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**Datasheet for the decision
of 12 November 2021**

Case Number: T 1667/19 - 3.2.02

Application Number: 10196673.7

Publication Number: 2332484

IPC: A61B34/30, A61B34/00,
A61B34/37, B25J3/00

Language of the proceedings: EN

Title of invention:

Software Center and Highly Configurable Robotic Systems for
Surgery and other uses

Patent Proprietor:

Intuitive Surgical Operations, Inc.

Opponent:

Lavialle, Bruno François Stéphane

Headword:

Relevant legal provisions:

EPC Art. 56, 76(1), 84

RPBA Art. 12(4)

RPBA 2020 Art. 13(2)

Keyword:

Late-filed request - admitted (no) (yes)

Inventive step (no) (yes)

Divisional application - subject-matter extends beyond content
of earlier application (yes)

Claims - clarity (no)

Decisions cited:

Catchword:



Beschwerdekammern

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Chambres de recours

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Case Number: T 1667/19 - 3.2.02

D E C I S I O N
of Technical Board of Appeal 3.2.02
of 12 November 2021

Appellant: Intuitive Surgical Operations, Inc.
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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
28 March 2019 concerning the maintenance of
European Patent No. 2332484 in amended form**

Composition of the Board:

Chairman M. Alvazzi Delfrate
Members: D. Ceccarelli
N. Obrovski

Summary of Facts and Submissions

- I. The patent proprietor and the opponent have appealed against the Opposition Division's decision, posted on 28 March 2019, that, account being taken of the amendments according to the second auxiliary request made by the patent proprietor during the opposition proceedings, European patent No. 2 332 484 and the invention to which it related met the requirements of the EPC.
- II. The Board summoned the parties to oral proceedings and sent a preliminary opinion in a communication dated 11 February 2020. In this communication, the Board raised, on their own motion, an objection of lack of clarity directed to claim 1 of the then pending ninth auxiliary request.
- III. Oral proceedings took place on 12 November 2021.

The appellant/patent proprietor ("the proprietor") requested that the decision under appeal be set aside and the patent be maintained on the basis of the main request or one of the first to tenth auxiliary requests or one of auxiliary requests 1a, 1b, 2a, 2b, 3a, 4a, 5a, 6a, 7a, 8a, 9a and 10a, of which the main request and the first to third auxiliary requests were filed with the submission dated 7 August 2019, the fourth to tenth auxiliary requests were filed with the submission dated 18 December 2019, and auxiliary requests 1a, 1b, 2a, 2b, 3a, 4a, 5a, 6a, 7a, 8a, 9a and 10a were filed with the submission dated 23 March 2020.

The appellant/opponent ("the opponent") requested that the decision under appeal be set aside and that the

patent be revoked.

IV. The following documents are relevant for this decision:

D1: WO-A-99/50721

D3: US-A-5,855,583

D4: US-A-2003/0109780

D6: "Constrained Cartesian Motion Control for Teleoperated Surgical Robots", J Funda et al., IEEE Transactions on Robotics and Automation, vol. 12, no. 3, June 1996

D7: "Obstacle Avoidance for Kinematically Redundant Manipulators in Dynamically Varying Environments", AA Maciejewski and CA Klein, The International Journal of Robotics Research, vol. 4, no. 3, Fall 1985

V. Claim 1 of the **main request** reads as follows:

"A surgical robotic system comprising:

a manipulator assembly (304) configured to robotically move a surgical end effector (50), the manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the manipulator assembly (304) to a primary

solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (304) so as to provide a desired combination of the joint states during the desired end effector (50) movement."

Claim 1 of the **first auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a manipulator assembly (304) configured to robotically move a surgical end effector (50), the manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the manipulator assembly (304) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (304) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the processor is configured to gradually abandon a secondary control task as a primary control

task corresponding to the primary solution gets harder and employs more degrees of freedom of the manipulator assembly."

Claim 1 of the **second auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a manipulator assembly (304) configured to robotically move a surgical end effector (50), the manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the manipulator assembly (304) to a primary solution to effect the desired movement of the end effector (50), the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (304) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the processor is configured to gradually abandon a secondary control task as a primary control task corresponding to the primary solution gets harder

and employs more degrees of freedom of the manipulator assembly."

Claim 1 of the **third auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a manipulator assembly (304) configured to robotically move a surgical end effector (50), the manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the manipulator assembly (304) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (304) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the primary solution corresponds to the desired end effector (50) movement and the configuration-dependent filter is configured for a secondary control task of urging the manipulator assembly (304) toward a desired pose indicated by an input signal to the configuration-dependent filter that

is different from the command to effect said desired movement of the end effector received by said input."

Claim 1 of the **fourth auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a manipulator assembly (304) configured to robotically move a surgical end effector (50), the manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the manipulator assembly (304) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (304) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the primary solution corresponds to the desired end effector (50) movement;

wherein the configuration-dependent filter is configured for a secondary control task of driving the manipulator assembly (304) toward a desired pose; and

wherein the configuration dependent filter is configured to receive an input signal that is used to drive the manipulator assembly (304) towards the desired pose, the input signal representing the secondary control task and being different from the command to effect said desired movement of the end effector received by said input."

Claim 1 of the **fifth auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a manipulator assembly (304) configured to robotically move a surgical end effector (50), the manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the manipulator assembly (304) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (304) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the primary solution corresponds to the desired end effector (50) movement and the configuration-dependent filter is configured for a secondary control task of urging the manipulator assembly (304) toward a collision-inhibiting pose indicated by an input signal to the configuration-dependent filter that is different from the command to effect said desired movement of the end effector received by said input."

Claim 1 of the **sixth auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a manipulator assembly (304) configured to robotically move a surgical end effector (50), the manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the manipulator assembly (304) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (304) so as to provide a

desired combination of the joint states during the desired end effector (50) movement;

wherein the primary solution corresponds to the desired end effector (50) movement;

wherein the configuration-dependent filter is configured for a secondary control task of driving the manipulator assembly (304) toward a collision-inhibiting pose; and

wherein the configuration dependent filter is configured to receive an input signal that is used to drive the manipulator assembly (304) toward the collision-inhibiting pose, the input signal representing the secondary control task and being different from the command to effect said desired movement of the end effector received by said input."

Claim 1 of the **seventh auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a first manipulator assembly (304a) configured to robotically move a surgical end effector (50), the first manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

a second manipulator assembly (304b) provided adjacent the first manipulator assembly;

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the first manipulator assembly (304a), the processor (210) comprising a primary joint controller configured to drive the first manipulator assembly (304a) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the first manipulator assembly (304a) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the primary solution corresponds to the desired end effector (50) movement and the configuration-dependent filter is configured for a secondary control task of urging the first manipulator assembly (304a) toward a collision-inhibiting pose indicated by an input signal to the configuration-dependent filter that is different from a command to effect a desired movement of the end effector received by said input, for inhibiting collisions of the first manipulator assembly (304a) with the second manipulator assembly (304b)."

Claim 1 of the **eighth auxiliary request** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a first manipulator assembly (304a) configured to robotically move a surgical end effector (50), the first manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator~~

~~assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

a second manipulator assembly (304b) provided adjacent the first manipulator assembly;

an input configured to receive a command to effect a desired movement of the end effector (50) within the surgical workspace; and

a processor (210) coupling the input to the first manipulator assembly (304a), the processor (210) comprising a primary joint controller configured to drive the first manipulator assembly (304a) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the first manipulator assembly (304a) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the primary solution corresponds to the desired end effector (50) movement;

wherein the configuration-dependent filter is configured for a secondary control task of driving the manipulator assembly (304) toward a collision-inhibiting pose for inhibiting collisions of the first manipulator assembly (304a) with the second manipulator assembly (304b); and

wherein the configuration dependent filter is configured to receive an input signal that is used to drive the manipulator assembly (304) toward the collision-inhibiting pose, the input signal representing the secondary control task and being different from the command to effect said desired movement of the end effector received by said input."

Claim 1 of the **ninth auxiliary request** reads as follows (amendments to the main request highlighted by the

Board):

"A surgical robotic system comprising:

a first manipulator assembly (304) configured to robotically move a first surgical end effector (50), the first manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace ~~when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;~~

a second manipulator assembly (304b) provided adjacent the first manipulator assembly and configured to robotically move a second surgical end effector (50), the second manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace;

~~a~~ first input configured to receive a first command to effect a desired movement of the first end effector (50) within the surgical workspace;~~and~~

a processor (210) coupling the first input to the first manipulator assembly (304), and the second input to the second manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the first manipulator assembly (304) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the first manipulator assembly (304) so as to provide a desired combination of the joint states during the desired end effector (50) movement;

wherein the primary solution corresponds to the desired first end effector (50) movement and the configuration-dependent filter is configured for a secondary control task of urging the first manipulator assembly (304) toward a collision-inhibiting pose indicted by an input signal to the configuration-dependent filter that is different from a command to effect a desired movement of the first or second end effectors received by said first or second inputs, for inhibiting collisions of the first manipulator assembly (304) with the second manipulator assembly; and

wherein the processor (210) is configured to determine a priority between the desired end effector (50) movement and the secondary control task during the end effector (50) movement, the priority varying in response to changes in a configuration of the manipulator assembly (304)."

Claim 1 of **auxiliary request 1a** is the same as claim 1 of the first auxiliary request.

Claim 1 of **auxiliary request 1b** is the same as claim 1 of the first auxiliary request except that after "secondary control task" the following wording has been added:

"that is desirable but not necessarily required".

Claim 1 of **auxiliary request 2a** is the same as claim 1 of the second auxiliary request.

Claim 1 of **auxiliary request 2b** is the same as claim 1 of the second auxiliary request except that after "secondary control task" the following wording has been added:

"that is desirable but not necessarily required".

Claim 1 of **auxiliary requests 3a to 8a** is the same as claim 1 of the third to the eighth auxiliary requests respectively, except that after the first occurrence of "surgical workspace" the following wording has been added:

"when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace".

Claim 1 of **auxiliary request 9a** reads as follows (amendments to the main request highlighted by the Board):

"A surgical robotic system comprising:

a first manipulator assembly (304) configured to robotically move a first surgical end effector (50), the first manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace when a shaft of the manipulator assembly (304) extends through a minimally invasive aperture to the surgical workspace;

a second manipulator assembly (304) provided adjacent the first manipulator assembly and configured to robotically move a second surgical end effector (50), the second manipulator assembly (304) having a plurality of joints, the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace;

a first input configured to receive a first command to effect a desired movement of the first end effector (50) within the surgical workspace;

a second input configured to receive a second command to effect a desired movement of the second end effector (50) within the surgical workspace; and

a processor (210) coupling the first input to the first manipulator assembly (304) and the second input to the second manipulator assembly (304), the processor (210) comprising a primary joint controller configured to drive the first manipulator assembly (304) to a primary solution, the primary solution being underconstrained, the processor (210) further comprising a configuration-dependent filter configured to restrict the actuation of the first manipulator assembly (304) so as to provide a desired combination of the joint states of the first manipulator assembly during the desired first end effector (50) movement;

wherein the primary solution corresponds to the desired first end effector (50) movement and the configuration-dependent filter is configured for a secondary control task of urging the first manipulator assembly (304) toward a collision-inhibiting pose indicted [sic] by an input signal to the configuration-dependent filter that is different from a command to effect a desired movement of the first or second end effectors received by said first or second inputs, for inhibiting collisions of the first manipulator assembly (304) with the second manipulator assembly; and

wherein the processor (210) is configured to determine a priority between the desired first end effector (50) movement and the secondary control task during the first end effector (50) movement, the priority varying in response to changes in a

configuration of the first manipulator assembly (304)."

VI. The proprietor's arguments, where relevant to the present decision, can be summarised as follows:

Admittance of claim requests

The main request and the first to tenth auxiliary requests had been filed with the statement of grounds or with the reply to the opponent's statement of grounds. They addressed objections raised by the Opposition Division in the impugned decision and by the opponent on appeal. They should be admitted into the appeal proceedings.

Auxiliary requests 1a, 1b, 2a and 2b addressed an objection of added subject-matter regarding a non-allowable intermediate generalisation in claim 1 of each of the first and second auxiliary requests, raised for the first time by the Board in the preliminary opinion. These requests had been filed promptly in response to the preliminary opinion and should be admitted.

Auxiliary requests 3a to 8a addressed an objection on the part of the Board concerning the disclosure of collision avoidance in D6, raised for the first time in the preliminary opinion. These requests had been filed promptly in response to the preliminary opinion and should be admitted.

Auxiliary requests 9a and 10a addressed a clarity objection raised by the Board on their own motion in the preliminary opinion. These requests comprised a minor, almost self-evident clarification, and should be admitted.

Main request - inventive step

D6 disclosed a surgical robot with a manipulator assembly comprising a plurality of joints. However, it did not disclose that the joints were configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector position within a surgical workspace when a shaft of the manipulator assembly extended through a minimally invasive aperture to the surgical workspace. The surgical robot disclosed in D6 was not underconstrained when in the clinical setting. Moreover D6 did not disclose a processor with a primary joint controller configured to drive the manipulator assembly to a primary solution that was underconstrained and a configuration-dependent filter that restricted the actuation of the manipulator assembly so as to provide a desired combination of the joint states during the desired end effector movement. D6 disclosed a controller that achieved a primary task subject to some constraints. However, the controller was programmed to first meet the constraints and then, if it was possible to perform the primary task, to carry out this task too. Hence, the constraints were not configuration-dependent. This was contrary to the invention as claimed.

D1, rather than D6, should be considered the closest prior art.

Starting from D6, which disclosed a surgical robot, the person skilled in the art would not have considered D7, which was concerned with general-purpose industrial robots and obstacle avoidance in a technical environment which was very different from that of the claimed invention. The collision-avoidance techniques

disclosed in D7 had only been applied in simulations and would not be compatible with minimally invasive surgery. Moreover, D6 disclosed control techniques applied to the surgical robot which worked very well and represented an improvement over the control technique disclosed in D7, since this technique was criticised in the introduction of D6 in relation to the discussion of equation 1. On the basis of this disclosure of D6, the person skilled in the art would have had no reason to look back at D7.

The person skilled in the art would have had no reason to increase the number of degrees of freedom of the robot disclosed in D6. Each additional degree of freedom increased the complexity and the cost of the robot.

It followed that the subject-matter of claim 1 of the main request was inventive over the combination of D6 with D7.

*First and second auxiliary requests -
added subject-matter*

The feature of the processor being "configured to gradually abandon a secondary control task as a primary control task corresponding to the primary solution gets harder and employs more degrees of freedom of the manipulator assembly" in claim 1 of the first and the second auxiliary requests was based on paragraphs [0092] to [0128] of the application as filed.

No intermediate generalisation had been introduced, as the claim wording, read with a mind willing to understand, meant that only desirable but not necessarily required secondary control tasks could be

gradually abandoned. The claim did not imply that all secondary control tasks could be abandoned. The task of constraining motion of an intermediate portion of the manipulator assembly so as to inhibit injury to tissue adjacent to an access site, which was defined as a secondary task in claim 6 of the first and second auxiliary requests, was not a task which could be abandoned, since it was an essential task.

Third to eighth auxiliary requests - inventive step

None of the cited prior art disclosed a secondary control task of urging a manipulator assembly toward a desired pose or a collision-inhibiting pose.

Avoiding obstacles, as carried out in the cited prior art, determined and worked out dynamically a specific pose into which a robot arm was put by using sensors which detected proximity to nearby objects. This was not what claim 1 of the third to eighth auxiliary request meant by the definition that the configuration-dependent filter was configured for a secondary control task of urging the manipulator assembly toward a desired or collision-inhibiting pose. This pose was not calculated on the basis of a distance obtained by sensor outputs, but was predefined, as the term "desired" implied. The person skilled in the art would understand that the claim required the controller to try to aim for the desired or collision-inhibiting pose, but that this pose might not necessarily be reached, because of the primary task which had to be carried out.

Moreover, claim 1 of the seventh and eighth auxiliary requests additionally defined a second manipulator assembly. Adding a second manipulator assembly to the

robot disclosed in D6 was a complex and costly task, which the person skilled in the art would not have considered.

Ninth auxiliary request - clarity

Claim 1 of the ninth auxiliary request was clear when read in the context of the original claims. The last feature of the claim implicitly referred to the first end effector and the first manipulator assembly.

Auxiliary request 9a - inventive step

There was no disclosure in the cited prior art of a processor configured to determine a priority between the desired first end effector movement and the secondary control task during the first end effector movement, the priority varying in response to changes in a configuration of the first manipulator assembly.

D6 disclosed many secondary tasks which were provided with a weight representing a relative priority. However, there was no disclosure of any change of the priority in response to changes in a configuration of the manipulator assembly of D6.

D7 disclosed an algorithm which ultimately considered collision avoidance to be the highest-priority task.

VII. The opponent's arguments, where relevant to the present decision, can be summarised as follows:

Admittance of claim requests

The main request and the first to tenth auxiliary requests had not been filed at the earliest possible

date, i.e. in the first-instance proceedings. The proprietor had not offered an excuse for their belated submission. They addressed problems already raised by the Opposition Division during the first-instance proceedings, and hence they had not been rendered necessary by the reasons of the impugned decision. These requests should not be admitted.

Auxiliary requests 1a, 1b, 2a and 2b addressed an objection of added subject-matter regarding a non-allowable intermediate generalisation in claim 1 of each of the first and second auxiliary requests which had been raised by the opponent in his statement of grounds of appeal. There were no exceptional circumstances justifying their filing after the summons to oral proceedings. Auxiliary requests 1a, 1b, 2a and 2b should not be admitted.

In claim 1 of auxiliary requests 3a to 10a, the feature of the shaft of the manipulator assembly extending through a minimally invasive aperture to the surgical workspace had been added. This amendment did not overcome the objection as to lack of inventive step of the subject-matter of claim 1 of the third to tenth auxiliary requests raised in the opponent's statement of grounds of appeal and the reply to the proprietor's statement of grounds. There were no exceptional circumstances justifying the filing of auxiliary requests 3a to 10a after the summons to oral proceedings. These requests should not be admitted.

Main request - inventive step

D6 disclosed a surgical robot comprising all the features defined in claim 1 of the main request. Even if it was considered that D6 did not disclose a

manipulator assembly with joints providing sufficient degrees of freedom to allow a range of joint states for an end effector position within a surgical workspace when a shaft of the manipulator assembly extends through a minimally invasive aperture to the surgical workspace, the implementation of this feature would have been obvious in view of D7.

The person skilled in the art, wishing to improve the robot of D6 by including a secondary control task of collision avoidance, would have considered D7, which taught a manipulator with redundant degrees of freedom also when it extended into a cavity through an opening (Figures 5 and 6). It was not decisive that D7 concerned general-purpose manipulators, since the control technique of a redundant manipulator was not a specific problem of the surgical field but was rather a more general problem of mathematics and engineering. Whether the control techniques disclosed in D6 represented an improvement over those disclosed in D7, and whether D7 was concerned with simulations, was irrelevant. From D7 the person skilled in the art would have simply taken the teaching to provide a secondary control task of collision avoidance in the robot system of D6.

*First and second auxiliary requests -
added subject-matter*

The feature of the processor being "configured to gradually abandon a secondary control task as a primary control task corresponding to the primary solution gets harder and employs more degrees of freedom of the manipulator assembly" in claim 1 of the first and the second auxiliary requests had been segregated from the context of paragraph [0127] of the application as

filed. Combining this feature with the features of clause 61 of the application as filed resulted in added subject-matter.

Third to eighth auxiliary requests - inventive step

D6 generally disclosed a controller configured to drive a manipulator assembly to a primary solution, the primary solution being underconstrained, the processor further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (combination of equations 18 and 19 of D6). The filters employed in equations 18 and 19 of D6 influenced the joint configuration of the manipulator disclosed in D6. These filters were applied also to avoid collisions ("obstacle avoidance" on page 454, left column, first paragraph of D6). It followed that these filters urged the manipulator to a desired or collision-inhibiting pose. Whether this pose was calculated on the basis of a distance obtained by sensor outputs was not decisive, since claim 1 of the third to eighth auxiliary requests was general in this respect. The configuration of the controller did not depend on the nature of the filter, which could be derived from a sensor signal.

The addition of a second manipulator in claim 1 of the seventh and the eighth auxiliary requests was an arbitrary definition of an object with which a collision was to be avoided. Since robots with multiple medical manipulators were known, for example from D3 and D4, the subject-matter of claim 1 of the seventh and the eighth auxiliary requests would have still been obvious.

Ninth auxiliary request - clarity

Claim 1 of the ninth auxiliary request was unclear for the reasons given by the Board in the preliminary opinion.

Auxiliary request 9a - inventive step

Both D6 and D7 disclosed a processor configured to determine a priority between a desired end effector movement and a secondary control task during the end effector movement, the priority varying in response to changes in a configuration of the manipulator assembly. Hence, this feature could not bring about an inventive step over the combination of D6 with D7.

D6 disclosed an assignment of optimisation weights to the primary solution and to the secondary control task (page 457, right column, fourth paragraph and equation 21). These weights, which were the product of a relative importance factor and a scaling factor, could be adjusted dynamically (page 458, left column, third paragraph) during execution of a task. This amounted to a disclosure of the variation of priority as defined in the claim.

D7 disclosed the same feature via equation 15 on page 113, which included a term representing a primary task of moving an end effector and a term representing a secondary task of avoiding obstacles. The term representing the secondary task was expressed by a product of a gain factor and other factors. The gain factor varied in response to a distance from the object to be avoided and gradually dropped to zero with increasing distance. This amounted to a disclosure of gradually lowering the priority of the secondary task

during the end effector movement if the distance from the object increased.

Reasons for the Decision

1. The invention

The invention relates to a surgical robotic system.

The claimed system comprises a manipulator assembly configured to robotically move a surgical end effector, and an input configured to receive a command to effect a desired movement.

Typically, such a system, an example of which is shown in Figures 1B and 1C of the patent reproduced below, comprises a plurality of manipulator assemblies in the form of robotic arms (304), each for supporting a surgical instrument inside an operation room. The robotic arms are controlled remotely by a surgeon.

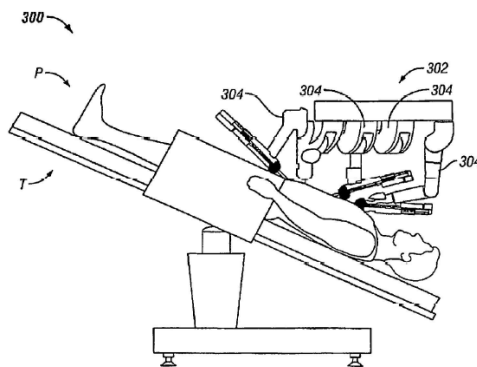


FIG. 1B

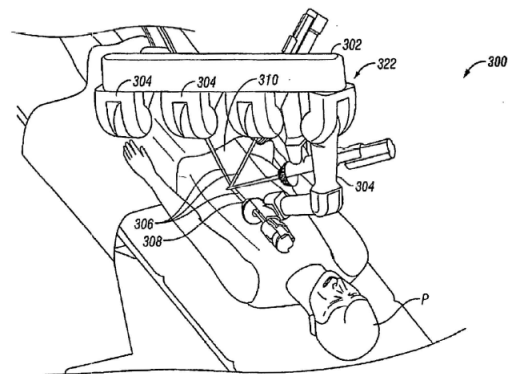


FIG. 1C

The manipulator assembly comprises a plurality of joints being configured to provide sufficient degrees

of freedom to allow a range of joint states for an end effector (50) position within a surgical workspace. A schematic representation of the joints can be seen in Figure 6 of the patent, reproduced below.

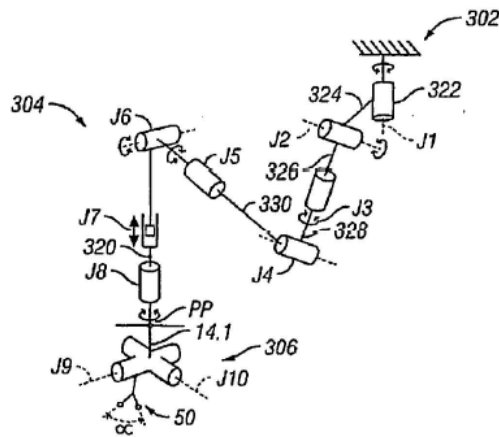


FIG. 6

The system further comprises a processor coupling the input to the manipulator assembly. The processor has a primary joint controller configured to drive the manipulator assembly to a primary solution for obtaining a certain movement of the end effector, and a configuration-dependent filter configured to restrict the actuation of the manipulator assembly so as to provide a desired combination of the joint states.

The controller and the filter may be used to avoid collisions and injury to the patient at the minimally invasive aperture, by restricting the range of possible joint positions and movements to achieve a desired movement of the end effector.

This results in a practical and safe robotic system.

2. The patent in suit is derived from a divisional application of European patent application No. 06 752 435.5 ("the parent application"). The

divisional application as filed comprises the description, the drawings and the claims (in the form of numbered clauses at the end of the description) of the parent application as filed. It follows that objections of added subject-matter can be examined only by referring to the parent application as filed. If the requirements of Article 76(1) EPC are fulfilled, then the requirements of Article 123(2) EPC will be fulfilled too.

3. *Admittance of claim requests*

The opponent objected to the admittance of the proprietor's claim requests.

- 3.1 The main request and the first to tenth auxiliary requests were filed by the proprietor with its statement of grounds of appeal or with its reply to the opponent's statement of grounds of appeal.

Under Article 12(4) RPBA 2007, which applies by virtue of Article 25(2) RPBA 2020, everything presented by a party with the statement of grounds of appeal and with the reply to another party's statement of grounds of appeal is normally to be taken into account by the Board if and to the extent it relates to the case under appeal and is appropriately reasoned. However, the Board retains a discretion not to admit requests which could have been presented in the first-instance proceedings.

The Board is satisfied that the main request and the first to tenth auxiliary requests are an appropriate reaction by the proprietor to the impugned decision and the opponent's objections in his statement of grounds of appeal.

The Board thus makes use of its discretion under Article 12(4) RPBA 2007 to admit the main and the first to tenth auxiliary requests into the appeal proceedings.

- 3.2 Auxiliary requests 1a, 1b, 2a, 2b and 3a to 10a are an amendment of the proprietor's appeal case, made after the notification of the summons to oral proceedings.

Under Article 13(2) RPBA, such amendments must, in principle, not be taken into account unless there are exceptional circumstances, which have been justified with cogent reasons by the proprietor.

- 3.2.1 The proprietor argued that auxiliary requests 1a, 1b, 2a and 2b addressed an objection of added subject-matter regarding a non-allowable intermediate generalisation in claim 1 of each of the first and second auxiliary requests, raised for the first time by the Board in its preliminary opinion.

In the preliminary opinion (point 7) the Board explained why the feature according to which the processor is configured "to gradually abandon a secondary control task [...]" appeared to introduce an intermediate generalisation which was not allowable under Article 76(1) EPC. However, an objection of added subject-matter directed to the same feature because of a non-allowable generalisation was already raised by the opponent in his statement of grounds of appeal (point 3.1).

The provision of a preliminary opinion on an objection already on file does not amount to exceptional circumstances within the meaning of Article 13(2) RPBA.

For this reason, the Board does not admit auxiliary requests 1a, 1b, 2a and 2b into the appeal proceedings.

- 3.2.2 The proprietor argued that auxiliary requests 3a to 8a addressed an objection on the part of the Board concerning the disclosure of collision avoidance in D6, raised for the first time in the preliminary opinion.

In the preliminary opinion (point 9) the Board provided its view on an objection of lack of inventive step on the basis of D6 and D7, which was already raised by the opponent against claim 1 of the third and the fifth auxiliary requests in his reply to the proprietor's statement of grounds of appeal (points 3.4 and 3.5). It is in the context of this objection of the opponent that the Board made an additional comment, referred to by the proprietor, with regard to the fact that the deletion of a feature in claim 1 of the third auxiliary request rendered novelty over D6 questionable.

The provision of a preliminary view on an objection already on file does not amount to exceptional circumstances within the meaning of Article 13(2) RPBA. For this reason, in accordance with this article, the Board does not admit auxiliary requests 3a to 8a into the appeal proceedings.

- 3.2.3 In its preliminary opinion (point 11), the Board raised a clarity objection for the first time and on its own motion. The proprietor explained that the reason for filing auxiliary requests 9a and 10a was to address this clarity objection by amending claim 1 of auxiliary requests 9a and 10a correspondingly. The opponent argued that the claim was additionally amended by the introduction of the wording "when a shaft of the manipulator assembly (304) extends through a minimally

invasive aperture to the surgical workspace". However, this wording was already present in claim 1 of the main request. Hence, it could not take the opponent by surprise. Moreover, the new wording overcomes *prima facie* the Board's objection and does not give rise to further objections. It also limits the claim further and has no negative impact on procedural economy.

The Board considers the above circumstances to be exceptional within the meaning of Article 13(2) RPBA 2020.

Therefore, the Board admits auxiliary requests 9a and 10a into the appeal proceedings.

4. Main request - inventive step

The opponent argued that the subject-matter of claim 1 of the main request lacked an inventive step when starting from D6, in combination with D7.

The proprietor argued that D1, not D6, should be considered the closest prior art.

The Board notes that D6 is in the same technical field as the claimed invention, since it concerns the control of motion of surgical robots. It is therefore a suitable realistic starting point for the person skilled in the art. Whether D1 could be closer than D6 is irrelevant for assessing the merits of the opponent's objection.

4.1 D6 discloses a surgical robot with a manipulator assembly having a plurality of joints (Figure 2), an input and a processor (implied by page 453, second paragraph, last sentence).

The processor comprises a primary joint controller configured to drive the manipulator to a primary, underconstrained solution in response to an input (objective function expressed in equations 16 and 18), the processor further comprising a configuration-dependent filter configured to restrict the actuation of the manipulator assembly (constraints expressed by equations 17 and 19).

The proprietor argued that D6 did not disclose a processor as claimed, in particular because it did not comprise a configuration-dependent filter.

Claim 1 of the main request does not assign any specific meaning to the term "configuration-dependent". It is the Board's view that any restriction of an underconstrained solution can be considered "configuration-dependent" within the broad meaning of the claim, as it inherently excludes some configurations of the manipulator assembly.

D6 generally discloses "kinematically redundant" robotic systems and, in particular, a manipulator assembly with joints providing eight degrees of freedom (section V). However, manipulator assemblies with more than eight degrees of freedom are not disclosed in D6.

In the art, an end effector position is not defined by three, but by six degrees of freedom, which include the rotational degrees of freedom about the respective position axes (x, y, z).

Robots with eight degrees of freedom can certainly be "kinematically redundant" for a specific task. For example, bringing an end effector to a given point

during open surgery may well be a kinematically redundant task for a manipulator having eight degrees of freedom.

However, the condition of a manipulator assembly extending through a minimally invasive aperture (access site of a patient) implies, *de facto*, the suppression of two degrees of freedom of the manipulator in that condition, since no movements transverse to the aperture are allowed, to avoid injuring the patient.

It follows that a manipulator assembly with joints providing eight degrees of freedom has to use all of its available degrees of freedom - which implies a single joint state - to reach given positions of the end effector within a surgical workspace when the manipulator assembly extends through a minimally invasive aperture.

Hence, the subject-matter of claim 1 of the main request is novel over D6 by virtue of the feature of the joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector position within a surgical workspace when a shaft of the manipulator assembly extends through a minimally invasive aperture to the surgical workspace.

- 4.2 Employing a manipulator assembly with joints being configured to provide sufficient degrees of freedom to allow a range of joint states for a given task of positioning an end effector permits an adaptation of the configuration of the manipulator assembly to the needs of the usage environment.

This solves the objective technical problem of

increasing the flexibility of use of the robotic system.

D7 teaches robotic systems including a manipulator assembly which possesses more than the required degrees of freedom to arbitrarily position and orient its end effector in space, in order to increase the dexterity and flexibility in the specification of motion (introduction, first paragraph). It specifically discloses motion control of a manipulator assembly with nine degrees of freedom (page 115, left column, second paragraph).

Hence, in view of the objective technical problem and the teaching of D7, it would have been obvious for the person skilled in the art to implement in the surgical robotic system of D6 a manipulator assembly with joints being configured to provide sufficient degrees of freedom to allow a range of joint states for an end effector position within a surgical workspace when a shaft of the manipulator assembly extends through a minimally invasive aperture to the surgical workspace.

In this respect it is irrelevant whether D7 specifically concerns surgical robots. The objective technical problem and its proposed solution of employing redundant manipulators for a given task are not exclusive to surgery but apply to robotics in general.

It is also irrelevant whether D7 focuses on simulation techniques. The proposed solution to the objective technical problem is to use a manipulator which is redundant for its task of positioning an end effector. The person skilled in the art would not have needed to adapt the motion control already disclosed in D6 for

the implementation of such a redundant manipulator. This is all the more the case if it is considered that the control techniques disclosed in D6 worked very well, as argued by the proprietor.

Considerations of cost and complexity are of secondary importance if a solution to the objective technical problem is sought.

4.3 In conclusion, the objection as to lack of inventive step (Article 56 EPC) prejudices the maintenance of the patent on the basis of the main request.

5. First and second auxiliary requests -
added subject-matter

Claim 1 of each of the first and second auxiliary requests comprises the feature according to which "the processor is configured to gradually abandon a secondary control task as a primary control task corresponding to the primary solution gets harder and employs more degrees of freedom of the manipulator assembly".

The proprietor argued that a basis for this feature was provided in paragraphs [0092] to [0128] of the application as filed, which correspond to paragraphs [0092] to [0128] of the parent application as filed.

However, these paragraphs do not disclose that any secondary control task can be abandoned. Paragraph [0127] specifically mentions "not necessarily required solutions", and "soft, lower priority goals". It gives some examples of such soft goals, which could be maintaining an elbow or joint apex of a manipulator pointing up and maximising the robot's workspace

dexterity. On the other hand there is no teaching in the parent application as filed that "constraining motion of an intermediate portion of the manipulator assembly [...] so as to inhibit injury to tissues adjacent an access site", which is defined as a secondary control task in claim 6 of the first and the second auxiliary requests, can be gradually abandoned.

Hence, although claim 1 of the first and second auxiliary requests teaches that any secondary control task can be abandoned, the parent application as filed discloses that this is the case for only some secondary control tasks.

The proprietor's argument, that the person skilled in the art would interpret the claim language to mean that only desirable but not necessarily required secondary control tasks could be gradually abandoned, is not convincing. The claim wording does not include any criterion for establishing whether a given secondary task is to be considered only desirable or necessarily required, nor does the description define any such criterion.

It follows that the subject-matter of claim 1 of each of the first and second auxiliary requests extends beyond the content of the parent application as filed, in breach of Article 76(1) EPC. Hence, the patent cannot be maintained on the basis of either the first or the second auxiliary request.

6. Third to eighth auxiliary requests - inventive step
- 6.1 In claim 1 of each of the third to the eighth auxiliary requests, it is specified that a primary solution corresponds to a desired end effector movement and that

the configuration-dependent filter is configured for a secondary control task of urging the manipulator assembly toward a desired or a collision-inhibiting pose.

D6 discloses a primary solution corresponding to a desired end effector movement (objective function expressed in equations 16 and 18), and provides a general teaching regarding secondary tasks expressed in terms of constraint equations (equations 17 and 19).

Formulating a constraint for urging the manipulator assembly of D6 towards a desired or a collision-inhibiting pose, in order to increase the flexibility of use of the robotic system, would have been obvious for the person skilled in the art, in particular in view of D7, which is concerned with such constraints for highly redundant robots (the obstacle avoidance being mentioned in the introduction). Making a manipulator assembly avoid an obstacle implies excluding an undesired pose of the manipulator which would cause a collision. In turn, this implies that the manipulator is urged towards a desired or collision-inhibiting pose.

The proprietor's argument, that the prior art did not teach urging the manipulator assembly to a predefined pose, but that it taught determining and working out dynamically a specific pose into which a robot arm was put by using sensors, is not convincing. The claim language, including the term "desired", provides no limitation to predetermined poses, but is general. It does not exclude, for example, that a pose may be classified as desired or collision-inhibiting during the movement of the end effector, depending also on

other environmental variables.

- 6.2 In claim 1 of the seventh and the eighth auxiliary requests, a second manipulator assembly is introduced and it is specified that the secondary control task is designed to inhibit collisions of the first manipulator assembly with the second manipulator assembly.

As explained above, the teaching of D6 with respect to secondary tasks and constraints in the field of surgical robots is general. As argued by the opponent, surgical robots having a plurality of manipulator assemblies are known from both D3 and D4 (abstracts and figures accompanying them). The person skilled in the art would have applied the computations taught by D6 and D7 to such known surgical robots as a mere design option.

If certain operations require, or are better performed by, a surgical system with more than one manipulator assembly, considerations of cost and complexity are of secondary importance.

- 6.3 In conclusion, the subject-matter of claim 1 of each of the third to eighth auxiliary requests lacks an inventive step (Article 56 EPC). Hence, the patent cannot be maintained on the basis of any of these requests.

7. Ninth auxiliary request - clarity

Claim 1 of the ninth auxiliary request specifies that "the processor (210) is configured to determine a priority between the desired end effector (50) movement and the secondary control task during the end effector (50) movement, the priority varying in

response to changes in a configuration of the manipulator assembly (304)".

However, in the part preceding this wording, the claim defines movements of a first and of a second end effector, and a first and a second manipulator assembly.

As a consequence, as noted by the Board in its preliminary opinion, it is unclear whether the claim wording refers to the movement of the first or the second end effector, and to the configuration of the first or the second manipulator assembly.

The proprietor's argument, that it was implicit for the person skilled in the art that the claim wording referred to the first end effector movement and the first manipulator assembly, is not convincing, as it does not find any support either in the claim or in the patent as a whole.

Hence, the requirements of clarity according to Article 84 EPC are not fulfilled, and the patent cannot be maintained on the basis of the ninth auxiliary request.

8. Auxiliary request 9a - inventive step

The only objection maintained by the opponent against auxiliary request 9a was an objection as to lack of inventive step of the subject-matter of claim 1 in view of the combination of D6 and D7.

According to claim 1 of auxiliary request 9a, the processor is configured to determine a priority between the desired first end effector movement and the

secondary control task of urging the first manipulator assembly toward a collision-inhibiting pose during the first end effector movement, the priority varying in response to changes in a configuration of the first manipulator assembly.

The opponent argued that this claimed adaptive determination of the priority was disclosed in D6 and in D7.

The Board does not share this view.

As submitted by the opponent, D6 discloses the assignment of optimisation weights, in terms of products of relative importance factors and scaling factors, to the primary solution and to the secondary control task (page 457, right column, fourth paragraph and equation 21). This amounts to giving different priorities to a desired movement of an end effector of a manipulator assembly and to the secondary control task. D6 also discloses that the weights could be adjusted dynamically and automatically by the controller during task execution, possibly using external sensory information (page 458, left column, third paragraph). However, there is no disclosure in D6 that the adjustment should be made in response to changes in a configuration of the manipulator assembly.

D7 discloses an algorithm for avoiding obstacles during the movement of an end effector of a kinematically redundant manipulator assembly. The algorithm makes use of an obstacle-avoidance term which is tapered as a function of the obstacle distance (page 113, first and second paragraph, equation 15 and Figure 2). This means that the obstacle-avoidance term becomes predominant and eventually takes exclusive control of the end

effector movement when the obstacle distance is sufficiently low. However, this does not amount to a variation of priority between a desired end effector movement and a secondary control task in response to changes in a configuration of the manipulator assembly. First of all, as the proprietor submitted, such a control algorithm actually implies that the task of obstacle avoidance is always the task of highest priority. No other task can be accomplished if it conflicts with the obstacle avoidance task. Moreover, the variation of the obstacle-avoidance term is responsive not to a change in configuration of the manipulator assembly, but rather to an obstacle distance.

Since the claimed adaptive determination of the priority, which addresses the problem of providing a safer and more effective surgical robot, is not disclosed in D6 or D7, the subject-matter of claim 1 of auxiliary request 9a is inventive (Article 56 EPC) over the combination of these documents.

9. The opponent had no objection to the proprietor's request, made at the end of the oral proceedings, that pages 2, 12 and 13 filed for the ninth auxiliary request with the submission dated 18 December 2019 should replace the corresponding pages of the patent specification.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the Opposition Division with the order to maintain the patent as amended in the following version:
 - claims 1 to 12 according to auxiliary request 9a filed with the submission dated 23 March 2020
 - description pages 3 to 11 and 14 to 29 of the patent specification and pages 2, 12 and 13 filed for auxiliary request 9 with the submission dated 18 December 2019
 - Figures 1A to 18G of the patent specification.

The Registrar:

The Chairman:



D. Hampe

M. Alvazzi Delfrate

Decision electronically authenticated