's side.

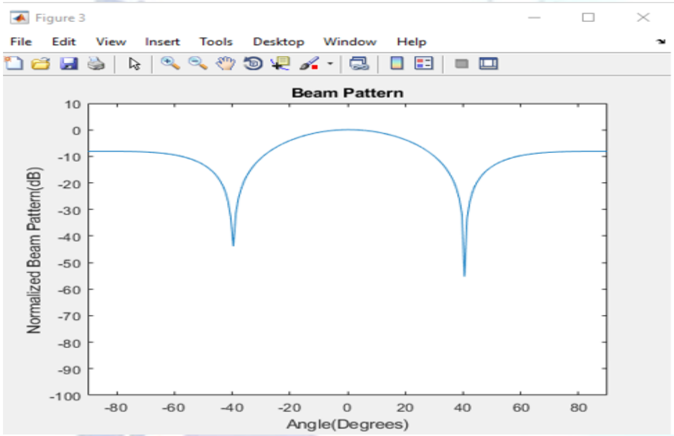


Fig 3 Beam Pattern

Finally, the beam formed at the receiver's side. The values at receiver's side forms a beam which sits with nulls at -40 and 40 and centred at 0. Beam formed at the receiver's side makes the desired beam's pattern which is a normalized beam pattern.

6. CONCLUSION

A new method based on the LC-LMS was proposed. The object function is given a log-sum penalty, and theoretical analysis is provided step by step until the final formula is derived. After then, experiments are run on the Matlab platform. The first experiment compares the steady state and convergence rates of the newly suggested method and the LC LMS. The outcomes demonstrate the new method's superiority and efficacy. In the second experiment, we examine the variables that could impact how well the method works. As can be seen, the setting of the parameter t affects how well the algorithm performs. In order to conclude, we compare beam patterns. The log-sum LC-LMS performs as well as or better than the LC-LMS.

Discussion

The Beam is formed better with minimizing the error with the application of Log-Sum for the LC-LMS Filter. The 5G Communication is better at forming beams better than the existing methods which makes our beam forming algorithm better. The interference is also eliminated majorly by applying the proposing Log-Sum LC-LMS Filtering technique.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] S. Wang, Y. Wang, B. Xu, Y. Li, and W. Xu, "Capacity of two-way in-band full-duplex relaying with imperfect channel state information," IEICE Trans. Commun., vol. E101-B, no. 4, pp. 1108–1115, Apr. 2018.

[2] S. Wang, D. D Wang, C. Li, and W. B Xu. "Full Duplex AF and DF Relaying Under Channel Estimation Errors for V2V Communications," IEEE Access. vol. 6, pp. 65321-65332, Nov., 2018.

[3] Z. Zhao, S. Bu, T. Zhao, Z. Yin, M. Peng, Z. Ding, and Tony Q. S. Quek, "On the design of computation offloading in fog radio access networks," to appear in IEEE Trans. on Veh. Technol., [Online] Availiable:https://ieeexplore.ieee.org/document/8730522.

[4] Z. Zhao, M. Xu, Yong Li, and M. Peng, "A non-orthogonal multiple access-based multicast scheme in wireless content caching networks," IEEE J. Sel. Areas Commun., vol. 35, no. 12, pp. 2723–2735, July 2017.

[5] B. Widrow and S. D. Stearns, Adaptive Signal Processing, New Jersey: Prentice Hall, 1985.

[6] D.L. Duttweiler, "Proportionate normalized least-meansquares adaptation in echo cancelers," IEEE Trans. Speech Audio Process., vol. 8, pp. 508C-518, 2000.

[7] W.Y. Chen, R.A. Haddad, "A variable step size LMS algorithm," Proceedings of the 33rd Midwest Symposium on Circuits and Systems, 1990, pp. 636–640.