A MODIFIED VARIABLE STEP SIZE SQUARE CONTOUR BLIND EQUALIZATION ALGORITHM

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ABSTRACT

Wireless communication is one of the useful communication techniques. The high demand for wireless communication services is the capacity of system. Here main target is increasing the capacity. Then most important solution would be to increase bandwidth. For increasing capacity in wireless communications services has led to developments of new technologies that exploit space selectivity. This is done by smart-antenna arrays and the adaptive beam forming algorithms. Smart-antenna systems provide techniques for higher system capacity and improved quality of service among other things. Most of the algorithms can be categorized into two classes according to whether a training signal is used or not. They are Non-Blind Adaptive algorithm and Blind Adaptive algorithm. Adaptive beam forming Algorithm are two types. One is blind beam forming where training signal is not needed. Another is non-blind beam forming where training signal is needed.

Keywords: Smart-Antenna, Square Contour Algorithm (SCA), Variable Step Size Square Contour Algorithm (VSS-SCA), Modified Variable Step Size Square Contour Algorithm (MVSS-SCA).

I. INTRODUCTİON

Equalization [1] is used for removing Inter-Symbol Interference (lSI). Equalizers are of two types: non-blind and blind equalizers. They mainly attempt to achieve equalization by restoring some property of the uncorrupted symbols. Hence, they are capable of saving bandwidth that is wasted by sending training data. One of the earliest efforts in this direction was the Constant Modulus Algorithm (CMA) [2]. CMA is unable to achieve correct phase recovery due to the very nature of its cost function. Hence, a separate phase tracking loop is required along with CMA. The Multi-Modulus Algorithm (MMA) [3] had good convergence properties, but here created an occasional $\pi/4$ phase rotation problem. A method is given in [3] to take care of this phase rotation problem of the MMA. The Square Contour Algorithm (SCA) [4] doesn't give any phase rotation problems. But its disadvantage lies in its speed of convergence. Many other schemes [5] were proposed to enhance the speed of convergence of the SCA by incorporating hard and soft Decision-Directed (DD) cost functions. Similarly, variable step size paradigms were also proposed recently [7] for similar purposes, which assigns a step size based on the deviation from fixed square contours around constellation points. The space-division multiple access technique is used for increasing the demand on mobile communication capacity. The smart antenna is used for separating signals which are transmitted on the same carrier frequency. In mobile systems, if capacity is increased then network efficiency and performance will also improve. The capacity is C.

$$C = B * \log_2(1 + \frac{S}{N}) \quad 1$$

Where B = band width, S = Signal power

II. SMART-ANTENNA

The term "smart antenna" generally refers to any antenna array, terminated in a sophisticated signal processor, which can adjust or adapt its own beam pattern in order to emphasize signals of interest and to minimize interfering signals. Smart antennas generally encompass both switched beam and beam formed adaptive systems. Switched beam systems have several available fixed beam patterns. A decision is made as to which beam to access, at any given point in time, based upon the requirements of the system.

III. THE SQUARE CONTOUR ALGORITHM

The cost function of CMA [2] is

$$J_{CMA} = E[(|y_n| - R_{CMA}^2)^2] \quad 2$$

For a square

$$max\{|y_{R,n}|,|y_{I,n}|\} = R \quad 3$$

The real part of the filtered output is $y_{R,n}$ and imaginary part is $y_{I,n}$

$$\max\{|y_{R,n}|,|y_{I,n}|\} = \frac{|y_{R,n}+y_{I,n}| + |y_{R,n}-y_{I,n}|}{2} \quad 4$$

$$R_{SCA} = 2R \quad 5$$

The cost function of SCA [4] is

$$J_{SCA} = E[(|y_{R,n} + y_{I,n}| + |y_{R,n} - y_{I,n}| - R_{SCA})^2] \quad 6$$

The gradient vector

$$\nabla_w J_{SCA} =$$

$$E[(|y_{R,n} + y_{I,n}| + |y_{R,n} - y_{I,n}| - R_{SCA})\{Sgn[y_{R,n} + y_{I,n}] + Sgn[y_{R,n} - y_{I,n}] + j(Sgn[y_{R,n} + y_{I,n}] - Sgn[y_{R,n} - y_{I,n}])\}\underline{x}_n^*] \quad 7$$

The update weight

$$\underline{w}(n+1) = \underline{w}(n) - \mu[(|y_{R,n} + y_{I,n}| + |y_{R,n} - y_{I,n}| - R_{SCA})\{Sgn[y_{R,n} + y_{I,n}] + Sgn[y_{R,n} - y_{I,n}] + j(Sgn[y_{R,n} + y_{I,n}] - Sgn[y_{R,n} - y_{I,n}])\}\underline{x}_n^*] \quad 8$$

For perfect equalizer

$y_n = s_n$ & $\nabla_w J_{SCA} = 0$

So,

$$E[(|y_{R,n} + y_{I,n}| + |y_{R,n} - y_{I,n}| - R_{SCA})\{Sgn[y_{R,n} + y_{I,n}] + Sgn[y_{R,n} - y_{I,n}] + j(Sgn[y_{R,n} + y_{I,n}] - Sgn[y_{R,n} - y_{I,n}])\}\underline{x}_n^*] = 0 \quad 9$$

The R_{SCA} is define in [4]

$$R_{SCA} = \frac{E[(|s_{R,n}+s_{I,n}|+|s_{R,n}-s_{I,n}|)R']}{E[R']} \quad 10$$

Where

$$R' = \{Sgn[s_{R,n}+S_{I,n}] + Sgn[S_{R,n}-S_{I,n}] + j(Sgn[S_{R,n}+S_{I,n}] - Sgn[S_{R,n}-S_{I,n}])\}S_n^* \quad 11$$

The convergence rate of SCA is very slow.

IV. THE VARIABLE STEP SIZE SQUARE CONTOUR ALGORITHAM

The variable step size [9] is

$$\mu = \mu_0(1-exp(-\alpha|e(n)|)) \quad 12$$

α is a constant that defines the constancy or variability of the step size with respect to error term.

The update weight is

$$\underline{w}(n+1) = \underline{w}(n) - \mu[(|y_{R,n}+y_{I,n}| + |y_{R,n}-y_{I,n}| - R_{SCA})\{Sgn[y_{R,n}+y_{I,n}] + Sgn[y_{R,n}-y_{I,n}] + j(Sgn[y_{R,n}+y_{I,n}] - Sgn[y_{R,n}-y_{I,n}])\}\underline{x}_n^*] \quad 13$$

Where

$$e(n) = (|y_{R,n}+y_{I,n}| + |y_{R,n}-y_{I,n}| - R_{SCA})\{Sgn[y_{R,n}+y_{I,n}] + Sgn[y_{R,n}-y_{I,n}] + j(Sgn[y_{R,n}+y_{I,n}] - Sgn[y_{R,n}-y_{I,n}])\} \quad 14$$

V. THE MODIFIED VARIABLE STEP SIZE SQUARE CONTOUR ALGORITHM

Here the variable step sizes consider for the in-phase and quadrature phase equalizers

$$\mu_R = \mu_0(1-exp(-\alpha|e_R(n)|)) \quad 15$$

$$\mu_I = \mu_0(1-exp(-\alpha|e_I(n)|)) \quad 16$$

VI. RESULT & DISCUSSIONS

First of all we consider AWGN channel. The residual ISI [6] at the output of the equalizer is defined as

$$ISI = \frac{\Sigma_k[|\,\underline{h}(k)*\underline{w}^*(K)|^2] - max[|\,\underline{h}(k)*\underline{w}^*(K)|^2]}{max[|\,\underline{h}(k)*\underline{w}^*(K)|^2]} \quad 17$$

Where $|\mathbf{h}(k) * \mathbf{w}^*(K)|^2_{max}$ is the maximum absolute value among all values of $\mathbf{h}(k) * \mathbf{w}^*(K)$. All simulation experiments described in this section employ the equalizer of transversal filter structure with 9 tap weights and the equalizers were initialized with the central tap weights set to one and all others set to zero. '∗' denotes convolution operation. We see that the MVSS-SCA better than the proposal in [9] and also the SCA, in terms of convergence to a lower lSI in Fig.-1.

Now consider the data symbols are 16-QAM [8]. The noise power is adjusted such that it gives rise to a channel signal-to noise ratio (SNR) of 30 dB We have taken 15,000 symbols to estimate the channel, of which last 2000 are shown in Fig. 2 which shows the received signal and equalized signal constellations of three blind equalizers after convergence. The results confirm the founding that the MVSS-SCA has superior performance over conventional VSS-SCA & SCA.

VII. CONCLUTION

The MVSSSCA decreases the inter symbol interference (ISI) comparison with Variable Step-size SCA and SCA. The MVSSSCA gives lower ISI and improves the convergence. So The MVSSSCA is better than others algorithm.

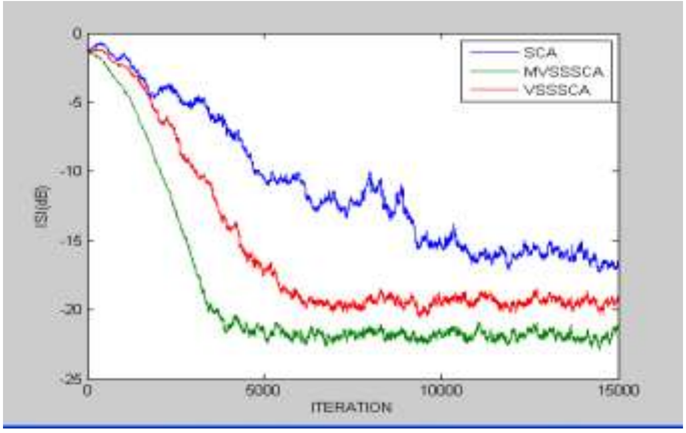
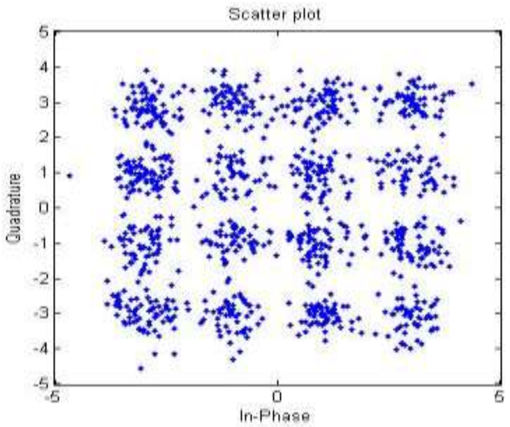
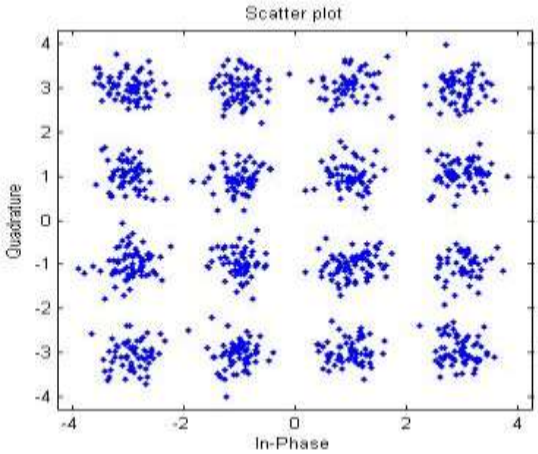


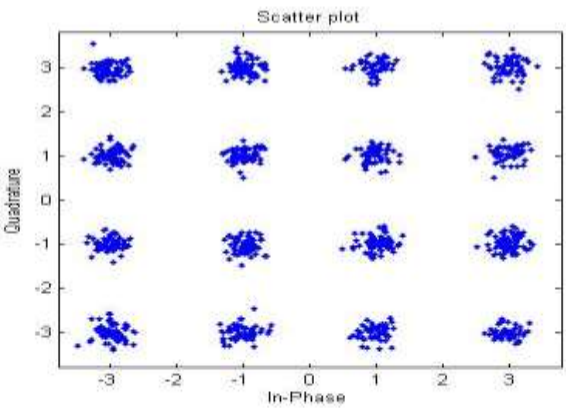
Fig-1 Comparison of Averaged ISI for SCA, VSS-SCA, MVSS-SCA



(a)



(b)



(c)

Fig-2 Equalized Signal Constellations (a) SCA (b) VSS-SCA (c) MVSS-SCA

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