

METHOD AND SYSTEM FOR ADAPTIVE CHANNEL ESTIMATION IN PILOT SYMBOL ASSISTED MODULATION SYSTEMS

Field of the Invention

[0001] The present invention relates to a method and system for adaptive channel estimation in Pilot Symbol Assisted Modulation (PSAM) systems. In particular, this invention relates to a method and system for suppressing noise in channel estimates in a modem receiver, in particular a rake receiver of a PSAM system.

Background of the Invention

[0002] In a radio communication system, signals are typically transmitted from a Base Station (BS), an example of which is a radio transmission tower, to a Mobile Station Receiver (MSR), an example of which is a mobile phone and vice versa. The signals received by the MSR often differ from the original transmitted signal, due to interference from the physical environment during signal propagation. By the time the transmitted signal is received by the MSR, the signals from each of the different propagation paths may each be attributed with a different phase delay.

[0003] Some systems (such as 3GPP UTRA-FDD systems) use a pilot channel, which is a continuous modulation of a known bit sequence of the transmitted signal. Using the pilot channel, it is possible to estimate the phase of different signals received corresponding to different propagation paths before combining them together.

[0004] Code Division Multiple Access (CDMA) systems are spread spectrum systems that employ radio channels with a much larger bandwidth (for example, 1.5 MHz for IS-95 systems and 5.0 MHz for 3GPP UTRA-FDD systems) than conventional Frequency Modulated (FM) systems. In CDMA systems, a single

radio channel can simultaneously support multiple users, as opposed to FM systems, which can only support one user per radio channel.

[0005] In order to differentiate information intended for different recipients transmitted over a shared radio channel in a CDMA system, each user is assigned a unique pseudo random (PN) code. For example, an information sequence such as a stream of bits to be transmitted to a particular user typically involves multiplying each bit transmitted on the shared channel with the intended recipient's PN Code. The PN Code is a stream of chips where each bit of the information sequence correlates to SF chips of the PN code. SF is termed as the Spreading Factor. This technique is known as spreading, and is one of many ways of transmitting a signal intended for one user over a shared channel. The signal is received by all users of the shared channel but can only be successfully decoded by the MSR containing the intended recipient's PN Code. This phenomenon of encoding the data by a PN sequence is applicable in the case of uplink where the user sends data to base station.

[0006] A MSR that has knowledge of a particular user's PN Code is able to differentiate information sequences in the signal received that are intended for that particular MSR from other information sequences intended for other users on the shared channel. Bits in the original transmitted information sequence are extracted from the signal by de-correlating the PN Code with the signal received by the MSR. This process of correlation is known as de-spreading.

[0007] For CDMA systems to work properly, the following must occur: the signals received by the MSR and PN code used for de-spreading must be time-aligned; the auto-correlation properties of the PN Codes are preferably high (This means the correlation is high if the sequence is correlated with a zero-shifted sequence of itself and nearly zero if it is correlated with a non-zero time shift of itself); and the cross-correlation properties of the PN Codes are preferably near ideal (i.e. nearly zero).

[0008] As such, CDMA systems may employ a pilot signal to maintain the integrity of the above conditions. The pilot signal is a constant bit sequence that is spread using a predefined PN code, which is specific to that particular BS. Both the pilot signal bit sequence and the PN Code used for its spreading remain the same for a particular BS. The pilot signal is spread and transmitted by the BS as part of the transmitted signal over the shared channel.

[0009] Referring to FIG.1, a Rake Receiver 10 typically found in a MSR is shown. The Rake Receiver 10 comprises a plurality of Rake Fingers 12. The received input signal 11 can be considered as the sum of many multipath signals. The received input signal 11 is utilized by 16 and passed along a plurality of processing paths each via a Rake Finger 12 in the MSR. Each Rake Finger 12 is assigned to de-spread one of the many multipath signals from the received input signal 11. The output of each Rake Finger 12 is then sent to a Combiner 15. Such Rake Receivers 10 may also be used similarly in Base Stations (BS).

[0010] The Combiner 15 then combines all de-spread outputs from each of the Rake Fingers 12 and sends the combined output signal 17 for further processing.

[0011] Referring to FIG.2, a functional block diagram of a single Rake Finger 12 of FIG.1 is shown. The Rake Finger 12 receives an input signal 11 comprising of traffic signals (which are bits corresponding to data symbols) and pilot signals (which are bits corresponding to pilot symbols). The Rake Finger 12 also includes a Traffic PN Code Generator 22, which generates a particular unique traffic PN Code, and a Traffic Correlator 24, which correlates the traffic PN Codes generated by the Traffic PN code generator 22 with the received input signal 11 and outputs de-spread data symbols 27. Similarly there is a pilot PN code generator 21 and pilot Correlator 23 to de-spread pilot symbols 18. The number of inputs (or also known as "chips") from the received input signal 11 that are used in order to de-spread one output bit corresponding to a data symbol 27 or a pilot symbol 18 is known as the spreading factor. The spreading factor for the data and pilot symbols

can be the same or different. For the data symbol the permissible values are 4,8,16,32,64,128 and 256. For the pilot symbol it is fixed at 256.

[0012] Due to the time varying nature of the channel, the traffic and data symbols undergo attenuation and phase rotation (or phase delay) by the time they reach the MSR or the BS. An estimate of the attenuation and phase delay is performed in the channel estimation unit 29. For this purpose the Pilot Correlator 23 outputs de-spread pilot symbols 18 to the adaptive channel estimation unit 29. The adaptive channel estimation unit 29 outputs channel estimates 28 to the phase correction unit 25. The phase of the signal received 11 is corrected by the Phase Correction Unit 25. The Phase Correction Unit 25 determines the phase delay for the current portion of the received input signal using channel estimates 28 from the channel estimation unit 29, and accordingly corrects any phase delay in the current portion of the de-spread traffic symbols from the Traffic Correlator 24.

[0013] To achieve optimal performance in a W-CDMA system, it is important that the pilot and traffic PN Codes are synchronized to the signal received by the MSR (i.e. they are kept time aligned). The Timing and Control Unit 26 corrects the timing and helps maintain the time alignment between the pilot PN code generator 21 / the Traffic PN code generator 22 and the received signal 11.

[0014] Channel estimates 28 in the rake receiver are often corrupted by Additive White Gaussian Noise (AWGN) and fading. Averaging the AWGN, results in the reduction of AWGN noise power. In AWGN, the larger the averaging the better the noise reduction. However, in a fading channel if the averaging length is too long, the dynamics of the channel changes and the results will deteriorate. Therefore, the shorter the averaging length the better the fading immunity provided there is no deep fade occurring at that instance. A deep fade is a condition where the signal quality is too bad for any estimation purposes. Due to these two contradicting effects (AWGN and channel dynamics), the accuracy of the channel estimates 28 and Bit Error Rate (BER) achieved is dependent on the averaging length employed. The optimum averaging length to obtain the channel estimates is

dependent on the speed (v) of the MSR and signal to noise ratio (SNR) of the received signal. It therefore becomes necessary to find the optimum averaging length to improve the channel estimates 28 as the speed v of the MSR continues to change.

Summary of the Invention

[0015] The present invention seeks to provide a method and system for suppressing noise in channel estimates in a modem receiver, in particular a rake receiver of a PSAM system.

[0016] Accordingly, in one aspect, the present invention provides an adaptive channel estimation unit of a rake finger in a mobile station receiver, the adaptive channel estimation unit comprising: a channel estimation unit for processing de-spread pilot symbols and for generating noisy channel estimates; and an adaptive averaging unit for suppressing noise in the noisy channel estimates using averaging techniques; wherein the adaptive averaging unit comprises: a plurality of averaging units, each of the plurality of averaging units having a different predetermined averaging length; the plurality of averaging units for averaging the noisy channel estimates to generate a corresponding plurality of noise-averaged channel estimates according to the different predetermined averaging lengths; a plurality of subtractors for subtracting the plurality of noise-averaged channel estimates from the noisy channel estimates producing a plurality of noise-averaged differences; a power calculations unit for calculating the power of the plurality of noise-averaged differences; and a processor for calculating total error power for each of the plurality of noise-averaged channel estimates and for selecting one of the plurality of averaging units corresponding to the lowest total error power for suppressing noise in the noisy channel estimates.

[0017] In another aspect, the present invention provides, a method for suppressing noise in channel estimates of a rake finger in a mobile station receiver, the method comprising the steps: receiving noisy channel estimates; averaging the noisy

channel estimates with a plurality of averaging lengths to obtain a corresponding plurality of noise-averaged estimates; subtracting the plurality of noise-averaged estimates from the noisy channel estimates to obtain a plurality of noise-averaged differences; calculating power of the plurality of noise-averaged differences; calculating the noise power of the noisy channel estimates; calculating total error power for each of the plurality of noise-averaged estimates; and selecting one of the plurality of averaging lengths corresponding to the lowest total error power for suppressing noise in the channel estimates.

Brief Description of the Drawings

[0018] A preferred embodiment of the present invention will now be more fully described, by way of example, with reference to the drawings of which:

[0019] FIG. 1 illustrates a typical prior art rake receiver;

[0020] FIG.2 illustrates a rake finger of FIG.1;

[0021] FIG.3 illustrates an adaptive channel estimation unit of FIG.2 in accordance with the preferred embodiment;

[0022] FIG.4 illustrates a graph showing the relationship between averaging length and error power in accordance with the preferred embodiment;

[0023] FIG.5 illustrates an adaptive averaging unit of FIG.3 in accordance with the preferred embodiment;

[0024] FIG.6 illustrates a Noise power calculation unit of FIG.5 in accordance with the preferred embodiment;

[0025] FIG.7 illustrates a flow chart of the method in accordance with the present invention; and

[0026] FIG.8 illustrates results of a simulation in a graph of Bit Error Rate (BER) against Averaging Length L ; and

[0027] FIG.9 illustrates results of a simulation in a graph of Total Error Power against Averaging Length L .

Detailed Description of the Invention

[0028] In the following description, details are provided to describe the preferred embodiment and alternative embodiment. It shall be apparent to one skilled in the art, however, that the preferred embodiment may be practiced without such details. Some of these details may not be described at length so as not to obscure the preferred embodiment.

[0029] The preferred embodiment utilizes an adaptive channel estimation unit 29 in a rake finger 12 of a rake receiver 10 of a PSAM system, in the present example of which an MSR is illustrated. The adaptive channel estimation unit 29 provides channel estimates 28 by processing de-spread pilot signals 18 via an optimum averaging length, determined by an adaptive averaging unit in the adaptive channel estimation unit 29.

[0030] Referring to FIG.3, the adaptive channel estimation unit 29 further comprises a channel estimation unit 30 and an adaptive averaging unit 32. The adaptive channel estimation unit 29 first calculates noisy channel estimates 31 and then adaptively determines the optimum averaging length.

[0031] The adaptive averaging unit 32 need not be present in all rake fingers 12 in the rake receiver 10. At least one rake finger 12 having the adaptive averaging unit 32 in the adaptive channel estimation unit 29 is required. The optimum averaging

length found by the adaptive averaging unit 32 could be relayed across to other rake fingers 12 receiving signals from the same base station.

[0032] In an alternative embodiment, a plurality of adaptive averaging units 32 may be employed in all or a predetermined number of the rake fingers 12. The results from the plurality of adaptive averaging units 32 may then be consolidated and estimates having better performance may be obtained.

[0033] The noisy channel estimates 31 comprise of desired channel estimates (fading profile) and noise in the form of AWGN having error noise power E_n . The noisy channel estimates 31 are then fed into the adaptive averaging unit 32 where the noise is suppressed using averaging techniques.

[0034] The averaging length used to average the noise is denoted by L . After averaging, the error power of the averaged AWGN is reduced from E_n to (E_n/L) . In the fading channel the averaging however introduces errors, since the channel changes slowly over time. The error power due to the averaging depends on the averaging length L and speed of the MSR v . The error power due to averaging in fading channels is thus denoted by $E_a(L, v)$. The total error power $E(L)$, of the averaged channel estimates 28 thus comprises of the error power of the averaged AWGN and the error power due to averaging, given by:

$$E(L) = (E_n/L) + E_a(L, v) \quad (\text{Eq. 1})$$

[0035] In Eq. 1, E_n is the noise power which is assumed known, a method of the preferred embodiment for estimating E_n is disclosed in later discussions.

[0036] The power of the noisy channel estimates 31 may further be written as:

$$\text{Power}(31) = P + E_n \quad (\text{Eq. 2})$$

where P is the power of the channel estimates uncorrupted by AWGN. In Eq. 2, we assume the channel to be constant over one symbol duration, i.e.,

$$E_a(1,v) = 0$$

[0037] Referring to FIG. 4, as L increases, the total error power first decreases, reaches a minimum and thereafter, increases.

[0038] To achieve a minimum total error power $E(L)$, an optimum averaging length L_{opt} is used. L_{opt} is dependent on the speed v . As the speed of the mobile changes it becomes necessary to re-estimate the value of L_{opt} . This is equivalent to maximizing the SNR of the channel estimates 28.

[0039] The adaptive channel estimation unit 29 employs an adaptive averaging unit 32 to adaptively determine and employ the optimum averaging length L_{opt} in averaging the noisy channel estimates 31.

[0040] Referring to FIG.5 and FIG.7, the adaptive averaging unit 32 comprises a processor 40 and a power calculations unit 39. The adaptive averaging unit 32 further comprises a plurality of averaging units 34. Each averaging unit 34 having a different predetermined averaging length. The different predetermined averaging lengths of all the plurality of averaging units 34 are spread over a range of values.

[0041] While the present embodiment refers to each averaging unit 34 as a separate function, it is understood that they may be implemented using a single functional block for the entire range of the averaging lengths.

[0042] The plurality of averaging units 34 are for averaging the noisy channel estimates 31 according to their respective averaging lengths. Referring to one of the plurality of averaging units 34, namely averaging unit 34A, having an averaging length of $L1$. The averaging unit 34A takes the input of the noisy channel estimates 31 from the channel estimation unit 30 and performs an averaging to obtain a noise-averaged channel estimate 47.

[0043] The noise-averaged channel estimate 47 is then subtracted from the noisy channel estimates 31 to obtain the noise-averaged difference 38 and this is fed into a power calculations unit 39. The power calculations unit 39 calculates the power of the noise-averaged difference 38 and may be written in the form:

$$\text{Power}(38) = E_n\{(L_I - I)/L_I\} + E_a(L_I, v) \quad (\text{Eq. 3})$$

[0044] The power of the noise-averaged difference 38 is then passed on to the processor 40. All the values from the averaging units 34 will be processed similarly and passed on to the processor 40 for processing. The processor 40 will use all calculated powers of the noise-averaged differences 38 of all the averaging units 34 to determine the averaging unit 34 having the total lowest error power. The averaging unit 34 having the lowest total error power will correspondingly be using the optimum averaging length.

[0045] Referring to averaging unit 34A having averaging length L_I , the total error power can be written in the form :

$$E(L_I) = \text{Power}(38) + E_n\{(2 - L_I)/L_I\} \quad (\text{Eq. 4})$$

[0046] The adaptive averaging unit 32 also comprises a switch 45 controlled by the processor 40 for the selection of the averaging unit 34 having the optimum averaging length. Channel estimates 28 from the adaptive channel estimation unit 29 will then have the least amount of error from AWGN and averaging operation. The concept of the switch 45 is notional and is understood by one skilled in the art to be implementable by software or hardware means.

[0047] The adaptive averaging unit 32 further comprises a noise power calculation unit 33 for calculating the noise power E_n 46 of the AWGN in the noisy channel estimates 31. The noise power E_n in the AWGN is further used by the processor 40 in calculating the total error power for each of the averaging units 34.

[0048] The noise power calculation unit 33 is shown in FIG. 6 and comprises a fixed position averaging unit 50 and two power calculation units 53. The noisy channel estimates 31 are fed into the fixed position averaging unit 50 where the noisy channel estimates 31 undergo averaging to obtain the noise fixed average estimate 51. The power of the noise fixed average estimate 51 may be written in the form :

$$\text{Power}(51) = P + (E_n/2) + E_a(2, v) \approx P + (E_n/2) \quad (\text{Eq. 5})$$

where the averaging length = 2.

[0049] The approximation above holds true in the above Eq. 5 as $E_a(2, v) \approx 0$ even at high speeds of up to $v = 300$ km/hr.

[0050] The noise fixed average estimate 51 is then fed into one of the power calculation units 53 to calculate the power of the noise fixed average estimate 51. The power of the noisy fixed average estimate 51 is then subtracted from the power of the noisy channel estimates 31, which is calculated by the other power calculation unit 53. The resulting difference is then multiplied by a factor of 2. This is then the noise power E_n 46 of the AWGN of the noisy channel estimates 31.

[0051] The noise power E_n 46 of the AWGN can then be written in the form :

$$E_n = \{\text{Power}(31) - \text{Power}(51)\} * 2 \quad (\text{Eq. 6})$$

[0052] While the system of the preferred embodiment has been described to comprise the various units, it is understood by one skilled in the art that the system and the various units are implementable by computer software means. Furthermore, the later described method of the preferred embodiment is similarly

known by one skilled in the art to be implementable by computer software means or other processing means.

[0053] Referring to FIG.7, the method in accordance with the preferred embodiment starts with the step of the adaptive averaging unit receiving 110 the noisy channel estimates 31. Next, the step of averaging 115 the noisy channel estimates 31 is performed with a plurality of averaging lengths to obtain a corresponding plurality of noise-averaged estimates 47.

[0054] Following which the step of subtracting 120 the noise-averaged estimates 47 from the noisy channel estimates 31 is performed to obtain the noise-averaged differences 38.

[0055] Next, the calculating 125 of the power of the noise-averaged differences 38 is done in the Power Calculations Unit 39.

[0056] The step of calculating 130 noise power of the noisy channel estimates 31 is also performed. After which the calculating 135 of the total error power is performed for each of the averaging lengths using the noise power of noisy channel estimates 31 and the power of the noise-averaged differences 38.

[0057] The processor 40 then selects the averaging unit 34 with the averaging length having the lowest total error power as the averaging unit 34 for generating the channel estimates 28.

Simulation Results

[0058] Simulations were performed using the adaptive channel estimation unit of the preferred embodiment.

[0059] A propagation channel was set up to simulate rayleigh fading with three multipaths. The relative powers of the multipaths are all equal to 0 dB. Their

relative delays are 0 chips, 3.75 chips and 15 chips where a chip period is $260 \mu s$. The method of the preferred embodiment was applied on the strongest path. FIG. 8 shows a graph of the bit error rate(BER) against the averaging length L at various speeds v . A total of 1000 bits were tested.

[0060] The following can be observed :

- there is an optimum averaging length L_{opt} at which the BER is at a minimum; and
- the optimum averaging length L_{opt} is dependent on the speed v of the MSR.

[0061] FIG.9 shows a graph of the total error power against the averaging length L at various speeds v . The following can be observed :

- the total error power decreases with increasing averaging lengths, reaches a minimum, and thereafter increases ; and
- the optimum averaging length L_{opt} at which the total error power reaches its minimum is dependent on the speed of the MSR and SNR.

[0062] From FIG.9, we estimate the optimum averaging length at which the total error power is a minimum. Denote this as L'_{opt} , the estimated optimum averaging length. The actual value of the optimum averaging length L_{opt} can be deduced from FIG.8 and is the value at which the BER is a minimum.

[0063] The actual and estimated values of the optimum averaging length are compared in Table 1.

Sl. No.	Speed v	Actual Optimum Averaging length L_{opt}	Estimated Optimum Averaging Length L'_{opt}
1	30	20-40	20
2	60	10-20	10
3	120	5-10	5

4	240	2-5	3
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Table 1

[0064] The following can be observed:

- the estimated optimum averaging length L'_{opt} is approximately equal to the true value L_{opt} ; and
- as the speed changes, the true and estimated optimum values also change accordingly.

[0065] Since the speed of the MSR may be varying constantly, the method of the preferred embodiment could be run at fixed intervals to continually provide an estimate of the new optimum averaging value. Since the changes in MSR speed are not very drastic, the frequency of the method need not be high. It is typically of the order of 0.1 seconds -1 seconds.

[0066] It will be appreciated that although one preferred embodiment has been described in detail using the example of an MSR, various modifications and improvements can be made by a person skilled in the art without departing from the scope of the present invention. Further, the preferred embodiment may further be utilized in a PSAM system and in the Base Station of such a PSAM system.

Claims

1. An adaptive channel estimation unit of a rake finger in a mobile station receiver, the adaptive channel estimation unit comprising:
 - a channel estimation unit for processing de-spread pilot symbols and for generating noisy channel estimates; and
 - an adaptive averaging unit for suppressing noise in the noisy channel estimates using averaging techniques;wherein the adaptive averaging unit comprises:
 - a plurality of averaging units, each of the plurality of averaging units having a different predetermined averaging length;
 - the plurality of averaging units for averaging the noisy channel estimates to generate a corresponding plurality of noise-averaged channel estimates according to the different predetermined averaging lengths;
 - a plurality of subtractors for subtracting the plurality of noise-averaged channel estimates from the noisy channel estimates producing a plurality of noise-averaged differences;
 - a power calculations unit for calculating the power of the plurality of noise-averaged differences; and
 - a processor for calculating total error power for each of the plurality of noise-averaged channel estimates and for selecting one of the plurality of averaging units corresponding to the lowest total error power for suppressing noise in the noisy channel estimates.
2. The adaptive channel estimation unit of claim 1, further comprising a noise power calculations unit for calculating noise power in the noisy channel estimates.
3. The adaptive channel estimation unit of claim 2, wherein the processor further uses the noise power in the noisy channel estimates for calculating total error power for each of the plurality of noise-averaged channel estimates.

4. The adaptive channel estimation unit of claim 2, wherein the noise power calculations unit comprises:

a fixed position averaging unit for averaging the noisy channel estimates to produce a noise fixed average estimate; and

a power calculations unit for calculating power of the noise fixed average estimate and power of the noisy channel estimates;

wherein the power of the noise fixed average estimate is subtracted from the power of the noisy channel estimates, and further multiplying by two to obtain the noise power in the noisy channel estimates.

5. The adaptive channel estimation unit of claim 1, wherein the fixed position averaging unit has an averaging length of 2.

6. The adaptive channel estimation unit of claim 1, further comprising a switch for selecting between the plurality of averaging units.

7. The adaptive channel estimation unit of claim 6, wherein the switch is controlled by the processor.

8. A method for suppressing noise in channel estimates of a rake finger in a mobile station receiver, the method comprising the steps:

- a. receiving noisy channel estimates;
 - b. averaging the noisy channel estimates with a plurality of averaging lengths to obtain a corresponding plurality of noise-averaged estimates;
 - c. subtracting the plurality of noise-averaged estimates from the noisy channel estimates to obtain a plurality of noise-averaged differences;
 - d. calculating power of the plurality of noise-averaged differences;
 - e. calculating the noise power of the noisy channel estimates;
 - f. calculating total error power for each of the plurality of noise-averaged estimates;
- and

g. selecting one of the plurality of averaging lengths corresponding to the lowest total error power for suppressing noise in the channel estimates.

9. The method of claim 8, wherein the step b. and the step e. may be performed simultaneously.

10. The method of claim 8, wherein the step f. is performed using the noise power of the noisy channel estimates and the power of the plurality of noise-averaged differences.

11. The method of claim 8, wherein the step a. is performed by an adaptive averaging unit, the adaptive averaging unit comprises a plurality of averaging units, each of the plurality of averaging units having a different predetermined averaging length.

12. An adaptive channel estimation unit of a rake finger in a PSAM system, the adaptive channel estimation unit comprising:

a channel estimation unit for processing de-spread pilot symbols and for generating noisy channel estimates; and

an adaptive averaging unit for suppressing noise in the noisy channel estimates using averaging techniques;

wherein the adaptive averaging unit comprises:

a plurality of averaging units, each of the plurality of averaging units having a different predetermined averaging length;

the plurality of averaging units for averaging the noisy channel estimates to generate a corresponding plurality of noise-averaged channel estimates according to the different predetermined averaging lengths;

a plurality of subtractors for subtracting the plurality of noise-averaged channel estimates from the noisy channel estimates producing a plurality of noise-averaged differences;

a power calculations unit for calculating the power of the plurality of noise-averaged differences; and

a processor for calculating total error power for each of the plurality of noise-averaged channel estimates and for selecting one of the plurality of averaging units

corresponding to the lowest total error power for suppressing noise in the noisy channel estimates.

13. The adaptive channel estimation unit of claim 12, further comprising a noise power calculations unit for calculating noise power in the noisy channel estimates.

14. The adaptive channel estimation unit of claim 13, wherein the processor further uses the noise power in the noisy channel estimates for calculating total error power for each of the plurality of noise-averaged channel estimates.

15. The adaptive channel estimation unit of claim 13, wherein the noise power calculations unit comprises:

a fixed position averaging unit for averaging the noisy channel estimates to produce a noise fixed average estimate; and

a power calculations unit for calculating power of the noise fixed average estimate and power of the noisy channel estimates;

wherein the power of the noise fixed average estimate is subtracted from the power of the noisy channel estimates, and further multiplying by two to obtain the noise power in the noisy channel estimates.

16. The adaptive channel estimation unit of claim 12, wherein the fixed position averaging unit has an averaging length of 2.

17. The adaptive channel estimation unit of claim 12, further comprising a switch for selecting between the plurality of averaging units.

18. The adaptive channel estimation unit of claim 17, wherein the switch is controlled by the processor.

19. A method for suppressing noise in channel estimates of a rake finger in a PSAM system, the method comprising the steps:

- a. receiving noisy channel estimates;
- b. averaging the noisy channel estimates with a plurality of averaging lengths to obtain a corresponding plurality of noise-averaged estimates;
- c. subtracting the plurality of noise-averaged estimates from the noisy channel estimates to obtain a plurality of noise-averaged differences;
- d. calculating power of the plurality of noise-averaged differences;
- e. calculating the noise power of the noisy channel estimates;
- f. calculating total error power for each of the plurality of noise-averaged estimates; and
- g. selecting one of the plurality of averaging lengths corresponding to the lowest total error power for suppressing noise in the channel estimates.

20. The method of claim 19, wherein the step b. and the step e. may be performed simultaneously.

21. The method of claim 19, wherein the step f. is performed using the noise power of the noisy channel estimates and the power of the plurality of noise-averaged differences.

22. The method of claim 19, wherein the step a. is performed by an adaptive averaging unit, the adaptive averaging unit comprises a plurality of averaging units, each of the plurality of averaging units having a different predetermined averaging length.