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D E C I S I O N
of 1 April 2003

Case Number: T 0353/99 - 3.4.1

Application Number: 94900952.6

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Language of the proceedings: EN

Title of invention:
Method and apparatus for the classification of an article

Patentee:
Mars Incorporated

Opponent:
GIESECKE & DEVRIENT GmbH

Headword:
Method and apparatus for the classification of an article/Mars Inc.

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
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Case Number: T 0353/99 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 1 April 2003

Appellant: (Opponent)
GIESECKE & DEVRIENT GmbH
Prinzregentenstrasse 159
D-81677 München (DE)

Representative:
-

Respondent: (Proprietor of the patent)
Mars Incorporated
6885 Elm Street
McLean,
Virginia 22101-3883 (US)

Representative:
Burke, Steven David
R.G.C. Jenkins & Co.
26 Caxton Street
London SW1H ORJ (GB)

Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 17 February 1999 rejecting the opposition filed against European patent No. 0 671 040 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: G. Davies
Members: H. K. Wolfrum
M. G. L. Rognoni

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the decision of the opposition division, dispatched on 17 February 1999 rejecting the opposition against European patent No. 0 671 040. The notice of appeal was received on 25 March 1999, the prescribed fee being paid on the same day. The statement setting out the grounds of appeal was received on 21 June 1999.

II. Opposition had been filed against the patent as a whole and based on the grounds of Articles 100(a) and 100(b) EPC and substantiated on the grounds of lack of inventive step (Articles 52(1) and 56 EPC) and lack of sufficiency of disclosure (Article 83 EPC).

III. Oral proceedings were held on 1 April 2003 at the request of both parties.

IV. The appellant requested that the contested decision be set aside and that the European patent be revoked.

Of the grounds of opposition, the appellant maintained only lack of inventive step, making reference to document:

E2: EP-A-0 477 711.

V. The respondent (patentee) requested that the appeal be dismissed and that the patent be maintained as granted.

VI. Independent claim 1 of the granted patent reads as follows:

"*1. A method of validating an article of currency by*

determining whether the article belongs to a target class associated with a particular denomination in a particular orientation, the method comprising producing a k-dimensional feature vector (X) describing the article, determining from among a plurality of target vectors all associated with said target class that target vector (W_c) which is closest to the feature vector (X), and designating the article as belonging to the target class if the components of the feature vector (X) meet a predetermined criterion indicating that the feature vector (X) lies within a predetermined boundary containing the closest target vector (W_c)."

Further independent claims 13 and 19 read:

"*13. Apparatus for validating an article of currency, the apparatus comprising a measuring system, a preliminary processing system and a classification system for the classification of an article that can be described by k-dimensional feature vector (X), the preliminary processing system being responsive to measurements of physical features of a test specimen supplied by the measuring system for deriving the k-dimensional feature vector (X) and supplying the feature vector to the classification system, the classification system comprising a recognition unit for determining whether or not the article belongs to a target class representing a particular denomination in a particular orientation, the recognition unit being operable to determine which, amongst a plurality of target vectors associated with said target class, is the closest target vector (W_c) to the feature vector (X), and to designate the article as*

belonging to the target class if the components of the feature vector (X) meet a predetermined criterion indicating that the feature vector (X) lies within a predetermined boundary containing the closest target vector (W_c)."

"*19. A method of validating an article of currency, the method comprising providing*
a signal indicating that the article of currency belongs to a target class associated with a particular denomination in a particular orientation, if (a) a feature vector (X) descriptive of the article has been determined to lie within one of a plurality of Voronoï polygons associated with that target class, and (b) the feature vector (X) also lies within an acceptance boundary restricting the area of that Voronoi polygon."

VII. The appellant's submissions may be summarised as follows:

In the method of validating an article of currency known from document E2, the measurement of pattern data along a scan line of the article corresponded to the step of producing a feature vector defined in claim 1 of the patent in suit. Moreover, allowable range reference data stored according to the known method for each scan line was to be considered as constituting a plurality of target vectors describing a target class associated with a particular denomination in a particular orientation within the meaning of claim 1 under consideration. The known step of comparing the measured scan line pattern data with the corresponding reference data for the same scan line corresponded to the claimed step of designating the article as

belonging to the target class. In this context, an equivalent to the claimed step of determining from among the plurality of target vectors all associated with the target class that target vector which was closest to the feature vector was to be seen in the known method in the step of selecting from the plurality of the allowable range reference data stored for each scan line the set of data for the corresponding scan line.

In particular with respect to the latter step, it had to be taken into consideration that claim 1 of the patent in suit defined the invention in terms of an abstract concept which was open to a wide range of interpretations. Hence the claimed step of "determining the closest vector" did not necessarily mean a mathematical vector operation but encompassed *inter alia* activities such as the step of establishing for a measured scan line the corresponding reference scan line data known from E2.

But even if claim 1 was narrowly interpreted as involving a vector operation in determining the target vector closest to the feature vector, such vector operations would have to be regarded as being obvious to the average skilled person.

Moreover, it had to be taken into consideration that claim 1 of the patent in suit did not specify for instance the nature of the feature vector, so that it was indeed indispensable for a successful validation to determine from all the possible target vectors describing the target class the one which corresponded to the physical property which happened to underlie the measured feature vector and thus constituted the

closest vector thereto. In a similar manner, if, in the method according to E2, it was for some reason unknown for which scan line a feature vector had been measured, the corresponding reference scan line data (ie the closest target vector) would have to be determined from a comparison with all reference scan line data as well.

Besides, claim 1 under consideration was in fact so vague that even the step of determining the target class known from E2, which consisted in a comparison of a measured feature vector with class reference patterns for the respective classes and for the corresponding scan lines, fell under the terms of the claim relating to the determination of the closest target vector.

In summary, it appeared that the subject-matter of claim 1 as granted even lacked novelty with respect to the teaching of E2. At any rate, its subject-matter was rendered obvious by E2.

Since claim 13 defined the required means of an apparatus for validating an article of currency by the terms of claim 1, the same considerations also applied to its subject-matter. In particular, the definition of the recognition unit responsible for determining the closest target vector gave no hint that it had to perform mathematical vector operations.

As far as claim 19 was concerned, a skilled person who was considered capable of putting the necessary mathematical operations relying on Voronoï polygons into practice had to possess such a far-reaching knowledge of the mathematical methods involving Voronoï polygons that he had also to be considered capable of devising such a method without the exercise of

inventive skill.

VIII. The respondent disputed the appellant's view, relying essentially on the following arguments:

The key to the invention was the step of determining from among a plurality of target vectors associated with a single target class that target vector which was closest to a measured feature vector. Hence according to the patent one feature vector was compared to all target vectors of a given target class. As was clear from the claim language and in particular from the terms "determined" and "closest vector", the method according to claim 1 as granted involved mathematical vector operations so as to calculate the various distances between the feature vector and the target vectors and to determine therefrom that vector which had the shortest distance to the feature vector. Any remaining ambiguity in this respect would be dispersed by the patent specification.

In distinction thereto, the method known from E2 compared a single set of measured scan line data forming a feature vector with the corresponding set of reference data for the same scan line constituting a single target vector. The selection of the corresponding reference scan line data was based on additional information known in advance which identified the position of the scan line. In the known method, it would not make any technical sense to compare measured data of a given scan line with reference data of any other scan line.

To the extent that in the method known from E2 the target class (ie the denomination and orientation of

the article of currency) was determined, a measured feature vector was compared to target vectors of different classes so as to identify a class reference pattern indicative of a respective class. There was no teaching in E2 that for the purpose of classification any class would be described by more than one class reference pattern, ie more than one target vector. Moreover, the wording of claim 1 under consideration left no doubt that the claimed method concerned the validation of the article of currency and not the determination of its class which could have been established in advance.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.

2. The sole issue remaining in dispute between the parties in the appeal proceedings concerns the matter of inventive step.

3. *Subject-matter of the patent in suit*

Claim 1 as granted is directed to a method of validating an article of currency by determining whether the article belongs to a target class associated with a particular denomination in a particular orientation, and comprises the steps of:

(a) producing a k-dimensional feature vector (X) describing the article,

(b) determining from among a plurality of target vectors all associated with said target class that target vector (Wc) which is closest to the feature vector (X), and

(c) designating the article as belonging to the target class if the components of the feature vector (X) meet a predetermined criterion indicating that the feature vector (X) lies within a predetermined boundary containing the closest target vector (Wc).

Claim 13 is directed to an apparatus having the respective means (measuring system, preliminary processing system, classification system including a recognition unit) for validating an article of currency by performing method steps as defined in claim 1.

Claim 19 is directed to a particular mathematical concept for implementing a method of validating an article of currency, the solution principle constituting a specific embodiment of the method according to claim 1 which is based on Voronoï polygons associated with a target class and thus representing the target vectors describing said class.

3.2 The invention seeks to improve the reliability of the validation of an article of currency. By describing a target class by means of a plurality of target vectors it becomes possible to implement a complex multidimensional acceptance range for genuine articles which makes it easier to accommodate the method to known dispersions in the features of genuine articles and to individually modify acceptance criteria for each target vector and thus to better reject counterfeit

articles (see column 2, lines 8 to 30, and column 10, lines 12 to 25 of the patent specification).

4. *Prior art*

The Board agrees with the parties that document E2 constitutes the most relevant prior art on file.

E2 discloses a method and apparatus for validating an article of currency (here a banknote) by determining whether it belongs to a class associated with a particular denomination in a particular orientation (see column 4, lines 10 to 20). In operation, a banknote is scanned along a plurality of longitudinal lines ("scan lines") and electric signals reflecting a physical property (such as the reflectance of light, the intensity of transmitted light or the spatial density of magnetic ink) of the banknote are detected along each scan line. These signals are stored as a detected pattern data P(t) for each scan line. Classifying means are provided for identifying the respective class (ie denomination) from the detected pattern data. Moreover, the detected pattern data is tested for authenticity. According to a first embodiment (see Figures 2, 3, 4A and 4B with the corresponding description), the detected pattern data P(t) is differentiated and the differentiated detected pattern data P'(t) is then compared to allowable range reference data indicative of allowable range patterns for the respective classes and the respective scan lines. In this respect, memory units 16-1 to 16-n are provided for the respective classes, each of the memory units storing the allowable range reference data for all the scan lines on the banknote of the class for which it is provided. More specifically, the allowable

range reference data for each scan line of each class comprises an upper-limit reference pattern $g_{max}(t)$ and a lower-limit reference pattern $g_{min}(t)$. The comparison is made for all scan lines of the identified class under the control of control means ("read control means 14") providing identical address information for the stored reference pattern and the pattern data P'(t). If, as shown in Figure 3, pattern P'(t) of each scan line is found to fully lie within the area between the boundaries $g_{max}(t)$ and $g_{min}(t)$ stored in the corresponding addresses of the respective memory unit 16-i, the banknote is identified as belonging to the class associated with that memory unit. According to an alternative embodiment (see Figures 6, 7A to 7E and 8A to 8E with the corresponding description), memory units 26-1 to 26-n store reference pattern data representing reference patterns for all the scan lines on the banknote of a respective class. The detected scan line data for each scan line and the respective reference pattern data are subtracted from each other so as to obtain a difference pattern. The difference pattern is filtered in order to remove dc- and low-frequency components. An authenticity judgement is made by determining the absolute value of the filtered difference pattern and comparing the latter with a threshold value V_R for the particular scan line of the particular class. The threshold value is predetermined so as not to be exceeded by the absolute value of the filtered difference pattern if the banknote is genuine.

5. Since the pattern data along a scan line is normally measured for discontinuous points, the step of measuring scan line pattern data in the known method can be perceived as a step of producing a k-dimensional feature vector describing the article, in accordance

with aforementioned step (a) included in claim 1 of the patent in suit.

Likewise, the allowable range reference data stored in the known method for each scan line can be considered as constituting a plurality of target vectors describing a target class associated with a particular denomination in a particular orientation within the meaning of claim 1 under consideration.

Furthermore, the known method comprises, at least in partial accordance with aforementioned feature (c), a step of designating the article as belonging to the target class if the components of the feature vector meet a predetermined criterion indicating that the feature vector lies within a predetermined boundary corresponding to the allowable range reference data of the scan line for which the feature vector was measured.

6. The major point of dispute between the parties concerns the question whether the selection of the corresponding reference data to the measured pattern data of a particular scan line in the known method could be considered as falling within the terms of aforementioned feature (b), ie whether it could be perceived as **determining** from among the plurality of target vectors that one which is **closest** to the feature vector.

As regards the interpretation of feature (b), the Board concurs with the respondent that a skilled person reading claim 1 of the patent in suit could not be in doubt that the reference to a step of "determining the closest vector" meant nothing else than the performance

of mathematical vector operations executed on the vector components so as to establish which one of the target vectors would be closest, ie had the smallest distance to the feature vector, the more so as nothing in the patent specification hinted at a broader interpretation.

Corresponding vector operations are, however, not performed in the method known from document E2. As a matter of fact, the teaching of E2 (see for instance column 2, lines 52 to 55; column 3, lines 25 to 27, and 34 to 37; column 4, line 56 to column 5, line 3; and column 5, lines 37 to 57) contains various indications that the selection of the reference data corresponding to the measured pattern data of a particular scan line relies on address information for access to respective memory locations which in turn is determined from position information which unambiguously identifies the scan line under study. Thus, when performing the known method of validating an article so as to find out which set of reference data would correspond to the measured pattern data of a given scan line, there is no need at that stage for comparing measured data with any reference data and in particular no purpose in comparing the measured data of one scan line with the complete reference pattern data of all scan lines. Besides, E2 would not provide any indication as to which criteria would have to be applied in evaluating the results of such comparisons. As far as such comparisons could make technical sense at all, they would render any subsequent validation step obsolete and be contrary to the unambiguous teaching of E2, which foresees a comparison of measured scan line data with only a single set of reference data, ie the reference data corresponding to the same scan line.

7. It follows from these considerations that, contrary to the appellant's allegation, the subject-matter of claim 1 of the patent in suit is distinguished from the method of validating an article of currency as known from document E2 by the step of determining from among the plurality of target vectors all associated with a given target class that target vector which is closest to the feature vector and, furthermore, that it would not be technically meaningful to implement the distinguishing feature in the known method.

As far as the appellant sees a determination of the closest target vector in the teaching of E2 relating to the determination of the target class which precedes the actual validation procedure, the Board notes that the wording of claim 1 of the patent in suit, which refers to a "method of validating an article" *inter alia* by the step of "designating the article as belonging to a target class", leaves no reasonable doubt that the claimed subject-matter is not concerned with classification, ie the determination of the respective target class, but with authentification, ie the determination whether or not an article would belong to a given target class and thus would be genuine or counterfeit. Moreover, there is no indication in E2 that, in the disclosed process of classification, measured pattern data, ie a feature vector, would be compared with different class reference patterns, ie target vectors, of a single class.

By defining a target class by a plurality of target vectors and, furthermore, by determining the target vector having the smallest distance to a feature vector measured for an article, the invention allows not only

for an effective authentification on the basis of a comparison of a feature vector with a single target vector but also increases the reliability of the authentification in that it allows to individually tailor the acceptance criterion for each target vector.

8. For the sake of completeness the Board notes that none of the further documents relied on in the written appeal proceedings teaches a method of validating an article of currency involving a step of determining from among a plurality of target vectors the one which would be closest to a feature vector within the meaning indicated in point 6 above.

9. On the basis of the above considerations, the Board concludes that the subject-matter of claim 1 is not only novel but is also not rendered obvious by the teaching of the prior art.

The same considerations and conclusions apply to the subject-matter of independent claim 13 defining an apparatus having the necessary means for performing the method defined in claim 1, as well as to the subject-matter of independent claim 19, which, by defining a specific mathematical procedure of determining the closest target vector not indicated in any of the available prior art documents for the purpose of validating an article of currency, corresponds to a specific embodiment of the method of claim 1.

10. For these reasons, the ground of opposition under Article 100(a) EPC together with Article 56 EPC does not prejudice the maintenance of the patent unamended.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

R. Schumacher G. Davies