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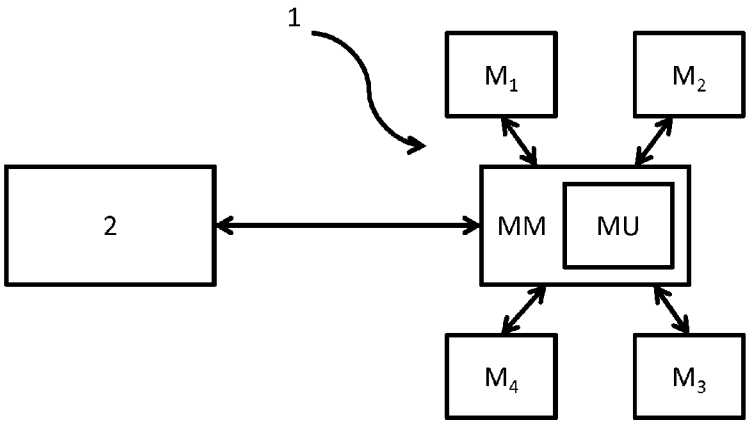


Fig. 1

(57) Abstract: The invention proposes a calculation system (1) for manufacturing an ophthalmic lens, comprising: - a set of calculation modules (M_1, M_2, M_3, M_4) associated to partial calculation in relation with manufacturing process of said ophthalmic lens, - a managing unit (MU) configured to: -receive input data, -calculate output data through one or several iteration(s) of: - determining one or several calculation module(s) to be activated, - determining an order of activation of the one or several calculation module(s), - activating the determined one or several calculation module(s), in accordance with the determined order of activation, and - transmit an indication that the output data have been calculated.

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CALCULATION SYSTEM FOR MANUFACTURING AN OPHTHALMIC LENS

The invention relates to a calculation system for manufacturing an ophthalmic lens.

The discussion of the background of the invention herein is included to explain the context of the invention. This is not to be taken as an admission that any of the material referred to was published, known or part of the common general knowledge at the priority date of any of the claims.

Ophthalmic lens is commonly used for correcting many different types of vision deficiencies of a wearer of the ophthalmic lens. These include defects such as near-sightedness (myopia) and far-sightedness (hypermetropia), astigmatism, and defects in near-range vision usually associated with aging (presbyopia).

An ophthalmic lens is typically made of plastic or mineral material and generally has two opposing surfaces which co-operate with one another to provide a required refractive property, generally corresponding to the wearer's prescription.

Currently, for providing an ophthalmic lens, an eye care practitioner orders the ophthalmic lens at an ophthalmic lab by sending an order request to the ophthalmic lab. The order request comprises wearer data, for example the wearer's prescription, and optionally other wearer's parameters, such as a head/eye movement coordination parameter and/or an eye rotation center. The order request further comprises spectacle frame data, for example the type of spectacle frame the wearer has selected, and lens data, for example the type of ophthalmic lens the wearer has selected.

The ophthalmic lab receives the order request and sends it to an ophthalmic lens designer. The lens designer uses the data comprised in the order request to calculate an ophthalmic lens design, by using an ophthalmic lens calculator. The ophthalmic lens design comprises optical data of the ophthalmic lens

to be provided to the wearer, and manufacturing process data related to the manufacturing process of the ophthalmic lens.

The ophthalmic design determined by the lens designer is sent to the ophthalmic lab and the ophthalmic lens is manufactured based on the calculated design. The manufacturing process may for instance comprise a blocking step, a surfacing step, a polishing step and a marking step.

The current ophthalmic lens manufacturing process presents some drawbacks.

Firstly, each ophthalmic lab has its own management entity, and its own apparatus and tools. Consequently, each lens designer has to be adapted to calculate manufacturing process data for the different ophthalmic labs.

This may be achieved by using, in the ophthalmic lens calculator, a database containing ophthalmic labs data related to the different labs. However, some labs data may not be obtained or updated, and this may result in performing a manufacturing process based on incorrect calculated manufacturing process data.

In a similar way, each ophthalmic lab has to be adapted to perform a manufacturing process based on manufacturing process data calculated by different lens designers. In particular, some lens designer calculators are configured to compute all the necessary information (optical information and manufacturing information) to manufacture an ophthalmic lens in a single calculation, while other lens designer calculators are mainly focused on optical calculations, and not as much on how to manufacture the design.

Secondly, the manufacturing process data are calculated prior to the beginning of the manufacturing process, and it is not possible to recalculate some of the manufacturing process data during the manufacturing process, for example to update the manufacturing process data based on measured process data. This may result in a lack of precision.

One object of the invention is to provide a calculation system for manufacturing an ophthalmic lens that does not present the drawbacks mentioned hereinabove.

To this end, the invention proposes a calculation system for manufacturing an ophthalmic lens, comprising:

- a set of calculation modules 1 to N, N being an integer higher than or equal to 1, each calculation module being associated to a partial calculation in relation with manufacturing process of said ophthalmic lens, each calculation module being configured to be activated independently and asynchronously from another calculation module,
- a managing unit configured to:
  - receive input data, the input data being related to the manufacturing process and/or to an ophthalmic lens manufacturing system configured to manufacture the ophthalmic lens,
  - calculate output data related to the manufacturing process from the input data, through one or several iteration(s) of:
    - determining one or several calculation module(s) to be activated,
    - determining an order of activation of the one or several calculation module(s) to be activated,
    - activating the determined one or several calculation module(s), in accordance with the determined order of activation, and
  - transmit, to the ophthalmic lens manufacturing system, an indication that the output data have been calculated, and make the output data available to the ophthalmic lens manufacturing system.

According to an embodiment of the invention, the managing unit is embedded in a master module, each calculation module being a slave calculation module configured to be activated by the master module.

According to another embodiment of the invention, the calculation system comprises N managing units, each calculation module comprising one of the said N managing units, one calculation module being determined as managing module for an output data calculation, depending on the received input data.

According to an embodiment of the invention, the set of calculation modules comprises at least one optical calculation module, configured to calculate values of optical parameters related to the ophthalmic lens to be manufactured, the optical parameters comprising geometrical parameters related to the ophthalmic lens. In this embodiment, the input data may comprise a request to calculate values of the optical parameters, the input data further comprising prescription data for the wearer of the ophthalmic lens.

According to an embodiment of the invention, the set of calculation modules comprises at least one manufacturing calculation module, configured to calculate values of ophthalmic lens manufacturing process parameters. In this embodiment, the input data may comprise a request to calculate values of the manufacturing process parameters. The request to calculate values of the manufacturing process parameters may specify one or several manufacturing step(s) to be performed. The output data may further specify one or several manufacturing step(s) to be performed.

The at least one manufacturing calculation module may be configured to return, in response to its activation, a list of parameters values, and/or indication that the calculation is impossible to perform for the said one or several manufacturing step(s).

When the calculation system comprises at least an optical calculation module and at least a manufacturing calculation module, the input data may comprise a request to calculate values of the optical parameters and values of the manufacturing process parameters. Here, the input data further comprise prescription data for the wearer of the ophthalmic lens.

The input data may further comprise measurement data measured during the manufacturing process of the ophthalmic lens, operation state data related to an equipment of the ophthalmic lens manufacturing system, and/or process change data related to a change in the manufacturing process.

The managing unit may be configured to determine an order of activation of the one or several calculation module(s) to be activated, through one or several iteration(s) of:

- determining a first calculation module impacted by the input data,

- determining a second calculation module impacted by a parameter value calculated by the first calculation module.

The managing unit may be configured to use predetermined priority rules related to the calculation modules to determine the order of activation of the one or several calculation module(s) to be activated.

The invention further proposes a calculation method for manufacturing an ophthalmic lens, in a calculation system comprising a set of calculation modules 1 to N, N being an integer higher than or equal to 1, each calculation module being associated to a partial calculation in relation with manufacturing process of said ophthalmic lens, each calculation module being configured to be activated independently and asynchronously from another calculation module, the method comprising, at a managing unit:

- a receiving step during which input data are received, the input data being related to the manufacturing process and/or to an ophthalmic lens manufacturing system configured to manufacture the ophthalmic lens,
- a calculating step during which output data related to the manufacturing process are calculated from the input data, through one or several iteration(s) of:
    - determining one or several calculation module(s) to be activated,
    - determining an order of activation of the one or several calculation module(s) to be activated,
    - activating the determined one or several calculation module(s), in accordance with the determined order of activation, and
- a transmitting step during which an indication that the output data have been calculated is transmitted to the ophthalmic lens manufacturing system, the output data being available to the ophthalmic lens manufacturing system.

The invention further proposes a computer program product comprising one or more stored sequences of instructions that are accessible to a processor and which, when executed by the processor, causes the processor to carry out the steps of the method.

The invention further proposes a computer readable medium carrying one or more sequences of instructions of the computer program product.

Unless specifically stated otherwise, as apparent from the following discussions, it is appreciated that throughout the specification discussions utilizing

terms such as "computing", "calculating", "generating", or the like, refer to the action and/or processes of a computer or computing system, or similar electronic computing device, that manipulate and/or transform data represented as physical, such as electronic, quantities within the computing system's registers and/or memories into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission or display devices.

Embodiments of the present invention may include apparatuses for performing the operations herein. This apparatus may be specially constructed for the desired purposes, or it may comprise a general purpose computer or Digital Signal Processor ("DSP") selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs) electrically programmable read-only memories (EPROMs), electrically erasable and programmable read only memories (EEPROMs), magnetic or optical cards, or any other type of media suitable for storing electronic instructions, and capable of being coupled to a computer system bus.

The processes and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct a more specialized apparatus to perform the desired method. The desired structure for a variety of these systems will appear from the description below. In addition, embodiments of the present invention are not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the inventions as described herein.

Non limiting embodiments of the invention will now be described with reference to the accompanying drawing wherein:

- Figure 1 is a functional view of a calculation system according to an embodiment of the invention;
- Figure 2 is a functional view of a calculation system according to another embodiment of the invention;
- Figure 3 is schematic view showing dependences of calculation modules in respect with parameters values calculated by other calculation modules; and
- Figure 4 is a flow chart showing steps of a calculation method for manufacturing an ophthalmic lens according to an embodiment of the invention.

Elements in the Figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help improve the understanding of the embodiments of the present invention.

Figure 1 shows a calculation system 1 for manufacturing an ophthalmic lens according to an embodiment of the invention.

In the context of the present invention, the term "ophthalmic lens" can refer to a lens blank, an uncut lens, or a semi-finished lens.

The calculation system 1 comprises a set of calculation modules M_1 to M_N, N being an integer higher than or equal to 1. According to the example embodiment represented in Figure 1, N=4.

Each calculation module M_1 to M_4 is associated to a partial calculation in relation with manufacturing process of said ophthalmic lens. In the context of the present invention, the term “partial calculation” refers to a portion of the complete manufacturing process of the ophthalmic lens. When the calculation system 1 comprises a single calculation module M_1 (N=1), the term “each calculation module” refers to the calculation module M_1.

Each calculation module M_i is configured to be activated independently and asynchronously from another calculation module M_j, with i an integer such as $1 \leq i \leq N$, and j an integer such as $1 \leq j \leq N$ and $j \neq i$.

The set of calculation modules M_1 to M_4 may comprise one or several optical calculation module(s), and/or one or several manufacturing calculation module(s). For instance, the calculation system 1 may comprise one optical calculation module M_1 and three manufacturing calculation modules M_2 to M_4.

An optical calculation module M_1 is configured to calculate values of optical parameters related to the ophthalmic lens to be manufactured.

A manufacturing calculation module M_2, M_3, M_4 is configured to calculate values of ophthalmic lens manufacturing process parameters. The manufacturing calculation module M_2, M_3, M_4 may be associated to the manufacturing side. It may be arranged for instance in the ophthalmic lab comprising the manufacturing apparatus.

The set of calculation modules M_1 to M_4 may further comprise one or several other calculation module(s), for instance a control data calculation module, a process validation calculation module, a Job Ticket managing calculation module, a statistical calculation module, a calculation system related data calculation module, and/or any type of calculation module in relation with manufacturing process of the ophthalmic lens.

The calculation system 1 further comprises at least one managing unit MU.

According to the embodiment of the invention represented in Figure 1, the managing unit MU is embedded in a master module MM. In this embodiment, each calculation module M_1 to M_N is a slave calculation module configured to be activated by the master module MM.

According to another embodiment of the invention represented in Figure 2, the calculation system 1 comprises N managing units MU_1 to MU_N, each calculation module M_i comprising one managing units MU_i. In this embodiment,

when the calculation system 1 comprises several calculation modules M_1 to M_4, one of the calculation modules M_1 to M_4 is determined as managing module for an output data calculation. For instance, the calculation module M_1 to M_4 determined as managing module for an output data calculation is the first calculation module M_1 to M_4 receiving, from a remote device 2, input data related to the output data calculation.

In this embodiment, when the managing module receives input data, it determines a list of calculation modules to be activated and an order of activation, or it determines whether a predetermined list has to be updated. If a predetermined list has to be updated, the managing module updates the predetermined list.

Then, the managing module determines whether it has to perform a calculation. If it has to perform a calculation, the managing module performs the said calculation, updates the input data, and determines whether the list has to be updated.

Then, the managing module transmits the input data, or the updated input data, to the next calculation module to be activated according to the current list.

Then, the calculation module receiving the data performs the corresponding calculation, updates the input data, and determines whether the list has to be updated. The data are updated and transmitted in the same way until the last calculation has been performed. Then, the output data are made available to the ophthalmic lens manufacturing system, as disclosed below.

Each managing units MU_1 to MU_N is similar to the managing unit MU of Figure 1.

The managing unit MU comprises receiving means configured to receive input data. The input data are received from a remote device 2, which may be, for instance, a managing entity (LMS) of the ophthalmic lab, or an ophthalmic lens calculator of a remote ophthalmic lens designer.

The input data may comprise calculated data and/or measured data. The input data may be related to the manufacturing process and/or to an ophthalmic lens manufacturing system configured to manufacture the ophthalmic lens.

The manufacturing process related data may comprise optical and/or manufacturing calculation request. The type of calculation requests which can be handled by the calculation system 1 depend on the calculation modules M_1 to M_4 included in the calculation system.

For instance, when the set of calculation modules M_1 to M_4 comprises at least one optical calculation module, the input data may comprise an optical calculation request. When the set of calculation modules M_1 to M_4 comprises at least one manufacturing module, the input data may comprise a manufacturing calculation request. When the set of calculation modules M_1 to M_4 comprises at least one optical calculation module and at least one manufacturing calculation module, the input data may comprise an optical and/or manufacturing calculation request.

The manufacturing calculation request may specify one or several manufacturing step(s) to be performed.

The manufacturing process related data further comprises the data which are useful for performing the optical and/or manufacturing calculation, for instance order request data, optical data, manufacturing process data, and/or measurement data.

The order request data comprise at least prescription data of the wearer of the ophthalmic lens. The prescription data comprise a set of optical characteristics such as spherical power, cylindrical power, cylinder axis, addition power, and prescribed prism, determined by an ophthalmologist in order to correct the vision defects of the wearer. The order request may further comprise other wearer's parameters, such as a head/eye movement coordination parameter and/or an eye rotation center position.

The optical data comprise geometrical data related to the ophthalmic lens to be manufactured. The geometrical data may comprise data related to a front surface of the ophthalmic lens, data related to a back surface of the ophthalmic lens, data related to a relative position of the front and back surfaces, and/or data related to a shape of the ophthalmic lens.

The measurement data comprise data measured during the manufacturing process of the ophthalmic lens.

The ophthalmic lens manufacturing system refers to a combination of a management entity (LMS) and associated manufacturing equipments or apparatus. The ophthalmic lens manufacturing system may also include an ordering system, for instance an ordering system of an eye care practitioner or an ordering system based on an individual internet access.

The ophthalmic lens manufacturing system related data may comprise operation state data related to an equipment of the ophthalmic lens manufacturing system, and/or process change data related to a change in the manufacturing process.

The operation state data may comprise data related to a wear state of an equipment of the ophthalmic lens manufacturing system.

The process change data may comprise data related to a change of process decided by the manufacturer, for instance data related to a change of topcoat to be used.

The managing unit MU further comprises calculation means configured to calculate, from the input data, output data related to the manufacturing process. The output data may be calculated by:

- determining one or several calculation module(s) M_1 to M_N to be activated,
- determining an order of activation of the one or several calculation module(s) M_1 to M_N to be activated, and
- activating the determined one or several calculation module(s) M_1 to M_N, in accordance with the determined order of activation.

The determination of an order of activation aims at calculating the manufacturing process data associated with each equipment in chronological order. This order is important because of the dependences of certain process steps on the previous.

For example, the surfacing, polishing and engraving steps depend on how the lens was blocked (e.g. initial and final thicknesses, orientation of the lens member). This implies that the blocking parameters must be calculated first in order to calculate the remaining steps of the process.

In the same way, the polishing calculation depends on a lens surface state parameter, which may have a value calculated by a surfacing module.

In the same way, the engraving calculation depends on a coloration process parameter, which may have a value calculated by a coloration module.

Figure 3 represents a general illustration of these dependences. We consider here that the calculation module M_1 is configured to calculate values of parameters A, B, C and D, the calculation module M_2 is configured to calculate values of parameters E, F, G and H, the calculation module M_3 is configured to calculate values of parameters I and J, and the calculation module M_4 is configured to calculate values of parameters K and L.

In the represented example, the calculation module M_2 depends on the values of the parameters A, C and D calculated by the calculation module M_1, as symbolized by the arrows F_1, F_2 and F_3. The calculation module M_3 depends on the value of the parameter D calculated by the calculation module M_1, as symbolized by the arrow F_4. The calculation module M_2 depends on the value of the parameter K calculated by the calculation module M_4, as symbolized by the arrow F_5. The calculation module M_3 depends on the value of the parameter E calculated by the calculation module M_2, as symbolized by the arrow F_6. And the calculation module M_4 depends on the value of the parameter J calculated by the calculation module M_3, as symbolized by the arrow F_7.

To manage these multiple dependences, the output data may be calculated through one or several iteration(s). For instance, the order of activation of the one or several calculation module(s) to be activated may be determined through one or several iteration(s) of:

- determining a first calculation module impacted by the input data,
- determining a second calculation module impacted by a parameter value calculated by the first calculation module.

Referring to Figure 3, we are considering that the input data comprise measured data related to the parameter A.

During a first iteration, it is determined that the module M_2 is a first module impacted by the input data. Then, it is determined that the module M_3 is a second module impacted by the value of the parameter E recalculated by the module M_2.

During a second iteration, it is determined that the module M_4 is a third module impacted by the value of the parameter J recalculated by the module M_3.

The number of iterations is not limited. It is thus possible to determine a subset of calculation modules impacted by any type of input data, and to activate these calculation modules, in a suitable order. Consequently, it is possible to improve the precision of the calculation process, without having to perform a complete recalculation for each new input data.

When two calculation modules M_1 to M_4 are impacted during a same iteration, the order of activation may be determined by further using predetermined priority rules related to the calculation modules M_1 to M_4.

According to some embodiments of the invention, a manufacturing calculation module M_1 to M_4 is configured to return, in response to its activation, a list of parameters values, and/or indication that the calculation is impossible to perform for the said one or several manufacturing step(s). This feature aims at being alerted as soon as possible when a calculation is impossible to perform.

The managing unit MU further comprises transmitting means configured to transmit, to the ophthalmic lens manufacturing system, an indication that the output data have been calculated, and to make the output data available to the ophthalmic lens manufacturing system.

The output data may be made available by transmitting the output data to the ophthalmic lens manufacturing system, directly or via another device.

Alternatively, the output data may be made available by storing the output data in a calculation module M_1 to M_4, or in the master module MM, or in another device. In this alternative, an indication that the output data are available may be sent to the ophthalmic lens manufacturing system.

The output data may further specify one or several manufacturing step(s) to be performed.

Figure 4 represents steps of a calculation method for manufacturing an ophthalmic lens, according to an embodiment of the invention. The method may be implemented by the calculation system 1 disclosed above. The method comprises:

- a first receiving step S1,

- a calculating step S2,

- a first transmitting step S3,

- a second receiving step S4,

- a recalculating step S5, and

- a second transmitting step S6.

During the receiving step S1, input data are received at a managing unit MU.

When the calculation system 1 comprises a master module MM, the managing unit MU is embedded in the master module MM.

When each calculation modules M_1 to M_4 comprise a managing unit MU, the calculation module M_i associated to the managing unit MU that first receives the input data is determined as being the managing module for the steps S2 and S3.

During the calculating step S2, the output data related to the manufacturing process are calculated from the input data.

As explained above, the calculating step S2 may comprise one or several iteration(s) of:

- determining one or several calculation module(s) to be activated,
- determining an order of activation of the one or several calculation module(s) to be activated, and
- activating the determined one or several calculation module(s), in accordance with the determined order of activation.

During the transmitting step S3, the output data are made available to the ophthalmic lens manufacturing system, and an indication that the output data have been calculated is transmitted to the ophthalmic lens manufacturing system.

During the second receiving step S4, updated input data are received at a managing unit MU. The updated input data are, for instance, data measured during the manufacturing of the ophthalmic lens. The updated input data may for instance comprise blocking position error data measured after the blocking step of the lens, measured prism deviation, or measured blocking material thickness error.

When each calculation modules M_1 to M_4 comprise a managing unit MU, the calculation module M_j associated to the managing unit MU that first receives the input data in step S4 may be different than the calculation module M_i determined as being the managing module in step S1.

During the second calculation step S5, the output data dependent of the measured data are recalculated from the actual measured data. For instance, the blocking data dependent of the blocking position, such as the blocking material quantity, may thus be recalculated from the actual position data. The second calculation step S5 is similar to the calculation step S3, but is performed based on updated input data.

During the transmitting step S6, the updated output data are made available to the ophthalmic lens manufacturing system, and an indication that the output data have been calculated is transmitted to the ophthalmic lens manufacturing system.

Many further modifications and variations will suggest themselves to those skilled in the art upon making reference to the foregoing illustrative embodiments, which are given by way of example only and which are not intended to limit the scope of the invention, that being determined solely by the appended claims.

In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. The mere fact that different features are recited in mutually different dependent claims does not indicate that a combination of these features cannot be advantageously used. Any reference signs in the claims should not be construed as limiting the scope of the invention.

CLAIMS

1. Calculation system (1) for manufacturing an ophthalmic lens, comprising :
   - a set of calculation modules 1 to N, N being an integer higher than or equal to 1, each calculation module (M_1, M_2, M_3, M_4) being associated to a partial calculation in relation with manufacturing process of said ophthalmic lens, each calculation module being configured to be activated independently and asynchronously from another calculation module,
   - a managing unit (MU) configured to:
     - receive input data, the input data being related to the manufacturing process and/or to an ophthalmic lens manufacturing system configured to manufacture the ophthalmic lens,
     - calculate output data related to the manufacturing process from the input data, through one or several iteration(s) of:
       - determining one or several calculation module(s) to be activated,
       - determining an order of activation of the one or several calculation module(s) to be activated,
       - activating the determined one or several calculation module(s), in accordance with the determined order of activation, and
     - transmit, to the ophthalmic lens manufacturing system, an indication that the output data have been calculated, and make the output data available to the ophthalmic lens manufacturing system.

2. Calculation system according to claim 1, wherein the managing unit (MU) is embedded in a master module (MM), each calculation module (M_1, M_2, M_3, M_4) being a slave calculation module configured to be activated by the master module.

3. Calculation system according to claim 1, comprising N managing units (MU_1, MU_2, MU_3, MU_4), each calculation module (M_1, M_2, M_3, M_4) comprising one of the said N managing units, one calculation module being determined as managing module for an output data calculation, depending on the received input data.

4. Calculation system according to one of claims 1 to 3, wherein the set of calculation modules (M_1, M_2, M_3, M_4) comprises at least one optical calculation module, configured to calculate values of optical parameters related to the ophthalmic lens to be manufactured, the optical parameters comprising geometrical parameters related to the ophthalmic lens.

5. Calculation system according to claim 4, wherein the input data comprise a request to calculate values of the optical parameters, the input data further comprising prescription data for the wearer of the ophthalmic lens.

6. Calculation system according to one of claims 1 to 5, wherein the set of calculation modules (M_1, M_2, M_3, M_4) comprises at least one manufacturing calculation module, configured to calculate values of ophthalmic lens manufacturing process parameters.

7. Calculation system according to claim 6, wherein the request to calculate values of the manufacturing process parameters specifies one or several manufacturing step(s) to be performed.

8. Calculation system according to one of claims 6 to 7, wherein the manufacturing calculation module (M_1, M_2, M_3, M_4) is configured to return, in response to its activation, a list of parameters values, and/or indication that the calculation is impossible to perform for the said one or several manufacturing step(s).

9. Calculation system according to claim 4 and 6, wherein the input data comprise a request to calculate values of the optical parameters and values of

the manufacturing process parameters, the input data further comprising prescription data for the wearer of the ophthalmic lens.

10. Calculation system according to one of claims 1 to 9, wherein the input data comprise measurement data measured during the manufacturing process of the ophthalmic lens.

11. Calculation system according to one of claims 1 to 9, wherein the input data comprise operation state data related to an equipment of the ophthalmic lens manufacturing system.

12. Calculation system according to one of claims 1 to 9, wherein the input data comprise process change data related to a change in the manufacturing process.

13. Calculation system according to one of claims 1 to 12, wherein the managing unit (MU) is configured to determine an order of activation of the one or several calculation module(s) (M_1, M_2, M_3, M_4) to be activated, through one or several iteration(s) of:
- determining a first calculation module impacted by the input data,
- determining a second calculation module impacted by a parameter value calculated by the first calculation module.

14. Calculation system according to one of claims 1 to 13, wherein the managing unit (MU) is configured to use predetermined priority rules related to the calculation modules (M_1, M_2, M_3, M_4) to determine the order of activation of the one or several calculation module(s) to be activated.

15. Calculation method for manufacturing an ophthalmic lens, in a calculation system (1) comprising a set of calculation modules 1 to N, N being an integer higher than or equal to 1, each calculation module (M_1, M_2, M_3, M_4) being associated to a partial calculation in relation with manufacturing process of said ophthalmic lens, each calculation module being configured to

be activated independently and asynchronously from another calculation module, the method comprising, at a managing unit:

- a receiving step during which input data are received, the input data being related to the manufacturing process and/or to an ophthalmic lens manufacturing system configured to manufacture the ophthalmic lens,
- a calculating step during which output data related to the manufacturing process are calculated from the input data, through one or several iteration(s) of:
    - determining one or several calculation module(s) to be activated,
    - determining an order of activation of the one or several calculation module(s) to be activated,
    - activating the determined one or several calculation module(s), in accordance with the determined order of activation, and
- a transmitting step during which an indication that the output data have been calculated is transmitted to the ophthalmic lens manufacturing system, the output data being available to the ophthalmic lens manufacturing system.

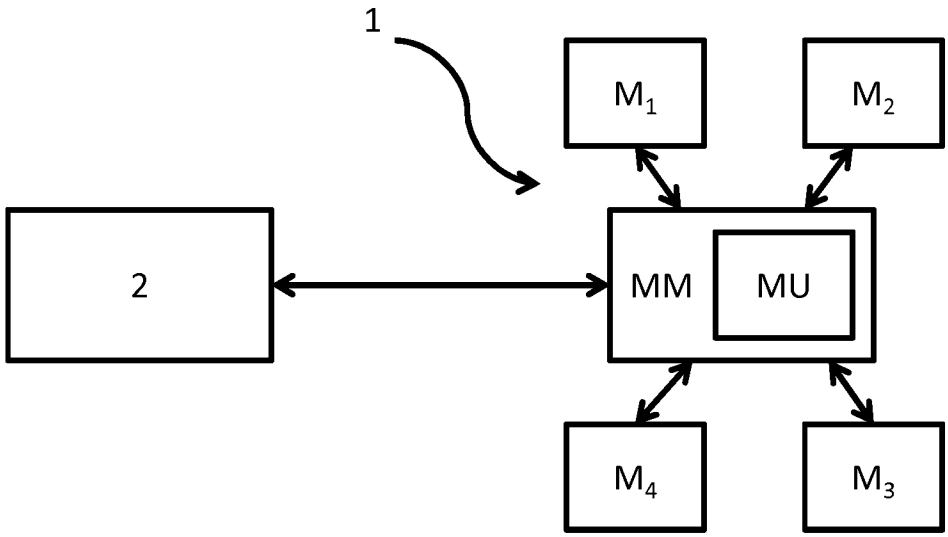


Fig. 1

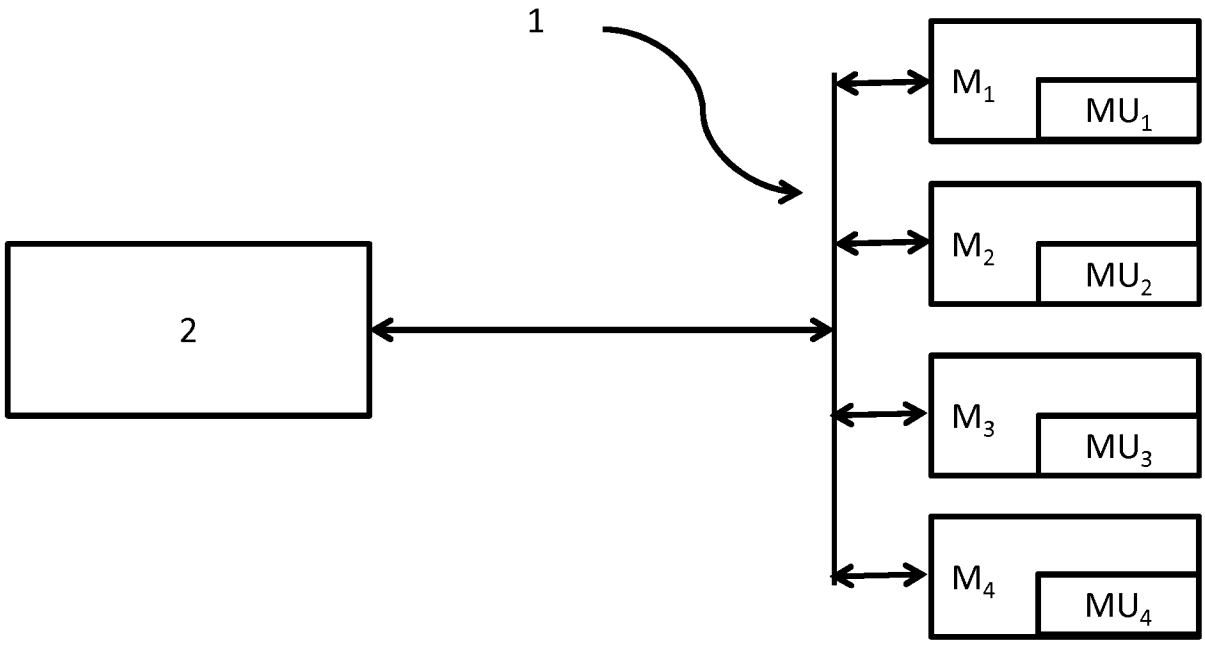


Fig. 2

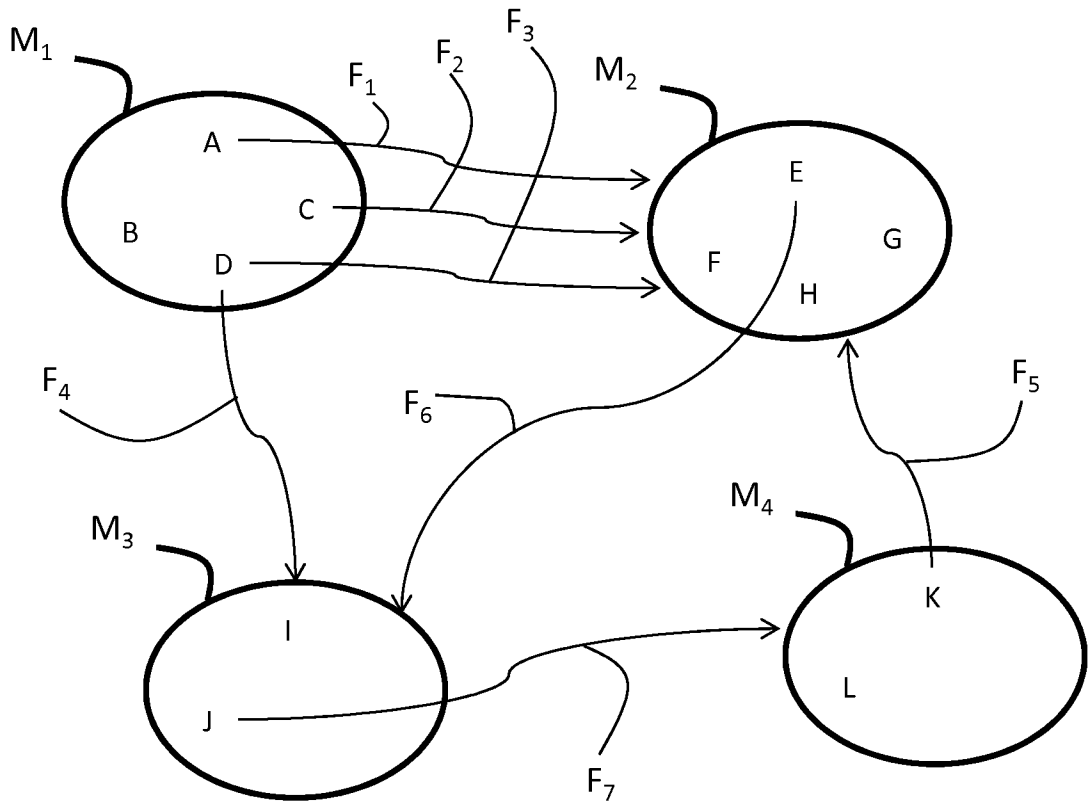


Fig. 3

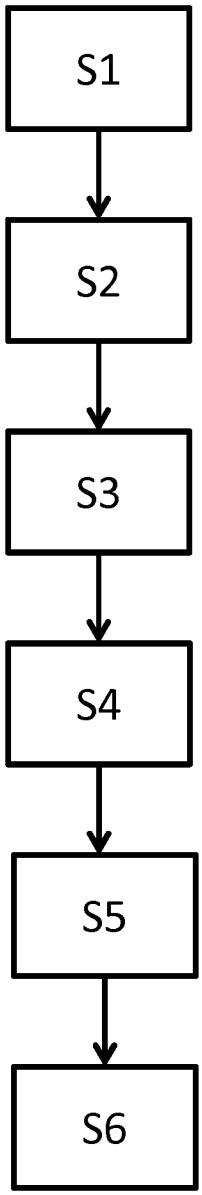


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/057779

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05B19/418 B29D11/00 G02C7/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G05B G02C B29D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2001/050752 A1 (SHIRAYANAGI MORIYASU [JP]) 13 December 2001 (2001-12-13) paragraph [0031] - paragraph [0032] paragraph [0067] - paragraph [0080] claims 11-12 figure 2	1-9, 13-15 10-12
Y A	EP 2 199 021 A1 (ESSILOR INT [FR]) 23 June 2010 (2010-06-23) paragraph [0006] - paragraph [0018] paragraph [0045] - paragraph [0059] claim 1	10-12 1-9, 13-15

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 May 2014	26/05/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Orobitg Oriola, R

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/057779

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2009/068613 A1 (ESSILOR INT [FR]; LAVRADOR ISABELLE [FR]; LIPPENS XAVIER [FR]; CHANSAV) 4 June 2009 (2009-06-04) page 4, line 5 - page 7, line 2 page 8, lines 14-20 page 9, line 5 - page 13, line 22 claims 1,8	10-12
A	EP 1 267 238 A1 (GRAVINDUS [FR]) 18 December 2002 (2002-12-18) paragraph [0021] - paragraph [0037] paragraph [0046] - paragraph [0049] figures 1,2	1-3,6-8, 11-15
A	US 2002/072875 A1 (BARNEY DENNIS A [US] ET AL) 13 June 2002 (2002-06-13) paragraph [0023] - paragraph [0028]	2,3,14
A	US 2011/029140 A1 (JORDAN CARSTEN [DE] ET AL) 3 February 2011 (2011-02-03) paragraph [0004] - paragraph [0007] paragraph [0017] paragraph [0020] - paragraph [0026] claims 5,12,15	1,2,13, 15
A	TAGAWA K ET AL: "Iterative task division method or multiprocessor scheduling problem", INDUSTRIAL ELECTRONICS, CONTROL AND INSTRUMENTATION,, vol. 3, 5 September 1994 (1994-09-05), pages 1773-1778, XP010137651, DOI: 10.1109/IECON.1994.398083 ISBN: 978-0-7803-1328-6 the whole document	1,13,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/057779

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2001050752 A1	13-12-2001	DE 10122707 A1	15-11-2001
		FR 2810121 A1	14-12-2001
		GB 2364508 A	30-01-2002
		JP 3869624 B2	17-01-2007
		JP 2001318349 A	16-11-2001
		US 2001050752 A1	13-12-2001
EP 2199021 A1	23-06-2010	AU 2009331537 A1	07-07-2011
		CA 2746962 A1	01-07-2010
		CN 102307704 A	04-01-2012
		EP 2199021 A1	23-06-2010
		EP 2367657 A1	28-09-2011
		KR 20110110173 A	06-10-2011
		US 2011257930 A1	20-10-2011
		WO 2010072749 A1	01-07-2010
WO 2009068613 A1	04-06-2009	AT 502728 T	15-04-2011
		CN 101918178 A	15-12-2010
		EP 2214868 A1	11-08-2010
		ES 2363746 T3	12-08-2011
		US 2013084778 A1	04-04-2013
		WO 2009068613 A1	04-06-2009
EP 1267238 A1	18-12-2002	EP 1267238 A1	18-12-2002
		FR 2826146 A1	20-12-2002
US 2002072875 A1	13-06-2002	NONE	
US 2011029140 A1	03-02-2011	DE 102007043795 A1	02-04-2009
		EP 2188681 A1	26-05-2010
		US 2011029140 A1	03-02-2011
		WO 2009037198 A1	26-03-2009