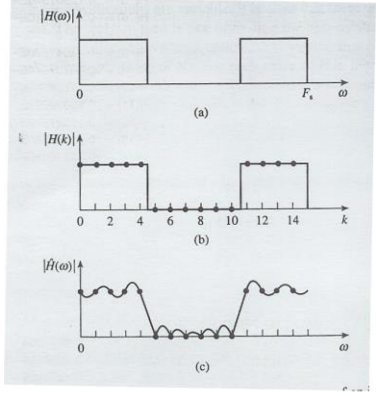
Navodila - laboratorijske vaje 9

Nekatere funkcije za realizacijo:

- magplot, xtitle, window frmag
- freqsamp(ampl_odziv), magplotlin
- eqfir (N, [sp1. zg.1; sp2. zg.2; spx 0.5],[Hd1 Hd2 …],[W1 W2 …]);

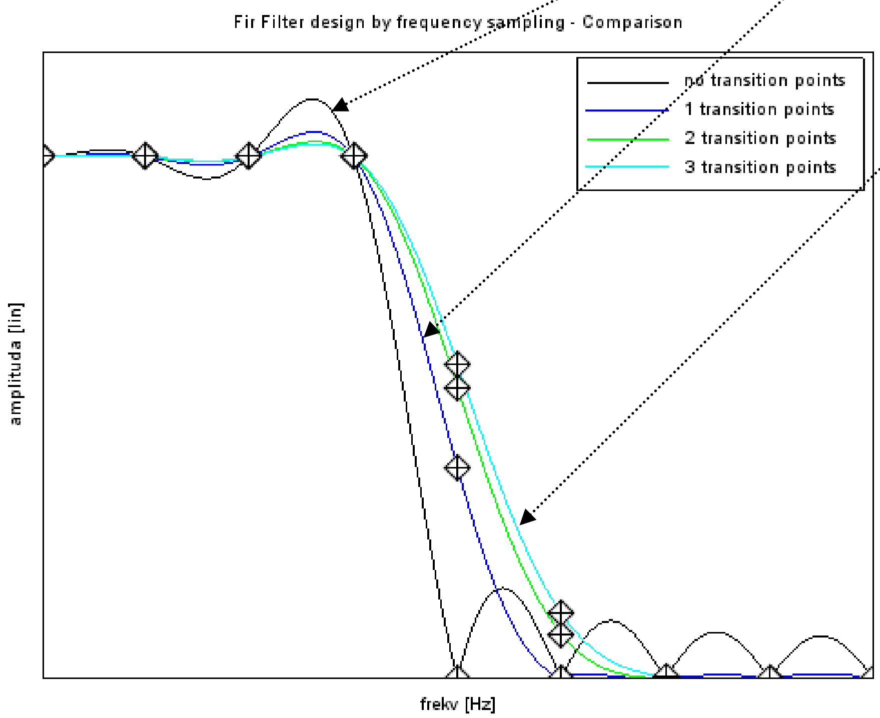
Prikaz ideje FV



NAČRTOVANJE KEO FILTROV Z LINEARNO FAZO II

1. *Načrtovanje s frekvenčnim vzorčevanjem (FV)*
   - uporabite funkcijo freqsamp, ki iz danega amplitudnega odziva |H(k)| izračuna ustrezni enotin odziv filtra h(n).
   - metodo preizkusite tudi na primerih z optimalnimi vrednostmi v prehodnem pasu (desna tabela).
   - primerjajte amplitudne odzive filtrov. Kaj se dogaja s prehodnim pasom pri izboljševanju dušenja filtra ?
   - z nekaj različnimi vrednostmi preizkusite optimalnost vrednosti v "prehodnih točkah".

Primer načrtovanja s F.V.	
k=0,1,2,3	*1*
k=4,5,6,7	*0*
k=0,1,2,3	*1*
k=4	*0.40406*
k=5,6,7	*0*
k=0,1,2,3	*1*
k=4	*0.5571*
k=5	*0.0841*
k=6,7	*0*
k=0,1,2,3	*1*
K=4	*0.6018*
K=5	*0.1239*
K=6	*0.0038*
k=7	*0*



2.Načrtovanje optimalnih filtrov po Čebiševem kriteriju (Parks,Mc Clellan)

- s pomočjo Parks-Mc Clellanove metode (funkcija eqfir) načrtuj naslednje pare filtrov:
  - N=41, enakomerne uteži (1), z naslednjimi mejami prepustnega in zapornega pasu:
  - 1. par:
    - filter 1: meja med prep. in zapornim pasom je točka z relativno vrednostjo 0.25
    - filter 2: prep. pas [0, 0.24]   zap. pas [0.26, 0.5]
  - 2.par
    - filter 3: zap. pas [0, 0.24]   prep. pas [0.26, 0.5], N=41
    - filter 4: zap. pas [0, 0.24]   prep. pas [0.26, 0.5], N=42
  - primerjajte analizirajte amplitudne odzive filtrov v obeh parih 1-2 in 3-4 (»frmag«)
- Odgovorite:
  - razložite smisel uvedbe prehodnega pasu.
  - zakaj pride do velikega odstopanja v primeru filtrov 3 in 4 ?

Praktični primer : Načrtovanje KEO NOTCH filtra

Podobno kot v 2. nalogi poskušajte načrtovati KEO NOTCH filter in ga primerjajte z rešitvami 3. naloge s 7. laboratorijskih vaj:

- analizirajte dobljen filter
- opišite postopek načrtovanja in komentirajte morebitne probleme.
- uporabite sodo in liho število koeficientov N. Kaj ugotovite ? Ugotovitve tudi utemeljite.

Pomembni poudarki iz literature

Kriteriji za oceno napake filtrov

The design of FIR filters by windowing is straightforward and is quite general, even though it has a number of limitations. However, we often wish to design a filter that is the "best" that can be achieved for a given value of M. It is meaningless to discuss this question in the absence of an approximation criterion. For example, in the case of the window design method, it follows from the theory of Fourier series that the rectangular window provides the best mean-square approximation to a desired frequency response for a given value of M. That is,

$$h[n] = \begin{cases} h_d[n], & 0 \le n \le M, \\ 0, & \text{otherwise}, \end{cases} \tag{7.72}$$

minimizes the expression

$$\varepsilon^2 = \frac{1}{2\pi} \int_{-\pi}^{\pi} |H_d(e^{j\omega}) - H(e^{j\omega})|^2 d\omega. \tag{7.73}$$

The particular criterion used in this design procedure is the so-called minimax or Chebyshev criterion, where, within the frequency intervals of interest (the passband and stopband for a lowpass filter), we seek a frequency response $A_e(e^{j\omega})$ that *minimizes* the *maximum* weighted approximation error of Eq. (7.83). Stated more compactly, the best approximation is to be found in the sense of

$$\min_{\{h_e[n]:0\le n\le L\}} \left(\max_{\omega\in F} |E(\omega)| \right),$$

$$E(\omega) = W(\omega)[H_d(e^{j\omega}) - A_e(e^{j\omega})], \tag{7.83}$$

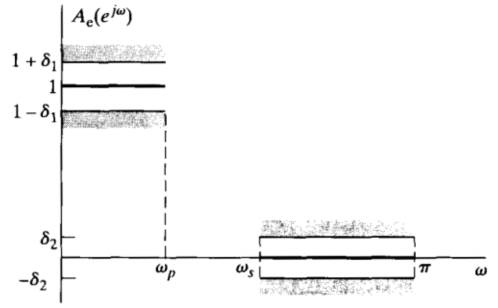


Figure 7.31 Tolerance scheme and ideal response for lowpass filter.

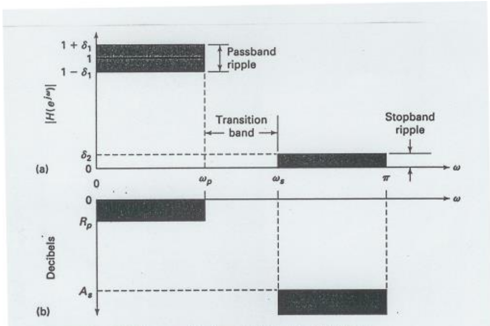


FIGURE 7.1 *FIR filter specifications: (a) Absolute (b) Relative*

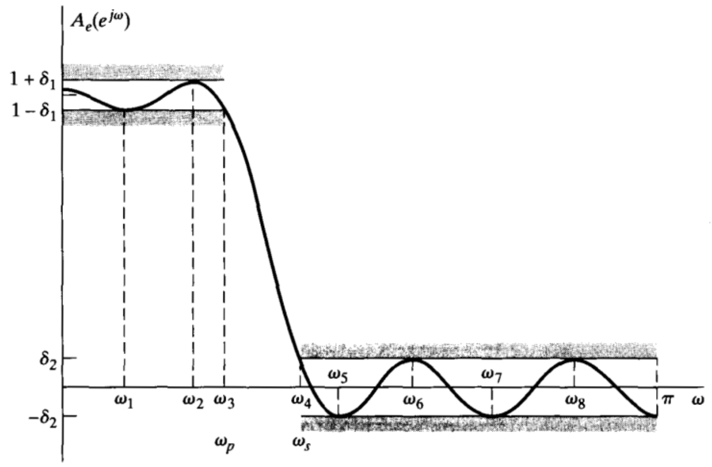


Figure 7.35 Typical example of a lowpass filter approximation that is optimal according to the alternation theorem for $L = 7$.

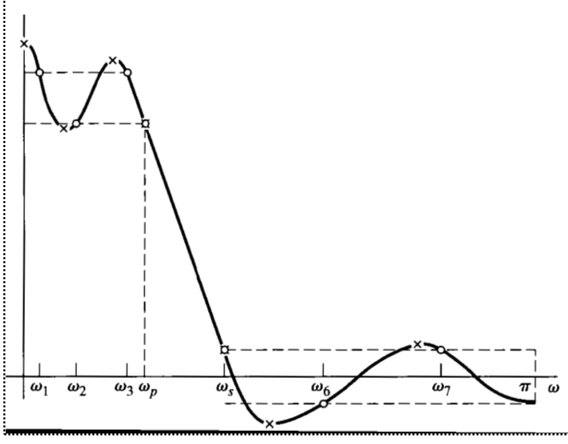


Figure 7.40 Illustration of the Parks–McClellan algorithm for equiripple approximation.

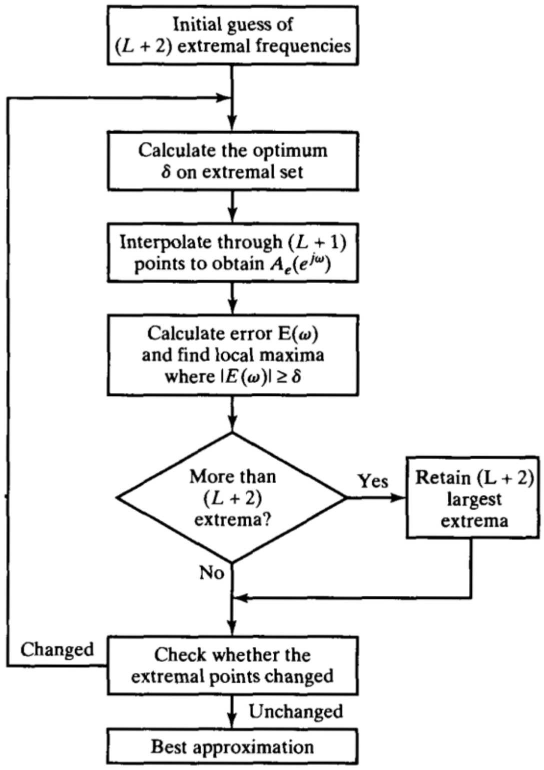


Figure 7.41 Flowchart of Parks–McClellan algorithm.