Friquency Offset Estimation

1. Maximum likelyhood mathod

1) In a multicarrier system there is a dissimilarity of the oscillators used at the transmitter and receiver which causes a ofset in the carrier friquency.Due to this at the receiver end when the signal is demodulated, we get a very high bit rate error.
   To overcome this eror ML stimation is used and ML carrier frequency estimater
   $$\triangle f = \frac{1}{2\pi T_s}\frac{\sum_{k=1}^{M} ImR(k)}{\sum_{k=1}^{M} kReR(k)} \tag{1}$$
   Where the △f is the frquency offsetT_s is the sampeling interval.
2) R(k) denotes the estimated autocorrelation of the sequence r_k.
   $$R(k) = \frac{1}{N-K}\sum_{i=k+1}^{M} r_i r_{i-k}^* \tag{2}$$
   $r_k$is the sampled signal which can be represnted as →
   $$r_k = e^{j2\pi\triangle f T_s+\theta} + v_k \tag{3}$$
   $1 \leq k \leq N$
   v_k is the compex noise.
   $$\sum_{k=1}^{M} ImR(k) = Marg\sum_{k=1}^{M} R(k) \tag{4}$$
   $$\sum_{k=1}^{M} kReR(k) = M\frac{M+1}{2} \tag{5}$$
3) Thus total no of the quation used are 5.

2. Simulation for frequency estimation

Simulation shows that symbols with a constant offset frequency are transferred through a wirless comunication channel.At the receiver end this offset frequency is estimated with the ML mwthode.Process is repated for the different value of the signal's amplitude A.

In ML estimation r_k is the received signal and R(k) represents the autocorelation of the r_k. If the length of the incomming signal is N then R(k)will be →

$$\sum_{i=k+1}^{M} r_i r_{i-k}^* \tag{6}$$

When the value of the k is near to the N then it gives a poor estimate of the autocorilation of r_k so we use values of k lower than N to discard the unrelible autocorrelation estimates.Using the taylor series expansion of the frequency estimator we aproximate and get the final equation as→

$$\triangle f = \frac{1}{2\pi T_s}\frac{\sum_{k=1}^{M} ImR(k)}{\sum_{k=1}^{M} kReR(k)} \tag{7}$$

3. Observation

For different value of m and for fix length of simlen simulaton is performed.From $m = 5$ to $m = 50$ is taken for different graphs where simlen is 50 and frequency is 50K.

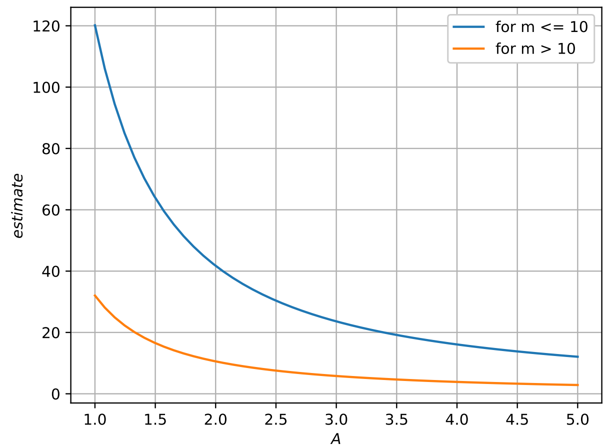

Fig. 1: comaprision of graph of offset friquency for different M

table for the variables and values used in the code

Frequency offeset Estimation variable			
No	**variable name**	**Dimensions**	**value**
1	A	18x1	[1.000; 1.2353; 1.4706 ...4.7647; 5.0000]
2	M	1x1	5,10,20,30,40
3	RK	1x1	2.3530 + 0.98340i
4	Ts	$1x1$	$1.00E-09$
5	V	18x1	[2.588 + 0.4577i; 1.073 + 0.924i;...1.111 + 0.1142i]
6	delf	1x1	5000000
7	estimate	18x1	[0.552209; 0.55271; 0.53406...0.24770]
8	f_hat	$1x1$	$3.76E+06$
9	fdm	1x1	1479.9
10	fnm	1x1	34.976
11	r	18x1	[7.5880 + 0.4577i; 6.0709 + 1.0817i;....5.4149 + 2.6594i]
12	r1	18x1	[0.00000 + 0.00000i; 0.00000 + 0.03142i...0.00000 + 0.53407i]
13	simlen	1x1	50
14	theta	1x1	0
15	tot	1x1	42.305 + 17.701i
16	v	18x1	[0; 0;....0; 0]
17	variance	1x1	1

TABLE II: List of variable

4. Conclusion

In this simulation frequency and simlen is constant and M varies from 5 to 50. For m≤10 the value of estimate variable varies from 10 to 400 and everage is 120 for A = 1 as shown in graph. For m≥10 the value of the estimate variable varies from 0.2 to 70 and average is 35 for A = 1.thus in short we can say that for the smaler value of M error is large than that of for larger M.