Homework #2

Due date: October 5, 2016

Submission: Hard Copy (N1, 415)

1. Let us consider the up-conversion from the sampling lattice Λ_1 to Λ_2. Their respective sampling matrices are

$$[\mathbf{V}_1]=\begin{bmatrix}2 & 1\\ 0 & 1\end{bmatrix}, \quad [\mathbf{V}_2]=\begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix}.$$

- Assume the spectrum of the original continuous signal has a circular support. Let v_1^* and v_2^* denote Voronoi cell of lattice Λ_1 and Λ_2, respectively.

(a) Find the corresponding sampling matrices for the reciprocal lattices.

[Solution]

$$[\mathbf{U}_1]=\begin{bmatrix}2 & 1\\ 0 & 1\end{bmatrix}^{-T}=\begin{bmatrix}1/2 & 0\\ -1/2 & 1\end{bmatrix} \text{ and } [\mathbf{U}_2]=\begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix}^{-T}=\begin{bmatrix}1 & 0\\ -1 & 1\end{bmatrix}$$

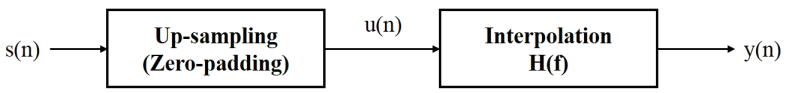
(b) How is low pass filter for the up-conversion?

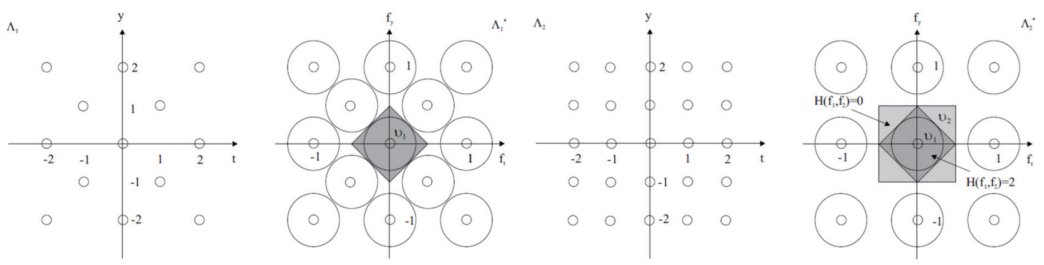
[Solution]

$$H_u(\mathbf{f})=\begin{cases} d(\Lambda_2)/d(\Lambda_1)=2, & \mathbf{f}\in v_1^* \\ 0, & \mathbf{f}\in v_2^*\setminus v_1^* \end{cases}$$

(c) Illustrate the up-conversion process from lattice Λ_1 to lattice Λ_2 in the given conditions (sketch the sampling lattice and its reciprocal after up-conversion in detail).

[Solution] We can first fill all points in Λ_2 but not in Λ_1 by zeros (i.e., zero padding), and then estimate the values of these points, which can be accomplished by an interpolation filter over Λ_2.





2. Explain the process of conversion from ITU-R 4:2:2 format to CIF format.

- Assumptions: 1) frame rate is fixed, 2) use only odd field.

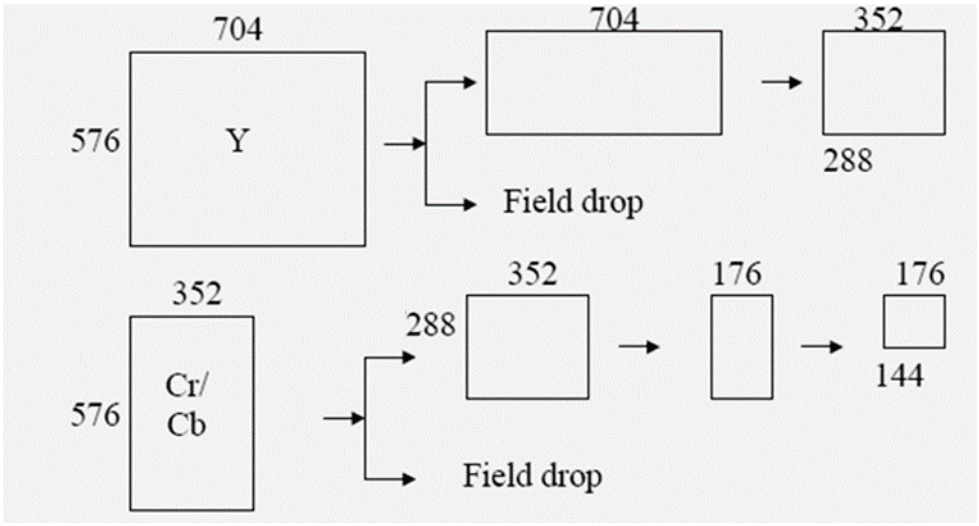
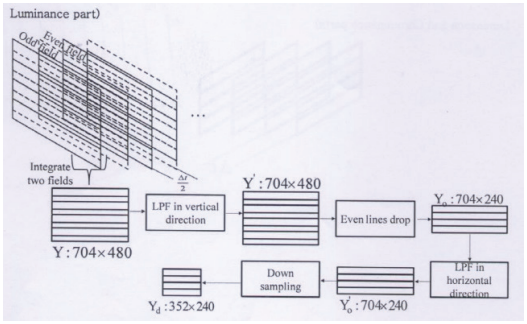
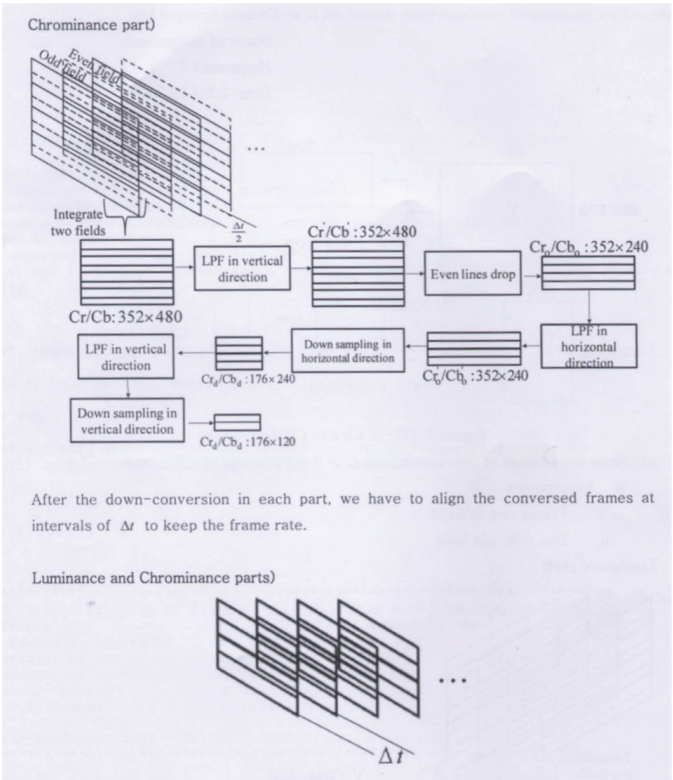


Fig.1. ITU-R 4:2:2 (PAL) to CIF conversion.

[Solution] The conversion process from ITU-R 4:2:2 format to CIF format can be divided into the processes for luminance part and chrominance part.



Conversion for luminance part



Conversion for chrominance part