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Title: A Proposed Receiver for System-Level Evaluations

Document for: Discussion

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1. SUMMARY

It is recommended to consider a linear MMSE receiver as a baseline for comparing various multi-antenna schemes.

2. DISCUSSION

Rake receivers are commonly used to evaluate the performance of CDMA systems. However, Rake receivers can perform poorly on the high-speed downlink shared channel (HS-DSCH) in multipath (especially at high geometry locations). This is mainly due to the loss of orthogonality among Walsh codes in frequency selective channels. In addition, Rake receivers cannot be used with MIMO transmitters, for which multiple data streams are transmitted on the same Walsh code(s).

The use of linear MMSE receivers for equalization in multipath channels is well known, [1], and the application of MMSE to CDMA with a long spreading code was demonstrated in [2]. In addition, space-time MMSE receivers can be used for both equalization and separation of data streams in MIMO antenna systems applied to the HS-DSCH, [3, 4]. Channel estimation errors can have an impact on equalizer performance; however their effects can be modeled straightforwardly for MMSE receivers [5]. Furthermore, the MMSE receivers can have performance comparable to more complicated, non linear approaches over the range of SINR found in cellular systems [3].

3. PROPOSED RECEIVER SIMULATION PROCEDURE

The proposed system-level simulation procedure is similar to that given in [6]. For each slot, the receiver function is outlined below (see Figure 1):

- Given the space-time propagation model and transmitter state[1], form a channel (expressed as one or more convolution matrices) relating all transmit and receive antennas.
- Using the above channel, produce an estimate of the channel.
- Using the estimated channel, compute the space-time MMSE filter coefficients -- one FIR filter per antenna per data stream.
- Estimate SINR per data stream at the output of the MMSE filters.

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[1] The transmitter state includes power allocation, Walsh codes used, MCS, diversity method, etc.

Map the per stream SINR values to per stream throughput and delay using the transmitter state. HARQ can be easily incorporated in this process. For example, for each repeated frame, combine the SINR values (per data stream) and lookup the corresponding frame error rate.

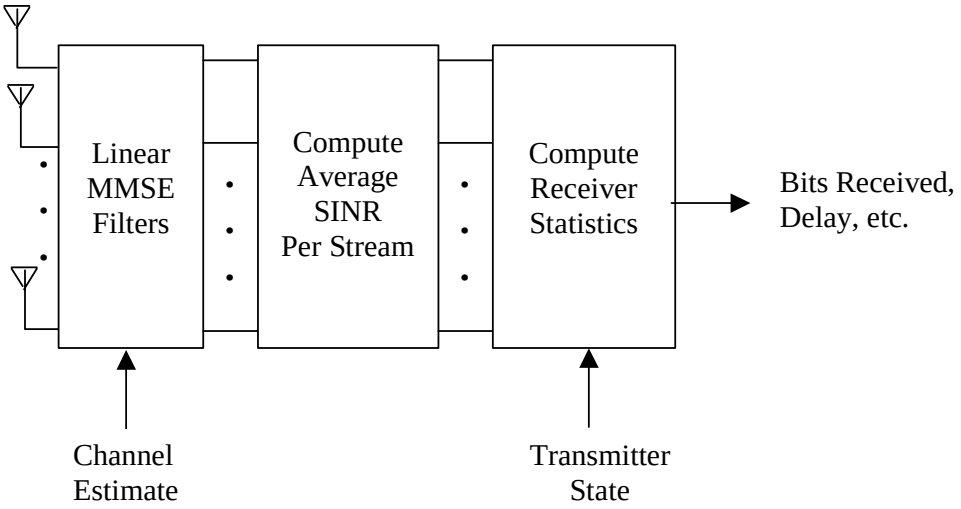

Figure 1. UE Receiver Processing.

Issues for further study include:

- Channel estimation
- High mobile velocities
- MMSE algorithm details

4. CONCLUSIONS

Since linear MMSE receivers are straightforward to simulate and provide good performance in a cellular environment, their use is proposed as a baseline for system simulations.

5. REFERENCES

[1] J. G. Proakis, *Digital Communications*, Fourth Edition, McGraw-Hill, 2001.

[2] C. D. Frank, E. Visotsky, "Adaptive Interference Suppression for Direct-Sequence CDMA Systems with Long Spreading Codes," Proceedings of Allerton Conference on Communication, Control, and Computing (Univ. of Illinois), Monticello, IL, pp. 411-420, Sept. 23-25, 1998.

[3] M. Ahmed, J. Pautler, and K. Rohani, "CDMA Receiver Performance for Multiple-Input Multiple-Output Antenna Systems," IEEE Vehicular Technology Conference, Oct. 7-11, 2001.

[4] Lucent Technologies, "Equalization for Frequency Selective Channels," Standards Contribution to 3GPP TSG RAN WG1, R1(02)0327, Orlando, FL, USA, February 18-21, 2002.

[5] 3GPP2 WG5 Evaluation AHG, 1xEV-DV Evaluation Methodology – Addendum (V6), July 25, 2001.

[6] J. Pautler, M. Ahmed, and K. Rohani, "On Application of Multiple-Input Multiple-Output Antennas to CDMA Cellular Systems," IEEE Vehicular Technology Conference, Oct. 7-11, 2001.