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Mitigation of Noise in OFDM Based Plc System Using Filter Kernel Design

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Abstract
Power line communication is a technology that transforms power line in to pathway for conveyance of broadband data. It is cost less than other communication approach and for better bandwidth efficiency OFDM based PLC system is used. In real PLC environment some electrical appliances will produce noise. To mitigate this noise filter kernel design is used, so periodic impulsive noise and Gaussian noises are removed from PLC communication system by using this filter kernel design. MATLAB is used for the simulation and the result shows that filter kernel is simple and effective noise mitigation technique. Further in future, interference due to obstacles also wants to be mitigated for the better data transmission without noise.
Keywords- PLC, Adaptive Notch Filter, Guassian Filter, OFDM.

I. INTRODUCTION

Power Line Communication, based on OFDM have high bandwidth efficiency and less cost than other communication approach. Power line communication is a technology that transforms power line into pathways for the conveyance of broadband data. But in real PLC environment some electrical appliances will produce noises such as colored background noise; narrowband noise; periodic impulsive noise asynchronous to the mains frequency; periodic impulsive noise synchronous to the mains frequency; and asynchronous impulsive noise. The periodic impulsive noise asynchronous to the mains frequency is one type of impulsive noise which remain stationary over period of seconds, minutes or even hours. Since the impulsive noise is similar to damped sinusoidal noise, in real PLC environment the impulsive noise is modelled as damped sinusoidal noise. The impulsive noise produced by the real PLC environment with fixed frequency and the power spectral density (PSD) usually greatly exceeding that of the received signals. Its frequency is between 40 and 200 kHz (only the impulsive noise with the frequency in the frequency band of the system 42–89 kHz is considered here), and it is usually found remaining stationary over periods of minutes or even for hours. When the signal received by the OFDM based PLC system are added by damped sinusoidal signals, the correlation result of the synchronization of the OFDM-based PLC system will greatly change, then the synchronization module of PLC receiver may work incorrectly or even fail to work, the bit-error rate (BER) of the PLC system will greatly increase, and it will lead to the significant degradation of the throughput or even corruption of the PLC system. So the periodic impulsive noise should be mitigated before the synchronization of the PLC receiver to ensure the correct synchronization result. Additive white Gaussian noise (AWGN) is a basic noise model used in Information theory to mimic the effect of many random processes that occur in nature. iovascular diseases, falls, cognitive injuries etc cause people helplessness at home. So a novel Remote Health Monitoring system is used to provide pervasive health care to the people in real time. Advanced wireless communication, and body sensors help to hold the promise to reduce the health crises. Photoelectricity sensor is used to measure the health parameter in a situation where large sized and standard equipment are not available.

II. Mitigation of Noise in OFDM Based PLC System

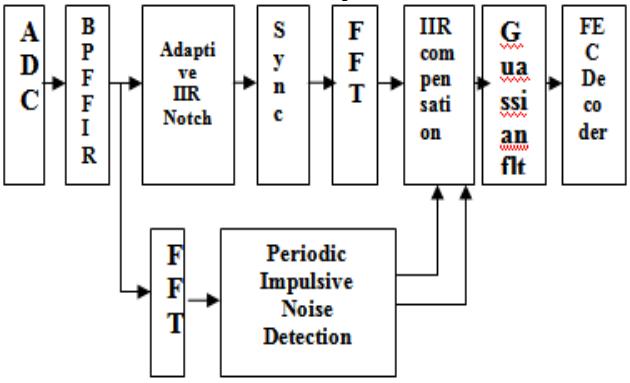

Fig :1 Block diagram of mitigation of noise in PLC system

The output data from the analog to digital converter are given to the FIR BPF for filtering.

When the periodic impulsive noise detection module begins to work, the output data of the bandpass filter are sent to the FFT module. If it is confirmed that periodic impulsive noise exists at the period, the frequency of periodic impulsive noise will be located [1], and the output data of the BPF will be filtered by the adaptive IIR notch filter, and then the output data of the IIR notch filter will be sent to the synchronization module of the system. If periodic impulsive noise does not exist, the output data of BPF will be sent to the synchronization module directly with the IIR notch filter bypassed. The IIR compensation module will work if the periodic impulsive noise exists, or else, it stops working. Then the data is given to Gaussian Filter in order to reduce the background noise. FEC is always working to decrease the BER of the system. A Gaussian filter is a filter whose impulse response is a Gaussian function. Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behaviour is closely connected to the fact that the Gaussian filter has the minimum possible group delay.

A. Periodic Impulsive Noise Detection

The PLC system is idle most of the time, so the periodic impulsive noise detection module can work periodically by sharing the FFT module with the OFDM demodulation time division.

The time realization of the of the periodic impulsive noise in power line communication can be modelled as

$$PIN(t) = A\, e^{-\tau t} \cos(2\pi f_0 t)$$

where A is the peak value of the amplitude of the periodic impulsive noise, τ is the damping factor, and f_0 is the frequency of the periodic impulsive noise.

Then, the received data *r(t)* can be represented as

$$r(t) = s(t) + n_{background}(t) + imp(t)$$

where *s(t)* is the transmitted data from the transmitter. $n_{background}(t)$ is the background noise which can be modelled as white Gaussian noise (WGN) *imp(t)* is impulsive noise, and the periodic impulsive noise is the dominant impulsive noise[1],[2]. After periodic impulsive noise mitigation, the received signal contains the transmitted signal and background noise and it is considered as additive white Gaussian noise.

To simulate the real PLC environment, WGN is added to the transmitted signals transmitted by the PLC transmitter. For all simulations, the SNR of the WGN is set to 15 dB. The SNR is defined as

$$SINR = E_b / N_{PIN}$$

where E_b is the bit energy of the signal, while N_{PIN} is the PSD of the periodic impulsive noise.

The BER of the PLC system will be significantly decreased when the system is interfered by the periodic impulsive noise. Below which the BER of the PLC system with the proposed impulsive noise mitigation method is less than that of the PLC system without impulsive noise mitigation under the interference of the same periodic impulsive noise The PLC system can work normally when the SINR is above 2 dB.

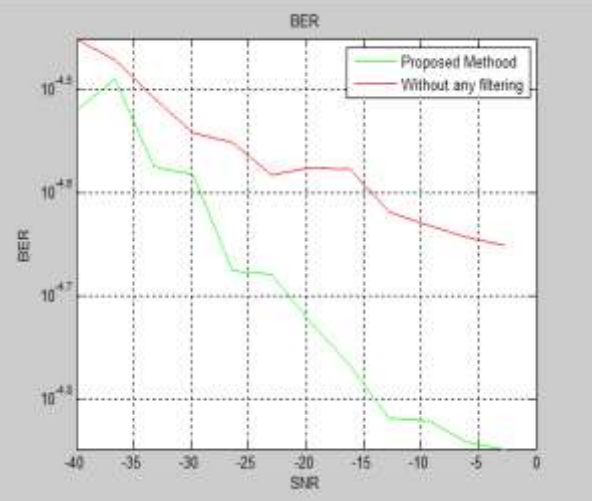

Fig 3 Simulation result of mitigation of periodic impulsive noise

B) Additive Gaussian Noise Mitigation

Noise generated by electronic devices varies greatly, as it can be produced by several different effects. Thermal noise is unavoidable at non-zero temperature while other types depend mostly on device type (such as shot noise, which needs steep potential barrier) or manufacturing quality and semiconductor defects, such as conductance fluctuations. In communication systems, noise is an error or undesired random disturbance of a useful information signal in a communication channel. The noise is a summation of unwanted or disturbing energy from natural and sometimes man-made sources.

A Gaussian filter is a device or process that removes from a signal some unwanted component or feature. Filtering is a class of signal processing; most often this means removing some frequencies and not others in order to suppress interfering signals and reduce background noise. To mitigate additive white Gaussian noise, Gaussian filter kernel design is used. In this method a convolution matrix is used for getting the actual signal from noise and the values of the matrix can be changed depending upon required signal by iteration. That minimizes the error between the idealized and the actual filter characteristic over the range of the filter

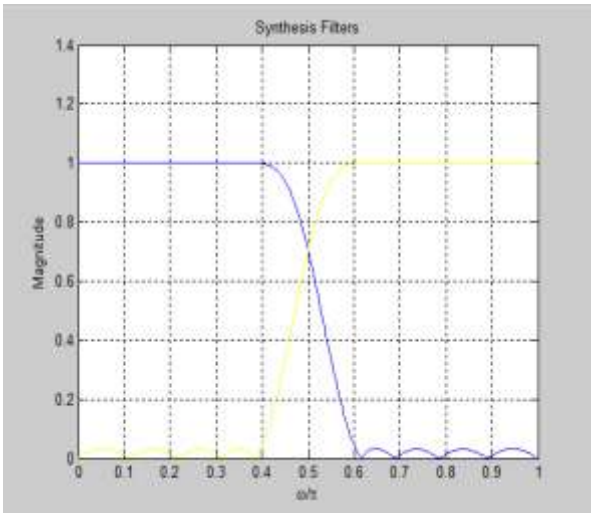

Fig 3 Filter synthesis of Gaussian noise

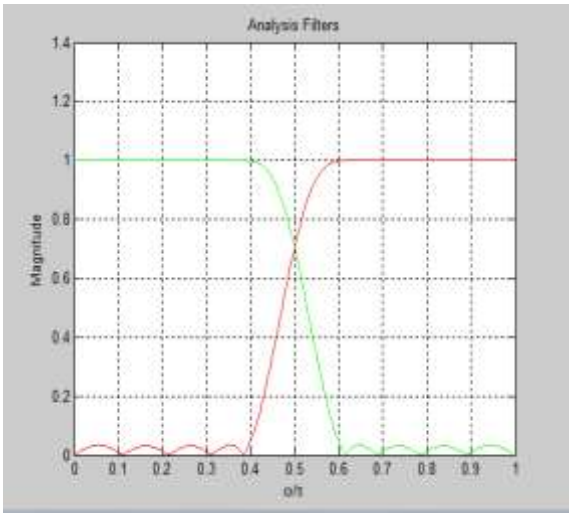

Fig 4 Filter Analysis of Gaussian Noise

The above fig 3 and fig 4 shows that the error rate due to Additive White Gaussian noise reduced by Gaussian filter kernel design.

III. CONCLUSION

In real PLC environment various types of noises such as periodic impulsive noise and Gaussian noises are present. In order to reduce this noise, filter kernel design. The simulation is done using MATLAB. The simulation result shows that this method is effective for the noise reduction. In future the interference caused in PLC environment also wants to be reduced.

REFERENCES

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