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(54) **CALCULATION METHOD AND DEVICE OF INTRA-TURBO CODE INTERLEAVER**

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(57) **ABSTRACT**

A calculation method of a turbo code internal interleaver is disclosed by the present invention, and comprises: dividing a sequence with a length of K_j, which is input into a turbo code internal interleaver, into a plurality of windows each with a window length of Δ_j, the window length Δ_j satisfying $2f_2\Delta_j \pmod{K_j}=0$, and K_j being divided exactly by Δ_j, wherein f_2 is a parameter dependent on K_j; obtaining output indices each of which corresponds to each input index in a first window; calculating successively output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window. A calculation device of a turbo code internal interleaver is also disclosed by the present invention. With the present invention, the computational complexity of the turbo code internal interleaver can be reduced, so as to reduce the time delay of a specific calculation and save memory resources.

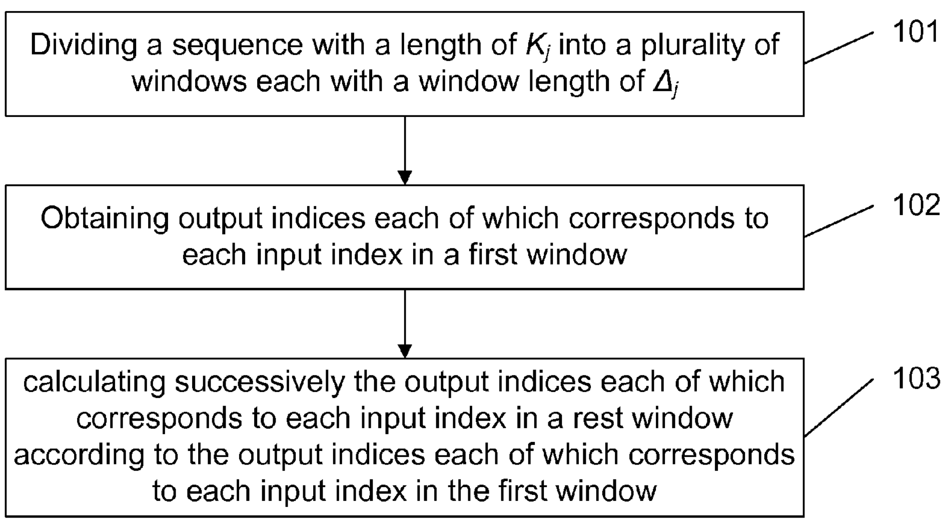


FIG. 1

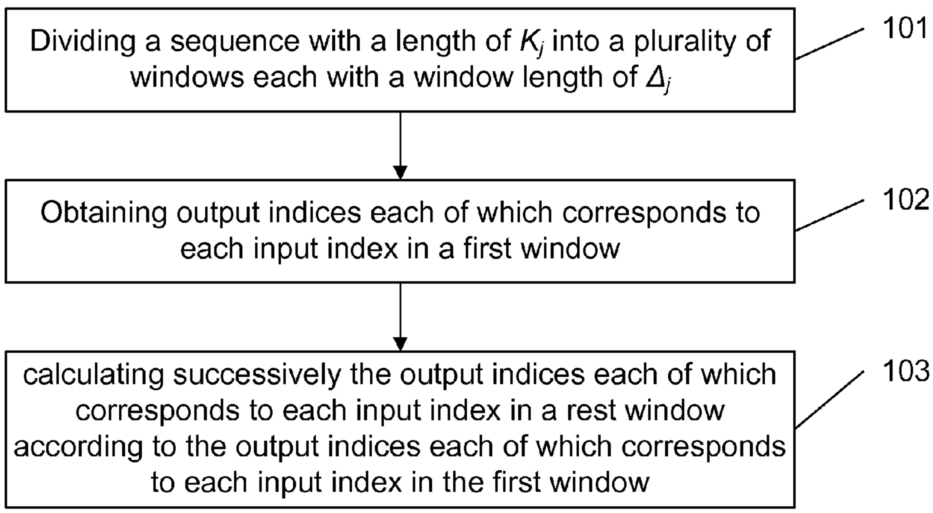
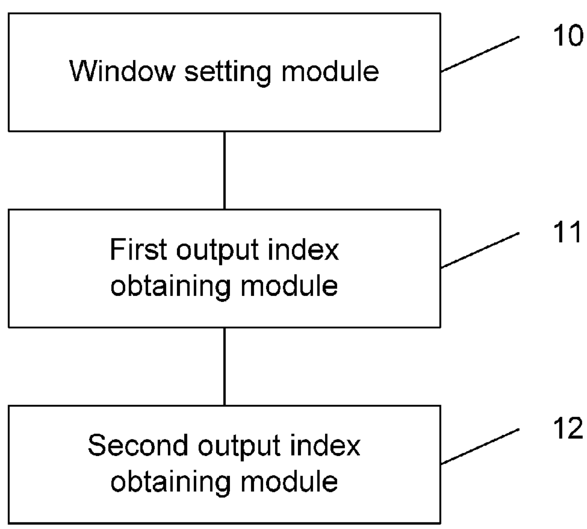

Dividing a sequence with a length of K_j into a plurality of windows each with a window length of Δ_j
101
Obtaining output indices each of which corresponds to each input index in a first window
102
calculating successively the output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window
103

FIG. 2


Window setting module
10
First output index obtaining module
11
Second output index obtaining module
12

CALCULATION METHOD AND DEVICE OF INTRA-TURBO CODE INTERLEAVER

TECHNICAL FIELD

[0001] The present invention relates to the Long Term Evolution (LTE) technology in the 3rd Generation Partnership Project (3GPP), particularly to a calculation method and device of turbo code internal interleaver in the LTE.

BACKGROUND

[0002] The internal interleaver in a turbo code encoder or turbo code decoder uses

[0003] Formula (1) to calculate an output index according to an input index:

$$\Pi(i)=(f_1 \cdot i+f_2 \cdot i_2)\bmod K \quad (1)$$

where i is an input index and set to 0, 1, 2, . . . , K−1;

[0004] Π(i) is an output index;

[0005] f_1 and f_2 are parameters dependent on K;

[0006] K is a length of an input sequence.

[0007] When Formula (1) is used in a turbo code encoder, the input sequence is a bit sequence; when it is used in a turbo code decoder, the input sequence is a soft bit sequence which refers to a non-binary sequence.

[0008] Further, the concrete values of f_1, f_2 and K may be obtained from the parameter table of a turbo code internal interleaver in 3GPP TS 36.212 Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding (Release 8) v8.5.0 (2008-12).

[0009] When prior art directly uses Formula (1) to calculate output index Π(i), excessive modular arithmetic is involved, making the calculation very complex and thereby consuming excessive memory resources and resulting in a long time delay in implementation of the encoding process of a turbo code encoder or implementation of the decoding process of a turbo code decoder.

SUMMARY

[0010] For this reason, the main object of the present invention is to provide a calculation method of a turbo code internal interleaver, which can reduce computational complexity, so as to save memory resources and reduce time delay.

[0011] To achieve the foregoing object, the technical solution of the present invention is realized in the following way.

[0012] A calculation method of a turbo code internal interleaver comprises:

[0013] dividing a sequence with a length of K_j, which is input into a turbo code internal interleaver, into a plurality of windows each with a window length of Δ_j, the window length Δ_j satisfying $2f_2\Delta_j(\bmod K_j)=0$, and K_j being divided exactly by Δ_j, wherein f_2 is a parameter dependent on K_j;

[0014] obtaining output indices each of which corresponds to each input index in a first window;

[0015] calculating successively output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window.

[0016] A formula used for calculating the output indices each of which corresponds to each input index in the rest window may be:

$$\Pi(i+k\cdot\Delta_j)=\Pi(i)+[k\cdot(f_1\Delta_j+f_2\Delta_j^2)](\bmod K_j)$$

[0017] where i is an input index in the first window and set to 0, 1, 2, . . . , Δ_j-1;

[0018] a value of k is set to 1, 2, . . . ,

$$\frac{K_j}{\Delta_j}-1;$$

[0019] Δ_j is window length;

[0020] f_1 and f_2 are parameters dependent on K_j;

[0021] K_j is the length of the sequence.

[0022] A formula used for calculating the output indices each of which corresponds to each input index in the rest window may be:

$$\Pi(i+\Delta_j)=\Pi(i)+(f_1\cdot\Delta_j+f_2\cdot\Delta_j^2)(\bmod K_j)$$

[0023] where i is an input index in a previous window and set to 0, 1, 2, . . . , Δ_j-1;

[0024] Δ_j is window length;

[0025] f_1 and f_2 are parameters dependent on K_j;

[0026] K_j is the length of the sequence.

[0027] The plurality of windows may refer to two or more windows.

[0028] The step of obtaining output indices each of which corresponds to each input index in the first window may refer to: reading from a memory or obtaining through calculation.

[0029] The step of obtaining output indices each of which corresponds to each input index in the first window through calculation may be calculating with a following formula:

$$\Pi(i)=(f_1\cdot i+f_2\cdot i^2)\bmod K_j$$

[0030] where i is an input index and set to 0, 1, 2, . . . , K_j-1.

[0031] The sequence may be a bit sequence or a soft bit sequence.

[0032] A calculation device of a turbo code internal interleaver comprises:

[0033] a window setting module, for dividing a sequence with a length of K_j, which is input into a turbo code internal interleaver, into a plurality of windows each with a window is length of Δ_j, the window length Δ_j satisfying $2f_2\Delta_j(\bmod K_j)=0$, and K_j being divided exactly by Δ_j, wherein f_2 is a parameter dependent on K_j;

[0034] a first output index obtaining module, for obtaining output indices each of which corresponds to each input index in a first window; and

[0035] a second output index obtaining module, for calculating successively output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window.

[0036] The first output index obtaining module may be specifically used for reading from a memory or obtaining through calculation the output indices each of which corresponds to each input index in the first window.

[0037] The plurality of windows may refer to two or more windows; and/or

[0038] the sequence may be a bit sequence or a soft bit sequence.

[0039] From the foregoing technical solution, it may be known that by dividing a sequence with a length of K_j into a plurality of windows each with a window length of Δ_j, and making the window length Δ_j satisfy $2f_2\Delta_j(\bmod K_j)=0$ and K_j divided exactly by Δ_j, starting from the second window, the present invention can obtain through calculation the output indices each of which corresponds to each input index in each window according to the output indices each of which corresponds to each input index in the first window. The modular arithmetic involved in this method is very simple, therefore the method can significantly reduce the computational complexity of the turbo code internal interleaver, thereby saving the memory resources used for this computation. In other words, it may reduce the memory area used for this computation, thereby reducing cost. Further, the output indices obtained through calculation are used for a turbo code encoder or turbo code decoder. As the computational complexity of the turbo code internal interleaver is reduced, the time delay in the implementation of the entire encoding process of a turbo code encoder or in the implementation of the entire decoding process of a turbo code decoder is reduced; thus, the present invention can save the cost and time delay of the whole system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] FIG. **1** is a schematic diagram showing a flow of a calculation method of a turbo code internal interleaver according to the present invention;

[0041] FIG. **2** is a schematic diagram showing a structure of a calculation device of a turbo code internal interleaver according to the present invention.

DETAILED DESCRIPTION

[0042] Before detailed description of a calculation method of a turbo code internal interleaver according to the present invention, the principle of this calculation method is introduced.

[0043] Firstly, a bit sequence or soft bit sequence with a length of K_j, which is input into the turbo code internal interleaver, is divided into a plurality of segments which have a same length. Each segment is called a window. It is supposed that the length of each window is Δ_j, an input index of an element a in window n is i, and an output index after i is interleaved with Formula (1) is $\Pi(i)$; in window n+1, the input index of element b with a distance of Δ_j, from element a is $i+\Delta_j$, and the output index after $i+\Delta_j$ is interleaved with Formula (1) is $\Pi(i+\Delta_j)=[f_1(i+\Delta_j)+f_2(i+\Delta_j)^2](\text{mod } K_j)$.

[0044] Successively, the following equation may be obtained:

$$\begin{aligned}\Pi(i+\Delta_j)-\Pi(i) &= [f_1\cdot(i+\Delta_j)+f_2\cdot(i+\Delta_j)^2-f_1\cdot i-f_2\cdot i^2](\text{mod}K_j)\\ &= [f_1\cdot\Delta_j+f_2\cdot\Delta_j^2+2f_2\Delta_j i](\text{mod}K_j)\end{aligned}$$

[0045] From the foregoing equation, it may be known that if $2f_2\Delta_j(\text{mod } K_j)=0$, then $2f_2\Delta_j i(\text{mod } K_j)=0$, and Formula (2) may be obtained:

$$\Pi(i+\Delta_j)=\Pi(i)+[f_1\cdot\Delta_j+f_2\cdot\Delta^2](\text{mod } K_j) \tag{2}$$

[0046] i.e., $\Pi(i+\Delta_j)=\Pi(i)$+Constant independent of i (mod K_j).

[0047] Therefore, if window length Δ_j can satisfy $2f_2\Delta_j(\text{mod } K_j)=0$, then an output index of an element in a subsequent window may be easily calculated based on the output index of the element in the first window.

[0048] In fact, according to the parameter table of the turbo code internal interleaver, for every K_j, an appropriate Δ_j can be obtained to make $2f_2\Delta_j(\text{mod } K_j)=0$ and K_j divided exactly by Δ_j. According to the parameter table of the turbo code internal interleaver, the range of j is 1, 2, 3, . . . , 188.

[0049] For example, $K_j=40$, $f_1=3$, $f_2=10$, to make $2\times10\times\Delta_j$ mod 40=0 and 40 divided exactly by Δ_j, Δ_j may be set to 20. Here, the value of Δ_j is not exclusive as long as $2f_2\Delta_j(\text{mod } K_j)=0$ is satisfied and K_j is divided exactly by Δ_j. For example, Δ_j may be 2 or 4.

[0050] Therefore, from the foregoing example, it may be known that for different K_j, as long as $2f_2\Delta_j(\text{mod } K_j)=0$ is satisfied and K_j is divided exactly by Δ_j, Δ_j may be set to different values.

[0051] Here, those skilled in the art may know why Δ_j needs to satisfy the condition that K_j is divided exactly by Δ_j in addition to satisfying the condition of $2f_2\Delta_j(\text{mod } K_j)=0$. This is because all windows should have a same length and the number of windows should be an integer.

[0052] From Formula (2), Formula (3) may be deduced:

$$\Pi(i+k\cdot\Delta_j)=\Pi(i)+[k\cdot(f_1\cdot\Delta_j+f_2\cdot\Delta_j^2)](\text{mod } K_j) \tag{3}$$

[0053] where i is an input index in the first window and set to 0, 1, 2, . . . , Δ_j-1;

[0054] the value of k is set to 1, 2, . . . ,

$$\frac{K_j}{\Delta_j}-1.$$

[0055] When k=1, it means the output indices each of which corresponds to each input index in the second window is calculated based on the output indices $\Pi(i)$ each of which corresponds to each input index i in the first window. When k is another value, the rest may be deduced by analogy.

[0056] Below the technical solution of the present invention is described in details.

[0057] As shown in FIG. **1**, a calculation method of a turbo code internal interleaver according to the present invention comprises the following steps.

[0058] **S101**, dividing a sequence with a length of K_j, which is input into the turbo code internal interleaver, into a plurality of windows each with a window length of Δ_j, the window length Δ_j satisfying $2f_2\Delta_j(\text{mod } K_j)=0$, and K_j being divided exactly by Δ_j, wherein f_2 is a parameter dependent on K_j.

[0059] The sequence is a bit sequence or soft bit sequence; the soft bit sequence refers to a non-binary sequence.

[0060] The plurality of windows refers to two or more windows.

[0061] **S102**, obtaining output indices each of which corresponds to each input index in a first window.

[0062] When a memory stores pre-calculated output indices each of which corresponds to each input index in the first window, then the output indices each of which corresponds to each input index in the first window may be directly read from the memory, or obtained through calculation with Formula (1).

[0063] **S103**, calculating successively the output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window.

[0064] The so-called "successively" refers to: calculating the output indices each of which corresponds to each input index in a window at first, and then calculating the output indices each of which corresponds to each input index in a next window.

The actual calculation formula may be Formula (3) as described above:

$$\Pi(i+k\cdot\Delta_j)=\Pi(i)+[k\cdot(f_1\cdot\Delta_j+f_2\cdot\Delta_j^2)](\text{mod } K_j) \tag{3}$$

[0065] where i is an input index in the first window and set to 0, 1, 2, . . . , Δ_j-1;

[0066] the value of k is set to 1, 2, . . . ,

$$\frac{K_j}{\Delta_j}-1;$$

[0067] Δ_j is window length;

[0068] f_1 and f_2 are parameters dependent on K_j;

[0069] K_j is the length of the sequence.

[0070] Alternatively, Formula (4) may be adopted for the calculation, i.e. calculating the output indices each of which corresponds to each input index in a next window according to the output indices each of which corresponds to each input index in a previous window.

$$\Pi(i+\Delta_j)=\Pi(i)+(f_1\cdot\Delta_j+f_2\cdot\Delta_j^2)(\text{mod } K_j) \quad (4)$$

[0071] where i is an input index in the previous window and set to 0, 1, 2, . . . , Δ_j-1;

[0072] Δ_j is window length;

[0073] f_1 and f_2 are parameters dependent on K_j;

[0074] K_j is the length of the sequence.

[0075] In the following parameter matrix of the turbo code internal interleaver, the first column is K_j, the second column is f_1, the third column is f_2, and the fourth column is Δ_j:

interleave_matrix= …

[40	3	10	20;
48	7	12	16;
56	19	42	28;
64	7	16	64;
72	7	18	36;
80	11	20	40;
88	5	22	22;
96	11	24	32;
104	7	26	26;
112	41	84	16;
120	103	90	8;
128	15	32	32;
136	9	34	8;
144	17	108	16;
152	9	38	8;
160	21	120	32;
168	101	84	24;
176	21	44	16;
184	57	46	8;
192	23	48	32;
200	13	50	8;
208	27	52	16;
216	11	36	27;
224	27	56	32;
232	85	58	8;
240	29	60	16;
248	33	62	8;
256	15	32	32;
264	17	198	8;
272	33	68	8;
280	103	210	8;
288	19	36	32;
296	19	74	296;

-continued

304	37	76	16;
312	19	78	8;
320	21	120	16;
328	21	82	8;
336	115	84	16;
334	193	86	8;
352	21	44	32;
360	133	90	8;
368	81	46	16;
376	45	94	8;
384	23	48	8;
392	243	98	8;
400	151	40	10;
408	155	102	8;
416	25	52	8;
424	51	106	8;
432	47	72	12;
440	91	110	8;
448	29	168	64;
456	29	114	8;
464	247	58	16;
472	29	118	8;
480	89	180	32;
488	91	122	8;
496	157	62	16;
504	55	84	24;
512	31	64	32;
528	17	66	16;
544	35	68	32;
560	227	420	16;
576	65	96	12;
592	19	74	16;
608	37	76	32;
624	41	234	16;
640	39	80	16;
656	185	82	16;
672	43	252	32;
688	21	86	16;
704	155	44	64;
720	79	120	48;
736	139	92	32;
752	23	94	16;
768	217	48	64;
784	25	98	16;
800	17	80	40;
816	127	102	16;
832	25	52	64;
848	239	106	16;
864	17	48	36;
880	137	110	16;
896	215	112	64;
912	29	114	16;
928	15	58	32;
944	147	118	16;

-continued

960	29	60	64;
976	59	122	16;
992	65	124	32;
1008	55	84	48;
1024	31	64	64;
1056	17	66	32;
1088	171	204	64;
1120	67	140	32;
1152	35	72	32;
1184	19	74	32;
1216	39	76	64;
1248	19	78	32;
1280	199	240	32;
1312	21	82	32;
1344	211	252	64;
1376	21	86	32;
1408	43	88	64;
1440	149	60	96;
1472	45	92	64;
1504	49	846	32;
1536	71	48	64;
1568	13	28	28;
1600	17	80	20;
1632	25	102	32;
1664	183	104	64;
1696	55	954	32;
1728	127	96	36;
1760	27	110	32;
1792	29	112	64;
1824	29	114	32;
1856	57	116	64;
1888	45	354	32;
1920	31	120	64;
1952	59	610	32;
1984	185	124	64;
2016	113	420	48;
2048	31	64	64;
2112	17	66	64;
2176	171	136	64;
2240	209	420	64;
2304	253	216	64;
2368	367	444	64;
2432	265	456	64;
2496	181	468	64;
2560	39	80	64;
2624	27	164	64;
2688	127	504	64;
2752	143	172	64;
2816	43	88	64;
2880	29	300	24;
2944	45	92	64;
3008	157	188	64;
3072	47	96	64;
3136	13	28	56;

-continued

3200	111	240	60;
3264	443	204	64;
3328	51	104	64;
3392	51	212	64;
3456	451	192	72;
3520	257	220	64;
3584	57	336	64;
3648	313	228	64;
3712	271	232	64;
3776	179	236	64;
3840	331	120	64;
3904	363	244	64;
3968	375	248	64;
4032	127	168	36;
4096	31	64	64;
4160	33	130	64;
4224	43	264	64;
4288	33	134	64;
4352	477	408	64;
4416	35	138	64;
4480	233	280	64;
4544	357	142	64;
4608	377	480	72;
4672	37	146	64;
4736	71	444	64;
4800	71	120	60;
4864	37	152	64;
4928	39	462	64;
4992	127	234	64;
5056	39	158	64;
5120	39	80	64;
5184	31	96	54;
5248	113	902	64;
5312	41	166	64;
5376	251	336	64;
5440	43	170	64;
5504	21	86	64;
5568	43	174	64;
5632	45	176	64;
5696	45	178	64;
5760	161	120	24;
5824	89	182	64;
5888	323	184	64;
5952	47	186	64;
6016	23	94	64;
6080	47	190	64;
6144	263	480	64];

[0076] The above parameter matrix of the turbo code internal interleaver lists the reasonable values of Δ_j in real application.

[0077] Below the technical solution of the present invention is further described in combination with an embodiment.

[0078] When the length K_j of a bit sequence, which is input into the turbo code internal interleaver, is 6144, it may be known from the parameter table of the turbo code internal interleaver that f_1=263, f_2=480. According to the condition that window length Δ_j needs to satisfy $2f_2\Delta_j$ (mod K_j)=0 and K_j is divided exactly by Δ_j, window length is set to Δ_j=64, then there will be 6144/64=96 windows.

[0079] 64 is not the only value of window length Δ_j, but is used here as an example only.

[0080] The output indices each of which corresponds to each input index in the first window are read from the memory or obtained through calculation with Formula (1).

[0081] The input index i in the first window is 0, 1, 2, . . . , 63.

[0082] Supposing k=1, the output indices each of which corresponds to each input index in the second window are calculated with Formula (3).

[0083] The formula used to calculate the output indices each of which corresponds to each input index in the second window is:

$$\begin{aligned}\Pi(i+64) &= \Pi(i) + (263\times 64 + 480\times 64^2)(\mathrm{mod}6144)\\ &= \Pi(i) + 4544\end{aligned}$$

[0084] Next, the output indices each of which corresponds to each input index in the rest windows are successively calculated with Formula (3).

[0085] In this embodiment, except the first window, the general formula used for calculating the output indices each of which corresponds to each input index in the rest windows is:

$$\begin{aligned}\Pi(i+k\cdot 64) &= \Pi(i) + [k\cdot(263\times 64 + 480\times 64^2)](\mathrm{mod}6144)\\ &= \Pi(i) + (k\cdot 4544)(\mathrm{mod}6144)\end{aligned}$$

[0086] where k is set to 1, 2, 3, . . . , 95.

[0087] From the above analysis, it may be known that when the present invention calculates the output indices each of which corresponds to each input index in a window, the modular arithmetic involved is very simple, so compared with the prior art, the present invention significantly reduces the computational complexity of the turbo code internal interleaver.

[0088] To realize the foregoing method, the present invention provides a calculation device of the turbo code internal interleaver accordingly, as shown in FIG. **2**. This calculation device comprises:

[0089] a window setting module **10**, for dividing a sequence with a length of K_j, which is input into the turbo code internal interleaver, into a plurality of windows each with a window length of Δ_j, the window length Δ_j satisfying $2f_2\Delta_j$(mod K_j)=0, and K_j being divided exactly by Δ_j, wherein f_2 is a parameter dependent on K_j;

[0090] a first output index obtaining module **11**, for obtaining output indices each of which corresponds to each input index in a first window, and the output indices in the first window may be read from a memory or obtained through calculation; and

[0091] a second output index obtaining module **12**, for calculating successively output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window.

[0092] The first output index obtaining module **11** is specifically used for reading from the memory or obtaining through calculation the output indices each of which corresponds to each input index in the first window.

[0093] The plurality of windows refers to two or more windows.

[0094] The sequence is a bit sequence or a soft bit sequence.

[0095] The foregoing description is a preferred embodiment of the present invention and is not intended to limit the protection scope of the present invention.

What is claimed is:

1. A calculation method of a turbo code internal interleaver, comprising:

dividing a sequence with a length of K_j, which is input into a turbo code internal interleaver, into a plurality of windows each with a window length of Δ_j, the window length Δ_j satisfying $2f_2\Delta_j$(mod K_j)=0, and K_j being divided exactly by Δ_j, wherein f_2 is a parameter dependent on K_j;

obtaining output indices each of which corresponds to each input index in a first window;

calculating successively output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window.

2. The method according to claim **1**, wherein a formula used for calculating the output indices each of which corresponds to each input index in the rest window is:

$$\Pi(i+k\cdot\Delta_j)=\Pi(i)+[k\cdot(f_1\cdot\Delta_j+f_2\cdot\Delta_j^2)](\mathrm{mod}\ K_j)$$

where i is an input index in the first window and set to 0, 1, 2, . . . , Δ_j−1;

a value of k is set to 1, 2, . . . ,

$$\frac{K_j}{\Delta_j}-1;$$

Δ_j is window length;

f_1 and f_2 are parameters dependent on K_j;

K_j is the length of the sequence.

3. The method according to claim **1**, wherein a formula used for calculating the output indices each of which corresponds to each input index in the rest window is:

$$\Pi(i+\Delta_j)=\Pi(i)+(f_1\cdot\Delta_j+f_2\cdot\Delta_j^2)(\mathrm{mod}\ K_j)$$

where i is an input index in a previous window and set to 0, 1, 2, . . . , Δ_j1;

Δ_j is window length;

f_1 and f_2 are parameters dependent on K_j;

K_j is the length of the sequence.

4. The method according to claim **1**, wherein the plurality of windows refers to two or more windows.

5. The method according to claim **1**, wherein the step of obtaining output indices each of which corresponds to each input index in the first window, refers to: reading from a memory or obtaining through calculation.

6. The method according to claim **5**, wherein the step of obtaining output indices each of which corresponds to each input index in the first window through calculation is calculating with a following formula:

$$\Pi(i)=(f_1\cdot i+f_2\cdot i_2)\bmod K_j$$

where i is an input index and set to 0, 1, 2, . . . , K_j-1.

7. The method according to claim **1**, wherein the sequence is a bit sequence or a soft bit sequence.

8. A calculation device of a turbo code internal interleaver, comprising:

a window setting module, for dividing a sequence with a length of K_j, which is input into a turbo code internal interleaver, into a plurality of windows each with a window length of Δ_j, the window length Δ_j satisfying $2f_2\Delta_j$ (mod K_j)=0, and K_j being divided exactly by Δ_j, wherein f_2 is a parameter dependent on K_j;

a first output index obtaining module, for obtaining output indices each of which corresponds to each input index in a first window; and

a second output index obtaining module, for calculating successively output indices each of which corresponds to each input index in a rest window according to the output indices each of which corresponds to each input index in the first window.

9. The device according to claim **8**, wherein the first output index obtaining module is specifically used for reading from a memory or obtaining through calculation the output indices each of which corresponds to each input index in the first window.

10. The device according to claim **8**, wherein

the plurality of windows refers to two or more windows; and/or

the sequence is a bit sequence or a soft bit sequence.

11. The method according to claim **2**, wherein the plurality of windows refers to two or more windows.

12. The method according to claim **3**, wherein the plurality of windows refers to two or more windows.

13. The method according to claim **2**, wherein the step of obtaining output indices each of which corresponds to each input index in the first window, refers to:

reading from a memory or obtaining through calculation.

14. The method according to claim **3**, wherein the step of obtaining output indices each of which corresponds to each input index in the first window, refers to:

reading from a memory or obtaining through calculation.

15. The method according to claim **13**, wherein the step of obtaining output indices each of which corresponds to each input index in the first window through calculation is calculating with a following formula:

$$\Pi(i)=(f_1\cdot i+f_2\cdot i_2)\bmod K_j$$

where i is an input index and set to 0, 1, 2, . . . , K_j-1.

16. The method according to claim **14**, wherein the step of obtaining output indices each of which corresponds to each input index in the first window through calculation is calculating with a following formula:

$$\Pi(i)=(f_1\cdot i+f_2\cdot i_2)\bmod K_j$$

where i is an input index and set to 0, 1, 2, . . . , K_j-1.

17. The method according to claim **2**, wherein the sequence is a bit sequence or a soft bit sequence.

18. The method according to claim **3**, wherein the sequence is a bit sequence or a soft bit sequence.

19. The device according to claim **9**, wherein the plurality of windows refers to two or more windows; and/or the sequence is a bit sequence or a soft bit sequence.

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