Method of determining coincidence positions subcarrier frequencies by QOFDM

The Article has propose of method for determining coincidence positions subcarrier frequencies by QOFDM what has realize on basis pairwise comparison frequency plans signal ensemble’s by quasiorthogonal frequency-division multiplexing (QOFDM) which permits to reduce level intrasystem noise on phase forming frequency plans.

Key words: determination subcarrier frequencies, spectrum holes, collision frequency, band, frequency plan, ensemble, intrasystem noise.

Statement problem

The Method of quasiorthogonal access on subcarrier frequencies developed and base on principle null orthogonal property between subcarrier frequencies [1]. One of the problems to by forming signal of method quasiorthogonal access on subcarrier frequencies (QOFDM) it is problem of determining subcarrier frequencies what coincided by pairwise comparison frequency plans. The result of unequal variants distribution subcarrier frequencies appeared is problem of determining combination subcarriers in different of frequency ensemble’s plans. Problem was solution by propose apply method what described below.

Analysis literature

The dynamic changing demand in cognitive wirelesses probably effect frequency collisions i.e. simultaneous occupancy by different subscribers one and that same band what dues augmentation level intrasystem noise [1, 4, 7]. Therefore the method QOFDM have been proposed what allows to solve problem of augmentation capability of system and contraction of level of intrasystem noise. At the same time appeared problem of determining combination subcarrier frequencies appeared problem of determining combination subcarrier frequencies in different frequency ensemble’s plans. It problem have been solution by using the expressions (2), (3), (4).

Coefficient of coincidence characterizes as integral on the interval of frequency band from $F_{min}$ to $F_{max}$ of composition to $i$-th and $j$-th frequency plan

$$B_i(\Delta f_j) = \int_{F_{min}}^{F_{max}} S_i(\Delta f_j) \cdot S_j(\Delta f_j - \Delta f) d\Delta f ,$$

where $\Delta f$ - integration step.

At the same time calculation of coincidence coefficient characterizes in the moment of zero count for frequency plans that is comparing $\Delta f = 0$.

At the same time this condition will carry $n_i, n_j$ - amount of frequency subcarriers in $i$-th and $j$-th frequency plans.

Aim of article

The aim of article is developing of method of determining coincidence positions subcarrier frequencies by QOFDM what enables to simplify process synthesis and permits to reduce level intrasystem noise on phase forming of frequency plans.

Basic material

Analytic form what characterize quasiorthogonal frequency-division multiplexing have been submitting in the expression [1, 8]

$$S_i(\Delta f_j) = \text{Re}\left\{e^{i2\pi f_j \Delta f_i} \cdot \sum_{k=-\Delta f/2}^{\Delta f/2} C_k \cdot e^{i2\pi (\Delta f_i - T_s)}\right\},$$

where $C_k$ - complex formulation of symbol QAM;

$\Delta f_i$ - frequency interval between subcarriers in $i$-th frequency plan;

$f_j$ - zero frequency;

$\Delta F$ - frequency band;

$T_s$ - pulse duration.

As a result unequal variants distribution subcarrier frequencies appeared problem of determining combination subcarrier frequencies in different frequency ensemble’s plans. It problem have been solution by using the expressions (2), (3), (4).

Coefficient of coincidence characterizes as integral on the interval of frequency band from $F_{min}$ to $F_{max}$ of composition to $i$-th and $j$-th frequency plan $\Delta$ [2, 4]

$$B_i(\Delta f_j) = \int_{F_{min}}^{F_{max}} S_i(\Delta f_j) \cdot S_j(\Delta f_j - \Delta) d\Delta f ,$$

where $\Delta$ - integration step.

At the same time calculation of coincidence coefficient characterizes in the moment of zero count for frequency plans that is comparing $\Delta f = 0$.

At the same time this condition will carry $n_i, n_j$ - amount of frequency subcarriers in $i$-th and $j$-th frequency plans.
Simultaneously it will coincide not more the one subcarrier frequency for every frequency plan.

Subcarrier frequencies what coincided characterize in pairs agreeably with expression (4).

Subcarrier frequencies coincided then, when the amount of the sums frequency intervals of $i$-th and $j$-th frequency plans will match.

$$F_{ij} = \sum_{k=1}^{n_i} \Delta f_{ik} = \sum_{m=1}^{n_j} \Delta f_{jm},$$

where $k_i \neq m_j$;

$$k \in f(10^6...1001\times10^9) \Gamma_{\Delta f};$$

$$m \in f(10^6...1001\times10^9) \Gamma_{\Delta f};$$

$F_{ij}$ - subcarrier frequency what coincided of comparison in pairs of the $i$-th and $j$-th frequency plans;

$k$ - amount of subcarrier frequencies in the $i$-th frequency plan;

$m$ - amount of subcarrier frequencies in the $j$-th frequency plan;

$$\sum_{k=1}^{n_i} \Delta f_{ik}$$ - sum of frequency intervals of the $i$-th frequency plan to subcarrier frequency what coincided with subcarrier frequency of the $j$-th frequency plan;

$$\sum_{m=1}^{n_j} \Delta f_{jm}$$ - sum of frequency intervals of the $j$-th frequency plan to subcarrier frequency what coincided with subcarrier frequency of the $i$-th frequency plan.

Combined equations (5) must resolve for determination of position coincidence the subcarrier frequencies.

$$F_{12} = \sum_{k=1}^{n_1} \Delta f_{1k} = \sum_{m=1}^{n_2} \Delta f_{2m},$$

$$F_{13} = \sum_{k=1}^{n_1} \Delta f_{1k} = \sum_{m=1}^{n_3} \Delta f_{3m},$$

$$F_{14} = \sum_{k=1}^{n_1} \Delta f_{1k} = \sum_{m=1}^{n_4} \Delta f_{4m},$$

$$F_{23} = \sum_{k=1}^{n_2} \Delta f_{2k} = \sum_{m=1}^{n_3} \Delta f_{3m},$$

$$F_{24} = \sum_{k=1}^{n_2} \Delta f_{2k} = \sum_{m=1}^{n_4} \Delta f_{4m},$$

$$F_{34} = \sum_{k=1}^{n_3} \Delta f_{3k} = \sum_{m=1}^{n_4} \Delta f_{4m}.$$
Table 2

Results of solution frequency position what coincided and coefficients of coincidence

<table>
<thead>
<tr>
<th>$F_{ij}$, Hz</th>
<th>$F_{12}$=440000</th>
<th>$F_{13}$=440000</th>
<th>$F_{14}$=605000</th>
<th>$F_{23}$=423000</th>
<th>$F_{24}$=141000</th>
<th>$F_{34}$=516000</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_{comp12}$</td>
<td>0.0556</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>$B_{comp13}$</td>
<td></td>
<td>0.0529</td>
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<tr>
<td>$B_{comp14}$</td>
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<td></td>
<td>0.0506</td>
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<td></td>
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</tr>
<tr>
<td>$B_{comp23}$</td>
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<td></td>
<td></td>
<td>0.0501</td>
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</tr>
<tr>
<td>$B_{comp24}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0478</td>
<td></td>
</tr>
<tr>
<td>$B_{comp34}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0455</td>
</tr>
</tbody>
</table>

| $B_{sim12}$  | 0.0524           |                  |                  |                  |                  |                  |
| $B_{sim13}$  |                  | 0.0483           |                  |                  |                  |                  |
| $B_{sim14}$  |                  |                  | 0.0493           |                  |                  |                  |
| $B_{sim23}$  |                  |                  |                  | 0.0452           |                  |                  |
| $B_{sim24}$  |                  |                  |                  |                  | 0.0456           |                  |
| $B_{sim34}$  |                  |                  |                  |                  |                  | 0.0424           |

Fig. 1. Results of solution frequency position what coincided

Fig. 2. Amount coefficient of coincidence by the modeling (simulated result) and calculation (computational result)
Conclusion

Method of determining subcarrier frequencies what coincided by pairwise comparison frequency plans allows to simplify the process by compiling of frequency plans and decrease the mark of intrasystem noise what appears by the simultaneous use the equal frequency plans by the many users in the cognitive radio. It's allows to boost the capability of the cognitive radio system.

It's necessary committing of statistical analysis of develop the method for its blanket assessment i.e. it determining expectancy, dispersion and other characteristics what will assist to afford of the blanket idea about its effectiveness. The results so procedure it will plan to release in the next works.

Literature