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2018 Antwerpen (BE)**

(54) **Method for cross-talk cancellation**

(57)   A method to provide cross-talk cancellation in a multiple input multiple output system that comprises a plurality of outputs is described. The method comprises a step determining during a first phase and according to a heuristic model, for a first signal to be transmitted to a first output of the plurality of outputs at least one dominant interfering tone of at least one second signal to be transmitted to a second output of the plurality of outputs. The at least one dominant interfering tone is in fact a tone of at least one second signal that would generate cross-talk upon the first signal when it would be transmitted to the first output. The method further comprises a step of executing a step of partial cross-talk cancellation for the first signal during a second phase for the one or more determined dominant interfering tones associated to one or another second signal.
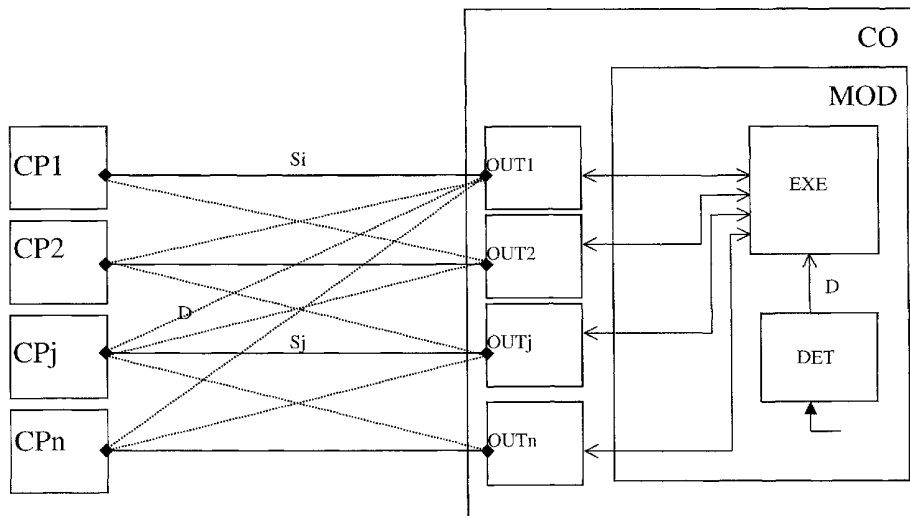
Figure 1

Description

[0001]   The present invention relates to a method to provide cross-talk cancellation as described in the preamble of claim 1 and to a module as described in the preamble of claim 7 to execute such a method.

[0002]   Such a method and module are already known in the art. Indeed, telecommunication systems such as access systems might comprise a Multiple Input Multiple Output MIMO system. Such a system comprises a plurality of downstream transceivers, each being coupled, respectively, to a plurality of upstream transceivers. It has to be explained here that each downstream transceiver is enabled to receive a signal in the downstream direction from a respective upstream transceiver and also to transmit on its turn a signal in the upstream direction to this upstream transceiver.

[0003]   However such a transceiver, either a downstream transceiver or an upstream transceiver, that receives a signal from its associated transceiver will also receive cross-talk interference from the other transceivers which are interchanging signals as well.

[0004]   Therefore, instead of demodulating the signals on each line e.g. each twisted pair separately, a Multiple Input Multiple Output system relies on a joint processing of all signals which leads to increased performance. In order to realize this joint processing, it has to be understood that each plurality of transceivers has to be coupled among each other.

[0005]   Multiple access systems such as e.g. Very high bit-rate Digital Subscriber Line systems VDSL are operating in high frequency ranges whereby considerable cross-talk is introduced into the received signals. When an operator has access to the multiple transceivers at one side e.g. at the central office side, cross-talk cancellation or cross-talk pre-compensation can be applied via joint processing in order to reduce cross-talk.

[0006]   It has to be explained that full cross-talk cancellation cancels all interfering signals, i.e. the signals transmitted by all other transceivers. According to prior art methods, this is done for every tone of the signals coming from every transceiver at the other side. Full cross-talk cancellation results in a high computational complexity and large memory requirements. Therefore according to a known prior art method only a subset of the interfering signals are cancelled. This is called partial cross-talk cancellation whereby cross-talk cancellation is enabled at lower complexity. Indeed, by only canceling dominant interferers, most of the benefits of cross-talk cancellation are gained whilst significantly reducing the computational complexity and large memory requirements.

[0007]   Such a subset of dominant interferers is usually determined under the assumption that the most dominant interferers are physically located near each other in the same binder. Indeed, twisted pairs that are located near each other in a same binder will easily introduce cross-talk interference to each other. Indeed, this introduces considerably more cross-talk than the twisted pairs which are located at the opposite side in this binder.

[0008]   However, cross-talk elimination for all tones of such a selected subset of interferers still requires too many computing resources.

[0009]   The object of the present invention is to provide a method and module to provide partial cross-talk cancellation such as the above known schemes but which improve the computational complexity during operational phase of the system.

[0010]   According to the invention, this object is achieved with the method to provide cross-talk cancellation in a multiple input multiple output system according to claim 1 and with the module to provide cross-talk cancellation in a multiple input multiple output system according to claim 7 that executes such a method.

[0011]   Indeed, by pre-selecting during a first phase e.g. during initialization phase of the access environment, for every user the most dominant interfering tones and users, a general scheme is provided for allocation of computing resources during operation time across the different users, tones and interfering users.

[0012]   In this way, the method according to the present invention comprises a first step being executed by the determining means of the module according to the present invention, of determining during a first phase and according to a heuristic model, for a first signal that will be transmitted to a first output of a plurality of outputs of the multiple input multiple output system, at least one dominant interfering tone of at least one second signal that will be transmitted to a second output of the plurality of outputs. This dominant interfering tone is a tone of the second signal that would generate cross-talk upon the first signal when this first signal would be transmitted to the first output. Hereafter, during a second phase of the method a step of cross-talk cancellation is executed by the executing means for the first signal for at least one determined dominant interfering tone of the second signal.

[0013]   This is described in the method of claim 1 and the module of claim 7.

[0014]   A preferred implementation is described in claim 2. Herein, the method to provide cross-talk cancellation according to the present invention further comprises executing the step of determining during a first phase and according to a heuristic model at least one dominant interfering tone. This at least one dominant interfering tone is determined for each first signal. Furthermore, this at least one dominant interfering tone is determined out of all tones of all other second signals which are different of the first signal.

[0015]   Hereby, the step of executing the cross-talk cancellation is done during the second phase for each first signal and for each determined dominant interfering tone coming out of the tones of one or another second signal.

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[0011]   Indeed, by pre-selecting during a first phase e.g. during initialization phase of the access environment, for every user the most dominant interfering tones and users, a general scheme is provided for allocation of computing resources during operation time across the different users, tones and interfering users.

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[0015]   Hereby, the step of executing the cross-talk cancellation is done during the second phase for each first signal and for each determined dominant interfering tone coming out of the tones of one or another second signal.

been cancelled. In the event when the utility value for this examined tone exceeds a utility threshold, the examined tone is indeed determined and selected as a dominant interfering tone D for the second signal.

[0041] This will now be explained in more detail. The division of available computing resources between users can also be adjusted to give more priority to users who suffer the most from cross-talk. When using a linear Minimum Mean Squared Error MMSE cross-talk canceller, canceling one interferer from a single user's signal, at one tone corresponds to a complex multiplication. In the event of partial cross-talk cancellation, the cross-talk canceling filter W(k) is a sparse matrix. The number of non-zero elements in W(k) corresponds to the number of multiplications per received DMT-block for tone k.

[0042] When the total number of available multiplications (per received DMT-block) is set to cKn where K is the number of tones, n the number of users in a common binder and c a freely chosen parameter. This definition is used to limit the complexity of cross-talk cancellation to c times that of a standard single-user frequency domain equalizer FDE.

[0043] To allow the division of computing resources between users to be tuned, a parameter μ_i is defined which determines the proportion of total multiplications allocated to user i.

[0044] The number of multiplications for user i is:

$$\text{mults}_i = \mu_i cKn \quad \Sigma_i \mu_i = 1$$

[0045] The multiplications are in this way divided between users. Given that there is a fixed number of multiplications available for a certain user, these multiplications must be allocated across tones and interferers.

[0046] The optimal solution to the computing resource allocation problem is highly complex and this arises from the high dimensional, combinational nature of the problem. In considering the allocation of resources across tones and interferers a heuristic model is hereby provided.

[0047] The usefulness or utility of cancelling a given interferer on a given tone, is defined as the increase in rate it would cause to the user, if all other interferers had already been cancelled. A utility measure as a function of a user is hereby defined:

$$\partial R_{k,j}{}^i = \log(1 + \frac{signal_i(k)}{noise_i(k)}) - \log(1 + \frac{signal_i(k)}{Interference_{i,j}(k) + noise_i(k)})$$

$$= \log(\frac{(signal_i(k) + noise_i(k))(Interference_{i,j}(k) + noise_i(k))}{noise_i(k)(signal_i(k) + Interference_{i,j}(k) + noise_i(k))})$$

where i is the user of interest, j the interferer, and k the tone.

[0048] It has to be remarked that the cross-talk parameters $h_{ij}(k)$ are already determined in a previous step of the model. This is shown in Figure 1 by means of an input-arrow to the determiner DET. However this goes beyond the aim of the present invention and is therefor not described here in more details.

[0049] Furthermore, the following is defined:

$$signal_i(k) = |h_{ii}(k)|^2 \, S_i(k)$$

$$Interference_{i,j}(k) = \Gamma |h_{ij}(k)|^2 \, S_j(k)$$

$$noise_i(k) = \Gamma \sigma_{n_i}^2(k)$$

[0050] Here Γ represents the SNR gap to capacity and is a function of the target BER, desired noise margin and coding gain.

[0051] Using this definition $\exp(\partial R_{k,j}^i)$ as the metric for dominant (tone, interferer) pair selection is defined:

$$\Delta^i_{k,j} = \exp(\partial R^i_{k,j}) = \begin{cases} \dfrac{(signal_i(k) + noise_i(k))(\mathrm{int}\, erference_{i,j}(k) + noise_i(k))}{noise_i(k)(signal_i(k) + \mathrm{int}\, erference_{i,j}(k) + noise_i(k))} & \to i \neq j \\ \infty & \to i = j \end{cases}$$

[0052] Δ^i_{jk} is defined as infinity when i=j to force the direct lines to always be equalized.

[0053] Hereby, user i's direct line is always included during detection of user i.

[0054] A vector that contains the metrics for user is sorted in descending order is defined:

$$t^i = \mathrm{sort}\,([\Delta^i_{1,1} \dots \Delta^i_{1,n} \dots \Delta^i_{K,1} \dots \Delta^i_{K,n}])$$

[0055] This is used as the threshold in the choice of dominant interferers whereby the set of dominant interferers for user i is defined as

$$D^i = \left\{ (k, j) : \Delta^i_{j,k} \geq t^i(\mu_i cKn) \right\}$$

where $t^i(a)$ denotes the a'th element of vector t^i.

[0056] Notice that $|D^i| = \mu_i cKn$ where |.| denotes cardinality.

[0057] The set of dominant interferers for user i at a single tone k is defined as :

$$D^i_k = \left\{ j : (k, j) \in D^i \right\}$$

[0058] In this way a set of dominant interferers i.e. D^i_k , or also called in the claims "at least one dominant interfering tone D", is determined for a first signal on a per tone and second signal base. The most interfering tones among the different second signals Sj are determined according to this heuristic model.

[0059] This set of dominant interfering tones D is provided by the determiner DET to the executor EXE. The executor EXE executes the cross-talk cancellation for the first signal Si during a second phase. This second phase is executed during operational time of the access system. The cross-talk cancellation is executed according to the determined set of dominant interfering tones D of a second signal.

[0060] In this way, the central office is enabled due to the presence of the module MOD to provide cross-talk cancellation according to the present invention to execute a cross-talk cancellation on the first signal Si upon reception of the signal from the customer premises equipment CPi. Even more, this cross-talk cancellation is a partial cross-talk cancellation that requires a minimum of computation resources due to the use of the heuristic model.

[0061] A final remark is that embodiments of the present invention are described above in terms of functional blocks. From the functional description of these blocks, given above, it will be apparent for a person skilled in the art of designing electronic devices how embodiments of these blocks can be manufactured with well-known electronic components. A detailed architecture of the contents of the functional blocks hence is not given.

[0062] While the principles of the invention have been described above in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention, as defined in the appended claims.

Claims

1. A method to provide cross-talk cancellation in a multiple input multiple output system comprising a plurality of outputs (OUT1, OUT2, ..., OUTn), said method comprises a step of executing for a first signal (Si) a cross-talk cancellation, **characterized in that** said method further comprises

   - determining during a first phase and according to a heuristic model, for said first signal (Si) to be transmitted to a first output (OUTi) of said plurality of outputs (OUT1, OUT2, ..., OUTn), at least one dominant interfering

tone (D) of at least one second signal (Sj) to be transmitted to a second output (OUTj) of said plurality of outputs (OUT1, OUT2, ..., OUTn), said at least one dominant interfering tone (D) being a tone of said at least one second signal (Sj) that would generate cross-talk upon said first signal (Si) when being transmitted to said first output (OUTi); and

- executing said step of cross-talk cancellation for said first signal (Si) during a second phase for said at least one determined dominant interfering tone (D) of said second signal (Sj).

2. The method to provide cross-talk cancellation according to claim 1, **characterized by** executing said step of determining during a first phase and according to a heuristic model said at least one dominant interfering tone (D), for each first signal (Si;i=1...n), and out of all tones of all other second signals (Sj; j=1...n; j≠i) being different of said first signal (Si); and executing said step of cross-talk cancellation for each said first signal (Si;i=1...n) during said second phase for each determined dominant interfering tone (D) of one of said all other second signals (Sj; j=1...n; j≠i).

3. The method to provide cross-talk cancellation according to anyone of claim 1 and claim 2, **characterized in that** said step of determining during a first phase and according to a heuristic model said at least one dominant interfering tone (D) comprises:

- determining a utility value for each predetermined tone of said second signal (Sj), said utility value reflecting a utility of canceling said predetermined tone and being defined in function of an increase in transmission rate it would cause to said first signal (Si) in the event when all other interfering signals (Sl; l≠j and l≠i) on that predetermined tone would have been cancelled; and
- in the event when said utility value exceeds a utility threshold, defining said predetermined tone as a dominant interfering tone (D).

4. The method to provide cross-talk cancellation according to anyone of claim 1 to claim 3, **characterized in** by executing said step of cross-talk cancellation during said second phase upon reception of said first signal (Si) in order to compensate cross-talk being imposed upon said first signal (Si) during transmission of said first signal (Si).

5. The method to provide cross-talk cancellation according to claim 1 to claim 3, **characterized in** by executing said step of cross-talk cancellation during said second phase, before transmission of said first signal (Si) in order to pre-compensate cross-talk that will be imposed upon said first signal (Si) during transmission of said first signal (Si).

6. The method according to anyone of claim 1 to claim 5, **characterized in** by executing said first phase during initialization of said multiple input multiple output system.

7. A module (MOD) to provide cross-talk cancellation in a multiple input multiple output system that comprises a plurality of outputs (OUT1, OUT2, ..., OUTn), said module comprises an executing means (EXE) coupled to each one of said plurality of outputs (OUT1, OUT2, ..., OUTn) to execute for a first signal (Si) a cross-talk cancellation, **characterized in that** said module further comprises

- determining means (DET) to determine during a first phase and according to a heuristic model, for said first signal (Si) to be transmitted to a first output (OUTi) of said plurality of outputs (OUT1, OUT2, ..., OUTn), at least one dominant interfering tone (D) of at least one second signal (Sj) to be transmitted to a second output (OUTj) of said plurality of outputs (OUT1, OUT2, ..., OUTn), said at least one dominant interfering tone (D) being a tone of said at least one second signal (Sj) that would generate cross-talk upon said first signal (Si) when being transmitted to said first output (OUTi); and that said executing means is coupled to said determining means (DET) in order to execute said cross-talk cancellation for said first signal (Si) during a second phase according to said at least one determined dominant interfering tone (D) of said second signal (Sj).

8. The module according to claim 7, **characterized in that** said multiple input multiple output system comprises a central office and that said module is comprised in said central office.

9. The module according to claim 7, **characterized in that** said module is comprised in said multiple input multiple output system which is comprised in a Digital Subscriber Line system.
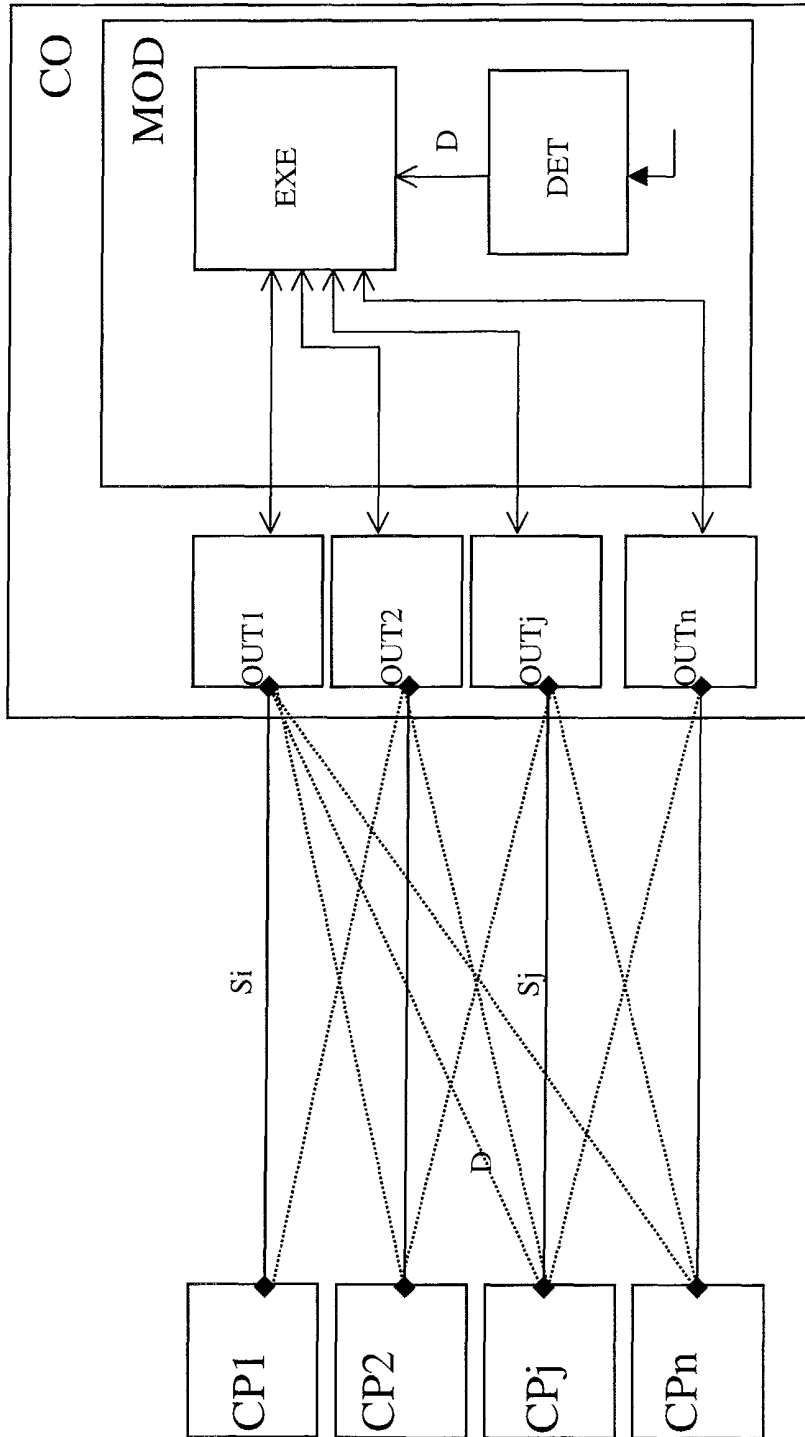
Figure 1

European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 02 29 2659

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 887 032 A (CIOFFI JOHN M) 23 March 1999 (1999-03-23) * column 3, line 35 - column 4, line 12 * * column 4, line 63 - line 64 * * column 7, line 31 - line 65 * * column 11, line 26 - column 12, line 12 *	1-9	H04B3/32
A	EP 1 109 329 A (ST MICROELECTRONICS SA ;STMICROELECTRONICS N V (NL)) 20 June 2001 (2001-06-20) * paragraphs [0021]-[0024] *	1-9	

			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 March 2003	De Iulis, M

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 29 2659

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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12-03-2003

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5887032	A	23-03-1999	AU	4170797 A	26-03-1998
			EP	1048129 A1	02-11-2000
			WO	9810528 A1	12-03-1998
EP 1109329	A	20-06-2001	EP	1109329 A1	20-06-2001
			JP	2001244855 A	07-09-2001
			US	2001006510 A1	05-07-2001

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82