Title: TRACKING OF TUMOR LOCATION FOR TARGETED RADIATION TREATMENT

Abstract: Systems, methods, and apparatuses are provided for targeting diseased tissue with a radiation beam. Functional models can be used to accurately obtain a location of specific tissue using sensors at identifiable locations of the patient's body. Using the relative distances between the identifiable sensor locations can allow a patient to be in various positions. The functional models can be prepared using accurate pre-treatment scans, which can be taken at various body positions (e.g., rotations and/or translations). The trajectory of the beam can be measured efficiently and accurately using beam sensors attached to a beam assembly, where a model maps the beam sensor locations to a trajectory of the beam. Further, a motion model can use measurements made during treatment to obtain a time-dependent functions of the movement of the specific tissue, the change of an optimal beam trajectory over time, or the change in input commands to a beam positioner.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/22274

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61B 5/05 (201 2.01)
USPC - 600/424

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)
USPC - 600/424

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 600/424,547,427,436;378/65,205

Electronic database consulted during the international search (name of data base and, where practical, search terms used)
PubWEST (USPT, PGPB, JPAB, EPAB); Google
Search Terms: Radiation detection sensor reflector computer motion MRI wireless

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 2008/0212737 A1 (D'Souza et al.) 04 Sep 2008 (04.09.2008), entire document especially Abstract, para [0044]-[0045], [0137/0138], [0036], [0106]-[0107], [0033], [0051]-[0054] and [0120]</td>
<td>1-36 and 81-85</td>
</tr>
</tbody>
</table>

* Special categories of cited documents:
  'A' document defining the general state of the art which is not considered to be of particular relevance
  'E' earlier application or patent but published on or after the international filing date
  'L' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  '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

Date of the actual completion of the international search
05 Jul 2012 (05.07.2012)

Date of mailing of the international search report
17 JUL 2012

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-3201

Form PCT/ISA/2 10 (second sheet) (July 2009)

Authorized officer: Lee W. Young
PCT Helpdesk: 571-272-4300
PCTOP: 571-272-7774
## Box No. II  Observations where certain claims were found unsearchable (Continuation of Item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2.☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3.☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III  Observations where unity of invention is lacking (Continuation of Item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

### —— please see supplemental box ——

1.☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2.☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3.☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4.☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos. 1-36 and 81-85

### Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: claims 1-36 and 81-85 directed to a method/system/instructions for providing radiation treatment to a patient, comprising: one or more beam assemblies, each configured to emit a radiation beam; a plurality of detectors configured to receive signals from a plurality of sensors of the patient's body; one or more processors that are in communication with the one or more beam assemblies and the plurality of detectors and that are configured for: detecting a position of each of a plurality of sensors of the patient's body, the positions of the sensors being determined with respect to a reference point having a known spatial relationship to a radiation beam assembly, the radiation beam assembly configured to provide a radiation beam; determining relative positions of the sensors with respect to each other; accessing a first mapping model that maps the relative positions of the sensors to determine a relative location of diseased tissue of the patient, the relative location of the diseased tissue being relative to the positions of the sensors; and using the positions of the sensors and the relative location of the diseased tissue to direct a radiation beam of the radiation beam assembly to the diseased tissue.

Group II: claims 37-80 directed to a system/method for providing radiation treatment to a patient, comprising: one or more beam assemblies, each configured to emit a radiation beam; a plurality of detectors configured to receive signals from a set of beam sensors attached to the beam assemblies; one or more processors that are in communication with the one or more beam assemblies and the plurality of detectors and that are configured to: detecting a first position of each of the set of beam sensors at a first time determining a trajectory of the radiation beam from the first positions of the beam sensors; and using the determined trajectory at the first time to move the beam assembly such that the trajectory of the radiation beam is focused at a location of diseased tissue of the patient, wherein the patient is in a physical position and wherein each physical position is different and involves a translation and/or a rotation of one or more selected from the first patient's head, torso, and appendages relative to another position, wherein the first patient has a plurality of first markers attached to the first patient's body.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

Group I does not include the inventive concept of using a determined trajectory at a given time for a beam assembly and focusing that trajectory of the radiation beam at the location of diseased tissue of a patient, wherein the patient is in a physical position and wherein each physical position is different and involves a translation and/or a rotation of one or more selected from the first patient's head, torso, and appendages relative to another position, wherein the first patient has a plurality of first markers attached to the first patient's body, as required by Group II.

Group II does not include the inventive concept of using the positions of the sensors and the relative location of the diseased tissue to direct a radiation beam of the radiation beam assembly to the diseased tissue of a relatively still patient, as required by Group I.

The common feature of providing radiotherapy to a patient via a plurality of sensors, detectors and processor that tracks and irradiates a target site, such as a tumor, on the patient are taught by US 2008/0212737 A1 to D'Souza et al. (Abstract; para [0044]-[0045] and [0106]-[0107]); therefore the common features are not an improvement over the prior art.

None of these technical features are common to the other groups, nor do they correspond to a special technical feature in the other groups. Therefore, unity of invention is lacking.