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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 by pairwise comparison different frequency plans. But not obtain famous origins wherein described method of determining coincidence positions subcarrier frequencies for quasiorthogonal frequency-division multiplexing.

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 submiting in the expression [1, 8]

$$S_i(\Delta f_i) = \mathrm{Re}\left\{ e^{j\cdot 2\cdot\pi\cdot f_0\cdot\Delta f_i} \cdot \sum_{k=-\Delta F/2}^{\Delta F/2} C_k \cdot e^{j\cdot 2\cdot\pi\cdot f(\Delta f_i - T_S)} \right\}, \quad (1)$$

where C_k - complex formulation of symbol QAM;

Δf_i - frequency interval between subcarriers in i-th frequency plan;

f_i - zero frequency;

ΔF- 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 Δ [2, 4]

$$B_{ij}(\Delta f) = \int_{F_{\min}}^{F_{\max}} S_i(\Delta f_i)\cdot S_j(\Delta f_j - \Delta)d\Delta f \, , \quad (2)$$

where Δ - integration step.

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

At the same time this condition will carry [5, 6]

$$B_{ij}(\Delta f) \le \frac{1}{\sqrt{n_i \cdot n_j}}, \quad (3)$$

where 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.

$$F_{ij} = \sum_{k=1}^{n_i} \Delta f_{ik} = \sum_{m=1}^{n_j} \Delta f_{jm} , \qquad (4)$$

where $k_i \neq m_j$;

$k \in f(10^9 ... 1{,}001 \times 10^9)\text{Гц}$;

$m \in f(10^9 ... 1{,}001 \times 10^9)\text{Гц}$;

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.

$$\begin{cases} F_{12} = \sum_{k=1}^{n_i} \Delta f_{1k} = \sum_{m=1}^{n_2} \Delta f_{2m}, \\ F_{13} = \sum_{k=1}^{n_i} \Delta f_{1k} = \sum_{m=1}^{n_3} \Delta f_{3m}, \\ F_{14} = \sum_{k=1}^{n_i} \Delta f_{1k} = \sum_{m=1}^{n_4} \Delta f_{4m}, \\ F_{23} = \sum_{k=1}^{n_2} \Delta f_{2k} = \sum_{m=1}^{n_3} \Delta f_{3m}, \\ F_{24} = \sum_{k=1}^{n_2} \Delta f_{2k} = \sum_{m=1}^{n_4} \Delta f_{4m}, \\ F_{34} = \sum_{k=1}^{n_3} \Delta f_{3k} = \sum_{m=1}^{n_4} \Delta f_{4m}. \end{cases} \qquad (5)$$

Subcarrier frequencies will coincide then, when results of equation will be equal.

After execution this operation it was finding numbers of subcarrier frequencies what coincided. Thus it's cans be determine the subcarrier frequencies what will be coincide by comparison different signals in the ensemble.

In results determination of subcarrier frequencies what coincided it's can do conclusion that between two comparing plans will coincide not more the one subcarrier frequency for every frequency plan. Thus amount of the frequencies what coincided will equal one less then amount of the frequency plans in the ensemble. It used software Matlab for decision of combined equation [8, 9]. In results of modulation it determined of subcarrier frequencies what coincided [3]. Results of calculation adduced in the table 1 and on the fig. 1.

Table 1

Result of solution frequency what coincided

F_{ij}	F_{12}	F_{13}	F_{14}	F_{23}	F_{24}	F_{34}
F_{ij}, Hz	440000	440000	605000	423000	141000	516000

In the table 2 and on the fig. 2 gave the results of the assessment to coefficients of coincidence by the modeling (simulated result) and calculation (computational result).

The figure shows what frequency plans with the smallest amount of the subcarrier frequencies have the largest amount to the coefficient of coincidence (B12 - coefficient of coincidence 1-th and 2-th frequency plans). Frequency plans 3-th and 4-th have the smallest amount of coefficient of coincidence, i.e. those who have largest amount of subcarrier frequencies.

Table 2

Results of solution frequency position what coincided and coefficients of coincidence

F_{ij}, Hz	F_{12}=440000	F_{13}=440000	F_{14}=605000	F_{23}=423000	F_{24}=141000	F_{34}=516000
B_{compij}	B_{comp12}=0.0556	B_{comp13}=0.0529	B_{comp14}=0.0506	B_{comp23}=0.0501	B_{comp24}=0.0478	B_{comp34}=0.0455
$B_{sim\ ij}$	B_{sim12}=0.0524	B_{sim13}=0.0483	B_{sim14}=0.0493	B_{sim23}=0.0452	B_{sin24}=.0456	B_{sim34}=0.0424

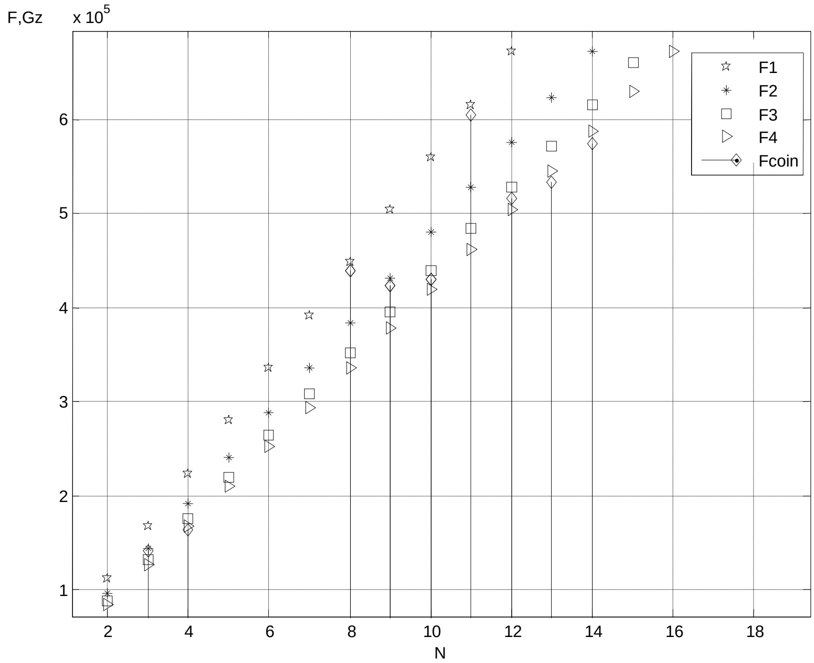

Fig. 1. Results of solution frequency position what coincided

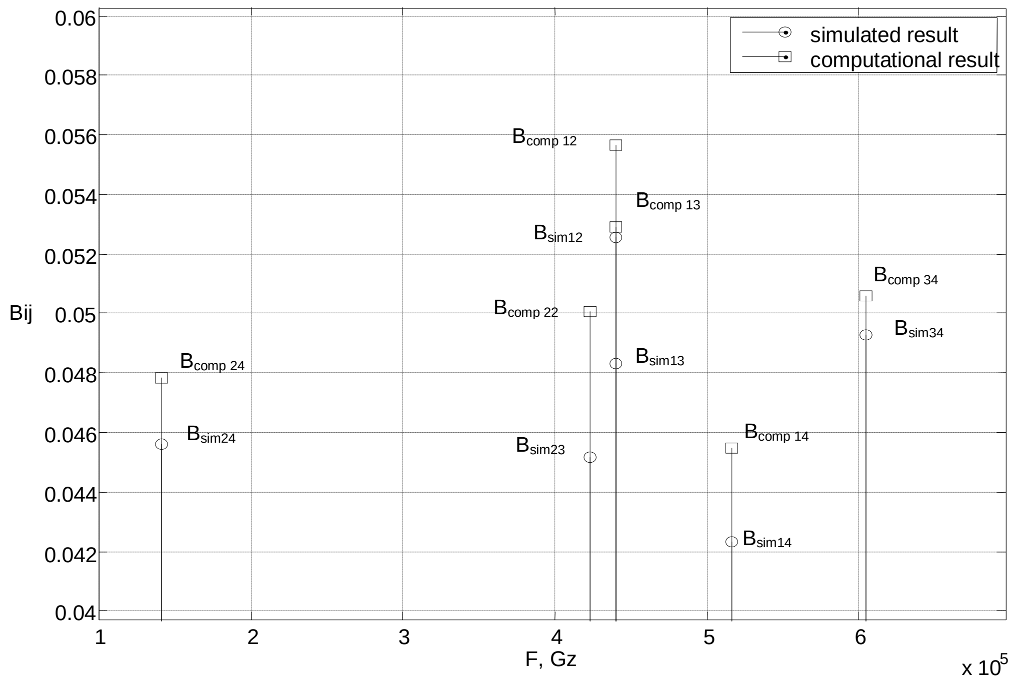

Fig. 2. Amount coefficient of coincidence by the modeling (simulated result) and calculation (computational result)

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

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Свергунова Ю.А., Лысечко В.П., Качуровский Г.Н. Метод определения совпадений позиций частотных поднесущих при QOFDM. В статье представлен разработанный метод определения совпадений позиций частотных поднесущих, который заключается в определении совпавших частотных позиций при попарном сравнении частотных планов ансамбля сигналов при квазиортогональном частотном разделении каналов с мультиплексированием - QOFDM.

Ключевые слова: определение частотних позиций, спектральные дыры, частотные коллизии, полоса частот, частотный план, ансамбль, внутрисистемные помехи.

Свергунова Ю.О., Лисечко В.П., Качуровський Г.М. Метод визначення співпадінь позицій частотних піднесних при QOFDM. У статті запропоновано метод визначення співпадінь позицій частотних піднесних, який реалізовано на основі попарного порівняння частотних планів ансамблю сигналів при квазіортогональному частотному розділенні каналів з мультиплексуванням (QOFDM), що дозволяє зменшити рівень внутрішньосистемних завад на етапі формування частотних планів.

Ключові слова: визначення частотних позицій, спектральні діри, частотні колізії, смуга частот, частотний план, ансамбль, внутрішньосистемні завади.

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