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Datasheet for the decision of 13 April 2010

Case Number: T 1915/07 - 3.5.02

Application Number: 03255069.1

Publication Number: 1394953

IPC: H03M 13/45

Language of the proceedings: EN

Title of invention:
LOG-MAP processor for higher radix trellis

Applicant:
Lucent Technologies Inc.

Headword:
-

Relevant legal provisions:
EPC Art. 56, 123(2)

Relevant legal provisions (EPC 1973):
-

Keyword:
"Added subject-matter (yes) - main request, first and second auxiliary requests"
"Inventive step (no) - third auxiliary request"

Decisions cited:
-

Catchword:
-

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Case Number: T 1915/07 **-** 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 13 April 2010

Appellant: Lucent Technologies Inc.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 18 June 2007 refusing European patent application No. 03255069.1 pursuant to Article 97(1) EPC 1973.**

Composition of the Board:

Chairman: M. Ruggiu
Members: R. Lord
H. Preglau

Summary of Facts and Submissions

I. This is an appeal of the applicant against the decision of the examining division to refuse European patent application No. 03 255 069.1.

II. The reasons given for the refusal were that the independent claims of all three requests then on file contravened Article 123(2) EPC and that the subject-matter of all of those independent claims was not novel with respect to the teaching of the document D1, thus not meeting the requirements of Article 52(1) EPC in combination with Article 54(1) and (2) EPC.

III. The following document of the state of the art cited during the procedure before the first instance is relevant to the present decision:

D1: A. Raghupathy and K.J.R. Liu, "A Transformation for Computational Latency Reduction in Turbo-MAP Decoding", Proceedings of the IEEE International Symposium on Circuits and Systems, 30 May 1999, pages IV-402 to IV-405.

IV. In a communication accompanying a summons to oral proceedings the board informed the appellant of its preliminary opinion that all of the requests then on file contravened Article 123(2) EPC, but that if those objections "were appropriately overcome, then the resultant subject-matter could be considered to be new and involve and inventive step". In this context the appellant was also informed in section 2.2 of that communication that "it would be essential, in order to establish the presence of an inventive step with

respect to [D1], that the independent claims define clearly that each LogSum operation involves only one step of accessing the LUT".

With a letter of reply dated 12 March 2010 the appellant implicitly requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request or in the alternative on the basis of the first or second or third auxiliary request, all these requests filed with that letter. He also requested that the oral proceedings be cancelled and that the procedure be continued in writing, and stated that he would not be attending the oral proceedings.

Oral proceedings before the board took place on 13 April 2010, which the appellant did not attend.

V. Claim 1 according to the appellant's main request reads as follows:

"A processor that is operative to perform calculations using a logarithmic number system, the processor comprising:

a device (100) having at least one input for receiving at least one input signal and having at least one output where the device processes the received signal using an N-state Radix-K trellis to produce at least one output signal where K is an integer equal to or greater than 4 and N is an integer equal to or greater than 2, and the device has at least one LogSum operator (202, 300, 350) having a comparison circuit and a single lookup table (314, 360) where the comparison circuit receives K inputs (204, 208, 212, 216, α, β, γ, A_1, A_2, A_3, A_4) and selects a largest

valued input and a value of one other input as two comparison outputs, and where the two comparison outputs are used to select a value from the lookup table for determining an approximation of a Jacobian definition of a LogSum operator."

Claim 7 according to the appellant's main request reads as follows:

"A method of processing information using LogMAP algorithm, the method comprises the step of:

providing an N-state Radix-K trellis on which the application of the information to the LogMAP algorithm is based where K is an integer equal to 4 or greater and N is an integer equal to 2 or greater, where the method includes at least one LogSum operation including a comparison of K inputs, wherein the comparison selects a largest valued input and a value of one other of the inputs as two comparison outputs, and where the two comparison outputs are used to select a value from a single lookup table for determining an approximation of a Jacobian definition of a LogSum operator."

Claim 1 according to the appellant's first auxiliary request differs from that according to his main request only in that in the opening paragraph the phrase "is operative to perform calculations using a logarithmic number system" is replaced by "performs calculations according to LogSums".

Claim 7 according to the appellant's first auxiliary request differs from that of his main request only by the omission of the comma after "comparison of K inputs".

Claim 1 according to the appellant's second auxiliary request reads as follows:

" A processor that is operative to perform calculations using a logarithmic number system, the processor comprising:

a device (100) having at least one input for receiving at least one input signal and having at least one output where the device processes the received signal using an N-state Radix-K trellis to produce at least one output signal where K is an integer equal to or greater than 4 and N is an integer equal to or greater than 2, and the device has at least one LogSum operator (202, 300, 350) having a comparison circuit and a single lookup table (314, 360) where the comparison circuit receives K inputs $A_1...A_K$ (204, 208, 212, 216, α, β, γ, A_1, A_2, A_3, A_4), the LogSum operator determining an approximation of a Jacobian definition of a LogSum operator according to LogSum $(A_1...A_K) = \max(A_1...A_K) + f(|A_{max1} - A_{max2}|)$, where the comparison circuit selects the largest valued input and another input of the K inputs as A_{max1} and A_{max2} and $f(|A_{max1} - A_{max2}|)$ is a value selected from the lookup table using A_{max1} and A_{max2}."

Claim 7 according to the appellant's second auxiliary request reads as follows:

"A method of processing information using LogMAP algorithm, the method comprises the step of:

providing an N-state Radix-K trellis on which the application of the information to the LogMAP algorithm is based where K is an integer equal to 4 or greater

and N is an integer equal to 2 or greater, where the method includes at least one LogSum operation including a comparison of K inputs, the LogSum operation determining an approximation of a Jacobian definition of a LogSum operator according to LogSum ($A_1...A_K$) = max($A_1...A_K$) + f(|A_{max1} - A_{max2}|), where the comparison circuit selects the largest valued input and another input of the K inputs as A_{max1} and A_{max2} and f(|A_{max1} - A_{max2}|) is a value selected from the lookup table using A_{max1} and A_{max2}."

Claim 1 according to the appellant's third auxiliary request differs from that according to his second auxiliary request by the addition at the end of the claim of the following text:

"wherein the device is a LogMAP processor (100) comprising a Soft Input Soft Output device that processes information in accordance with the LogMAP algorithm using the Radix-K N-state trellis where K is an integer equal to 4 or greater and N is an integer equal to 2 or greater, and where the Soft Input Soft Output device comprises:

at least one branch metric calculator (102);

at least one forward path metric calculator (108) and at least one backward path metric calculator where both calculators are in communication with the branch metric calculator;

at least one Log Likelihood calculator (118, 122) coupled to the path metric calculators; and

at least one subtractor circuit (416, 420) having an extrinsic information input and coupled to the at least one Log Likelihood calculator to provide at least one Log Likelihood Ratio output wherein the path metric

calculators and the at least one Log Likelihood calculator are constructed with LogSum operators which are designed based on an approximation of the Jacobian definition of a LogSum operation."

Claim 5 according to the appellant's third auxiliary request differs from claim 7 of his second auxiliary request by the addition at the end of the claim of the following text:

"receiving the information;
calculating branch metrics based on the received information and extrinsic information;
calculating path metrics based on the calculated branch metrics; calculating log likelihood values from the branch metrics and path metrics where the calculated log likelihood value and the calculated path metrics are obtained through logsum operations based on an approximation of a Jacobian definition; and
calculating a log likelihood ratio through a subtraction operation of the calculated log likelihood values and extrinsic information."

VI. The appellant essentially argued as follows:

The application as originally filed disclosed LogSum operators in isolation in at least two figures (Figs. 3 and 3A), and disclosed these operators in different devices (e.g. in Fig. 4, in paragraphs [0017] to [0025] of the published application, and in the abstract).

LogSum operators could be used in other processors and devices, such as channel estimation processors, and the skilled person would have readily derived from the

application as filed that the LogSum operators of the application were applicable to such processors.

Since the original application disclosed embodiments including only one lookup table, a claim to such an embodiment could not extend beyond the content of the application as originally filed.

In the communication accompanying the summons, the board indicated in section 2 that if the objections under Article 123(2) EPC were appropriately overcome, then the resultant subject-matter could be considered to be new and to involve an inventive step. The claims of his third auxiliary request had been amended to overcome those objections in the manner suggested by the board in section 2.1 of the communication, and thus their subject-matter should be considered to be new and to involve an inventive step.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. In two different respects, the independent claims 1 and 7 according to the appellant's main request define subject-matter which extends beyond the content of the application as originally filed.

2.1 Firstly, claim 1 defines the Logsum operator and claim 7 defines the LogSum operation in a more general context than originally disclosed.

2.1.1 In the original claims, the LogSum operator and operation were defined only in the dependent claims 3 and 8. Thus the LogSum operator was defined in claim 3 (which was dependent on claim 1 via claim 2) as part of a LogMAP processor comprising a Soft Input Soft Output device, which in turn comprised at least one branch metric calculator, at least one forward path metric calculator, at least one backward path metric calculator, at least one Log Likelihood calculator and at least one subtractor circuit for calculating a Log Likelihood Ratio, and the LogSum operation was defined in claim 8 as part of a method comprising the method steps corresponding to these elements. The general description of the processor (see paragraphs [0007] and [0010] of the published application) disclosed the same combinations of features, and the detailed embodiments of the description also included all of these features. Thus the original application disclosed the LogSum operator and operation only in the context of a processor and method including all of these further features.

2.1.2 In contrast to this, the independent claim 1 according to the present main request defines the LogSum operator merely as part of a processor which is operative to perform calculations using a logarithmic number system, the LogSum operator being part of a device which processes a received signal using a defined trellis to produce an output, without defining any of the further features of the processor discussed in paragraph 2.1.1 above. This reasoning applies correspondingly to the independent claim 7 of this request, with the exception that claim 7 defines also that the method uses a LogMAP

algorithm. These claims therefore define the LogSum operator and operation in a general context which was not disclosed in the original application.

2.1.3 The appellant has argued that the application as originally filed disclosed LogSum operators in isolation in Fig. 3 and Fig. 3A, and that in addition to disclosing processors (e.g. LogMAP processors) including devices, such as branch metric calculators, which include LogSum operators, the original application also disclosed LogSum operators in other devices, such as the Log Likelihood calculators of Fig. 4. The board is not convinced by this line of argumentation, since paragraphs [0008] and [0018] of the published application make clear that the Log Likelihood calculators of Fig. 4 are parts of the processor of Fig. 1, and since paragraph [0022] makes clear that the LogSum operator of Fig. 3 (and thus by implication, also that of Fig. 3A) is part of the circuit of Fig. 4. It thus follows that the LogSum operators which are described in detail with reference to Figs. 3 and 3A are part of the overall processor of Fig. 1, which corresponds to the definitions of the original claims 3 and 8. The appellant also referred in this respect to the Abstract of the application, but that is not relevant to Article 123(2) EPC, because the abstract does not form part of the content of the original application. The board is also not convinced by the appellant's argument that the skilled reader would readily derive that the LogSum operators of the application would be applicable to other types of processor, because, although the skilled person could be expected to be aware that Logsum operators in general can be used in other types of processor, he

would not be able to derive from the present application any teaching that the specific type of LogSum operator described there is suitable for use in any other type of processor than that explicitly described.

2.2 The second aspect referred to in paragraph 2 above is the definition in claim 1 that the at least one LogSum operator has a single lookup table, together with the corresponding definition in claim 7.

2.2.1 The application as originally filed disclosed a LogSum operator having only a single lookup table only in Figs. 3 and 3A. Thus, since the description did not mention this feature at all, it can only be considered to have been disclosed as part of the full disclosure of each of those figures in the context of the description, i.e. in combination with the other features of the LogSum operator depicted in those figures and the features described in the passages of the description referring to them, in particular that the LogSum operator carries out the operation in accordance with the equation of paragraph [0022], such that the lookup table provides the value of the $f(|A_{max1} - A_{max2}|)$ term. The independent claims 1 and 7 of the appellant's main request, however, explicitly define neither that equation nor what the content of the lookup table is, so represent an undisclosed generalisation of the teaching of the original application.

2.2.2 The appellant's only counter-argument in this respect is that, since Figs. 3 and 3A of the original application disclosed embodiments with only a single

lookup table, a claim to an embodiment with only one lookup table cannot extend beyond the content of the original application. This argument however overlooks the fact that those figures, taken in combination with the corresponding passages of the description, disclose only LogSum operators in which a single lookup table is provided to implement the specific mathematical function discussed in the previous paragraph. By defining a single lookup table which is not restricted to that specific function, the present claim 1 introduces teaching extending beyond the content of the application as originally filed.

2.3 The board therefore concludes for both of the above reasons that the appellant's main request contravenes Article 123(2) EPC.

First auxiliary request

3. The sole difference between the independent claim 1 of the appellant's first auxiliary request and that of his main request concerns only the general description of the operation of the processor, and thus has no impact on the above reasoning relating to the main request. The only difference between the independent claim 7 of the first auxiliary request and that of the main request is a matter of punctuation, which has no influence on the meaning of the claim. The board therefore concludes that this request also contravenes Article 123(2) EPC.

Second auxiliary request

4. The independent claim 1 according to the appellant's second auxiliary request differs from that according to the main request in substance in that the formula used for the calculation of the approximation of the Jacobian definition of the LogSum operator is defined in detail. The independent claim 7 of the second auxiliary request differs similarly from that according to the main request, and in addition no longer defines that there is a single lookup table. These differences, although relevant to the objection discussed section in 2.2 above, have no impact on that of section 2.1 above, since they define only features internal to the LogSum operator or operation, not of the overall processor or method of which it is part. The board therefore concludes that for the reasons given in section 2.1 above and its sub-sections, this request contravenes Article 123(2) EPC.

Third auxiliary request

5. The independent claims 1 and 5 of the appellant's third auxiliary request include the technical features of the original claims 3 and 8 respectively, and also both include the mathematical equation of the Jacobian approximation, so address both of the deficiencies under Article 123(2) EPC discussed above with respect to the appellant's higher ranked requests. However, the board considers that the subject-matter of these claims does not involve an inventive step according to Article 56 EPC, for the following reasons.

5.1 The document D1 describes (see for instance the abstract) a turbo decoding technique using a "low-latency log-MAP algorithm", and thus concerns a processor operative to perform calculations using a logarithmic number system. As such the processor of D1 inherently comprises a device which is a LogMAP processor comprising a Soft Input Soft Output device (SISO) having at least one input for receiving at least one input signal and having at least one output, the device processing the received signal using an N-state Radix-K trellis to produce at least one output signal. In the last part-paragraph on page 402 of D1 it is stated that the device operates "***to process 2 trellis stages at a time***", which implies that the value of K is equal to or greater than 4. In the paragraph following equation (2) on page 403, it is stated that the processor used "***the rate 1/2 turbo code ... with generators 37, 21***", thus implying that the value of N is 16 (i.e. it is equal to or greater than 2). As described in the first paragraph of section 2 of D1 and depicted in Fig. 2(b) the SISO device comprises forward and backward path metric calculators (FP, BP, ABP in Fig. 2(b)), and a Log Likelihood calculator (box "Calculate likelihood" in Fig. 2(b)). It is moreover implicit that branch metric calculators are connected to the path metric calculators (this being also indicated by the items "BM" in Fig. 5) and that the output from the Log Likelihood calculator is combined with extrinsic information to generate a Log Likelihood Ratio (this being an inherent part of log-MAP turbo decoding). The calculations make use of an approximation of the "max*" function as described in equations (1) and (2) on page 403, which by comparison with the present application can be seen to be a

Jacobian approximation of a LogSum operator, in the terminology of the present claims. The preferred device of D1 uses the ACS architecture of Fig. 5 for this calculation, which comprises (at least) a comparison circuit and (at least) a lookup table, the comparison circuit receiving four (=K) inputs (a, b, c, d), and selecting the largest valued input and another input (since one of max(a,b) and max(c,d) must be the largest of the inputs), and selecting a value from the right-hand lookup table (LUT) using those two values (specifically using $|A_{max1} - A_{max2}|$ as in the present application). The document also describes the operation of the device to process information using the LogMAP algorithm.

5.2 The processor of the independent claim 1 of the appellant's third auxiliary request is thus distinguished from that of D1 only in that the claim specifies that both the path metric calculators and the at least one Log likelihood calculator are constructed with the defined LogSum operators, and that the at least one LogSum operator has (implicitly, only) a single lookup table. The method of the independent claim 5 of this request is distinguished from that of D1 only by the method step corresponding to the first of these features, since this claim does not define that the LogSum operation uses only a single lookup table.

5.3 The board considers that the introduction of both of these features into the device and method of D1 would be obvious to the skilled person, for the following reasons.

5.3.1 D1 does not specify clearly which components of the decoder make use of the architecture described with reference to Fig. 5. However, given the advantages of that architecture described in D1, it would be obvious to the skilled person that it should be used for all components of the decoder requiring the ACS function, thus including the path metric calculators and the Log Likelihood calculator.

5.3.2 The ACS architecture depicted in Fig. 5 shows the lookup table (LUT) at three points. It is however immediately apparent from the corresponding description that each of these relates to the same function (the $f(|A_{max1} - A_{max2}|)$ function in the terminology of the application), so that for each LUT access depicted in the figure, the content of the LUT would be the same, and it would merely be addressed differently. On this basis, it would be obvious to the skilled person that it would not be necessary to actually provide three separate LUTs, and that instead a single LUT should be provided which could be accessed from the three different parts of the LogMAP processor.

5.4 The appellant has argued that the board stated in section 2 of the communication accompanying the summons to oral proceedings that "if the [-] objections under Article 123(2) EPC were appropriately overcome, then the resultant subject-matter could be considered to be new and to involve an inventive step", and that in his third auxiliary request he had addressed those objections in the manner indicated in section 2.1 of that communication, from which he appears to conclude that this request meets the requirements for novelty and inventive step. However, the statement in section 2

of that communication was qualified not only by the comments in section 2.1 to which the appellant refers, but also by those of section 2.2, in which it was argued that an inventive step could only be acknowledged if the independent claims were amended to clearly define that each LogSum operation involves only one step of accessing the lookup table. Since neither independent claim of the third auxiliary request defines that feature, the positive statement in section 2 of the communication does not apply to these claims.

5.5 Therefore, for the reasons explained in section 5.3 above and its sub-sections, the subject-matter of the independent claims of the appellant's third auxiliary request does not involve an inventive step according to Article 56 EPC.

Procedural matters

6. In his letter dated 12 March 2010 the appellant requested that the oral proceedings be cancelled and the procedure be continued in writing. In the light of the need for procedural efficiency, and since the appellant has not taken into account all of the comments made in the communication of the board, the board concluded that such a course of action would not be appropriate, and therefore the oral proceedings were maintained.

7. Since the appellant's main request and first and second auxiliary requests contravene Article 123 (2) EPC and since the subject-matter of the independent claims of his third auxiliary request does not involve an

inventive step, thus not meeting the requirements of Article 52(1) EPC in combination with Article 56 EPC, none of his requests is allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

U. Bultmann M. Ruggiu