Impulse Noise Mitigation for Receive Diversity OFDM Systems

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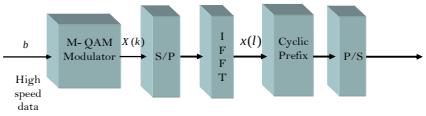
Introduction

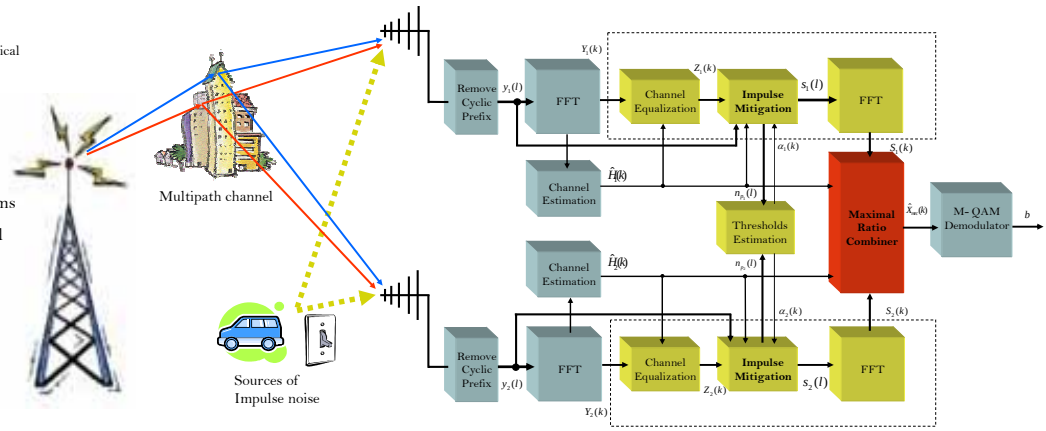
- Impulse noise is a short burst of high level noise typically caused by electrical appliances being switched on/off, vehicle ignition, etc.
- Impulse noise is a significant problem in many OFDM systems including digital video broadcast (DVB).

Objective

- Reduce the adverse effect of impulse noise on OFDM systems
- We present an optimal maximal ratio combiner (MRC) dual branch diversity receiver using decision directed impulse mitigation.



OFDM Transmitter



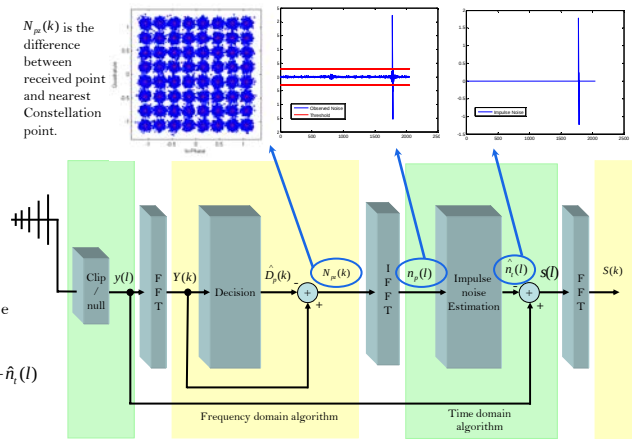
OFDM Receiver

How to mitigate impulse noise ?

Decision Directed Impulse Noise Mitigation Algorithm in each branch before combining

- Preliminary decision $\hat{D}_p(k)$ on transmitted data
- The observed noise samples $n_p(l)$ above a given threshold represent $\hat{n}_t(l)$ an estimation of the impulse noise
- Estimation must be a non linear process
- Subtract impulse noise from the original signal $s(l)=y(l)-\hat{n}_t(l)$

$N_{pn}(k)$ is the difference between received point and nearest Constellation point.



Why Receive diversity?

- Multi antenna receivers give better performance than Single Input Single Output (SISO) systems in fading channels. Maximal Ratio Combining (MRC) gives the greatest benefits.

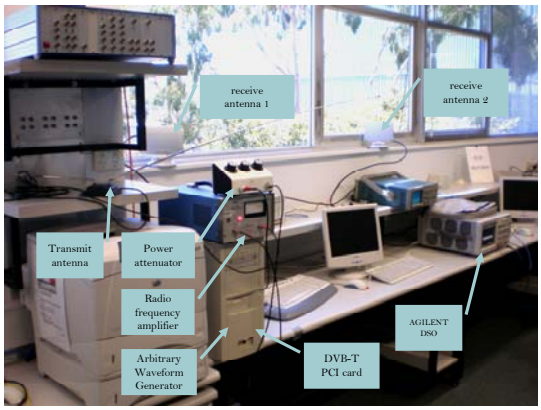
$$\hat{X}_{mrc}(k)=\sum_{j=1}^{J} S_j(k)\hat{H}_j^*(k) \Big/ \sum_{j=1}^{J}\left|\hat{H}_j^*(k)\right|^2 \qquad J=2$$

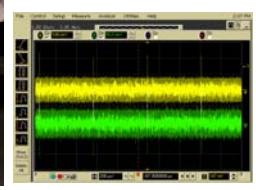
- Diversity threshold setting improves the effectiveness of the noise mitigation algorithm because the thresholds are calculated taking into account the relative power and correlations value of the impulses on the two receiver branch

Laboratory tests

The performance depends on two aspects of the impulse noise: The time domain statistics of the impulses and the correlation of the impulse noise between the two antennas.

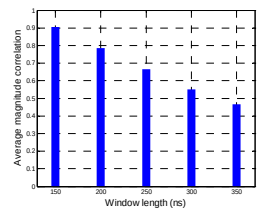
- Digitally generated impulses were transmitted and were received using two normal indoor television antennas. The signals were captured digitally at RF using an Agilent digital signal analyser. These signals were downconverted to the baseband with MATLAB processing.
- Correlation values in time of occurrence, magnitude and phase between the pulses at the two antennas were used to extend the BBC impulse noise model (for SISO systems) to the diversity receiver.
- The correlation of the impulses between the two antennas were calculated for different window lengths.





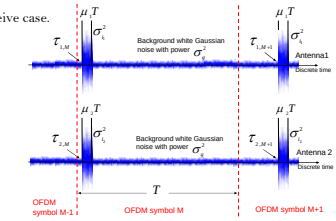
Correlation values

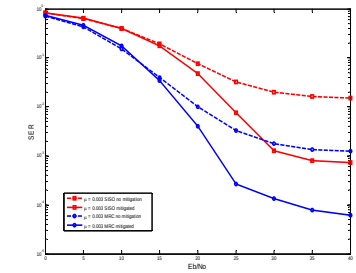
- Time of occurrences : ~ 1
- Phase: ~ 0
- Magnitude: highly correlated



Performance Analysis

- **Impulse noise Model**: *Gated Gaussian* model developed by the BBC on the basis of field measurements, extended to diversity receive case.





Simulation results show that the new technique gives significantly better performance than either diversity reception or impulse mitigation alone.

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