Design flow of Implementation of Transceiver System for UHF/VHF in Rayleigh Fading

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1. EQUALIZER

$$\hat{x}_m[v] = \mathcal{F}(u_m[v]) = \frac{1}{\sqrt{2}}\{sgn(Re\{u_m[v]\}) + j.sgn(Im\{u_m[v]\})\}$$

with the signum function $sgn\{a\} = \pm1$ for $\mathbb{R} \ni a \gtrless 0$.

$$\mathbf{w}_{m,i}[v] = \mathbf{w}_{m,i}^{(CM)}[v] + \mathbf{w}_{m,i}^{(DD)}[v]$$

CM Algorithm – Concurrent Constant ModulusAlgorithm
DD Algorithm – Decision Directed Algorithm

where $\mathbf{w}_{m,i}^{(CM)}[v]$ will be updated by a CM algorithm
$\mathbf{w}_{m,i}^{(DD)}[v]$ is adjusted in DD mode, with $m \in \{1, 2, ...40\}$ being the subcarrier index

$$v_m[v] = \sum_{i=0}^{2} \mathbf{w}_{m,i}^{H}[v]\mathbf{y}_{m,i}[v]$$

where $\mathbf{y}_{m,i}[v]$ is a tap-delay-line vector containing a data window of the polyphase signal $\mathbf{y}_{m,i}[v]$ in Fig.8,such that

$$\mathbf{y}_{m,i}[v] = \begin{pmatrix} y_{m,i}[v] \\ y_{m,i}[v-1] \\ . \\ . \\ . \\ y_{m,i}[v-L_{m,i}+1] \end{pmatrix}$$

If we neglect carrier frequency and phase offsets, then the subcarrier output is given by

$$\hat{x}_m[v] = \mathcal{F}(u_m[v])$$

$$\mathbf{w}_{m,i}^{(CM)}[v+1] = \mathbf{w}_{m,i}^{(CM)}[v] + \Delta\mathbf{w}_{m,i}^{(CM)}[v]\mathbf{y}_{m,i}[v]$$

$$\Delta\mathbf{w}_{m,i}^{(CM)}[v] = \mu_{CM}(1- \mid v_m[v]^2)v_m^*[v]\mathbf{y}_{m,i}[v]$$

$$v_m^{(CM)}[v] = \sum_{i=0}^{2}(\mathbf{w}_{m,i}^{(CM)}[v] + \Delta\mathbf{w}_{m,i}^{(CM)}[v])^{H}\mathbf{y}_{m,i}[v]$$

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$$\mathbf{w}_{m,i}^{(DD)}[v+1] =$$

$$\mathbf{w}_{m,i}^{(DD)}[v] + \mu_{DD}.\delta(\hat{x}_m[v] - \mathcal{F}(u_m[v])).(\mathcal{F}(u_m[v]) - v_m[v])^* \mathbf{y}_{m,i}[v]$$

where,

$$\delta(a) = \begin{cases} 1 & a = 0 \\ 0 & a \neq 0 \end{cases}$$

Parameter	Description
x?m [?]	It represents form for QPSK and it is Forier of signal u m [?]
w m,i [?]	Equalizer complex-valued weight vector
w(CM) m,i [?]	By CM Algorithm
w(DD) m,i [?]	By DD Algorithm
v m [?]	It is vth iteration for the equaliser output
(v m [?])^*	Indicates Transpose of v m [?]
L m,i	It is length polyphase component
y m,i [?]	tap-delay-line vector containing a data window of the polyphase signal and it of size (L m,i X 1)
?(a)	Indicator Function
? CM	Adaptive gain of the CM equalizer
? DD	Adaptive gain of the DD equalizer

REFERENCES FOR CM AND DD ALGORITHM

https://ieeexplore.ieee.org/document/1312937

TABLE I: PSK for $N = 2, 4, 8$. $n = 0, 1, \ldots, N - 1$.