Carrier Frequency Offset Estimation Algorithm for the 3GPP-LTE

Department of Electrical Engineering

曾柏翔

Introduction

- Synchronization is of fundamental importance for wireless system, therefore carrier frequency offset (CFO) estimation is essential in the initial synchronization
- The traditional CFO estimation schemes including PSS correlation based scheme, the cyclic prefix(CP) based scheme

System Model

- With the presentence of CFO and noise, the received time-domain complex baseband OFDM samples *r(n)* are given by:

- $r(n) = e^{j\frac{2\pi m\varepsilon}{N}} \sum_{l=0}^{L-1} h_l s_u\left((n-l) \bmod N\right) + V(n)$

  - s_u: *transmitted PSS samples*
  - h_l : the overall channel impulse response
  - ε : the carrier frequency offset
  - *v(n)* : the complex white Gaussian noise

The PSS Correlation Based Scheme

- The estimator is based on the correlation between the received PSS samples(r_{pss}) and the local PSS sequence(s_u), the correlation term: $y(n) = s_u^*(n) r_{pss}(n)$
- Divide the correlation sequence $\{y(n)\}$ into two equal-length parts and sum them to get two terms
- Hence, the CFO can be estimated by taking the conjugate multiplication of these terms, $y_{cor,0}$ and $y_{cor,1}$

$$\hat{\varepsilon}_{cor} = \frac{angle(y_{cor,0}^{*} y_{cor,1})}{\pi}$$

CP Based Scheme

- In this scheme, we use CP in the OFDM sample to estimate CFO
- $r(n) = e^{j\frac{2\pi m\varepsilon}{N}} \sum_{l=0}^{L-1} h_l s_u((n-l) \bmod N) + V(n)$
  - n = 0,1,….,N+Ng-1
  - N_g: the length of CP
- CFO can be estimated by

$$\hat{\varepsilon} = \frac{angle(\sum_{k=0}^{N_g-1} r^*(k)r(k+N))}{2\pi}$$

Performance comparison

- The CFO estimation performance comparison between PSS-correlation scheme and CP based scheme over AWGN channel