International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 3, March - 2014

Analysis of Hybrid Mobile Satellite System using SFC

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Abstract- **An increasing number of hybrid mobile systems comprising a satellite and a terrestrial component are becoming standardized and realized. The next generation of these systems will employ higher dimensions adopting multiple-input multiple output orthogonal frequency division multiplexing (MIMO_OFDM) techniques. The Multiple-Input Multiple-Output (MIMO) rush that has taken over the terrestrial wireless community, dual polarization transmission and reception has been envisaged as an effective MIMO realization for overcoming size limitations of either satellite or terrestrial mobile broadcasting systems. In this work, recent studies of dual polarization MIMO for each component is done and the use of full-rate full-diversity (FRFD) codes adopting a space frequency paradigm is reviewed. A scheme taking advantage of the separation between the subcarriers to enhance the coding gain is also proposed. By critically assessing the different options for the 4transmit, 2 receive hybrid scenario taking into account system and channel particularities, and the proposed scheme which is the solution for enhancing the performance of next generation hybrid mobile satellite systems is also demonstrated.**

I. INTRODUCTION

The hybrid mobile system comprising satellite and terrestrial's component the most promising way for achieving truly the service to the mobile user terminal .The recent impressive momentum of hybrids mobile system in terms of standardization and system implementation. The terrestrial infrastructure is not economically justified. The urban and indoor users are usually accommodated. Exclusively by terrestrial repeater and open and rural coverage satellite only, there are parts of the overall service area such as suburban both components are presents.

The better quality of service is achieved in such point the two components are received coherently. The state of art of algorithm digital video broad casting and satellite handheld specification employs the orthogonal frequency division multiplexing.OFDM on both links and utilizes the cyclic prefix along with the satellite handheld initialization packet for coherent reception.

Dual polarization transmission and reception has been effective MIMO realization for overcoming size limitation either satellite or terrestrial mobile broadcasting system. Several space time coding techniques for dual polarized transmission over satellite path have been consider for literature [7].Golden code and matrix-D code has been focused in the satellite MIMO OFDM[8].with regards to the hybrid system space time coding technique for single stream transmitter is considered in[10] assuming the multiple frequency network architecture.ST coding of signals from satellite using dual polarization and multiple terrestrial repeater employing single polarization considered in the recent work[11] for a SFN architecture.

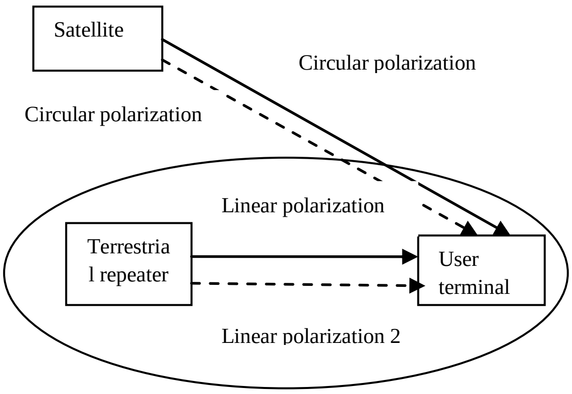
The paper focus on analytical performance characterization of space time coded for dual polarized hybrid mobile satellite systems employing two polarization per transmitter and co-located dual polarized antenna at the receiving user terminal [12] The exercise build on the study of and offer insight on the design of space time coded system with enhanced performance of both transmitter employ OFDM signalling and coherence reception is assumed.

The scenario can be abstracted 4 transmit and 2 receive MIMO system for each OFDM subcarrier, The STC system is designed is support the rate of 2 symbols/channel while achieving the maximum diversity of 8.[12]the said diversity of MIDO code can be observed high SNR and requires maximum likelihood receiver jointly decoding at least 6 symbols. The MIDO code degrades with increased power imbalance between two transmissions leading to a decoder overload when one path is lost the aspect is importance since hybrid system authority on satisfactory performance in the absence of either of the transmissions.
The motivate scheme the search of alternate transmit schemes with lower decoder complexity in absence of one paths.[13].

In this regard frequency selectivity induced by relative delay between the two transmission provides an additional degree of freedom that can be exploited [16].Toward this end the use of 2*2Full rate full diversity code as a space frequency codes [17] frequency selectivity contribution of paper.

A. Each transmitter network transmits two streams over orthogonal polarization for SFN hybrid mobile satellite system. Utilize the practical system parameter and appropriate channel models for the dual polarization satellite and terrestrial links.
B. The error bounds derived through pair wise error probability analysis shows that proposed scheme fully exploits the available of polarization diversity.
C. The coding gain of the FRFD code turns out to the function of relative delay between the transmission and

spacing between the separations of subcarriers. The proposed algorithm for enhancing the coding gain by choosing the subcarrier spacing. The introduce the additional degree of freedom to the coding gain of FRFD code.



The rest of the paper is organized as follows: section II describes related work, section III describes system model and SFC coding section IV provides different number of different system simulations. Sections V conclude the paper.

II. RELATED WORK

In this paper describes the MIDO are important in the future wireless communication. Especially tempting is the channel due to its immediate applicability in the digital video broadcasting .Such channels optimally employ rate two space time code consisting 4*4 matrices. Recently some reduced complexity constructions have been proposed. MIDO code will always result in at least 37.5% worst complexity reduction [1].

In wireless broadband system the available time, frequency and spatial diversity can be exploited using complex space time frequency codes. The channels need to be constant during transmission of one orthogonal design. In a4G OFDM system the element of orthogonal design can be distributed space time block code over neighbouring subcarriers which cause problem in frequency selective channel [3].

The 2*2 full rank full rate linear dispersion space time block codes (LD-STBC).This problem appears because either transcended element and linear dispersion element with high degree are used to construct the division algebra [4].satellite system represent a significant solution to provide communication services to mobile users in under populated regions. In all cases, satellite system has unique capabilities in terms of robustness, wide area coverage broadcast and multicast capabilities [5].

The space time frequency code and space frequency code constructions are focused. The systematic design of STF codes full diversity with high coding gain [6].BER performance is evaluated.BER performance of such optimized code is to be better than those of existing codes [7].

The Space Frequency codes offer considerable performance improvement over existing approach. The gain over the full diversity SF codes constructed orthogonal design, second apply interleaving method can have a significant effect on overall performance of the Space frequency code. The maximum likelihood decoding complexity of the proposed scheme increases exponentially with the number of transmit antenna and targeted frequency diversity order, but sphere decoding methods can be used to reduce the complexity [8].

Dual polarized arrays in multi antenna wireless system, Rayleigh and Rican fading channel for arbitrary array sizes. The model follows on a limited number of physical parameter, Such as channel spatial correlations, the channel Co-polar and cross polar and the antenna cross polar discrimination [10].

In the paper focus the reuse of same 2x2 full rate full diversity Space time code on both transmission. This leads to Single frequency network architecture the repetition assures the performance of even absence of one of the links. Further the

The performance of golden codes in a hybrid satellite/terrestrial system framework employing dual polarized MIMO-OFDM transmissions. Although the use of golden codes in satellite and terrestrial scenario has been independently.In this work exploits the relative delay to create a multipath scenario and further improve the coding gain of the golden codes, which is otherwise fixed. This is made possible by utilizing the golden code in a space frequency coding framework instead of space time coding.[13].

III. SYSTEM MODEL AND SFC CODING

A. System design

The purpose of analysis of an S-band Single frequency network hybrid system with single geostationary satellite and single terrestrial gap filter is assumed in the figure1.The feeder link from gateway station to the satellite is assumed ideal while downlink illuminates the global beam of orthogonal polarization. The satellite transmits over dual circular and terrestrial repeater over dual linear polarization.

B.Generic transmitter

The same data is transmitted from the satellite and terrestrial repeater. The transmitter employs a dual polarized antenna transmitting a OFDM signal with N subcarrier on each polarization, there Nis assumed to be even. The transmission strategy involves formulating the SFC, C is nothing but 2*N matrix such that N entries of its the row constitute of OFDM symbol transmitted m_{th} polarization=1, 2, 3, 4.towards generating C, The transmitted buffer stream of 2N symbols drawn from a M–QAM constellation. The stream is then arbitrarily into N/2 vectors each of length is 4.The kth vector is denoted by [a_0(k),a_1(k),a_2(k),a_3(k)]is used to connect the Full rate full diversity code G_k. A straight forward construction of C from the 2*2 dimensional vector involves stacking them as C=[$G_{1,}$G2.............$G_{N/2]}$.The requires G_k to be transmitted on subcarrier(2k-1) and 2(k-1).whatever the flexibility in subcarrier selection ,those advantage will became the motivate the following structure for C,

$$C=[G_1,G_2.............G_{N/2}]\prod \qquad (1)$$

There $\prod$ is a N*N permutation matrix the subcarriers used by $\{G_k\}.G_k$ employs the subcarriers k_1 and k_2.consquently an IFFT operations is performed on each row of C and Cyclic prefix corresponding to a channel delay spread of τ_{max} is inserted before modulating on to an appropriate polarized carrier.

C.Channel model

The typical block fading model denotes the 2*2 channel matrix corresponding to dual polarization transmission from satellite and terrestrial repeater by H_s and H_t. The both line of sight and non line of sight signals reach the mobile terminal. The Rican MIMO channel, where the channel matrices H_q are

$$H_q=\sqrt{K_q/(K_q+1)}\,\bar{E}_q+\sqrt{1/(K_q+1)}\hat{H}_q, \quad q=s,t \qquad (2)$$

Let $\bar{E}_q$ is the fixed LOS matrix, $\hat{H}_q$, denotes the NLOS component and K_q is the Rican $_{factor}$ for the channel. (q=s=satellite=r=terrestrial).correlation for NLOS components follows the kronecker model [18]

$$\bar{E}_q=[R_q^{tx}]^{x/2}\,H_{w,q}[R_q^{rx}]^{1/2}, q=s,t \qquad (3)$$

R_q^{tx} and R_q^{rx} are similarly same. In general, the satellite and terrestrial transmission the user terminal with reflective delay of $\tau 0$ seconds. Without the loss of generality, the satellite transmission is assumed to reach the terminal first. To consider the satellite signal as reference, the resulting cumulative channel matrix takes the following form due to the transmission of identical data,

$$H(\tau)=\sqrt{\varepsilon_s}\,H_s\delta(\tau)+H_t\delta(\tau-\tau_0) \qquad (4)$$

Here δ being the Dirac delta and ε_s denoting the receive power imbalance between the satellite and terrestrial component. This imbalance is a result of the un faded link budget, while the composite Rican channel of (4) is used in the sequel for error analysis, performance over the following channel model will be considered details follows.

1) Loo satellite channel

The satellite Line of sight component is fixed in (4), consider the proportional loo model [20] where LOS component follows lognormal distribution. In addition to R_s^* and average power of the Rayleigh component(σ_s^2),the channel parameters also include the correlation matrix of the components($\bar{y}_{Loo}$) as well as the mean (σ_{Loo}) and standard deviation(ψ_{Loo}) of the lognormal distribution[21]

2) Terrestrial channel

A terrestrial channel having L resolvable path with delays, The NLOS components of different terrestrial paths are assumed to be uncorrelated, and the terrestrial multipath channel considers a narrow band scenario for each path.

The satellite and terrestrial transmission reach the user terminal with relative delay without the loss of generality the satellite transmission is assumed to reach the terminal first. considering the satellite signal as a reference the resulting cumulative channel matrix takes the following form of the transmission identical data.

The power imbalance between the satellite and terrestrial components. the imbalance is a result of the unfaded link budget. While the composite Rican channel of(4) is used in the sequel for error analysis. This type of system either in a single or multi frequency network mode combines the high proliferation of terrestrial wireless with wide coverage of satellite, especially the area where a terrestrial infrastructure is not economically justified. Urban and indoor users are usually accommodated exclusively by terrestrial repeaters.

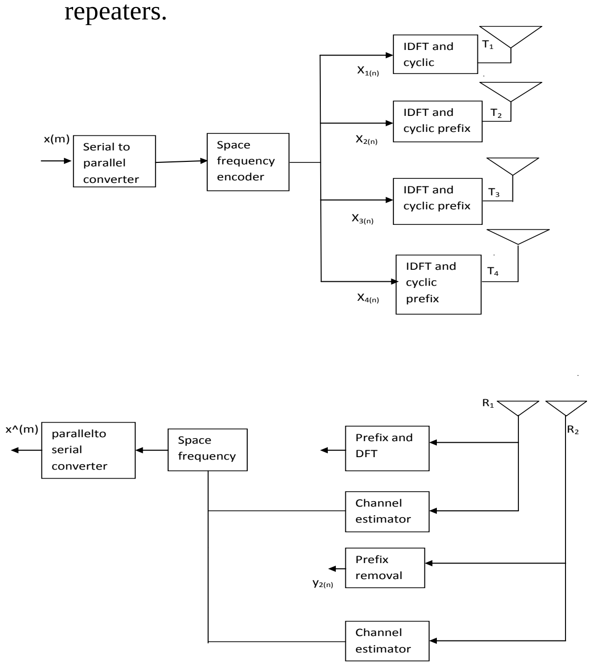


Figure a: Block diagram of four transmitter two receiver

D.Receiver

Consider that $\tau_0 \leq \tau_{max}$, standard OFDM receiver processing relates the transmitted and received signal on subcarrier basis [19].let $r_{n,n}$ ε[0,N-1] be the received signals on both polarizations of the n^{th} subcarrier and T be the

OFDM symbol duration. Further for the n^{th} subcarrier, let n denote the receiver noise

$$H^f(n)=\sqrt{\varepsilon_s}\ H_s+H_t e^{-j2\prod rn}/T \qquad (5)$$

The above equation denotes the channel frequency response,G_k uses separation of subcarriers are k_1 and k_2.The receiver having perfect channel knowledge and employs a maximum likelihood decoder based on (5).The symbols[$\underline{a}_0$(k),$\underline{a}_1$(k),$\underline{a}_2$(k),$\underline{a}_3$(k)] used to construct the G_k are independent for different k and the ML receiver .

IV. PAIR WISE ERROR PROBABILITY

The Pair wise error probability of decoding C is considered for performance analysis. Whatever ,since the independent decoding of different G_k is optimal in the present coding scheme,eneumerating the pair wise error probability of decoding G_k erroneously as $G_k^{\wedge}$ for each ^{k,}sufficient for assessing the diversity and coding gain[19].

A. Diversity gain

The transmission strategy the equivalent channel to have a dimension 2*2 and hence the maximum diversity gain it can be achieved is 4.

a) Extension of Loo satellite channel
b) Effect of terrestrial multipath channel
c) Hybrid system based on MIDO code

While the proposed scheme result in equivalent 2*2 system, MIDO code retain the 2 receive 4 transmit structure when both transmission are present. The MIDO codes to extract a diversity of 8 while offering full rate [12], there by motivating the scheme the study for hybrid system, MIDO codes result in decoder overload more symbol to decode than received data when any of link is missing, even if the remaining link can support full rate .In such situate code should be lowered to achieve the meaningful decoding. The result is the degradation in performance due to power imbalance among two links. The proposed scheme and the receiver can decode the transmitted FRFD as long as support the full rate.

B.Coding gain and its improvement

The coding gain of c is maximized when coding gain of G_k is maximized. The coding advantage for G_k takes the familiar form of $(\prod^4_{i=1}\lambda_i(s_k))^{1/4}$.the gain depends on the correlation matrices, codeword error, relative delay and the subcarriers used. While the coding gain considered FRFD codes are fixed otherwise, their use as SFC in a hybrid system allows for an enhancement.

Since R_q^*,q=s,t are assumed invertible, there exists a µ>0such that are positive semi definite for q=t,s.In order to focus the coding gain maximization. This eliminates the dependence of transmitter processing on various correlations matrices. Such a move seems appropriate since the transmitter may not be to the correlation matrix information. Where k1, k2 are only design variable recall the subcarriers used to excite Gk, Hence, in order to enhance the coding gain. The results in,

$$(k_1, k2)=\arg\min_{(m,n)} \cos(2\prod(m-n)\,\tau_0/T) \qquad (7)$$

The separation between the subcarriers could results in $(k_1-k_2)\,\tau_0/T=1/2$.the theme of subcarrier separation two enhance the coding gain was consider in paper [19].whatever the optimum subcarrier separation requires the knowledge of τ_0 at both the transmitters. This information is hard to obtain due to the lack of feedback, the separation such that $(k_1-k_2)\,\tau_{max}/T=1/2$.this is based on the fact that the system is designed for τ_{max} and the transmitters are aware of this quantity. Further it is desired that subcarrier separation for each G_k satisfies $(k_1-k_2)\tau_{max}/T=1/2$.this ensures similarly in average performance of the various G_k. In addition, all the subcarriers need to be utilized, once per transmission, to obtain high throughput.

1) subcarrier selection algorithm to enhance the coding gain: The subcarriers for each G_k that is k_1,k_2,such that

$\cos(2\prod(k1-k2)\,\tau max/T)$ is minimized while ensuring that all subcarriers are used in C.Such scheme has advantage of being used in transmitters to blind channel statics. A same procedure was used in the context of designing specific low rate space frequency code over Rayleigh channels.

2) Advantage of hybrid transmission: The advantages of hybrid transmission arise from the coding gain improvement. The hybrid transmission results in a higher coding gain compared to satellite only terrestrial only transmissions. Evaluate the bit error rate numerically to highlight the effect of improve the coding gain.

V. SIMULATION RESULTS

The satellite and terrestrial channel parameter employed in the simulations discussions. For the satellite case we have consulted that provides the results from a recent dual polarization experimental method. For the terrestrial technique assume a single path L=1,the Doppler effect due to UT mobility by appropriately filtering independent channel realizations. The channel is constant during transmission of codeword. The transmitted signal is shown in figure 1.the data is to be transmitted the number of transmitted data point is approximately 493 data points. In figure 2 is pseudo noise sequence signal, the PN sequence is allocated 0101110 the transmitted signal to be added the noise signal, the receiver side to recover the original signal.

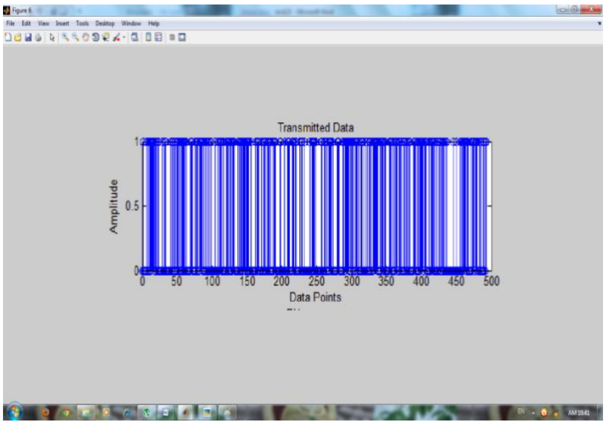


Fig.1.transmitted signal

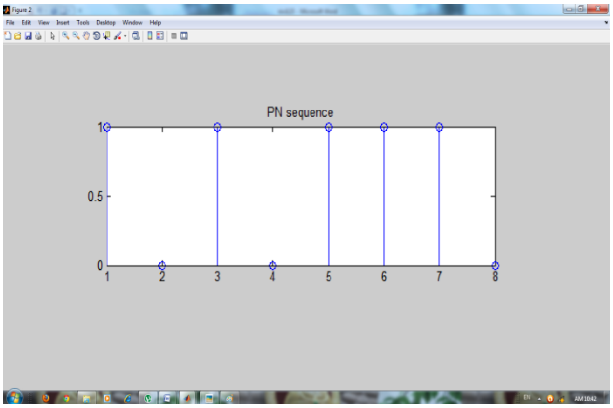


Fig.2.pseudo noise sequence signal

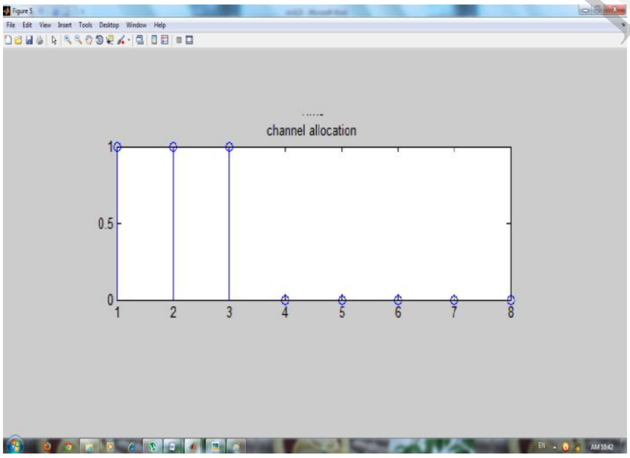


Fig.3.seperate channel allocation signal

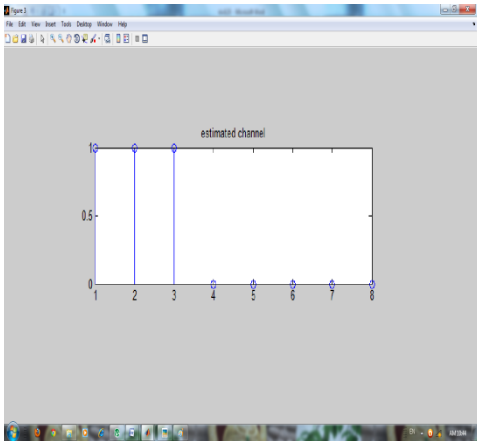


Fig.4.Estimated channel output signal

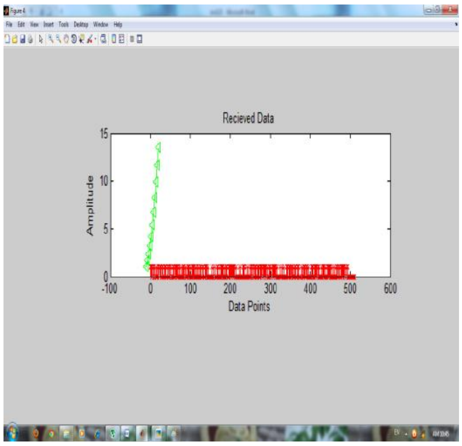


Fig.5.Received output data

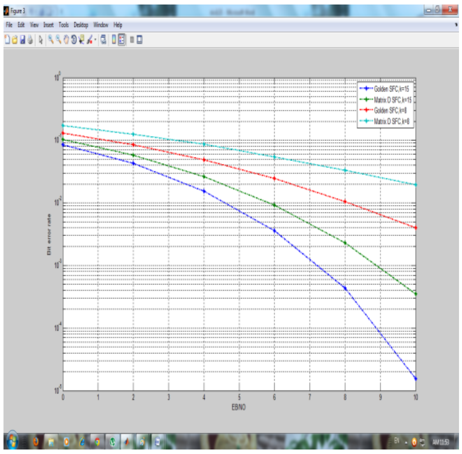


Fig.6.performance of full rate full diversity code

In figure 7 power imbalance on golden code and MIDO code, the golden code losses in the range 3-5 dB for power imbalance of 13 dB for the proposed scheme when the satellite component is missing, the losses of MIDO code grow very fast depicting a failure of the decoder when one of the component is completely lost.

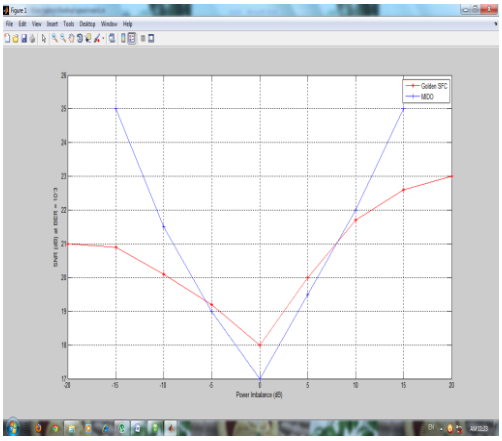


Fig.7.power imbalance on golden code and MIDO code

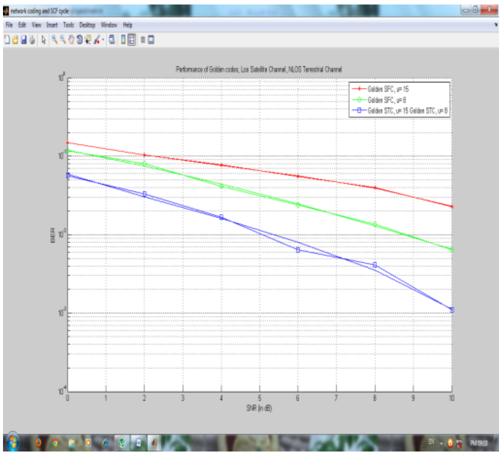


Fig.8. performance of loo satellite channel and NLOS terrestrial channel output

V. CONCLUSION

Dual polarized hybrid mobile satellite system is virtual role of advantage of hybrid transmission. Mean while the effect of power imbalance between the two system components. A technique to increase the coding gain that can easily incorporated in the design of MIMO_OFDM system. In the project is simulated using MATLAB. The proposed space frequency coding techniques are used. It is the result sharp decrease bit error rate curve.

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