

from taking too much time, which restricts the spatial resolution in the product to be produced.

Finally, the natural parallelisation of this processing is simple to implement: the processing for each cross-section
 5 can be made independently and in parallel. These processings are very likely to take a different time from one layer to the other, for example as a function of the number of entrance and exit limits of the layer. Thus, in the general case, processings will not be of the same duration from one layer to
 10 the other and they will have to use iterative mechanisms internal to each layer processing, and with complex synchronization between layer processings.

In a similar way, within one of these processings, the path of lines from one end to the other of the field can be
 15 performed in parallel (step 2 above). This is a comparable situation to the paralleling of the sections processings: there are lines that will be more complex than others, as a function of the number of crossings the entrance or exit lines, and with iterative algorithms and complex synchronizations.

It is thus possible to contemplate applying a complex but
 20 non-"massive" parallelism, that is only of the "MIMD" ("Multiple Instruction on Multiple Data") type and non of the "SIMD" ("Single Instruction on Multiple Data") type, whereas it is considered that the SIMD algorithms are potentially more
 25 efficient, but are restricted in their applicability to particularly simple operations. It is reminded that the SIMD parallelism is one of the four operating modes defined by Flynn taxonomy and designates an operating mode where several computing units operate in parallel, such that the same
 30 instruction is applied in parallel over time to several data to produce several results.

Embodiments ~~The purpose~~ of the present invention seeks to provide a lithography process or device enabling at least one of the abovementioned drawbacks to be solved.

Disclosure of the invention

According to a first aspect of the present invention, there is provided~~This purpose is achieved with~~ a process for producing a product, comprising determining ~~(typically from descriptive data of the object)~~ whether points of a finite space are inside or outside an object decomposed into elementary surfaces, said object ~~typically~~ corresponding to the product to be produced or to a part or layer or slice of the product to be produced,

characterised in that for each working point for which it is attempted to determine whether it is inside or outside the object, the process comprises:

- determining at least one line among a line passing through this working point with which is associated a counter dedicated solely to this working point, and a line passing through an image ~~(translation, rotation, combination of both, etc...)~~ of the working point with which image is associated a counter dedicated solely to this image of the working point, and
- iterating, on each of the elementary surfaces, the following operations:
 - searching for an intersection between the elementary surface and one of the lines from the line passing through the working point and the line passing through the image of the working point,
 - modifying the counter if the intersection exists,
 - and
- determining whether the working point is inside or outside the object as a function of the counter dedicated solely to the working point-

each of the preceding steps being implemented by at least a computer, a central processing or computing unit, an analogue electronic circuit, a digital electronic circuit, a microprocessor and/or software means.

Each line can be a straight line or a curved line.

In a first alternative, the process according to embodiments of the invention is characterised in that:

- determining at least one line comprises determining a line passing through the working point with which is associated a counter dedicated solely to this working point, and/or
- iterating comprises iterating, on each of the elementary surfaces, the following operations:

- searching for an intersection between the elementary surface and the line passing through the working point,
- modifying the counter if the intersection exists, and
- determining whether the working point is inside or outside the object comprises determining whether the working point is inside or outside the object as a function of the value of the counter dedicated solely to the working point.

In this first alternative, the line can pass through an origin, and modifying the counter can comprise:

- if the intersection is located beyond the working point with respect to the origin of the line, no modification of the counter, and
- if the intersection is not located beyond the working point with respect to the origin of the line, modifying the counter differently depending on whether the intersection of the line corresponds to an entrance of the line into the object or an exit of the line from the object with respect to the origin.

In a second alternative, the process according to embodiments of the invention is characterised in that:

- determining at least one line comprises determining a line passing through the working point with which is associated a counter dedicated solely to this working point and a line passing through an image of the working point with which is associated a counter dedicated solely to this image of the working point, and/or
- the process further comprises separating the elementary surfaces into two distinct groups, a group of surfaces for entrance into the object and a group of surfaces for exit from the object with respect to a direction of movement, and/or
- the iteration comprises an iteration, on each of the elementary surfaces, of the following operations:

- if the surface is an entrance surface, searching for an intersection between this elementary surface and the

at least a part of a layer to be deposited to produce the product by rapid prototyping.

The iteration step can be performed in parallel over time for several elementary surfaces.

5 For at least one elementary surface, the iteration step can be performed in parallel over time for several working points.

The iteration steps performed in parallel are preferably synchronized by a fixed run time, and not by waiting for a task end.

10 Preferably, each line passing through a working point is different from other lines passing through the other working points.

Typically, at least one of the steps of the process according to embodiments of the invention previously described, preferably each
15 of the steps of the process according to embodiments of the invention previously described is not performed in a purely abstract or purely intellectual matter but involves use of a technical means.

Typically, each of the steps of the process according to embodiments of the invention previously described can be implemented by at least one
20 computer, one central processing or computing unit, one analogue electronic circuit (preferably dedicated), one digital electronic circuit (preferably dedicated) and/or one microprocessor (preferably dedicated) and/or by software means.

Once which space point is located inside or outside the .
25 object has been determined, the process according to embodiments of the invention can comprise producing the product by rapid prototyping and/or by layer stacking, for example by stereolithography or by filament deposition.

According to a second aspect ~~yet another aspect~~ of the invention, it is
30 provided a device for producing a product, implementing a process according to the first aspect of the invention, comprising means for determining ~~(typically from descriptive data of the object)~~ whether points of a finite space are inside or outside an object decomposed into elementary surfaces, said object ~~typically~~ corresponding to the product to be produced or to a
35 part or layer or slice of the product to be produced,

characterised in that for each working point for which it is attempted to determine whether it is inside or outside the object, the device comprises:

- means for determining at least one line among a line passing through this working point with which is associated a counter dedicated solely to this working point, and a line passing through an image of the working point with which is associated a counter dedicated solely to this image of the working point, and
- means for iterating, on each of the elementary surfaces, the following operations:
 - searching for an intersection between the elementary surface and a single one of the lines from the line passing through the working point and the line passing through the image of the working point,
 - modifying the counter if the intersection exists, and
- means for determining whether the working point is inside or outside the object as a function of the counter dedicated solely to the working point-

each of the previous means comprises at least one computer, one central processing or computing unit, one analogue electronic circuit, one digital electronic circuit, one microprocessor and/or software means.

Each line can be a straight line or a curved line.

In a first alternative, the device according to embodiments of the invention is characterised in that:

- the means for determining at least one line comprise means for determining a line passing through the working point with which is associated a counter dedicated solely to this working point, and/or
- the means for iterating comprise means for iterating, on each of the elementary surfaces, the following operations:
 - searching for an intersection between the elementary surface and the line passing through the working point,
 - modifying the counter if the intersection exists, and/or
- the means for determining whether the working point is inside or outside the object comprise means for determining whether the working point is inside or outside the object as

a function of the value of the counter dedicated solely to the working point.

In this first alternative, the line can pass through an origin, and the means for iterating can be arranged to modify the counter the following way:

- if the intersection is located beyond the working point with respect to the origin of the line, there is no modification of the counter, and
- if the intersection is not located beyond the working point with respect to the origin of the line, there is a modification of the counter differently depending on whether the intersection of the line corresponds to an entrance of the line into the object or an exit of the line from the object with respect to the origin.

In a second alternative, the device according to embodiments of the invention is characterised in that:

- the means for determining at least one line comprise means for determining a line passing through the working point with which is associated a counter dedicated solely to this working point and for determining a line passing through the image of the working point with which is associated a counter dedicated solely to this image of the working point, and/or
- the device further comprises means for separating the elementary surfaces into two distinct groups, a group of surfaces for entrance into the object and a group of surfaces for exit from the object with respect to a direction of movement, and/or
- the means for iterating comprise means for iterating, on each of the elementary surfaces, the following operations:
 - if the surface is an entrance surface, searching for an intersection between this elementary surface and the line passing through the working point and modifying the counter associated with the working point if the intersection exists,

For at least one elementary surface, the means for iterating can be arranged to perform in parallel over time iterations for several working points.

5 The device according to embodiments of the invention can further comprise means for synchronizing, by a fixed run time, iterations performed in parallel, and not by waiting for a task end.

Preferably, each line passing through a working point is different from other lines passing through the other working points.

10 Typically, at least one of the means of the device according to embodiments of the invention previously described, preferably each of the means of the device according to embodiments of the invention previously described are technical means.

Typically, each of the means of the device according to embodiments of the invention previously described can comprise at least one computer, one 15 central processing or computing unit, one analogue electronic circuit (preferably dedicated), one digital electronic circuit (preferably dedicated) and/or one microprocessor (preferably dedicated) and/or software means.

20 The device according to embodiments of the invention can further comprise means for producing, once which space point is located inside or outside the object has been determined, the product for example by rapid prototyping and/or layer stacking, for example by stereolithography or filament deposition.

25 According to yet another aspect of the invention, it is provided a product obtained by a producing process according to the first aspect of the invention or by a producing device according to the second aspect of the invention.

Description of the figures and embodiments

30 Further advantages and features of the invention will appear upon reading the detailed description of implementations and embodiments in no way limiting, and the following appended drawings wherein:

- Fig. 1 illustrates a process according to the state of prior art;

35 - Fig. 2 illustrates different data of a process according to the invention,

CLAIMS

1. A process for producing a product, comprising determining whether points ~~(11, 30)~~ of a finite space are inside or outside an object ~~(14, 6)~~ decomposed into elementary surfaces ~~(15)~~, said object corresponding to the product to be produced or to a part or layer or slice of the product to be produced, characterised in that for each working point ~~(11, 30)~~ for which it is attempted to determine whether it is inside or outside the object, the process comprises:

- 10 - determining at least one line ~~(12)~~ among a line passing through this working point ~~(11, 30)~~ with which is associated a counter dedicated solely to this working point, and a line passing through an image ~~(31)~~ of the working point with which is associated a counter dedicated solely to this image of the
- 15 working point, and
- iterating, on each of the elementary surfaces, the following operations:
 - searching for an intersection between the elementary surface ~~(15)~~ and one of the lines from the line ~~(12)~~ passing through the working point ~~(11, 30)~~ and the line passing through the image of the working point ~~(31)~~,
 - modifying the counter if the intersection exists, and
- 20 - determining whether the working point is inside or outside the object as a function of the counter dedicated solely to the working point ~~(11, 30)~~
- 25 each of the preceding steps being implemented by at least a computer, a central processing or computing unit, an analogue electronic circuit, a digital electronic circuit, a microprocessor and/or software means.

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2. The process according to claim 1, characterised in that:

- determining at least one line comprises determining a line passing through the working point with which is associated a counter dedicated solely to this working point,

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images of the working points, the lines passing through these points do not intersect inside the finite space.

9. The process according to any of preceding claims,
5 characterised in that the space is a three dimension space.

10. The process according to claim 9, characterised in that the working points ~~(11)~~ are gathered in a working surface ~~(36)~~, and in that each line ~~(12)~~ passing through a working point and each
10 line passing through an image of a working point is transverse to this working surface ~~(36)~~ through this working point ~~(11)~~.

11. The process according to claim 10, characterised in that the working surface ~~(36)~~ corresponds to a layer or at least a
15 part of a layer to be deposited to produce the product by rapid prototyping.

12. The process according to any of claims 1 to 8,
20 characterised in that the space is a two dimension space.

13. The process according to any of the preceding claims, characterised in that the iteration step is performed in parallel over time for several elementary surfaces.

25 14. The process according to any of the preceding claims, characterised in that for at least one elementary surface, the iteration step is performed in parallel over time for several working points.

30 15. The process according to any of claims 13 or 14, characterised in that the iteration steps performed in parallel are synchronized by a fixed run time.