Wavelet Transform and Artificial Neural Network for Digital Signal Detection and Equalization in Optical Wireless Communication

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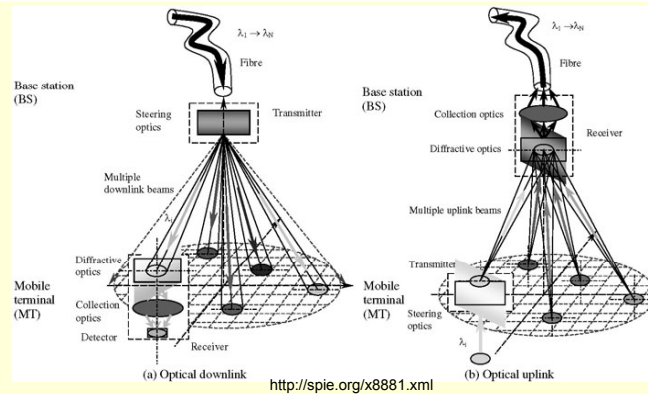
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Abstract: The task of signal detector in digital communication is to minimise the probability of error in the received signal which has been corrupted by noise and interference. The equalization and signal detection based on finite impulse response (FIR) filter and matched filter suffer from performance degradation in non-stationary environment. The new approach is based on feature extraction and pattern classification. Different feature extraction tools could be applied but wavelet transform (WT) is most suited in time varying channel because of time-frequency resolution. Artificial neural network(ANN) as a pattern classification tools provides the flexibility of adaptability and nonlinear signal processing.
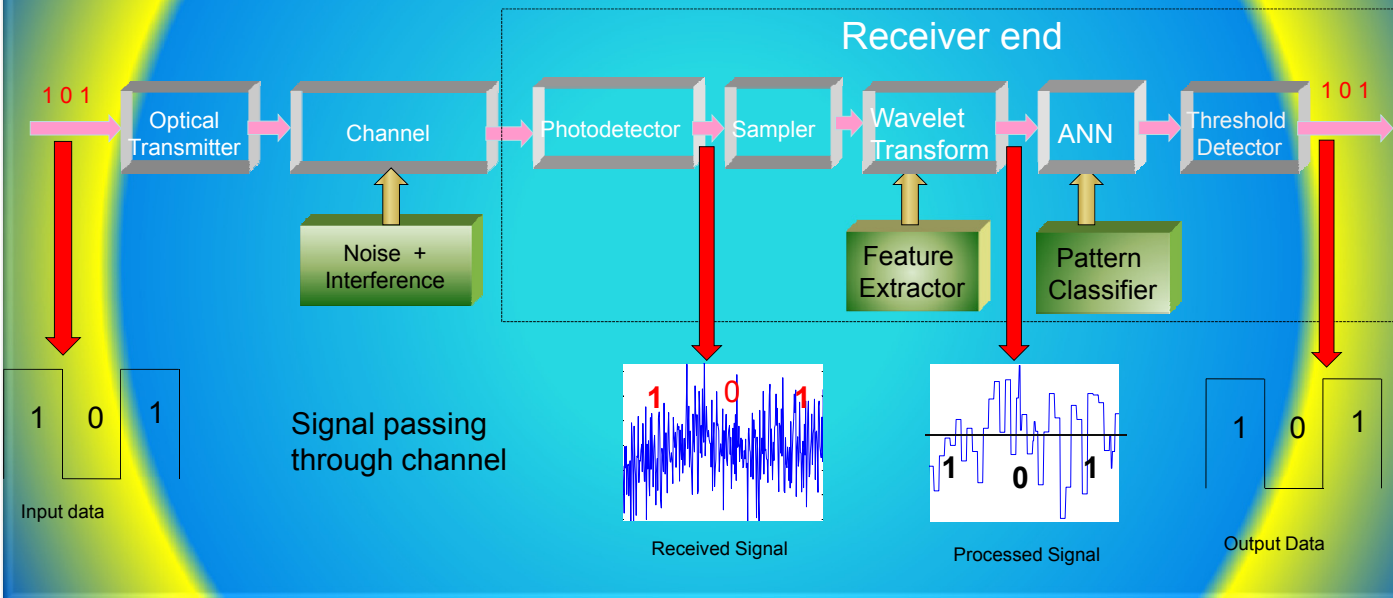
1. Optical Wireless Communication

Laser

Photodetector

http://spie.org/x8881.xml

(a) Optical downlink   (b) Optical uplink

Advantages

➢ **Huge unregulated bandwidth**
➢ **Low cost**
➢ **High data rate**
➢ **Secure data transmission**
➢ **License free operation**
➢ **Free from electromagnetic interference**
➢ **Compatible with optical fibre**
➢ **Quick to deploy**

2. The System Block Diagram of WT-ANN Based Equalizer /Receiver

Receiver end

1 0 1 → Optical Transmitter → Channel → Photodetector → Sampler → Wavelet Transform → ANN → Threshold Detector → 1 0 1

Noise + Interference

Feature Extractor

Pattern Classifier

1 0 1

Input data

Signal passing through channel

1 0 1

Received Signal

1 0 1

Processed Signal

1 0 1

Output Data

4. Advantages of WT-ANN based receiver

➢ Improved error performance compared to FIR based equalizer.
➢ No assumption on the channel and noise statistics.
➢ The non-linear, non-stationary and non-Gaussian channel is not a problem.
➢ ANN based receiver is able to adopt in the fast varying channel.

5. Disadvantages of WT-ANN based receiver

➢ Hardware complexity makes system more expensive.
➢ Processing is slow since a number of samples per symbol Is necessary.
➢ Modern electronics speed is not enough for real time

6. Challenges

➢ Hardware complexity.
➢ No analytical solution for the selection of an ANN with the best performance.
➢ The selection of an ANN is based on trial and error.