

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

PCT/US11/30498

International Application No.

30-03-2011

30 MAR 2011

International Filing Date

PCT INTERNATIONAL APPLICATION RO/US

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) 0837RF-H793P

Box No. I TITLE OF INVENTION

FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

Box No. II APPLICANT

☐ This person is also inventor

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

BELL HELICOPTER TEXTRON INC.
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Fort Worth, TX 76101
United States of America

Telephone No.

(817) 280-8852

Facsimile No.

(817) 280-8878

Applicant's registration No. with the Office

N/A

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or

☐ exclusively in electronic form (no paper notifications will be sent).

E-mail address: N/A

State (that is, country) of nationality:

US

State (that is, country) of residence:

US

This person is applicant for the purposes of:

☐ all designated States

☒ all designated States except the United States of America

☐ the United States of America only

☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

WALTON, James E.
LAW OFFICES OF JAMES E. WALTON, P.L.L.C
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E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☒ as advance copies followed by paper notifications; or

☐ exclusively in electronic form (no paper notifications will be sent).

E-mail address: jim@waltonpllc.com

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

CHRISTENSEN, KEVIN THOMAS
3905 Branchwood Drive
Plano, Texas 75093
United States of America

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office
N/A

State (that is, country) of nationality:
US

State (that is, country) of residence:
US

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

SHUE, SHYHPYNG JACK
2809 Woodland Hills Drive
Grapevine, Texas 76051
United States of America

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office
N/A

State (that is, country) of nationality:
US

State (that is, country) of residence:
US

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

CAUDILL, TROY SHELDON
6195 Oak Hollow Drive
Burleson, Texas 76028
United States of America

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office
N/A

State (that is, country) of nationality:
US

State (that is, country) of residence:
US

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No. V DESIGNATIONS

The filing of this request constitutes under Rule 4.9(a) the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

- ☐ DE Germany is not designated for any kind of national protection
- ☐ JP Japan is not designated for any kind of national protection
- ☐ KR Republic of Korea is not designated for any kind of national protection

(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing or subsequently under Rule 26bis.1, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application: regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

☐ The **International Bureau** is requested to obtain from a digital library, a certified copy of the earlier application(s) *(if the earlier application(s) is available to it from a digital library)* identified above as:*

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

☐ The **receiving Office** is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(if the earlier application(s) was filed with the Office which for the purposes of this international application is the receiving Office)* or to obtain a certified copy of the earlier application(s) from a digital library and transmit a copy of it to the International Bureau *(if the earlier application(s) is available to the receiving Office from a digital library)*, identified above as:*

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

* Where the certified copy of the earlier application(s) is not stored in a digital library under the number of the earlier application indicated above but under the application number of another application which also claims priority from it, indicate that number in the supplemental sheet (item 4).

Restore the right of priority: the receiving Office is requested to restore the right of priority for the earlier application(s) identified above or in the Supplemental Box as item(s) (_____). *(See also the Notes to Box No. VI; further information must be provided to support a request to restore the right of priority.)*

Incorporation by reference: where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if more than one International Searching Authority is competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA/ US

Continuation of Box No. VII USE OF RESULTS OF EARLIER SEARCH, REFERENCE TO THAT SEARCH

- ☐ The ISA indicated in Box No. VII is requested to take into account the results of the earlier search(es) indicated below (*see also Notes to Box VII; use of results of more than one earlier search*).

Filing date (day/month/year) Application Number Country (or regional Office)

- ☐ **Statement (Rule 4.12(ii)):** this international application is the same, or substantially the same, as the application in respect of which the earlier search was carried out except, where applicable, that it is filed in a different language.

- ☐ **Availability of documents:** the following documents are available to the ISA in a form and manner acceptable to it and therefore do not need to be submitted by the applicant to the ISA (Rule 12bis.1(f)):

- ☐ a copy of the results of the earlier search,*
☐ a copy of the earlier application,
☐ a translation of the earlier application into a language which is accepted by the ISA,
☐ a translation of the results of the earlier search into a language which is accepted by the ISA,
☐ a copy of any document cited in the results of the earlier search. (*If known, please indicate below the document(s) available to the ISA*);

- ☐ **Transmit copy of results of earlier search and other documents** (*where the earlier search was not carried out by the ISA indicated above but by the same Office as that which is acting as the receiving Office*): the receiving Office is requested to prepare and transmit to the ISA (Rule 12bis.1(c)):

- ☐ a copy of the results of the earlier search,*
☐ a copy of the earlier application,
☐ a copy of any document cited in the results of the earlier search.

* Where the results of the earlier search are neither available from a digital library nor transmitted by the receiving Office, the applicant is required to submit them to the receiving Office (Rule 12bis.1(a)) (*See item 11. in the check-list and also Notes to Box No. VII*).

Filing date (day/month/year) Application Number Country (or regional Office)

- ☐ **Statement (Rule 4.12(ii)):** this international application is the same, or substantially the same, as the application in respect of which the earlier search was carried out except, where applicable, that it is filed in a different language.

- ☐ **Availability of documents:** the following documents are available to the ISA in a form and manner acceptable to it and therefore do not need to be submitted by the applicant to the ISA (Rule 12bis.1(f)):

- ☐ a copy of the results of the earlier search,*
☐ a copy of the earlier application,
☐ a translation of the earlier application into a language which is accepted by the ISA,
☐ a translation of the results of the earlier search into a language which is accepted by the ISA,
☐ a copy of any document cited in the results of the earlier search. (*If known, please indicate below the document(s) available to the ISA*);

- ☐ **Transmit copy of results of earlier search and other documents** (*where the earlier search was not carried out by the ISA indicated above but by the same Office as that which is acting as the receiving Office*): the receiving Office is requested to prepare and transmit to the ISA (Rule 12bis.1(c)):

- ☐ a copy of the results of the earlier search,*
☐ a copy of the earlier application,
☐ a copy of any document cited in the results of the earlier search.

* Where the results of the earlier search are neither available from a digital library nor transmitted by the receiving Office, the applicant is required to submit them to the receiving Office (Rule 12bis.1(a)) (*See item 11. in the check-list and also Notes to Box No. VII*).

- ☐ Further earlier searches are indicated on a continuation sheet.

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) (*mark the applicable check-boxes below and indicate in the right column the number of each type of declaration*):

Number of
declarations

- | | | |
|---|--|---|
| ☐ Box No. VIII (i) | Declaration as to the identity of the inventor | : |
| ☐ Box No. VIII (ii) | Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent | : |
| ☐ Box No. VIII (iii) | Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application | : |
| ☒ Box No. VIII (iv) | Declaration of inventorship (only for the purposes of the designation of the United States of America) | : |
| ☐ Box No. VIII (v) | Declaration as to non-prejudicial disclosures or exceptions to lack of novelty | : |

3

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)
The declaration must conform to the following standardized wording provided for in Section 214; see Notes to Boxes Nos. VII, VIII (i) to (iv) (in general) and the specific Notes to Box No. VIII (iv). If this Box is not used, this sheet should not be included in the request.

**Declaration of inventorship (Rules 4.17(iv) and 51bis.1(a)(iv))
for the purposes of the designation of the United States of America:**

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/..... (if furnishing declaration pursuant to Rule 26ter).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

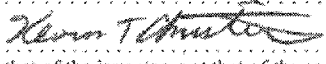
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name: KEVIN THOMAS CHRISTENSEN

Residence: Plano, Texas
(city and either US state, if applicable, or country)

Mailing Address: 3905 Branchwood Drive
Plano, Texas 75093
United States of America

Citizenship: US

Inventor's Signature:  Date: 1/26/2011
(The signature must be that of the inventor, not that of the agent)

Name: SHYHPYNG JACK SHUE

Residence: Grapevine, Texas
(city and either US state, if applicable, or country)

Mailing Address: 2809 Woodland Hills Drive
Grapevine, Texas 76051
United States of America

Citizenship: US

Inventor's Signature: Date:
(The signature must be that of the inventor, not that of the agent)

☒ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iv)".

Box No. VIII (iv) **DECLARATION OF INVENTORSHIP** (only for the purposes of the designation of the United States of America)
The declaration must conform to the following standardized wording provided for in Section 214, see Notes to Boxes Nos. VII, VIII (i) to (iv) in general and the specific Notes to Box No. VIII (iv). If this Box is not used, this sheet should not be included in the request.

**Declaration of inventorship (Rules 4.1⁷(iv) and 51bis.1(a)(iv))
for the purposes of the designation of the United States of America:**

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application)

This declaration is directed to international application No. PCT/..... (if furnishing declaration pursuant to Rule 26ter)

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

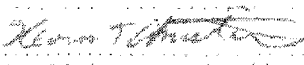
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name: KEVIN THOMAS CHRISTENSEN

Residence: Plano, Texas

Mailing Address: 3905 Branchwood Drive
Plano, Texas 75093
United States of America

Citizenship: US

Inventor's Signature:  Date: 1/26/2011

Name: SHYHPYNG JACK SHUE

Residence: Grapevine, Texas

Mailing Address: 2809 Woodland Hills Drive
Grapevine, Texas 76051
United States of America

Citizenship: US

Inventor's Signature:  Date: Jan 26, 2011

☒ This declaration is submitted on the following sheet, "Continuation of Box No. VIII (iv)"

Continuation of Box No. VIII (i) to (v) DECLARATION

If the space is insufficient in any of Boxes Nos. VIII (i) to (v) to furnish all the information, including in the case where more than two inventors are to be named in Box No. VIII (iv), in such case, write "Continuation of Box No. VIII..." (indicate the item number of the Box) and furnish the information in the same manner as required for the purposes of the Box in which the space was insufficient. If additional space is needed in respect of two or more declarations, a separate continuation box must be used for each such declaration. If this Box is not used, this sheet should not be included in the request.

Continuation of Box VIII(iv):

Name: TROY SHELDON CAUDILL

Residence: Burleson, Texas

Mailing Address:

6195 Oak Hollow Drive

Burleson, Texas 76028

United States of America

Citizenship: US

Signature: Troy Caudill

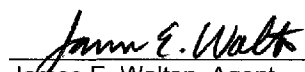
Date: 26 April

Box No. IX CHECK LIST for PAPER filings – this sheet is only to be used when filing an international application on **PAPER**

This international application contains the following:	Number of sheets	This international application is accompanied by the following item(s) (<i>mark the applicable check-boxes below and indicate in right column the number of each item</i>):	Number of items
(a) request form PCT/RO/101 (including any declarations and supplemental sheets).....	⁸ 7	1. ☒ fee calculation sheet	1
(b) description (excluding any sequence listing part of the description, see (f), below).....	13	2. ☐ original separate power of attorney	
(c) claims	6	3. ☐ original general power of attorney	
(d) abstract	1	4. ☐ copy of general power of attorney; reference number:	
(e) drawings (if any)	9	5. ☐ statement explaining lack of signature	
(f) sequence listing part of the description (if any)		6. ☐ priority document(s) identified in Box No. VI as item(s)	
Total number of sheets	³⁷ 36	7. ☐ Translation of international application into (language):	
		8. ☐ separate indications concerning deposited microorganism or other biological material	
		9. ☐ copy in electronic form (Annex C/ST.25 text file) on physical data carrier(s) of the sequence listing, not forming part of the international application, which is furnished only for the purposes of international search under Rule 13ter (type and number of physical data carriers)	
		10. ☐ a statement confirming that "the information recorded in electronic form submitted under Rule 13ter is identical to the sequence listing as contained in the international application" as filed on paper	
		11. ☐ copy of results of earlier search(es) (Rule 12bis.1(a)) ..	
		12. ☐ other (specify):	
Figure of the drawings which should accompany the abstract:	7	Language of filing of the international application:	English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).


James E. Walton, Agent
U.S. Reg. No. 47,245

3/30/11
Date

For receiving Office use only		2. Drawings: ☐ received: ☐ not received:
1. Date of actual receipt of the purported international application:	30-03-2011 30 MAR 2011	
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
5. International Searching Authority (if two or more are competent): ISA / US	6. ☐ Transmittal of search copy delayed until search fee is paid	

For International Bureau use only
Date of receipt of the record copy by the International Bureau:

FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

Technical Field

5 The present invention relates generally to flight control systems, and more particularly, to a flight control system having flight control laws which enable precise aircraft maneuvering relative to the ground.

Description of the Prior Art

10 Aircraft which can hover and fly at low speeds include rotorcraft, such as helicopters and tilt rotors, and jump jets, like the AV-8B Harrier and F-35B Lightning II. These aircraft can spend a large portion of their mission maneuvering relative to the ground. Sometimes, this maneuvering must be conducted in confined spaces around external hazards such as buildings, trees, towers, and power lines.

15 For traditional flight control systems, ground-referenced maneuvering (GRM) requires the pilot to make constant control inputs in multiple axes in order to counter disturbances caused by wind, as well as to remove the natural coupled response of the aircraft. The pilot workload during such maneuvers can become quite high since the pilot must sense un-commanded aircraft motions and then put in the appropriate control input to eliminate the disturbance. In a worst-case scenario, a pilot might be required to fly GRM in a degraded visual environment. With the lack of visual cues to detect off-axis motion, the pilot might accidentally fly into an external hazard while maneuvering in a confined space.

20 Traditional flight control law designs do not provide the pilot with an easy way to control aircraft crab angle during GRM. Crab angle is defined as the angle between the aircraft's heading and its actual ground path. With these prior designs, adjusting crab angle while maintaining ground track took considerable pilot concentration, since the pilot had to coordinate inputs to both the lateral and directional controllers.

Although pilots generally seek to minimize crab angle during GRM, some mission tasks may call for flat yawing turns while maintaining a constant vector across the ground. For example, on a steep approach, the pilot may need to fly with a crab angle so he or she can see the landing zone. Additionally, the pilot may want to quickly transition out of rearward or sideward flight while continuing along the same ground track. In a final example, the pilot may want to acquire and track a point on the ground without having to fly directly towards it. With prior flight control designs, such maneuvers required extraordinary pilot skill to coordinate the aircraft's motions in multiple control axes.

Although the foregoing developments represent great strides in the area of flight control laws, many shortcomings remain.

Brief Description of the Drawings

The novel features believed characteristic of the application are set forth in the appended claims. However, the application itself, as well as a preferred mode of use, and further objectives and advantages thereof, will best be understood with reference to the following detailed description when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a flight envelope with control law modes designed to enable ground reference maneuvers;

Figure 2 is a schematic of an aircraft utilizing a control system according to the preferred embodiment of the present invention;

Figure 3 is a set of plots comprising measured flight data of the aircraft of Fig. 2 while performing constant vector flat turns;

Figure 4 is a schematic view of the aircraft of Fig. 2 changing flight heading from sideward flight to forward flight;

Figure 5 is a schematic view of the aircraft of Fig. 2 changing flight heading from forward flight to sideward flight;

Figure 6 is a schematic view of the control system architecture for a set of longitudinal control laws;

5 Figure 7 is a schematic view of the control system architecture for a set of lateral control laws;

Figure 8 is a schematic view of the control system architecture for directional control laws;

Figure 9 is a schematic view of the control law logic for the control system; and

10 Figure 10 is a schematic view a control law flow chart for the control system.

15 While the control system of the present application is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular embodiment disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the process of the present application as defined by the appended claims.

Description of the Preferred Embodiment

20 This invention will enable seamless and transient free GRM. More specifically this invention will enable a pilot to use the directional controller to command flat yawing turns at low groundspeeds, while maintaining a constant vector across the ground. The seamless integration of this design requires no manual cockpit switches to select a Constant Vector Flat Turn (CVFT) mode. As a result of this auto-moding logic, the

control laws will automatically adjust pitch and roll attitude to keep the aircraft moving in the same direction at a constant speed whenever the pilot inputs a directional command at low speed.

5 The auto-moding logic of the present application enables seamless and transient free GRM without the need for manual cockpit switches. The control system utilizes relative groundspeed difference to automatically control pitch and roll attitudes so that the aircraft will maintain a constant vector during a low speed flat turn. The control system also allows the pilot to complete a CVFT with minimal workload since the ground vector will automatically be maintained by the control laws without the pilot
10 having to use cockpit switches to change modes.

Referring now to the drawings, Figure 1 shows a representative flight envelope 101 with a plurality of control law modes designed to enable GRM. Flight envelope 101 comprises a region 103 depicting the CVFT region, wherein the CVFT region is preferably from 10 to 35 knots groundspeed in any direction relative to the aircraft's
15 body axis. The lower bound of region 103 is set by the Hover Hold and Translational Rate Command (TRC) region 105. The upper bound of region 103 is set by the aircraft's sideward and rearward flight airspeed limits.

Figure 2 is a schematic of an aircraft 201 utilizing a control system according to the preferred embodiment of the present invention. Figure 2 shows aircraft 201 in
20 forward flight within region 103. Directional inputs turn aircraft 201 in a complete 360 degree yaw movement R1, stopping every 90 degrees, and without changing the speed and flight heading of aircraft 201, as represented with arrow D1. In the preferred embodiment, the control system is utilized with rotary aircraft, i.e., a helicopter; however, it should be appreciated that the control system is easily and readily adaptable
25 with control systems of different types of aircraft, both manned and unmanned.

Figure 2 depicts aircraft 201 traveling between 10 to 35 knots in a forward direction. As is shown, aircraft 201 preferably turns in a yaw direction R1 at

approximately 90 degrees relative to direction D1. Aircraft 201 continues to turn in direction R1 while maintaining a constant flight heading. It should be appreciated that the preferred control system is adapted to turn aircraft 201 at 90 degrees during each application; however, it should be appreciated that alternative embodiments could easily include a control system adapted to turn the aircraft at different angles, e.g., at 30 degrees in lieu of or in addition to 90 degrees. It should also be understood that although shown turning in a clockwise direction, the control system can also turn the aircraft in a counterclockwise movement.

Figure 2 provides an exemplary depiction of aircraft 201 turning 360 degrees while maintaining forward flight. Step 1 shows aircraft 201 traveling in a constant forward flight, as depicted with arrow D1, between 10 and 35 knots. Step 2 depicts application of the control system, namely, the pilot utilizes the control system to rotate aircraft 201 in the clockwise direction approximately 90 degrees, as indicated by arrow R1. Step 2 shows aircraft 201 traveling in forward flight while the fuselage faces 90 degrees relative to the directional movement. Steps 3-5 provide further illustration of the process being repeated. In particular, each time the control system is utilized, aircraft 201 rotates 90 degrees while maintaining a constant forward heading.

Referring now to Figure 3 in the drawings, measured flight data 301 of aircraft 201 is shown during a 360 degree CVFT. A plot 303 provides measured data representing the turning movement R1 of aircraft 201 during the 360 degree turn. A plot 305 provides measured data representing the groundspeed of aircraft 201 during the 360 degree turn. Plot 305 shows aircraft 201 initially starting at 20 knots forward groundspeed during the entire 360 degree CVFT. Plot 305 shows that aircraft 201 holds a relatively steady groundspeed during the 360 degree CVFT. A plot 307 provides measured data representing the ground track of aircraft 201 during the 360 degree CVFT. The forward groundspeed plotted on a plot 309 essentially depicts a cosine curve during the turn, while the sideward groundspeed plotted on a plot 311 shows a sine curve.

Referring now to Figure 4 in the drawings, a schematic view of aircraft 201 is shown changing flight heading from sideward flight to forward flight. In the exemplary embodiment, the CVFT control system is utilized such that aircraft 201 changes heading from a forward groundspeed V_x of about 0 knots and a sideward groundspeed between 10-35 knots to a forward groundspeed between 10-35 knots and a sideward groundspeed about 0 knots. Step 1 of Figure 4 shows aircraft 401 during hover, while a step 2 shows aircraft 401 traveling in a sideward groundspeed between 10-35 knots, as depicted with arrow D2. In step 2, a right lateral control stick (not shown) is utilized to generate a left sideward heading. Thereafter, a right 90 degree pedal turn is applied to rotate aircraft 201 in a forward heading with a pedal 203. In the preferred embodiment, pedal 203 is a pedal manipulated with the pilot's foot; however, it should be appreciated that other forms of devices, i.e, a hand switch could be utilized in lieu of or in addition to pedal 203. For purposes of this invention, a lateral controller, longitudinal controller, and directional controller are characterized as pedal 203 or similarly suited devices. Step 3 depicts application of the CVFT control system, wherein aircraft 201 turns 90 degrees for changing the heading of aircraft 201.

Referring now to Figure 5 in the drawings, an alternative application of the CVFT control system is shown. In the exemplary embodiment, the CVFT control system is utilized to turn aircraft 201 from a forward groundspeed V_x between 10-35 knots and a sideward groundspeed of about 0 knots to a sideward groundspeed between 10-35 knots and a forward groundspeed about 0 knots. Step 1 shows aircraft 201 during hover, while a step 2 shows aircraft 201 traveling in a forward heading having a groundspeed between 10-35 knots, as depicted with arrow D3. In step 2, a forward longitudinal stick is utilized to generate forward flight. Thereafter, a left 90 degree pedal turn is applied to rotate aircraft 201 such that the forward flight of aircraft 201 changes to a sideward flight heading.

Those skilled in the art will understand that the methods for aircraft guidance disclosed in this invention can be applied to any combination of the following: (1) full

authority fly-by-wire flight control systems, as well as partial authority mechanical systems; (2) traditional cockpit layouts with a center stick for longitudinal and lateral control, pedals for directional control, and a collective stick for vertical control, as well as more advanced designs which combine multiple control axes into a center or side stick controller; and, (3) any aircraft capable of GRM, including both rotorcraft and jump jets.

The key to enabling seamless and transient free GRM lies in the advanced control law architecture of the CVFT control system as shown in Figures 6 to 8. Figure 6 shows architecture 601 of the CVFT control system operably associated with one or more longitudinal control laws, Figure 7 shows architecture 701 of the CVFT control system operably associated with one or more lateral control laws, and Figure 8 shows architecture 801 of the CVFT control system operably associated with one or more directional control laws according to the preferred embodiment of the invention.

Referring now to Figure 6 in the drawings, architecture 601 includes one or more aircraft sensors 603 operably associated with the control laws to accomplish GRM. Aircraft sensors 603 can include: an inertial Navigation System (attitudes, attitude rates, and translational accelerations); a Global Positioning System (ground-referenced speeds and positions); an Air Data Computer (airspeed and barometric altitude); and, a Radar or Laser Altimeter (above ground level (AGL) altitude). An aircraft model can be obtained from aerodynamics data and a group of linear models can be developed based on its airspeed from aircraft sensors 603. These linear models include both lateral and longitudinal equations of motion. Since the aircraft model matrices are large and contain coupling terms of lateral and longitudinal motions within the matrices, it is difficult to determine the best performance control gains for all at the same time. In order to overcome these issues, the linear model of aircraft performance is decoupled first. After the aircraft model is decoupled to lateral and longitudinal equations of motion, the effect of coupling terms between lateral and longitudinal motions can be reduced to a minimum, thus stabilizing the system.

In the preferred embodiment, architecture 601 preferably comprises of a longitudinal control law for forward speed, represented as block 605 "Long_SPD"; a longitudinal control law for pitch angle, represented as block 607 "Long_ATT"; and, a longitudinal control law for pitch rate, represented as block 609 "Long_RATE". Architecture 601 is further provided with initialization logic 611 adapted for determining which loop is active in each axis based on flight conditions and pilot control inputs. Logic 611 will also re-initialize inactive loops in order to eliminate control jumps when switching between the loops to provide seamless and transient free mode changes.

Architecture 601 further includes a longitudinal command 613 generated in the control laws by referencing the pilot's cockpit control input in each axis. The input to the control laws is the difference between the controller's present position and the centered, no force position, which is also referred to as the "detent" position. The control commands can also be generated by a beep switch located in the cockpit to command small and precise changes in aircraft state. The control laws process these control inputs to generate the appropriate aircraft response commands. These commands are then sent out to the control law guidance blocks to maneuver the aircraft. The control law outputs are routed to an actuator 615 for each dynamic axis. For a conventional helicopter, the control laws send control signals to the following actuators: longitudinal axis – main rotor longitudinal swashplate angle; lateral axis – main rotor lateral swashplate angle; vertical axis – main rotor collective pitch; and, directional axis – tail rotor collective pitch.

Since pitch rate is the fastest longitudinal state, Long_RATE 609 is the inner loop of the longitudinal control laws. Next, the Long_ATT 607 loop feeds the Long_RATE control law 609 loop to control pitch attitude. Finally, the Long_SPD control law 605 loop feeds the Long_ATT 607 loop to control forward speed.

When flying with the longitudinal controller in detent outside of the Hover Hold / TRC region 105, depicted in Figure 1, the Long_SPD 605 loop will be active. At lower speeds, this loop will hold constant forward groundspeed, while at higher speeds,

airspeed will be held. Once the pilot moves the longitudinal controller out of detent, the control laws can command either pitch attitude (Long_ATT 607) or pitch rate (Long_RATE 609).

Referring now to Figure 7 in the drawings, architecture 701 comprises one or more lateral control laws operably associated with sensors 603, logic 611, lateral commands 702, and actuators 615. The lateral control laws include: a lateral control of roll rate, represented as block 703 "Lat_RATE"; a lateral control of the roll attitude, represented as block 705 "Lat_ATT"; a lateral control of sideward groundspeed, represented as block 707 "Lat_SPD"; a lateral control of the crab angle, represented as block 709 "Lat_CRAB"; and, lateral control of heading, represented as block 711 "Lat_HDG".

Similar to the longitudinal axis, Lat_RATE 703 is the inner loop of the lateral control laws and the Lat_ATT 705 loop feeds the Lat_RATE 703 loop to control roll attitude. The Lat_ATT 705 loop can be fed by one of three loops, Lat_SPD 707, Lat_CRAB 709, or Lat_HDG 711.

The crab angle used in the Lat_CRAB 709 loop is computed in the control laws using the following equation:

$$\eta = \tan^{-1}\left(\frac{V_y}{V_x}\right) \quad (1)$$

where η is the crab angle, V_y is the sideward groundspeed with right positive, and V_x is the forward groundspeed. To avoid a singularity in Equation 1, V_x is limited to be above the Hover Hold / TRC region 103.

When operating in the Ground-Coordinated Banked Turn (GCBT) envelope as shown by region 107 in Figure 1, if both the lateral and directional controllers are in detent, lateral control law logic will hold crab angle through the Lat_CRAB 709 loop. If

operating in the CVFT envelope, but not in the GCBT envelope, and the lateral and directional controllers are in detent, the control logic will hold sideward groundspeed constant with the Lat_SPD 707 loop. When operating at higher airspeeds with lateral and directional controllers in detent, the control logic will hold heading constant with the Lat_HDG 711 loop. When the pilot moves the lateral controller out of detent in any of these cases, the control laws can command either roll attitude (Lat_ATT 705) or roll rate (Lat_RATE 703).

Referring now to Figure 8 in the drawings, architecture 801 comprises one or more directional control laws operably associated with sensors 603, logic 611, commands 613, and actuators 615. The directional control laws include: directional control of yaw rate, represented as block 803 "Dir_RATE"; directional control of heading, represented as block 805 "Dir_HDG"; and, directional turn coordination, represented as block 807 "Dir_TC"

Since yaw rate is the fastest directional state, Dir_RATE 803 is the inner loop of the directional control laws. This loop is fed by the Dir_HDG 805 loop to control aircraft heading at lower speeds. Unlike traditional control law designs, this invention includes an additional loop, parallel to the Dir_HDG 805 loop, to feed the Dir_RATE 803 inner loop. The Dir_TC 807 loop is used to coordinate banked turns throughout the flight envelope.

In the GCBT envelope 107 shown in Figure 1, the Dir_TC 807 loop will control crab angle during banked turns. With no directional input, the Dir_TC 807 loop will hold crab angle at zero. Any directional control inputs during a GCBT will result in a change in crab angle in the appropriate direction. Additionally, if the aircraft is in the GCBT envelope, but above the CVFT envelope, directional controller inputs will command changes in crab angle through the Dir_TC 807 loop even in non-turning flight. In this case, once the directional controller is returned to detent, heading hold will be re-engaged (Dir_HDG 805 loop) and the crab angle will be held though the Lat_CRAB 709 loop.

When in the BCBT envelope, the Dir_TC 807 loop will automatically adjust yaw rate based on actual bank angle, true airspeed, and lateral acceleration in order to keep the slip ball centered. Any directional controller inputs in the BCBT envelope will command a change in lateral acceleration, which will subsequently result in sideslip away from the pedal input. Pedal inputs will also result in a slight roll in the direction of the input to provide lateral stability.

In the absence of lateral or directional control inputs while operating in either the GCBT or CVFT envelopes, the directional axis will hold heading through the Dir_HDG 805 loop. If the pilot moves the directional controller out of detent in the CVFT envelope with both the lateral and longitudinal controllers in detent, the directional control laws will command a yaw rate through the Dir_RATE 803 loop. In this case, the control laws will maintain a constant ground vector by using the Long_SPD 605 and Lat_SPD 707 loops.

During the CVFT, when the directional controller is first moved out of detent, the control laws will capture the aircraft's current groundspeed in the earth axis coordinate system. The control laws keep track of the difference between the aircraft's actual groundspeed and the captured groundspeed. This relative groundspeed difference is converted from the earth axis to the aircraft's body axis using the following equations:

$$\Delta V_x = \Delta V_{north} \cdot \cos \psi + \Delta V_{east} \cdot \sin \psi \quad (2)$$

$$\Delta V_y = \Delta V_{east} \cdot \cos \psi - \Delta V_{north} \cdot \sin \psi \quad (3)$$

where ΔV_x is the groundspeed difference in the body axis forward direction, ΔV_y is the groundspeed difference in the body axis sideward direction with right positive, ΔV_{north} is the groundspeed difference in the earth axis north direction, ΔV_{east} is the groundspeed difference in the earth axis east direction, and ψ is the aircraft heading. The values for ΔV_x and ΔV_y are then used in the Long_SPD 605 and Lat_SPD 707 blocks respectively to command the pitch and roll attitudes needed to minimize the relative groundspeed difference during the flat turn.

Referring now to Figure 9 in the drawings, control law logic 901 for the CVPT mode is shown. Control law logic 901 comprises one or more of latch 903, latch 905, and latch 907 adapted to control when a mode is turned on or off. If the reset conditions are met, then the mode will always be off. If the reset conditions are not met, then the mode will be latched on when the set conditions are met. The CVPT mode will be reset whenever lateral speed hold, depicted as block 909 "Lat_SPD_ON" or a longitudinal speed hold, depicted as block 911 "Long_SPD_ON" are not on and will be set when the directional controller is out of detent.

Both longitudinal speed hold latch 905 and lateral speed hold latch 907 will be reset when their respective controller is out of detent. Additionally, the lateral speed hold latch 907 will be reset when the banked turn (Bank_Turn_ON) or crab hold (Crab_ON) modes are on, or if forward speed exceeds the CVPT threshold (typically around 35 KGS). The longitudinal and lateral speed hold latches will be set when their respective acceleration falls below the acceleration threshold (typically around 2 ft/sec²).

Referring now to Figure 10 in the drawings, a control law flow chart 1001 for a CVFT is presented. When the directional controller is initially moved out of detent, the CVPT mode will be engaged. The longitudinal and lateral speed hold blocks (Long_SPD 605 and Lat_SPD 707) will be reinitialized to feedback the relative groundspeed differences calculated in equations 2 and 3. Once the directional controller is returned to detent following the CVFT, directional control laws will hold heading by re-engaging the Dir_HDG 805 loop. The longitudinal and lateral axes will continue to hold a constant ground vector until the pilot commands a change by moving either the longitudinal or lateral controller out of detent. This design enables the pilot to command and hold any crab angle around the 360 degree circle, while the aircraft continues to move across the ground on a constant vector. As shown, when the pedal stops, if the crab angle equals 0 degrees, then aircraft 201 travels in pure forward flight; if the crab angle is 90 degrees, aircraft 201 travels in pure right side flight; if the crab

angle is 180 degrees, then aircraft 201 travels in pure aft flight; and, if the crab angle is 270 degrees, then aircraft 201 travels in pure left sideward flight.

5 The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. It is therefore evident that the particular embodiments disclosed above may be altered or modified, and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the description. It is apparent that an invention with significant advantages has been described and illustrated. Although the present invention is shown in a limited number of forms, it is not limited to just these forms, but is amenable to various changes and modifications without departing from the spirit thereof.

10

Claims

1. An aircraft, comprising:

a sensor carried by the aircraft, the sensor being adapted to sense a directional movement of the aircraft;

5 an actuator carried by the aircraft, the actuator being utilized to control the directional movement of the aircraft; and

a control system in data communication with the aircraft sensor and operably associated with the actuator, the control system having:

10 a model adapted to decouple the directional movement of the aircraft into a lateral equation of motion and a longitudinal equation of motion;

a lateral control architecture in data communication with the model, the lateral control architecture being adapted to utilize the lateral equation of motion to control the lateral motion of the aircraft;

15 a longitudinal control architecture in data communication with the model, the longitudinal control architecture adapted to utilize the longitudinal equation of motion to control the longitudinal motion of the aircraft; and

an initialization command logic in data communication with the lateral control architecture and in data communication with the longitudinal control architecture;

20 wherein the initialization command logic selectively activates the lateral control architecture for controlling the lateral motion of the aircraft and selectively activates the longitudinal control architecture for controlling the longitudinal motion of the aircraft; and

25 wherein the control system utilizes the lateral control architecture and the longitudinal control architecture to control speed variations of the aircraft while the aircraft maintains a constant vector heading across a ground surface.

2. The aircraft of claim 1, the aircraft further comprising:
a directional controller, the directional controller being manipulated by a pilot controlling the aircraft, the directional controller being in data communication with the control system.

3. The aircraft of claim 2, the directional control architecture comprising:
a directional heading control loop;
a directional turn coordination control loop; and
a directional yaw rate control loop.

4. The aircraft of claim 2, further comprising:
a directional control latch in data communication with the directional control architecture;
wherein, as the directional controller is moved out of a detent position, the directional control latch activates a constant vector flat turn motion.

5. The aircraft of claim 1, the lateral control architecture comprising:
a lateral sideward groundspeed control loop;
a lateral roll attitude control loop; and
a lateral roll rate control loop.

6. The aircraft of claim 5, further comprising:
a lateral controller carried by the aircraft, the lateral controller being manipulated by a pilot controlling the aircraft, the lateral controller creating a lateral command in data communication with the lateral sideward groundspeed control loop, the lateral roll attitude control loop, and the lateral roll rate control loop.

7. The aircraft of claim 6, further comprising:
a lateral control latch in data communication with the control system;

wherein, as the lateral controller is moved out of a detent position, the lateral control latch resets a lateral speed hold.

8. The aircraft of claim 1, the longitudinal control architecture comprising:

a longitudinal forward speed control loop;
a longitudinal pitch angle control loop; and
a longitudinal pitch rate control loop.

9. The aircraft of claim 8, the longitudinal control architecture further comprising:

a longitudinal controller carried by the aircraft, the longitudinal controller being manipulated by a pilot controlling the aircraft, the longitudinal controller creating a longitudinal command in data communication with the longitudinal forward speed control loop, the longitudinal pitch angle control loop, and the longitudinal pitch rate control loop.

10. The aircraft of claim 9, further comprising:

a longitudinal control latch in data communication with the control system;
wherein, as the longitudinal controller is moved out of a detent position, the longitudinal control latch resets a longitudinal speed hold.

11. A method to control flat yawing turns of an aircraft while maintaining a constant vector heading across a ground surface, the method comprising:

sensing the speed variation of the aircraft with a sensor carried by the aircraft, the speed variation having:

a longitudinal direction of motion; and
a lateral direction of motion;

controlling the speed variation of the aircraft with actuators operably associated with the aircraft;

providing a control system in data communication with the aircraft sensor and operably associated with the actuators, the control system having:

a model;

a lateral control architecture;

a longitudinal control architecture; and

an initialization command logic in data communication with the lateral
control architecture and in data communication with the longitudinal control
architecture;

decoupling the directional movement of the aircraft into the lateral equation of
motion and the longitudinal equation of motion with the model;

controlling the lateral direction of motion with a lateral control architecture, the
lateral control architecture utilizing the lateral equation of motion;

controlling the longitudinal direction of motion with a longitudinal control
architecture, the longitudinal control architecture utilizing the longitudinal equation of
motion; and

selectively activating the lateral control architecture and the longitudinal control
architecture with the initialization command logic;

wherein the control system receives sensed speed variation data from the sensor
and operably controls the actuators, thus providing selective control of the yawing turns
of the aircraft while maintaining a constant vector across a ground surface.

12. The method of claim 11, the method further comprising:

commanding the flat yawing turns with a directional controller manipulated by a
pilot controlling the aircraft, the directional controller being operably associated with a
directional control architecture, the directional control architecture being in data
communication with the control system.

13. The method of claim 12, wherein the commanding of the flat yawing turns with
the directional control architecture comprises:

communicating data through a directional heading control loop;

communicating data through a directional turn coordination control loop; and

communicating data through a directional yaw rate control loop.

14. The method of claim 12, further comprising:

activating the constant vector flat turn with a directional control latch as the directional controller is moved out of a detent position, the directional control latch being operably associated with the directional control architecture.

15. The method of claim 11, wherein controlling the lateral direction of motion with the lateral control architecture comprises:

communicating lateral motion data through a lateral sideward groundspeed control loop;

communicating lateral motion data through a lateral roll attitude control loop; and

communicating lateral motion data through a lateral roll rate control loop.

16. The method of claim 11, further comprising:

controlling the lateral direction of motion with a lateral controller manipulated by a pilot controlling the aircraft, the lateral controller being operably associated with the lateral control architecture.

17. The aircraft of claim 16, further comprising:

resetting a lateral speed hold with a lateral control latch as the lateral controller is moved out of a detent position, the lateral control latch being in data communication with the lateral control architecture.

18. The method of claim 17, wherein controlling the longitudinal direction of motion with the longitudinal control architecture comprises:

communicating longitudinal motion data through a longitudinal forward speed control loop;

communicating longitudinal motion data through a longitudinal pitch angle control loop; and

communicating longitudinal motion data through a longitudinal pitch rate control loop.

5 19. The aircraft of claim 11, the longitudinal control architecture further comprising:
 controlling the longitudinal direction of motion with a longitudinal controller
manipulated by a pilot controlling the aircraft, the longitudinal controller being operably
associated with the longitudinal control architecture.

10 20. The aircraft of claim 19, further comprising:
 resetting a longitudinal speed hold with a longitudinal control latch as the
longitudinal controller is moved out of a detent position, the longitudinal control latch
being in data communication with the longitudinal control architecture.

15

FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

Abstract

5 An aircraft and method to control flat yawing turns of the aircraft while maintaining
a constant vector across a ground surface. The aircraft includes a control system in
data communication with control actuators, a lateral control architecture, a longitudinal
control architecture, and an initialization command logic. The lateral control architecture
controls the aircraft in the lateral direction, while the longitudinal control architecture
controls the aircraft in the longitudinal direction. The initialization command logic
10 automatically activates the lateral control architecture and the longitudinal control
architecture to maintain a constant vector across the ground whenever a directional
control input is made at low speed.

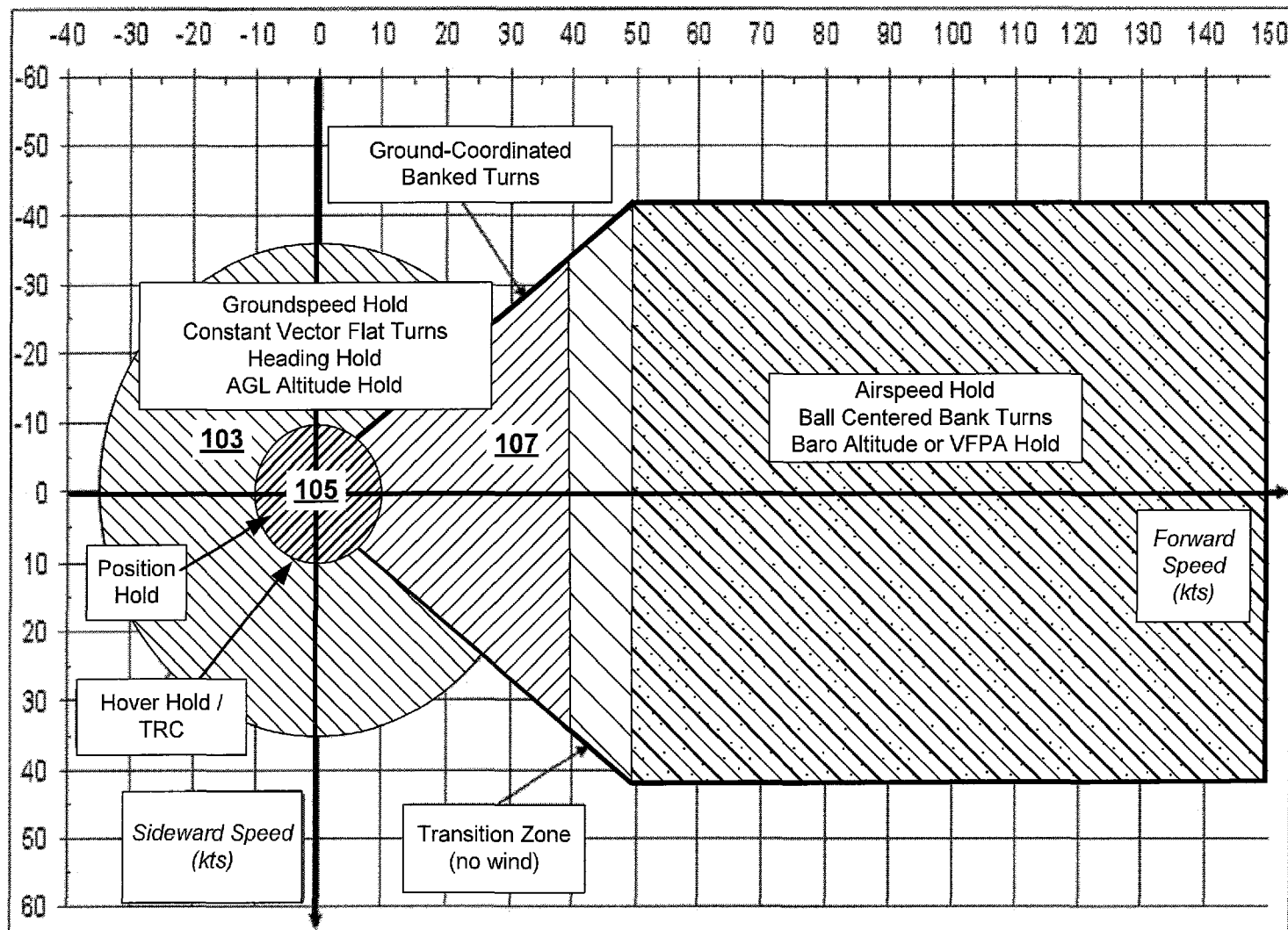


FIG. 1

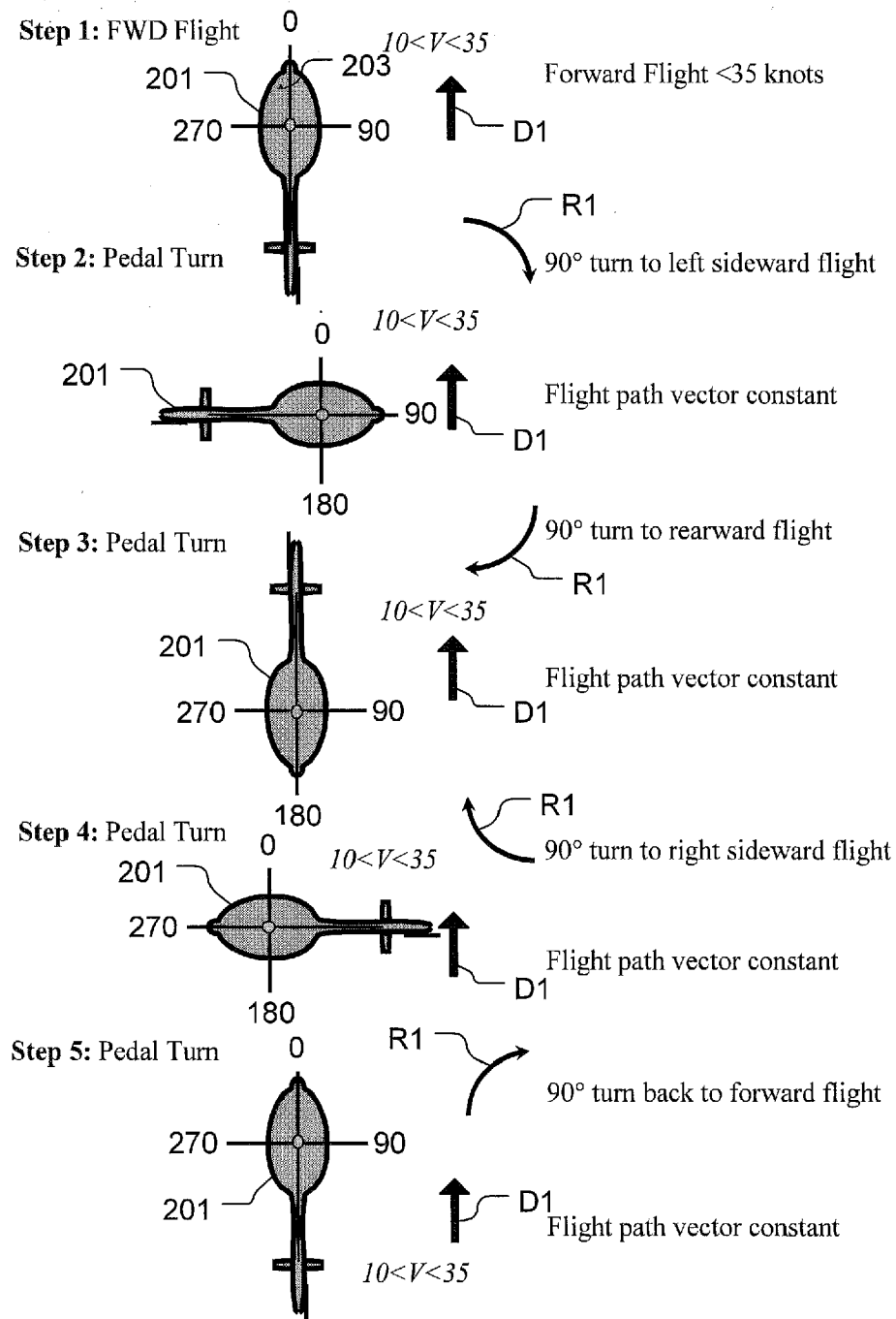


FIG. 2

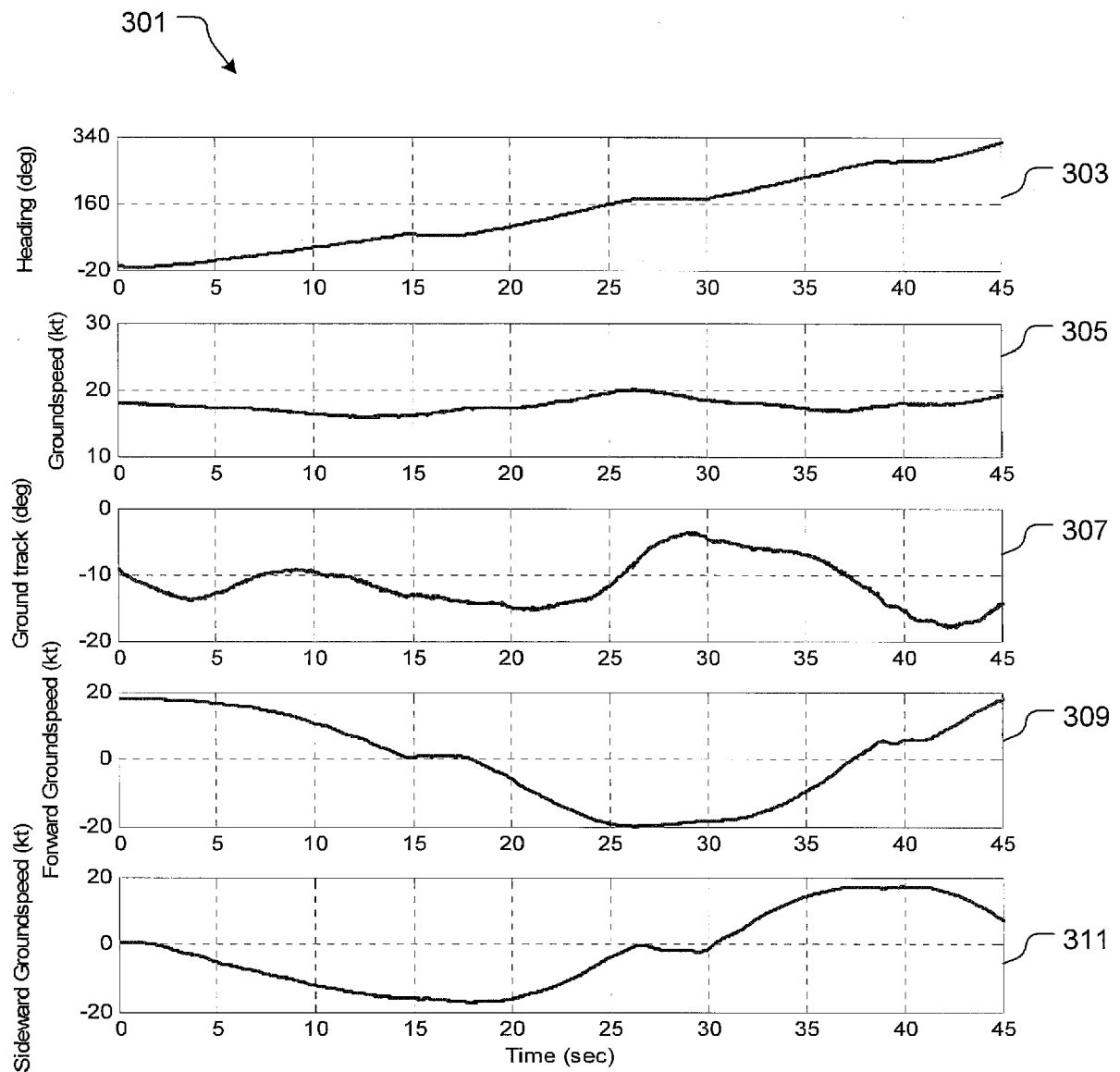


FIG. 3

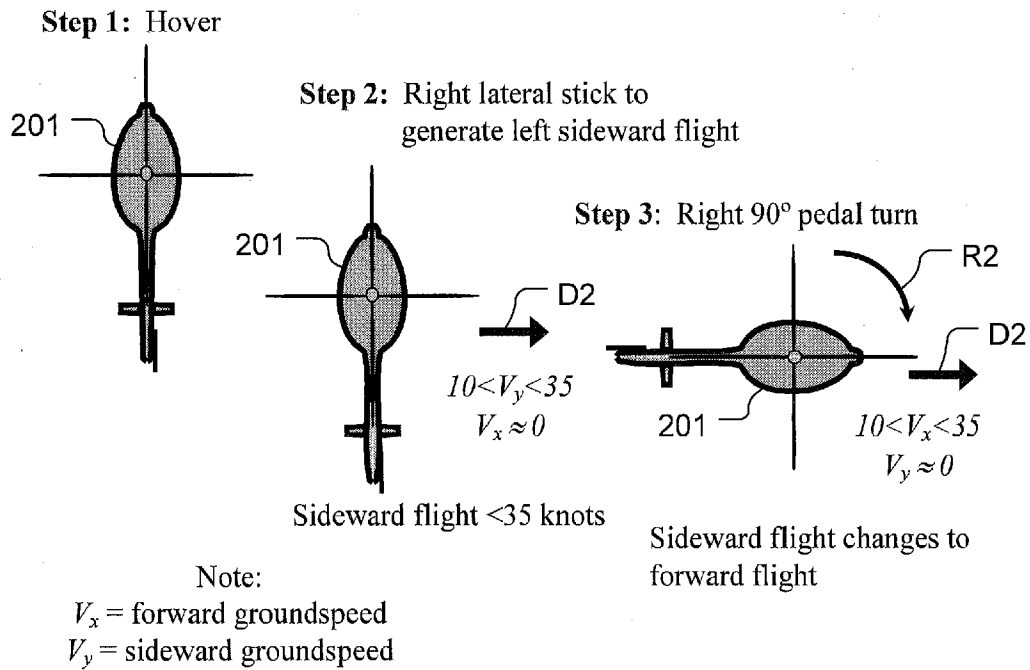


FIG. 4

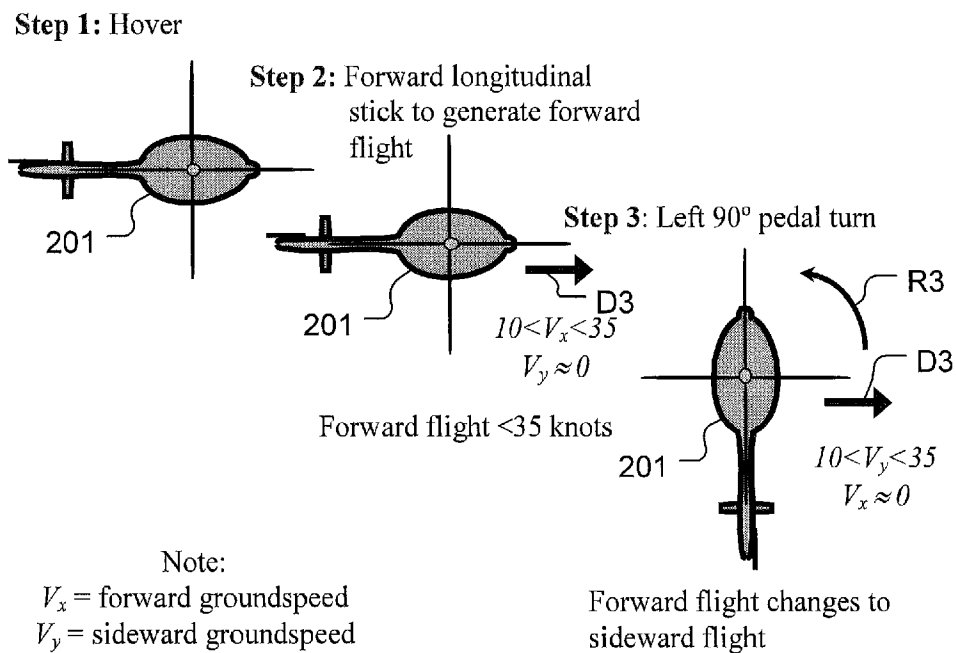
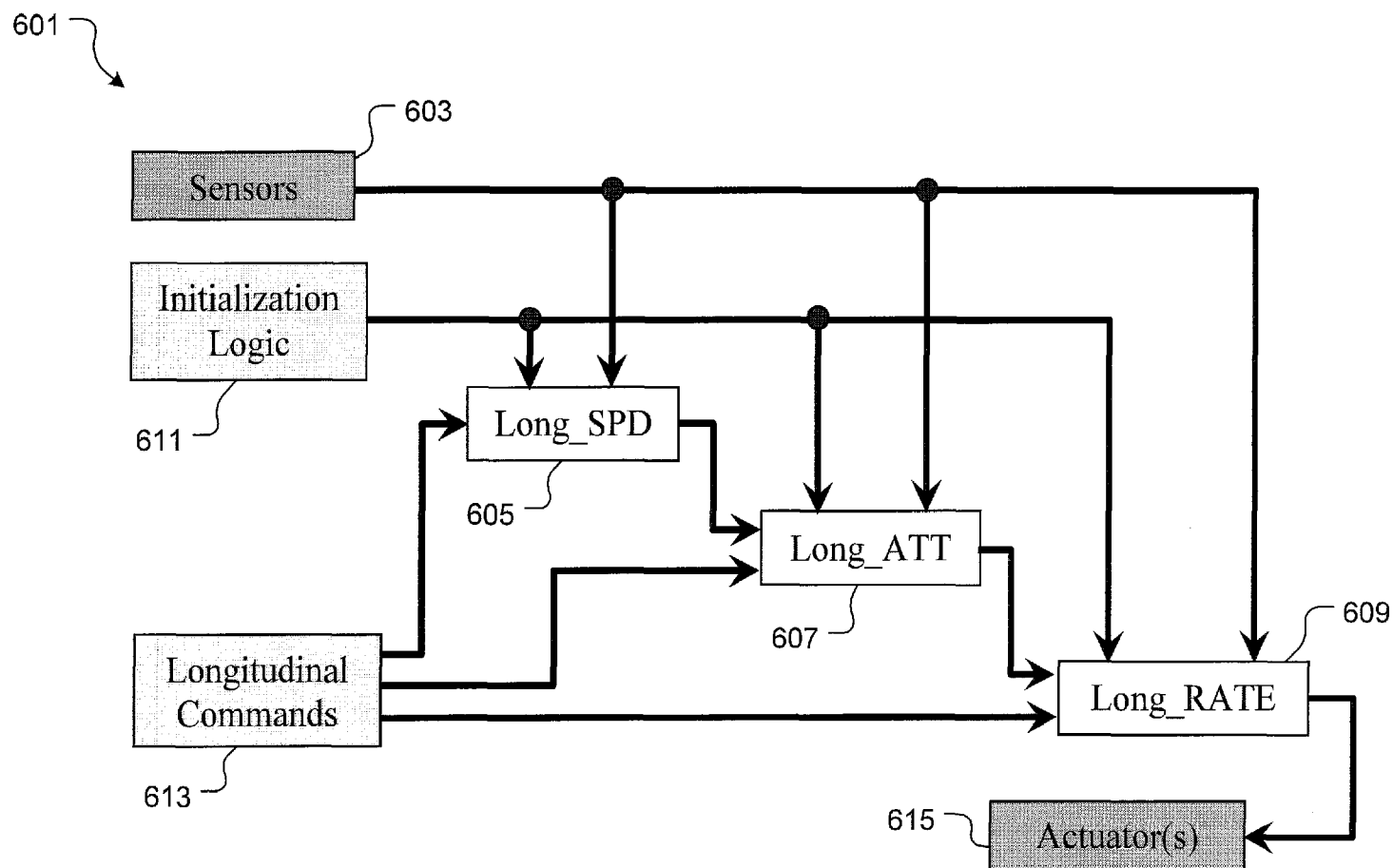
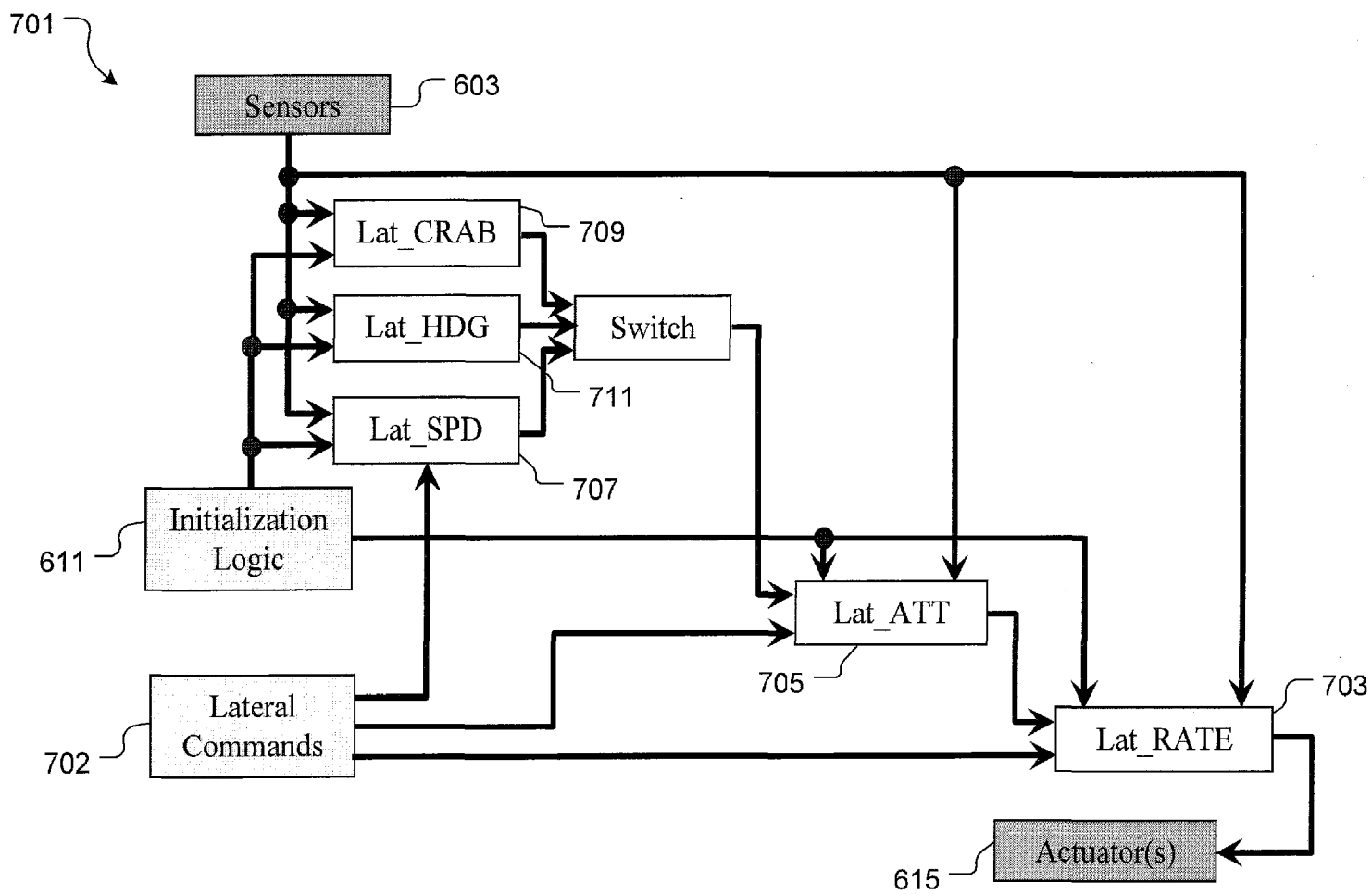


FIG. 5



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FIG. 6



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FIG. 7

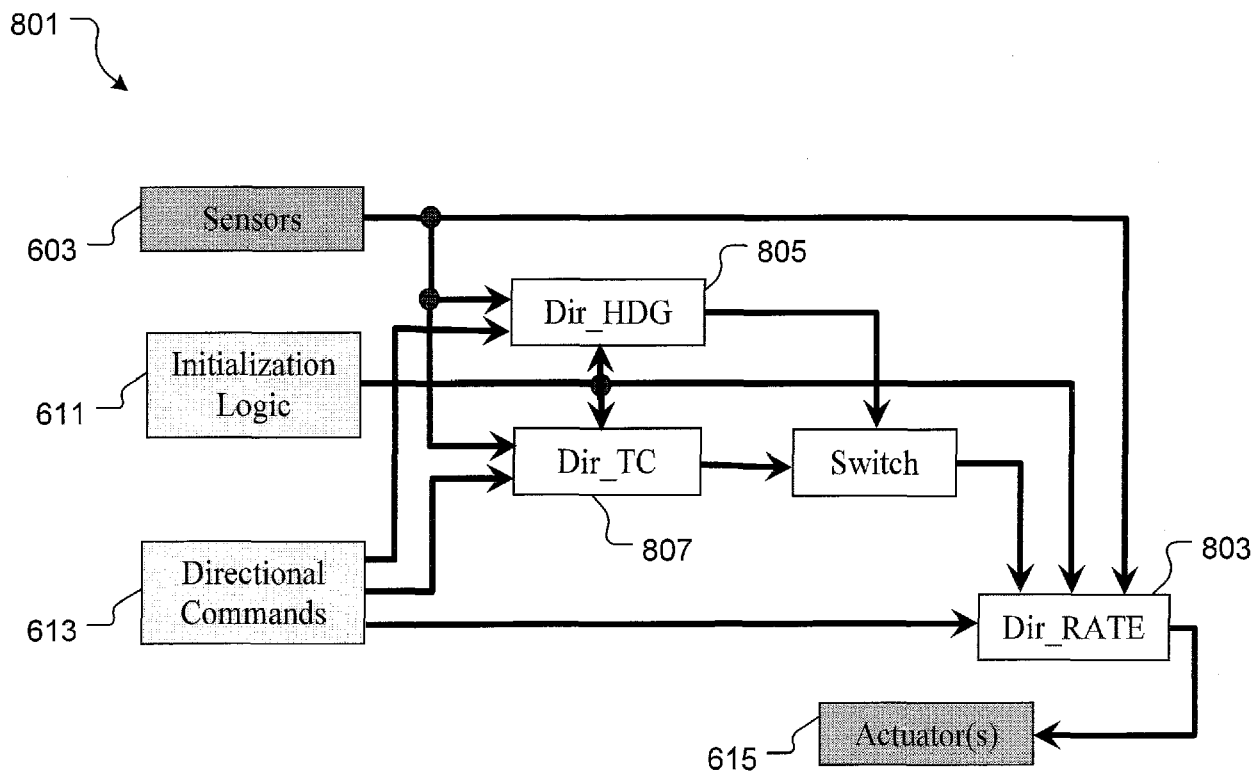


FIG. 8

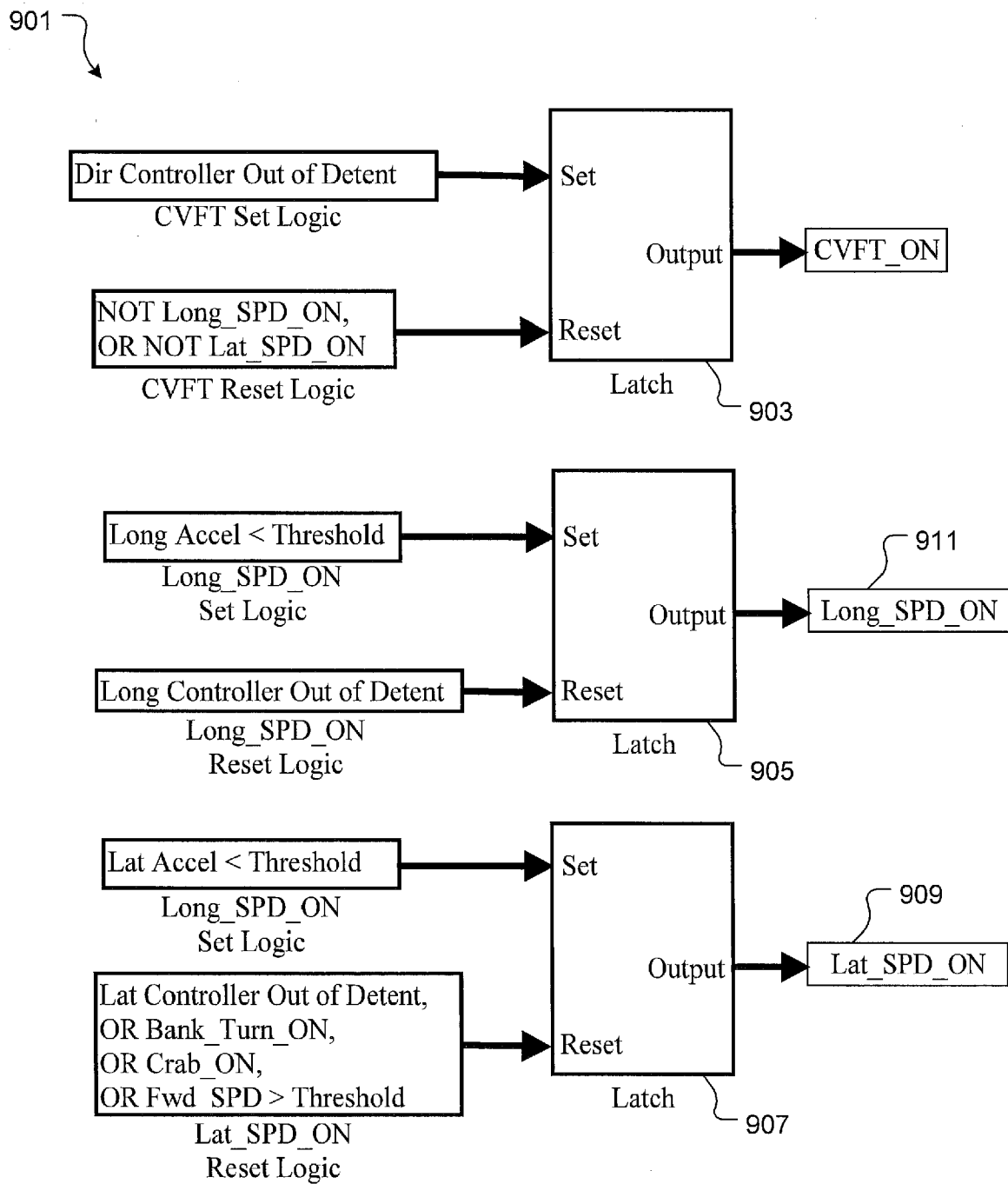


FIG. 9

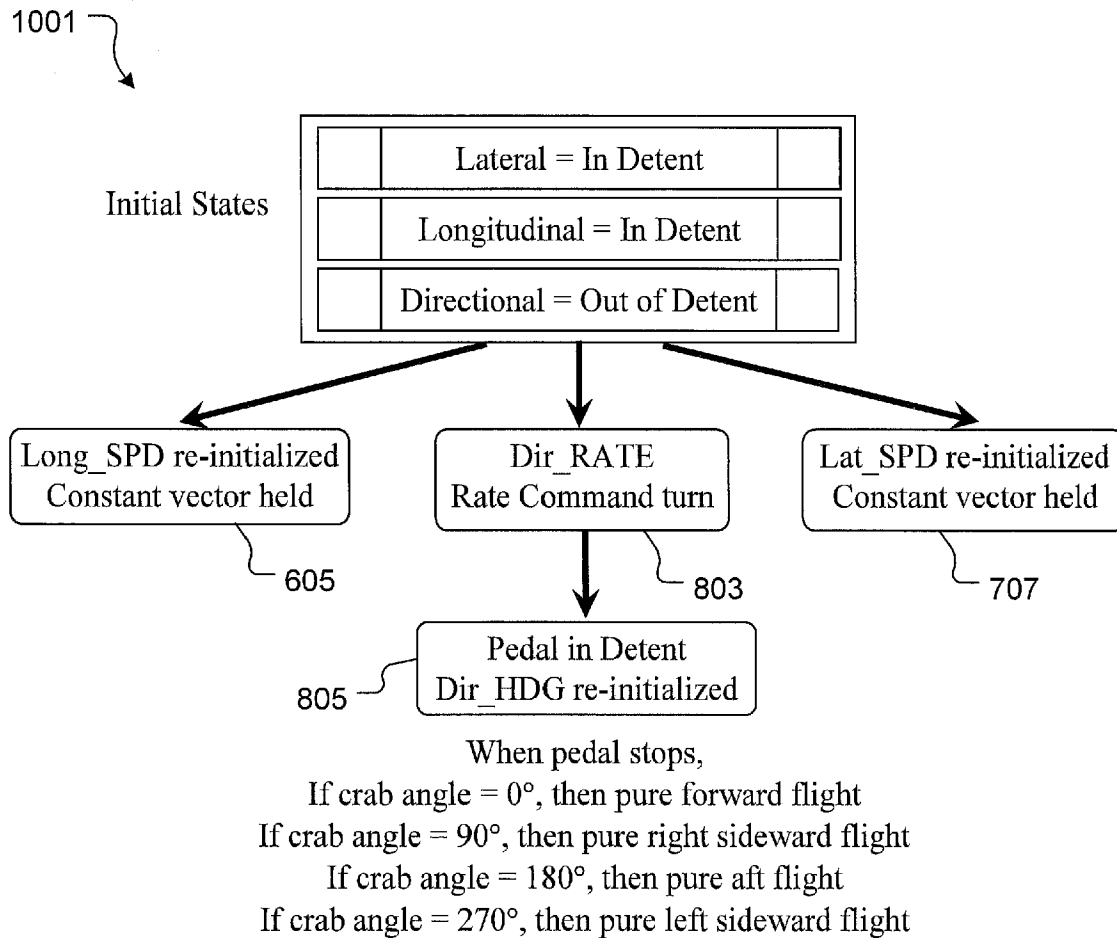


FIG. 10

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	KEVIN T. CHRISTENSEN	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	0837RF-H793-US	

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Application Number		
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First Named Inventor	KEVIN T. CHRISTENSEN	
Art Unit		
Examiner Name		
Attorney Docket Number	0837RF-H793-US	

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	1	International Search Report and the Written Opinion of the International Searching Authority mailed by ISA/USA, U.S. Patent and Trademark Office on 26 August 2011 for corresponding International Patent Application No. PCT/US2011/030498, 7 pages.	☐

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Application Number	
Filing Date	
First Named Inventor	KEVIN T. CHRISTENSEN
Art Unit	
Examiner Name	
Attorney Docket Number	0837RF-H793-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/jamesewaltonpat/	Date (YYYY-MM-DD)	2012-02-21
Name/Print	James E. Walton	Registration Number	47,245

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: JAMES WALTON
LAW OFFICES OF JAMES E. WALTON, P.L.L.C
1169 N. BURLESON BLVD., SUITE 107-328
BURLESON, TX 76028

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 0837RF-H793P	Date of mailing (day/month/year) 26 AUG 2011
International application No. PCT/US2011/030498	International filing date (day/month/year) 30 March 2011
Applicant BELL HELICOPTER TEXTRON INC.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes
1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90bis.1 and 90bis.3).

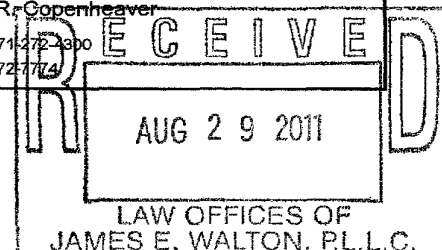
Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer Blaine R. Gopenheaver PCT Helpdesk: 571-272-1300 Telephone No. PCT OSP: 571-272-1774
---	--

Form PCT/ISA/220 (July 2010)



PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 0837RF-H793P	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2011/030498	International filing date (<i>day/month/year</i>) 30 March 2011	(Earliest) Priority Date (<i>day/month/year</i>)
Applicant BELL HELICOPTER TEXTRON INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of:

- ☒ the international application in the language in which it was filed.
☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

- ☒ the text is approved as submitted by the applicant.
☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

- ☒ the text is approved as submitted by the applicant.
☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

- a. the figure of the **drawings** to be published with the abstract is Figure No. 7
☒ as suggested by the applicant.
☐ as selected by this Authority, because the applicant failed to suggest a figure.
☐ as selected by this Authority, because this figure better characterizes the invention.
- b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2011/030498

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G05D 1/10 (2011.01)

USPC - 701/3

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)

IPC(8) - F02C 3/10, 9/28; G05D 1/00, 1/02, 1/10; G06F 7/00, 19/00 (2011.01)

USPC - 244/3.21, 76, 164; 701/1, 3, 4, 7, 10, 301

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

ECLA - B64C 13/16; G05D 1/06B2B, 1/10B

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

Patbase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008/0234881 A1 (CHEREPINSKY et al) 25 September 2008 (25.09.2008) entire document	1-20
A	WO 2007/018572 A2 (SHUE et al) 15 February 2007 (15.02.2007) entire document	1-20
A	US 2003/0191561 A1 (VOS) 09 October 2003 (09.10.2003) entire document	1-20

☐ Further documents are listed in the continuation of Box C.

* 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

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

09 August 2011

Date of mailing of the international search report

26 AUG 2011

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

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: JAMES WALTON
LAW OFFICES OF JAMES E. WALTON,
P.L.L.C
1169 N. BURLESON BLVD., SUITE 107-328
BURLESON, TX 76028

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year)

26 AUG 2011

Applicant's or agent's file reference
0837RF-H793P

FOR FURTHER ACTION

See paragraph 2 below

International application No.

PCT/US2011/030498

International filing date (day/month/year)

30 March 2011

Priority date (day/month/year)

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

IPC(8) - G05D 1/10 (2011.01)

USPC - 701/3

Applicant **BELL HELICOPTER TEXTRON INC.**

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

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

Date of completion of this opinion

09 August 2011

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2011/030498

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
☒ the international application in the language in which it was filed.
☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. ☐ This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a)).
3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:
 - a. (means)
☐ on paper
☐ in electronic form
 - b. (time)
☐ in the international application as filed
☐ together with the international application in electronic form
☐ subsequently to this Authority for the purposes of search
4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US2011/030498

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	None	NO
Inventive step (IS)	Claims	1-20	YES
	Claims	None	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-20 meet the criteria set out in PCT Article 33(2)-(3) because the prior art does not teach or fairly suggest certain subject matter in the claims, as follows:

As to Claim 1, the prior art of record, individually or in combination, does not teach or fairly suggest an aircraft, comprising a sensor carried by the aircraft, the sensor being adapted to sense a directional movement of the aircraft; an actuator carried by the aircraft, the actuator being utilized to control the directional movement of the aircraft; and a control system in data communication with the aircraft sensor and operably associated with the actuator, the control system having: a model adapted to decouple the directional movement of the aircraft into a lateral equation of motion and a longitudinal equation of motion; a lateral control architecture in data communication with the model, the lateral control architecture being adapted to utilize the lateral equation of motion to control the lateral motion of the aircraft; a longitudinal control architecture in data communication with the model, the longitudinal control architecture adapted to utilize the longitudinal equation of motion to control the longitudinal motion of the aircraft; and an initialization command logic in data communication with the lateral control architecture and in data communication with the longitudinal control architecture; wherein the initialization command logic selectively activates the lateral control architecture for controlling the lateral motion of the aircraft and selectively activates the longitudinal control architecture for controlling the longitudinal motion of the aircraft; and wherein the control system utilizes the lateral control architecture and the longitudinal control architecture to control speed variations of the aircraft while the aircraft maintains a constant vector heading across a ground surface.

As to Claim 11, the prior art of record, individually or in combination, does not teach or fairly suggest a method to control flat yawing turns of an aircraft while maintaining a constant vector heading across a ground surface, the method comprising sensing the speed variation of the aircraft with a sensor carried by the aircraft, the speed variation having: a longitudinal direction of motion; and a lateral direction of motion; controlling the speed variation of the aircraft with actuators operably associated with the aircraft; providing a control system in data communication with the aircraft sensor and operably associated with the actuators, the control system having: a model; a lateral control architecture; a longitudinal control architecture; and an initialization command logic in data communication with the lateral control architecture and in data communication with the longitudinal control architecture; decoupling the directional movement of the aircraft into the lateral equation of motion and the longitudinal equation of motion with the model; controlling the lateral direction of motion with a lateral control architecture, the lateral control architecture utilizing the lateral equation of motion; controlling the longitudinal direction of motion with a longitudinal control architecture, the longitudinal control architecture utilizing the longitudinal equation of motion; and selectively activating the lateral control architecture and the longitudinal control architecture with the initialization command logic; wherein the control system receives sensed speed variation data from the sensor and operably controls the actuators, thus providing selective control of the yawing turns of the aircraft while maintaining a constant vector across a ground surface.

Claims 2-10 and 12-20 depend from base Claims 1 and 11, respectively, and therefore have novelty for at least the same reasons as do base Claim 1 and 11.

(Continued in Supplemental Box)

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

Box V

The following prior art is made of record to support and further define the reasons for allowance of base Claims 1 and 22:

(i) Cherepinsky et al. disclose an aircraft (fig. 1), comprising: a sensor carried by the aircraft (32 fig. 3), the sensor being adapted to sense a directional movement of the aircraft (sensor 32 output includes vertical acceleration 94 and vertical velocity, fig. 3); an actuator carried by the aircraft (servos 50 and tail rotor servos 54, fig. 2), the actuator being utilized to control the directional movement of the aircraft (servos control main rotor 12 and tail rotor 14, fig. 2 para. [0032]); and a control system (flight control system 16, fig. 3) in data communication with the aircraft sensor and operably associated with the actuator (para. [0030] Referring to Fig. 2, the flight control system 16 includes ... includes a Primary Flight Control System (PFCS) 22 and a Flight Augmentation and Cueing System (FACS) 24. The PFCS and FACS each receive the force output command signals of a collective controller 18 on line 20, a cyclic controller 28 on lines 30, and the aircraft's sensed parameter signals from sensors 32, on lines 34), the control system having: a model (para. [0030] Referring to Fig. 2, the flight control system 16 includes a model following control system which shapes the pilot's controller and displacement commands through an inverse vehicle model to produce the desired aircraft response). Cherepinsky et al. does not teach, either alone or in combination with the prior art of record, a model is adapted to decouple the directional movement of the aircraft into a lateral equation of motion and a longitudinal equation of motion; a lateral control architecture in data communication with the model, the lateral control architecture being adapted to utilize the lateral equation of motion to control the lateral motion of the aircraft; a longitudinal control architecture in data communication with the model, the longitudinal control architecture adapted to utilize the longitudinal equation of motion to control the longitudinal motion of the aircraft; and an initialization command logic in data communication with the lateral control architecture and in data communication with the longitudinal control architecture; wherein the initialization command logic selectively activates the lateral control architecture for controlling the lateral motion of the aircraft and selectively activates the longitudinal control architecture for controlling the longitudinal motion of the aircraft; and wherein the control system utilizes the lateral control architecture and the longitudinal control architecture to control speed variations of the aircraft while the aircraft maintains a constant vector heading across a ground surface.

(ii) Shue et al. disclose a model (represented by in flowchart form in fig. 5) related to flight control of an aircraft (pg. 1, Ins. 4-6) adapted to decouple (block 29 separates into longitudinal motion 31 and lateral motion 37 components, fig. 5) a directional movement of the aircraft (equation 1, pg. 11, models an aircraft based on airspeed, pg. 11, Ins. 12-13) into a lateral equation of motion (equation 2, pg. 12) and a longitudinal equation of motion (equation 3, pg. 12); a lateral control architecture (lateral LQR 39, fig. 5 and pg. 11, Ins. 5-6, is a linear quadratic regulator as described on pg. 12, Ins. 13-17) in data communication with the model (lateral motion component 37 is in communication with model of fig. 5), the lateral control architecture being adapted to utilize the lateral equation of motion (lateral motion component 37 is an input for lateral LQR 39, fig. 5) to control the lateral motion of the aircraft (the LQR method of fig. 5 is what is used in the LQR feedback block of fig. 1, the result of which goes to outputs block of flight control system in fig. 1); a longitudinal control architecture (longitudinal LQR 33, fig. 5 and pg. 11, Ins. 6-8, is a linear quadratic regulator as described on pg. 12, Ins. 13-17) in data communication with the model (longitudinal motion component 31 is in communication with model of fig. 5), the longitudinal control architecture adapted to utilize the longitudinal equation of motion (longitudinal motion component 31 is an input for longitudinal LQR 33, fig. 5) to control the longitudinal motion of the aircraft (the LQR method of fig. 5 is what is used in the LQR feedback block of fig. 1, the result of which goes to outputs block of flight control system in fig. 1). Shue et al. does not teach, either alone or in combination with the prior art of record an initialization command logic in data communication with the lateral control architecture and in data communication with the longitudinal control architecture; wherein the initialization command logic selectively activates the lateral control architecture for controlling the lateral motion of the aircraft and selectively activates the longitudinal control architecture for controlling the longitudinal motion of the aircraft; and wherein the control system utilizes the lateral control architecture and the longitudinal control architecture to control speed variations of the aircraft while the aircraft maintains a constant vector heading across a ground surface.

Claims 1-20 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Electronic Patent Application Fee Transmittal

Application Number:

Filing Date:

Title of Invention:

Flight Control Laws for Constant Vector Flat Turns

First Named Inventor/Applicant Name:

Kevin T. Christensen

Filer:

James Edward Walton

Attorney Docket Number:

0837RF-H793-US

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
National Stage Fee	1631	1	380	380
Natl Stage Search - U.S. as IPE or ISA	1640	1	0	0
National Stage Exam Fee - U.S. was IPEA	1643	1	0	0

Pages:

Claims:

Miscellaneous-Filing:

Petition:

Patent-Appeals-and-Interference:

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				380

Electronic Acknowledgement Receipt

EFS ID:	12122824
Application Number:	13391522
International Application Number:	PCT/US11/30498
Confirmation Number:	6391
Title of Invention:	Flight Control Laws for Constant Vector Flat Turns
First Named Inventor/Applicant Name:	Kevin T. Christensen
Customer Number:	38441
Filer:	James Edward Walton
Filer Authorized By:	
Attorney Docket Number:	0837RF-H793-US
Receipt Date:	21-FEB-2012
Filing Date:	
Time Stamp:	16:14:10
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$380
RAM confirmation Number	3484
Deposit Account	502806
Authorized User	WALTON,JAMES E

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		NationalStageApplication20120221.pdf	1283530 b091e03bdbc00a5cde2c685aed35792696e31b0f	yes	17
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Miscellaneous Incoming Letter		1	2	
	Documents submitted with 371 Applications		3	5	
	Application Data Sheet		6	9	
	Documents submitted with 371 Applications		10	12	
	Transmittal Letter		13	14	
	Information Disclosure Statement (IDS) Form (SB08)		15	17	
Warnings:					
Information:					
2	Non Patent Literature	ISRandWOISA20110826.pdf	617328 4f49860ebe9122216262e6571bd3ecdb6a56dff0e	no	7
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32907 a0ff96999dc8a1e6239a85b25a5ec910e03de2fa	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			1933765		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No. 0837RF-H793-US

In Re Application of:

KEVIN T. CHRISTENSEN, ET AL.

Serial No: **TO BE ASSIGNED**

Filed: **HEREWITH**

For: **FLIGHT CONTROL LAWS FOR
CONSTANT VECTOR FLAT TURNS**

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§
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§
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§
§
§

Examiner: **TO BE ASSIGNED**

Art Unit: **TO BE ASSIGNED**

Conf. No.: **TO BE ASSIGNED**

TRANSMITTAL

Filed via EFS-Web

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

Please file the following enclosed documents in the subject National-Stage application:

1. This Transmittal with Certificate of Transmission;
2. Form PTO-1390;
3. Application Data Sheet;
4. Copy of Declaration that was filed in parent PCT application;
5. Information Disclosure Statement; and
6. Form PTO/SB/08a, along with a copy of the non-patent literature document.

CERTIFICATE OF TRANSMISSION UNDER 37 C.F.R. § 1.8(a)(1)(i)(C)

Date of Transmission: 2/21/12

I hereby certify that this correspondence is being transmitted to the U.S. Patent and Trademark Office (USPTO) via the USPTO electronic filing system (EFS-Web) on the date shown above.

By: _____


James E. Walton

The foregoing documents are being filed via the U.S. Patent and Trademark Office's EFS-Web electronic filing system, and the requisite fees are being paid via a designated credit card. No other fees are deemed to be necessary; however, the Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayments, to **Deposit Account No. 502806**.

Please link this application to Customer No. 38441, so that its status may be accessed via the PAIR System.

Respectfully submitted,

2/21/12
Date


James E. Walton
Registration No. 47,245
Law Offices of James E. Walton, P.L.L.C.
1169 N. Burleson Blvd., Suite 107-328
Burleson, Texas 76028
(817) 447-9955 (Voice)
(817) 447-9954 (Facsimile)
jim@waltonpllc.com (Email)

CUSTOMER NO. 38441

ATTORNEY FOR APPLICANT

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER 0837RF-H793-US U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
INTERNATIONAL APPLICATION NO. PCT/US2011/030498	INTERNATIONAL FILING DATE 30 MARCH 2011	PRIORITY DATE CLAIMED
TITLE OF INVENTION FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS		
APPLICANT(S) FOR DO/EO/US KEVIN T. CHRISTENSEN		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. ☒ This is a FIRST submission of items concerning a submission under 35 U.S.C. 371. 2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a submission under 35 U.S.C. 371. 3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below. 4. ☒ The US has been elected (Article 31). 5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)) a. ☐ is attached hereto (required only if not communicated by the International Bureau). b. ☐ has been communicated by the International Bureau. c. ☒ is not required, as the application was filed in the United States Receiving Office (RO/US). 6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). a. ☐ is attached hereto. b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4). 7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) a. ☐ are attached hereto (required only if not communicated by the International Bureau). b. ☐ have been communicated by the International Bureau. c. ☐ have not been made; however, the time limit for making such amendments has NOT expired. d. ☒ have not been made and will not be made. 8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (As filed with PCT Request in parent application) 10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).		
Items 11 to 20 below concern document(s) or information included:		
11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 13. ☐ A preliminary amendment. 14. ☒ An Application Data Sheet under 37 CFR 1.76. 15. ☐ A substitute specification. 16. ☐ A power of attorney and/or change of address letter. 17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.3 and 37 CFR 1.821- 1.825. 18. ☐ A second copy of the published International Application under 35 U.S.C. 154(d)(4). 19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).		

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering information, preparing, and submitting the completed form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEE S OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)		INTERNATIONAL APPLICATION NO. PCT/US2011/030498		ATTORNEY'S DOCKET NUMBER 0837RF-H793-US	
20. Other items or information:					
The following fees have been submitted				CALCULATIONS PTO USE ONLY	
21. ☒ Basic national fee (37 CFR 1.492(a))..... \$330				\$ 380.00	
22. ☒ Examination fee (37 CFR 1.492(c))				\$ 0.00	
If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... \$0					
All other situations..... \$220					
23. ☒ Search fee (37 CFR 1.492(b))				\$ 0.00	
If the written opinion of the ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... \$0					
Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority..... \$100					
International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB..... \$430					
All other situations..... \$540					
TOTAL OF 21, 22 and 23 =				380.00	
☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). The fee is \$270 for each additional 50 sheets of paper or fraction thereof.					
Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof (round up to a whole number)	RATE		
- 100 =	/50 =		x \$270	\$	
Surcharge of \$130.00 for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$	
Total claims	20 - 20 =	0	x \$ 52	\$ 0.00	
Independent claims	2 - 3 =	0	x \$ 220	\$ 0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$390	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 380.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by 1/2.					
SUBTOTAL =				\$ 380.00	
Processing fee of \$130.00 for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)).				\$	
TOTAL NATIONAL FEE =				\$ 380.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$ 380.00	
				Amount to be refunded:	\$
				Amount to be charged	\$

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

- a. ☐ A check in the amount of \$ _____ to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 502806.
- d. ☒ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.

ADVISORY: If filing by EFS-Web, do **NOT** attach the PTO-2038 form as a PDF along with your EFS-Web submission. Please be advised that this is **not** recommended and by doing so your **credit card information may be displayed via PAIR**. To protect your information, it is recommended paying fees online by using the electronic payment method.

NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

SEND ALL CORRESPONDENCE TO:

JAMES E. WALTON
CUSTOMER NO. 38441

 2/21/12
SIGNATURE
JAMES E. WALTON
NAME
47,245
REGISTRATION NUMBER

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	0837RF-H793-US
		Application Number	
Title of Invention	FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--------------------------	---

Applicant Information:

Applicant 1				
Applicant Authority ☒ Inventor		☐ Legal Representative under 35 U.S.C. 117		☐ Party of Interest under 35 U.S.C. 118
Prefix	Given Name	Middle Name	Family Name	Suffix
	Kevin	Thomas	Christensen	
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service				
City	Plano	State/Province	TX	Country of Residence i US
Citizenship under 37 CFR 1.41(b) i		US		
Mailing Address of Applicant:				
Address 1		3905 Branchwood Drive		
Address 2				
City	Plano	State/Province	TX	
Postal Code	75093	Countryi	US	
Applicant 2				
Applicant Authority ☒ Inventor		☐ Legal Representative under 35 U.S.C. 117		☐ Party of Interest under 35 U.S.C. 118
Prefix	Given Name	Middle Name	Family Name	Suffix
	Shyhyng	Jack	Shue	
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service				
City	Grapevine	State/Province	TX	Country of Residence i US
Citizenship under 37 CFR 1.41(b) i		US		
Mailing Address of Applicant:				
Address 1		2809 Woodland Hills Drive		
Address 2				
City	Grapevine	State/Province	TX	
Postal Code	76051	Countryi	US	
Applicant 3				
Applicant Authority ☒ Inventor		☐ Legal Representative under 35 U.S.C. 117		☐ Party of Interest under 35 U.S.C. 118
Prefix	Given Name	Middle Name	Family Name	Suffix
	Troy	Sheldon	Caudill	
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service				
City	Burleson	State/Province	TX	Country of Residence i US

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	0837RF-H793-US
		Application Number	
Title of Invention	FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS		

Citizenship under 37 CFR 1.41(b) i		US	
Mailing Address of Applicant:			
Address 1	6195 Oak Hollow Drive		
Address 2			
City	Burleson	State/Province	TX
Postal Code	76028	Country	US
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.			

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence information of this application.			
Customer Number	38441		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS		
Attorney Docket Number	0837RF-H793-US	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	9	Suggested Figure for Publication (if any)	1

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐ Request Not to Publish. I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.			
Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	0837RF-H793-US
		Application Number	
Title of Invention	FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS		
Customer Number	38441		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.			
Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/US2011/030498	2011-03-30
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).			
Remove			
Application Number	Country ⁱ	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			☐ Yes ☒ No
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.			
Assignee 1			
If the Assignee is an Organization check here. ☒			
Organization Name	BELL HELICOPTER TEXTRON INC.		
Mailing Address Information:			
Address 1	P.O. BOX 482		
Address 2			
City	FORT WORTH	State/Province	TX
Country ⁱ	US	Postal Code	76101
Phone Number		Fax Number	
Email Address			
Additional Assignee Data may be generated within this form by selecting the Add button.			

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number		0837RF-H793-US	
		Application Number			
Title of Invention	FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS				
Signature	/jamesewaltonpat/			Date (YYYY-MM-DD)	2012-02-21
First Name	James	Last Name	Walton	Registration Number	47245

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)

The declaration must conform to the following standardized wording provided for in Section 214; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (iv). If this Box is not used, this sheet should not be included in the request.

**Declaration of inventorship (Rules 4.17(iv) and 51bis.1(a)(iv))
for the purposes of the designation of the United States of America:**

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/..... (if furnishing declaration pursuant to Rule 26ter).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

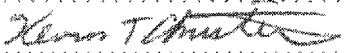
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name: KEVIN THOMAS CHRISTENSEN

Residence: Plano, Texas
(city and either US state, if applicable, or country)

Mailing Address: 3905 Branchwood Drive
Plano, Texas 75093
United States of America

Citizenship: US

Inventor's Signature:  Date: 1/26/2011
(The signature must be that of the inventor, not that of the agent)

Name: SHYHPYNG JACK SHUE

Residence: Grapevine, Texas
(city and either US state, if applicable, or country)

Mailing Address: 2809 Woodland Hills Drive
Grapevine, Texas 76051
United States of America

Citizenship: US

Inventor's Signature: Date:
(The signature must be that of the inventor, not that of the agent)

☒ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iv)".

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)
The declaration must conform to the following standardized wording provided for in Section 214 (see Notes to Box No. VII, VIII (i) to (iv))
in general and the specific Notes to Box No. VII (iv). If this Box is not used, this sheet should not be included in the request.

Declaration of inventorship (Rules 4.1^(iv) and 51 bis.1(a)(iv))
for the purposes of the designation of the United States of America:

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application)

This declaration is directed to international application No. PCT/..... (if furnishing declaration pursuant to Rule 26ter).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

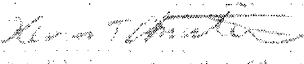
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name: KEVIN THOMAS CHRISTENSEN

Residence: Plano, Texas
 (city and either US state, if applicable, or country)

Mailing Address: 3905 Branchwood Drive
 Plano, Texas 75093
 United States of America

Citizenship: US

Inventor's Signature:  Date: 1/24/2011
 (The signature must be that of the inventor, not that of the agent)

Name: SHYHPYNG JACK SHUE

Residence: Grapevine, Texas
 (city and either US state, if applicable, or country)

Mailing Address: 2809 Woodland Hills Drive
 Grapevine, Texas 76051
 United States of America

Citizenship: US

Inventor's Signature:  Date: Jan 26, 2011
 (The signature must be that of the inventor, not that of the agent)

☒ I, the undersigned, do hereby declare that the above statements are true and correct to the best of my knowledge and belief.

Signature of the undersigned:

Continuation of Box No. VIII (i) to (v) DECLARATION

If the space is insufficient in any of Boxes Nos. VIII (i) to (v) to furnish all the information, including in the case where more than two inventors are to be named in Box No. VIII (iv), in such case, write "Continuation of Box No. VIII ..." (indicate the item number of the Box) and furnish the information in the same manner as required for the purposes of the Box in which the space was insufficient. If additional space is needed in respect of two or more declarations, a separate continuation box must be used for each such declaration. If this Box is not used, this sheet should not be included in the request.

Continuation of Box VIII(iv):

Name: TROY SHELDON CAUDILL

Residence: Burleson, Texas

Mailing Address:

6195 Oak Hollow Drive

Burleson, Texas 76028

United States of America

Citizenship: US

Signature: Troy CaudillDate: 26/11/11

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No. 0837RF-H793-US

In Re Application of:

KEVIN T. CHRISTENSEN, ET AL.

Serial No: TO BE ASSIGNED

Filed: HEREWITH

For: FLIGHT CONTROL LAWS FOR
CONSTANT VECTOR FLAT TURNS

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§
§
§

Examiner: TO BE ASSIGNED

Art Unit: TO BE ASSIGNED

Conf. No.: TO BE ASSIGNED

INFORMATION DISCLOSURE STATEMENT

Filed via EFS-Web

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

Filed herewith is one Form PTO-SB08A listing references that may be material to the patentability of the invention disclosed and claimed in the subject application.

This submission is made pursuant to 37 C.F.R. §§ 1.56 and 1.97(b).

This Information Disclosure Statement is being filed under 37 C.F.R. § 1.97(b)(2) within three months of the date of entry of the national stage.

CERTIFICATE OF TRANSMISSION UNDER 37 C.F.R. § 1.8(a)(1)(i)(C)

Date of Transmission: 2/21/12

I hereby certify that this correspondence is being transmitted to the U.S. Patent and Trademark Office (USPTO) via the USPTO electronic filing system (EFS-Web) on the date shown above.

By:

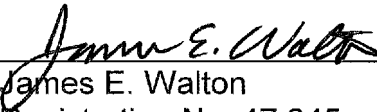
James E. Walton
James E. Walton

The foregoing documents are being filed via the U.S. Patent and Trademark Office's EFS-Web electronic filing system, and the requisite fees are being paid via a designated credit card. No other fees are deemed to be necessary; however, the Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayments, to **Deposit Account No. 502806**.

Please link this application to Customer No. 38441, so that its status may be accessed via the PAIR System.

Respectfully submitted,

2/21/12
Date


James E. Walton
Registration No. 47,245
Law Offices of James E. Walton, P.L.L.C.
1169 N. Burleson Blvd., Suite 107-328
Burleson, Texas 76028
(817) 447-9955 (Voice)
(817) 447-9954 (Facsimile)
jim@waltonpllc.com (Email)

CUSTOMER NO. 38441

ATTORNEY FOR APPLICANT



- (51) International Patent Classification:
G05D 1/10 (2006.01)
- (21) International Application Number:
PCT/US2011/030498
- (22) International Filing Date:
30 March 2011 (30.03.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (71) Applicant (for all designated States except US): **BELL HELICOPTER TEXTRON INC.** [US/US]; P.O. Box 482, Fort Worth, TX 76101 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **CHRISTENSEN, Kevin, Thomas** [US/US]; 3905 Branchwood Drive, Plano, TX 75093 (US). **SHUE, Shyhyng, Jack** [US/US]; 2809 Woodland Hills Drive, Grapevine, TX 76051 (US). **CAU-DILL, Troy, Sheldon** [US/US]; 6195 Oak Hollow Drive, Burleson, TX 76028 (US).
- (74) Agent: **WALTON, James, E.**; Law Offices of James E. Walton, P.L.L.C., 1169 N. Burleson Blvd., Suite 107-328, Burleson, TX 76028 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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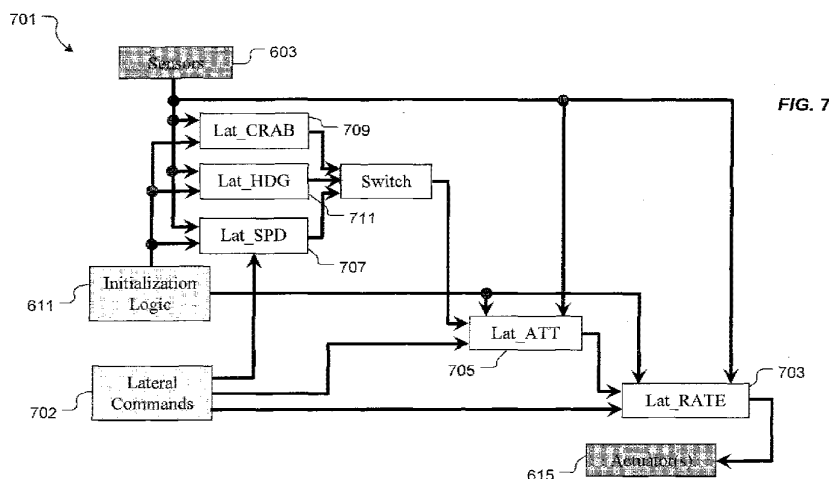


FIG. 7

(57) Abstract: An aircraft and method to control flat yawing turns of the aircraft while maintaining a constant vector across a ground surface. The aircraft includes a control system in data communication with control actuators, a lateral control architecture, a longitudinal control architecture, and an initialization command logic. The lateral control architecture controls the aircraft in the lateral direction, while the longitudinal control architecture controls the aircraft in the longitudinal direction. The initialization command logic automatically activates the lateral control architecture and the longitudinal control architecture to maintain a constant vector across the ground whenever a directional control input is made at low speed.

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FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

Technical Field

The present invention relates generally to flight control systems, and more particularly, to a flight control system having flight control laws which enable precise aircraft maneuvering relative to the ground.

Description of the Prior Art

Aircraft which can hover and fly at low speeds include rotorcraft, such as helicopters and tilt rotors, and jump jets, like the AV-8B Harrier and F-35B Lightning II. These aircraft can spend a large portion of their mission maneuvering relative to the ground. Sometimes, this maneuvering must be conducted in confined spaces around external hazards such as buildings, trees, towers, and power lines.

For traditional flight control systems, ground-referenced maneuvering (GRM) requires the pilot to make constant control inputs in multiple axes in order to counter disturbances caused by wind, as well as to remove the natural coupled response of the aircraft. The pilot workload during such maneuvers can become quite high since the pilot must sense un-commanded aircraft motions and then put in the appropriate control input to eliminate the disturbance. In a worst-case scenario, a pilot might be required to fly GRM in a degraded visual environment. With the lack of visual cues to detect off-axis motion, the pilot might accidentally fly into an external hazard while maneuvering in a confined space.

Traditional flight control law designs do not provide the pilot with an easy way to control aircraft crab angle during GRM. Crab angle is defined as the angle between the aircraft's heading and its actual ground path. With these prior designs, adjusting crab angle while maintaining ground track took considerable pilot concentration, since the pilot had to coordinate inputs to both the lateral and directional controllers.

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Although pilots generally seek to minimize crab angle during GRM, some mission tasks may call for flat yawing turns while maintaining a constant vector across the ground. For example, on a steep approach, the pilot may need to fly with a crab angle so he or she can see the landing zone. Additionally, the pilot may want to quickly transition out of rearward or sideward flight while continuing along the same ground track. In a final example, the pilot may want to acquire and track a point on the ground without having to fly directly towards it. With prior flight control designs, such maneuvers required extraordinary pilot skill to coordinate the aircraft's motions in multiple control axes.

Although the foregoing developments represent great strides in the area of flight control laws, many shortcomings remain.

Brief Description of the Drawings

The novel features believed characteristic of the application are set forth in the appended claims. However, the application itself, as well as a preferred mode of use, and further objectives and advantages thereof, will best be understood with reference to the following detailed description when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a flight envelope with control law modes designed to enable ground reference maneuvers;

Figure 2 is a schematic of an aircraft utilizing a control system according to the preferred embodiment of the present invention;

Figure 3 is a set of plots comprising measured flight data of the aircraft of Fig. 2 while performing constant vector flat turns;

Figure 4 is a schematic view of the aircraft of Fig. 2 changing flight heading from sideward flight to forward flight;

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Figure 5 is a schematic view of the aircraft of Fig. 2 changing flight heading from forward flight to sideward flight;

Figure 6 is a schematic view of the control system architecture for a set of longitudinal control laws;

5 Figure 7 is a schematic view of the control system architecture for a set of lateral control laws;

Figure 8 is a schematic view of the control system architecture for directional control laws;

Figure 9 is a schematic view of the control law logic for the control system; and

10 Figure 10 is a schematic view a control law flow chart for the control system.

15 While the control system of the present application is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular embodiment disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the process of the present application as defined by the appended claims.

Description of the Preferred Embodiment

20 This invention will enable seamless and transient free GRM. More specifically this invention will enable a pilot to use the directional controller to command flat yawing turns at low groundspeeds, while maintaining a constant vector across the ground. The seamless integration of this design requires no manual cockpit switches to select a Constant Vector Flat Turn (CVFT) mode. As a result of this auto-moding logic, the

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control laws will automatically adjust pitch and roll attitude to keep the aircraft moving in the same direction at a constant speed whenever the pilot inputs a directional command at low speed.

5 The auto-moding logic of the present application enables seamless and transient free GRM without the need for manual cockpit switches. The control system utilizes relative groundspeed difference to automatically control pitch and roll attitudes so that the aircraft will maintain a constant vector during a low speed flat turn. The control system also allows the pilot to complete a CVFT with minimal workload since the ground vector will automatically be maintained by the control laws without the pilot
10 having to use cockpit switches to change modes.

Referring now to the drawings, Figure 1 shows a representative flight envelope 101 with a plurality of control law modes designed to enable GRM. Flight envelope 101 comprises a region 103 depicting the CVFT region, wherein the CVFT region is preferably from 10 to 35 knots groundspeed in any direction relative to the aircraft's
15 body axis. The lower bound of region 103 is set by the Hover Hold and Translational Rate Command (TRC) region 105. The upper bound of region 103 is set by the aircraft's sideward and rearward flight airspeed limits.

Figure 2 is a schematic of an aircraft 201 utilizing a control system according to the preferred embodiment of the present invention. Figure 2 shows aircraft 201 in
20 forward flight within region 103. Directional inputs turn aircraft 201 in a complete 360 degree yaw movement R1, stopping every 90 degrees, and without changing the speed and flight heading of aircraft 201, as represented with arrow D1. In the preferred embodiment, the control system is utilized with rotary aircraft, i.e., a helicopter; however, it should be appreciated that the control system is easily and readily adaptable
25 with control systems of different types of aircraft, both manned and unmanned.

Figure 2 depicts aircraft 201 traveling between 10 to 35 knots in a forward direction. As is shown, aircraft 201 preferably turns in a yaw direction R1 at

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approximately 90 degrees relative to direction D1. Aircraft 201 continues to turn in direction R1 while maintaining a constant flight heading. It should be appreciated that the preferred control system is adapted to turn aircraft 201 at 90 degrees during each application; however, it should be appreciated that alternative embodiments could easily include a control system adapted to turn the aircraft at different angles, e.g., at 30 degrees in lieu of or in addition to 90 degrees. It should also be understood that although shown turning in a clockwise direction, the control system can also turn the aircraft in a counterclockwise movement.

Figure 2 provides an exemplary depiction of aircraft 201 turning 360 degrees while maintaining forward flight. Step 1 shows aircraft 201 traveling in a constant forward flight, as depicted with arrow D1, between 10 and 35 knots. Step 2 depicts application of the control system, namely, the pilot utilizes the control system to rotate aircraft 201 in the clockwise direction approximately 90 degrees, as indicated by arrow R1. Step 2 shows aircraft 201 traveling in forward flight while the fuselage faces 90 degrees relative to the directional movement. Steps 3-5 provide further illustration of the process being repeated. In particular, each time the control system is utilized, aircraft 201 rotates 90 degrees while maintaining a constant forward heading.

Referring now to Figure 3 in the drawings, measured flight data 301 of aircraft 201 is shown during a 360 degree CVFT. A plot 303 provides measured data representing the turning movement R1 of aircraft 201 during the 360 degree turn. A plot 305 provides measured data representing the groundspeed of aircraft 201 during the 360 degree turn. Plot 305 shows aircraft 201 initially starting at 20 knots forward groundspeed during the entire 360 degree CVFT. Plot 305 shows that aircraft 201 holds a relatively steady groundspeed during the 360 degree CVFT. A plot 307 provides measured data representing the ground track of aircraft 201 during the 360 degree CVFT. The forward groundspeed plotted on a plot 309 essentially depicts a cosine curve during the turn, while the sideward groundspeed plotted on a plot 311 shows a sine curve.

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Referring now to Figure 4 in the drawings, a schematic view of aircraft 201 is shown changing flight heading from sideward flight to forward flight. In the exemplary embodiment, the CVFT control system is utilized such that aircraft 201 changes heading from a forward groundspeed V_x of about 0 knots and a sideward groundspeed between 10-35 knots to a forward groundspeed between 10-35 knots and a sideward groundspeed about 0 knots. Step 1 of Figure 4 shows aircraft 401 during hover, while a step 2 shows aircraft 401 traveling in a sideward groundspeed between 10-35 knots, as depicted with arrow D2. In step 2, a right lateral control stick (not shown) is utilized to generate a left sideward heading. Thereafter, a right 90 degree pedal turn is applied to rotate aircraft 201 in a forward heading with a pedal 203. In the preferred embodiment, pedal 203 is a pedal manipulated with the pilot's foot; however, it should be appreciated that other forms of devices, i.e, a hand switch could be utilized in lieu of or in addition to pedal 203. For purposes of this invention, a lateral controller, longitudinal controller, and directional controller are characterized as pedal 203 or similarly suited devices. Step 3 depicts application of the CVFT control system, wherein aircraft 201 turns 90 degrees for changing the heading of aircraft 201.

Referring now to Figure 5 in the drawings, an alternative application of the CVFT control system is shown. In the exemplary embodiment, the CVFT control system is utilized to turn aircraft 201 from a forward groundspeed V_x between 10-35 knots and a sideward groundspeed of about 0 knots to a sideward groundspeed between 10-35 knots and a forward groundspeed about 0 knots. Step 1 shows aircraft 201 during hover, while a step 2 shows aircraft 201 traveling in a forward heading having a groundspeed between 10-35 knots, as depicted with arrow D3. In step 2, a forward longitudinal stick is utilized to generate forward flight. Thereafter, a left 90 degree pedal turn is applied to rotate aircraft 201 such that the forward flight of aircraft 201 changes to a sideward flight heading.

Those skilled in the art will understand that the methods for aircraft guidance disclosed in this invention can be applied to any combination of the following: (1) full

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authority fly-by-wire flight control systems, as well as partial authority mechanical systems; (2) traditional cockpit layouts with a center stick for longitudinal and lateral control, pedals for directional control, and a collective stick for vertical control, as well as more advanced designs which combine multiple control axes into a center or side stick controller; and, (3) any aircraft capable of GRM, including both rotorcraft and jump jets.

The key to enabling seamless and transient free GRM lies in the advanced control law architecture of the CVFT control system as shown in Figures 6 to 8. Figure 6 shows architecture 601 of the CVFT control system operably associated with one or more longitudinal control laws, Figure 7 shows architecture 701 of the CVFT control system operably associated with one or more lateral control laws, and Figure 8 shows architecture 801 of the CVFT control system operably associated with one or more directional control laws according to the preferred embodiment of the invention.

Referring now to Figure 6 in the drawings, architecture 601 includes one or more aircraft sensors 603 operably associated with the control laws to accomplish GRM. Aircraft sensors 603 can include: an inertial Navigation System (attitudes, attitude rates, and translational accelerations); a Global Positioning System (ground-referenced speeds and positions); an Air Data Computer (airspeed and barometric altitude); and, a Radar or Laser Altimeter (above ground level (AGL) altitude). An aircraft model can be obtained from aerodynamics data and a group of linear models can be developed based on its airspeed from aircraft sensors 603. These linear models include both lateral and longitudinal equations of motion. Since the aircraft model matrices are large and contain coupling terms of lateral and longitudinal motions within the matrices, it is difficult to determine the best performance control gains for all at the same time. In order to overcome these issues, the linear model of aircraft performance is decoupled first. After the aircraft model is decoupled to lateral and longitudinal equations of motion, the effect of coupling terms between lateral and longitudinal motions can be reduced to a minimum, thus stabilizing the system.

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In the preferred embodiment, architecture 601 preferably comprises of a longitudinal control law for forward speed, represented as block 605 "Long_SPD"; a longitudinal control law for pitch angle, represented as block 607 "Long_ATT"; and, a longitudinal control law for pitch rate, represented as block 609 "Long_RATE". Architecture 601 is further provided with initialization logic 611 adapted for determining which loop is active in each axis based on flight conditions and pilot control inputs. Logic 611 will also re-initialize inactive loops in order to eliminate control jumps when switching between the loops to provide seamless and transient free mode changes.

Architecture 601 further includes a longitudinal command 613 generated in the control laws by referencing the pilot's cockpit control input in each axis. The input to the control laws is the difference between the controller's present position and the centered, no force position, which is also referred to as the "detent" position. The control commands can also be generated by a beep switch located in the cockpit to command small and precise changes in aircraft state. The control laws process these control inputs to generate the appropriate aircraft response commands. These commands are then sent out to the control law guidance blocks to maneuver the aircraft. The control law outputs are routed to an actuator 615 for each dynamic axis. For a conventional helicopter, the control laws send control signals to the following actuators: longitudinal axis – main rotor longitudinal swashplate angle; lateral axis – main rotor lateral swashplate angle; vertical axis – main rotor collective pitch; and, directional axis – tail rotor collective pitch.

Since pitch rate is the fastest longitudinal state, Long_RATE 609 is the inner loop of the longitudinal control laws. Next, the Long_ATT 607 loop feeds the Long_RATE control law 609 loop to control pitch attitude. Finally, the Long_SPD control law 605 loop feeds the Long_ATT 607 loop to control forward speed.

When flying with the longitudinal controller in detent outside of the Hover Hold / TRC region 105, depicted in Figure 1, the Long_SPD 605 loop will be active. At lower speeds, this loop will hold constant forward groundspeed, while at higher speeds,

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airspeed will be held. Once the pilot moves the longitudinal controller out of detent, the control laws can command either pitch attitude (Long_ATT 607) or pitch rate (Long_RATE 609).

Referring now to Figure 7 in the drawings, architecture 701 comprises one or more lateral control laws operably associated with sensors 603, logic 611, lateral commands 702, and actuators 615. The lateral control laws include: a lateral control of roll rate, represented as block 703 "Lat_RATE"; a lateral control of the roll attitude, represented as block 705 "Lat_ATT"; a lateral control of sideward groundspeed, represented as block 707 "Lat_SPD"; a lateral control of the crab angle, represented as block 709 "Lat_CRAB"; and, lateral control of heading, represented as block 711 "Lat_HDG".

Similar to the longitudinal axis, Lat_RATE 703 is the inner loop of the lateral control laws and the Lat_ATT 705 loop feeds the Lat_RATE 703 loop to control roll attitude. The Lat_ATT 705 loop can be fed by one of three loops, Lat_SPD 707, Lat_CRAB 709, or Lat_HDG 711.

The crab angle used in the Lat_CRAB 709 loop is computed in the control laws using the following equation:

$$\eta = \tan^{-1}\left(\frac{V_y}{V_x}\right) \quad (1)$$

where η is the crab angle, V_y is the sideward groundspeed with right positive, and V_x is the forward groundspeed. To avoid a singularity in Equation 1, V_x is limited to be above the Hover Hold / TRC region 103.

When operating in the Ground-Coordinated Banked Turn (GCBT) envelope as shown by region 107 in Figure 1, if both the lateral and directional controllers are in detent, lateral control law logic will hold crab angle through the Lat_CRAB 709 loop. If

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operating in the CVFT envelope, but not in the GCBT envelope, and the lateral and directional controllers are in detent, the control logic will hold sideward groundspeed constant with the Lat_SPD 707 loop. When operating at higher airspeeds with lateral and directional controllers in detent, the control logic will hold heading constant with the Lat_HDG 711 loop. When the pilot moves the lateral controller out of detent in any of these cases, the control laws can command either roll attitude (Lat_ATT 705) or roll rate (Lat_RATE 703).

Referring now to Figure 8 in the drawings, architecture 801 comprises one or more directional control laws operably associated with sensors 603, logic 611, commands 613, and actuators 615. The directional control laws include: directional control of yaw rate, represented as block 803 "Dir_RATE"; directional control of heading, represented as block 805 "Dir_HDG"; and, directional turn coordination, represented as block 807 "Dir_TC"

Since yaw rate is the fastest directional state, Dir_RATE 803 is the inner loop of the directional control laws. This loop is fed by the Dir_HDG 805 loop to control aircraft heading at lower speeds. Unlike traditional control law designs, this invention includes an additional loop, parallel to the Dir_HDG 805 loop, to feed the Dir_RATE 803 inner loop. The Dir_TC 807 loop is used to coordinate banked turns throughout the flight envelope.

In the GCBT envelope 107 shown in Figure 1, the Dir_TC 807 loop will control crab angle during banked turns. With no directional input, the Dir_TC 807 loop will hold crab angle at zero. Any directional control inputs during a GCBT will result in a change in crab angle in the appropriate direction. Additionally, if the aircraft is in the GCBT envelope, but above the CVFT envelope, directional controller inputs will command changes in crab angle through the Dir_TC 807 loop even in non-turning flight. In this case, once the directional controller is returned to detent, heading hold will be re-engaged (Dir_HDG 805 loop) and the crab angle will be held though the Lat_CRAB 709 loop.

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When in the BCBT envelope, the Dir_TC 807 loop will automatically adjust yaw rate based on actual bank angle, true airspeed, and lateral acceleration in order to keep the slip ball centered. Any directional controller inputs in the BCBT envelope will command a change in lateral acceleration, which will subsequently result in sideslip away from the pedal input. Pedal inputs will also result in a slight roll in the direction of the input to provide lateral stability.

In the absence of lateral or directional control inputs while operating in either the GCBT or CVFT envelopes, the directional axis will hold heading through the Dir_HDG 805 loop. If the pilot moves the directional controller out of detent in the CVFT envelope with both the lateral and longitudinal controllers in detent, the directional control laws will command a yaw rate through the Dir_RATE 803 loop. In this case, the control laws will maintain a constant ground vector by using the Long_SPD 605 and Lat_SPD 707 loops.

During the CVFT, when the directional controller is first moved out of detent, the control laws will capture the aircraft's current groundspeed in the earth axis coordinate system. The control laws keep track of the difference between the aircraft's actual groundspeed and the captured groundspeed. This relative groundspeed difference is converted from the earth axis to the aircraft's body axis using the following equations:

$$\Delta V_x = \Delta V_{north} \cdot \cos \psi + \Delta V_{east} \cdot \sin \psi \quad (2)$$

$$\Delta V_y = \Delta V_{east} \cdot \cos \psi - \Delta V_{north} \cdot \sin \psi \quad (3)$$

where ΔV_x is the groundspeed difference in the body axis forward direction, ΔV_y is the groundspeed difference in the body axis sideward direction with right positive, ΔV_{north} is the groundspeed difference in the earth axis north direction, ΔV_{east} is the groundspeed difference in the earth axis east direction, and ψ is the aircraft heading. The values for ΔV_x and ΔV_y are then used in the Long_SPD 605 and Lat_SPD 707 blocks respectively to command the pitch and roll attitudes needed to minimize the relative groundspeed difference during the flat turn.

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Referring now to Figure 9 in the drawings, control law logic 901 for the CVPT mode is shown. Control law logic 901 comprises one or more of latch 903, latch 905, and latch 907 adapted to control when a mode is turned on or off. If the reset conditions are met, then the mode will always be off. If the reset conditions are not met, then the mode will be latched on when the set conditions are met. The CVPT mode will be reset whenever lateral speed hold, depicted as block 909 "Lat_SPD_ON" or a longitudinal speed hold, depicted as block 911 "Long_SPD_ON" are not on and will be set when the directional controller is out of detent.

Both longitudinal speed hold latch 905 and lateral speed hold latch 907 will be reset when their respective controller is out of detent. Additionally, the lateral speed hold latch 907 will be reset when the banked turn (Bank_Turn_ON) or crab hold (Crab_ON) modes are on, or if forward speed exceeds the CVPT threshold (typically around 35 KGS). The longitudinal and lateral speed hold latches will be set when their respective acceleration falls below the acceleration threshold (typically around 2 ft/sec^2).

Referring now to Figure 10 in the drawings, a control law flow chart 1001 for a CVFT is presented. When the directional controller is initially moved out of detent, the CVPT mode will be engaged. The longitudinal and lateral speed hold blocks (Long_SPD 605 and Lat_SPD 707) will be reinitialized to feedback the relative groundspeed differences calculated in equations 2 and 3. Once the directional controller is returned to detent following the CVFT, directional control laws will hold heading by re-engaging the Dir_HDG 805 loop. The longitudinal and lateral axes will continue to hold a constant ground vector until the pilot commands a change by moving either the longitudinal or lateral controller out of detent. This design enables the pilot to command and hold any crab angle around the 360 degree circle, while the aircraft continues to move across the ground on a constant vector. As shown, when the pedal stops, if the crab angle equals 0 degrees, then aircraft 201 travels in pure forward flight; if the crab angle is 90 degrees, aircraft 201 travels in pure right side flight; if the crab

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angle is 180 degrees, then aircraft 201 travels in pure aft flight; and, if the crab angle is 270 degrees, then aircraft 201 travels in pure left sideward flight.

The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. It is therefore evident that the particular embodiments disclosed above may be altered or modified, and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the description. It is apparent that an invention with significant advantages has been described and illustrated. Although the present invention is shown in a limited number of forms, it is not limited to just these forms, but is amenable to various changes and modifications without departing from the spirit thereof.

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Claims

1. An aircraft, comprising:

a sensor carried by the aircraft, the sensor being adapted to sense a directional movement of the aircraft;

5 an actuator carried by the aircraft, the actuator being utilized to control the directional movement of the aircraft; and

a control system in data communication with the aircraft sensor and operably associated with the actuator, the control system having:

10 a model adapted to decouple the directional movement of the aircraft into a lateral equation of motion and a longitudinal equation of motion;

a lateral control architecture in data communication with the model, the lateral control architecture being adapted to utilize the lateral equation of motion to control the lateral motion of the aircraft;

15 a longitudinal control architecture in data communication with the model, the longitudinal control architecture adapted to utilize the longitudinal equation of motion to control the longitudinal motion of the aircraft; and

an initialization command logic in data communication with the lateral control architecture and in data communication with the longitudinal control architecture;

20 wherein the initialization command logic selectively activates the lateral control architecture for controlling the lateral motion of the aircraft and selectively activates the longitudinal control architecture for controlling the longitudinal motion of the aircraft; and

25 wherein the control system utilizes the lateral control architecture and the longitudinal control architecture to control speed variations of the aircraft while the aircraft maintains a constant vector heading across a ground surface.

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2. The aircraft of claim 1, the aircraft further comprising:

a directional controller, the directional controller being manipulated by a pilot controlling the aircraft, the directional controller being in data communication with the control system.

3. The aircraft of claim 2, the directional control architecture comprising:

a directional heading control loop;

a directional turn coordination control loop; and

a directional yaw rate control loop.

4. The aircraft of claim 2, further comprising:

a directional control latch in data communication with the directional control architecture;

wherein, as the directional controller is moved out of a detent position, the directional control latch activates a constant vector flat turn motion.

5. The aircraft of claim 1, the lateral control architecture comprising:

a lateral sideward groundspeed control loop;

a lateral roll attitude control loop; and

a lateral roll rate control loop.

6. The aircraft of claim 5, further comprising:

a lateral controller carried by the aircraft, the lateral controller being manipulated by a pilot controlling the aircraft, the lateral controller creating a lateral command in data communication with the lateral sideward groundspeed control loop, the lateral roll attitude control loop, and the lateral roll rate control loop.

7. The aircraft of claim 6, further comprising:

a lateral control latch in data communication with the control system;

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wherein, as the lateral controller is moved out of a detent position, the lateral control latch resets a lateral speed hold.

8. The aircraft of claim 1, the longitudinal control architecture comprising:
a longitudinal forward speed control loop;
a longitudinal pitch angle control loop; and
a longitudinal pitch rate control loop.

9. The aircraft of claim 8, the longitudinal control architecture further comprising:
a longitudinal controller carried by the aircraft, the longitudinal controller being manipulated by a pilot controlling the aircraft, the longitudinal controller creating a longitudinal command in data communication with the longitudinal forward speed control loop, the longitudinal pitch angle control loop, and the longitudinal pitch rate control loop.

10. The aircraft of claim 9, further comprising:
a longitudinal control latch in data communication with the control system;
wherein, as the longitudinal controller is moved out of a detent position, the longitudinal control latch resets a longitudinal speed hold.

11. A method to control flat yawing turns of an aircraft while maintaining a constant vector heading across a ground surface, the method comprising:

sensing the speed variation of the aircraft with a sensor carried by the aircraft, the speed variation having:

a longitudinal direction of motion; and
a lateral direction of motion;

controlling the speed variation of the aircraft with actuators operably associated with the aircraft;

providing a control system in data communication with the aircraft sensor and operably associated with the actuators, the control system having:

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a model;

a lateral control architecture;

a longitudinal control architecture; and

an initialization command logic in data communication with the lateral
control architecture and in data communication with the longitudinal control
architecture;

decoupling the directional movement of the aircraft into the lateral equation of
motion and the longitudinal equation of motion with the model;

controlling the lateral direction of motion with a lateral control architecture, the
lateral control architecture utilizing the lateral equation of motion;

controlling the longitudinal direction of motion with a longitudinal control
architecture, the longitudinal control architecture utilizing the longitudinal equation of
motion; and

selectively activating the lateral control architecture and the longitudinal control
architecture with the initialization command logic;

wherein the control system receives sensed speed variation data from the sensor
and operably controls the actuators, thus providing selective control of the yawing turns
of the aircraft while maintaining a constant vector across a ground surface.

12. The method of claim 11, the method further comprising:

commanding the flat yawing turns with a directional controller manipulated by a
pilot controlling the aircraft, the directional controller being operably associated with a
directional control architecture, the directional control architecture being in data
communication with the control system.

13. The method of claim 12, wherein the commanding of the flat yawing turns with
the directional control architecture comprises:

communicating data through a directional heading control loop;

communicating data through a directional turn coordination control loop; and

communicating data through a directional yaw rate control loop.

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14. The method of claim 12, further comprising:

activating the constant vector flat turn with a directional control latch as the directional controller is moved out of a detent position, the directional control latch being operably associated with the directional control architecture.

15. The method of claim 11, wherein controlling the lateral direction of motion with the lateral control architecture comprises:

communicating lateral motion data through a lateral sideward groundspeed control loop;

communicating lateral motion data through a lateral roll attitude control loop; and

communicating lateral motion data through a lateral roll rate control loop.

16. The method of claim 11, further comprising:

controlling the lateral direction of motion with a lateral controller manipulated by a pilot controlling the aircraft, the lateral controller being operably associated with the lateral control architecture.

17. The aircraft of claim 16, further comprising:

resetting a lateral speed hold with a lateral control latch as the lateral controller is moved out of a detent position, the lateral control latch being in data communication with the lateral control architecture.

18. The method of claim 17, wherein controlling the longitudinal direction of motion with the longitudinal control architecture comprises:

communicating longitudinal motion data through a longitudinal forward speed control loop;

communicating longitudinal motion data through a longitudinal pitch angle control loop; and

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communicating longitudinal motion data through a longitudinal pitch rate control loop.

19. The aircraft of claim 11, the longitudinal control architecture further comprising:
controlling the longitudinal direction of motion with a longitudinal controller manipulated by a pilot controlling the aircraft, the longitudinal controller being operably associated with the longitudinal control architecture.

20. The aircraft of claim 19, further comprising:
resetting a longitudinal speed hold with a longitudinal control latch as the longitudinal controller is moved out of a detent position, the longitudinal control latch being in data communication with the longitudinal control architecture.

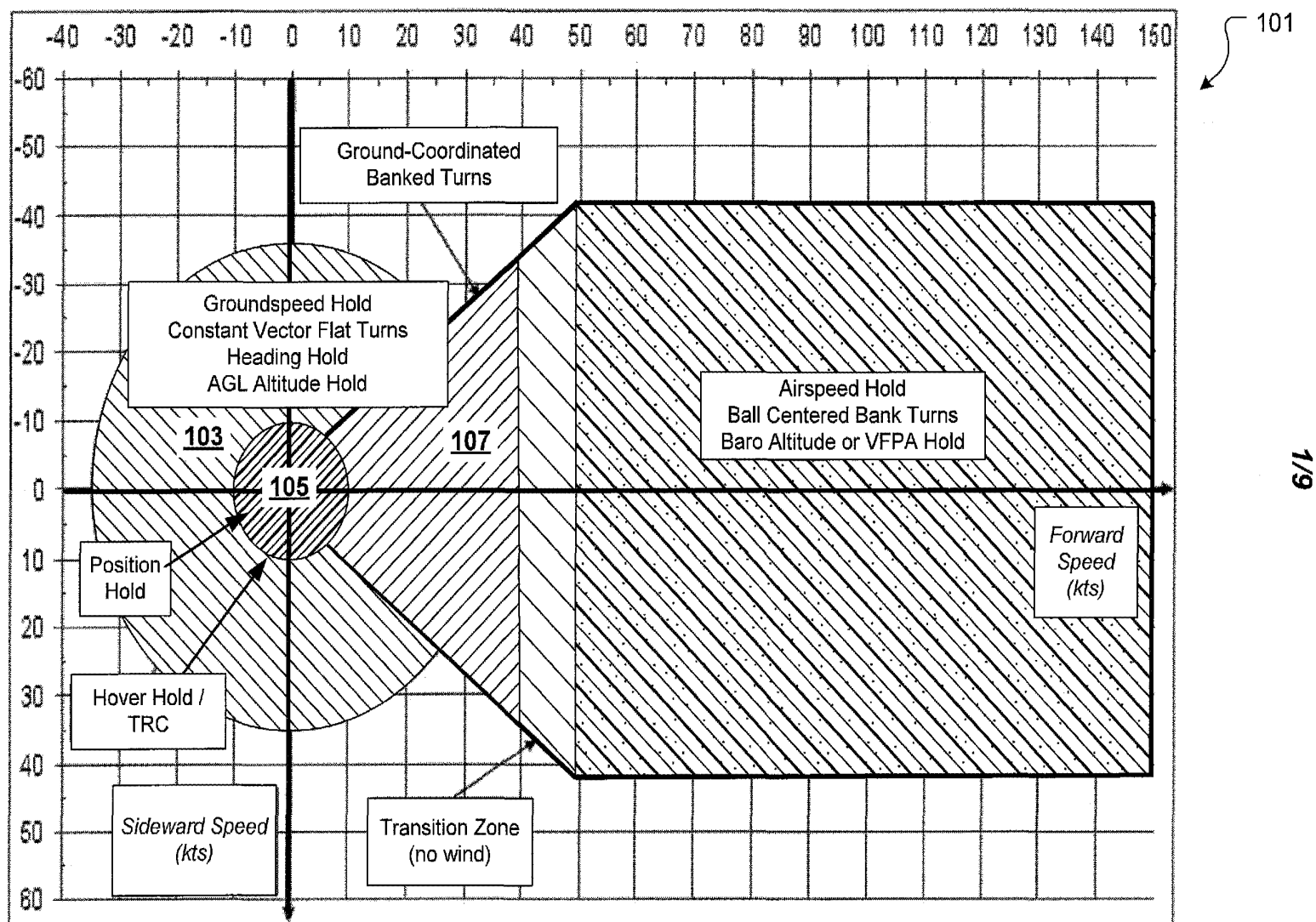


FIG. 1

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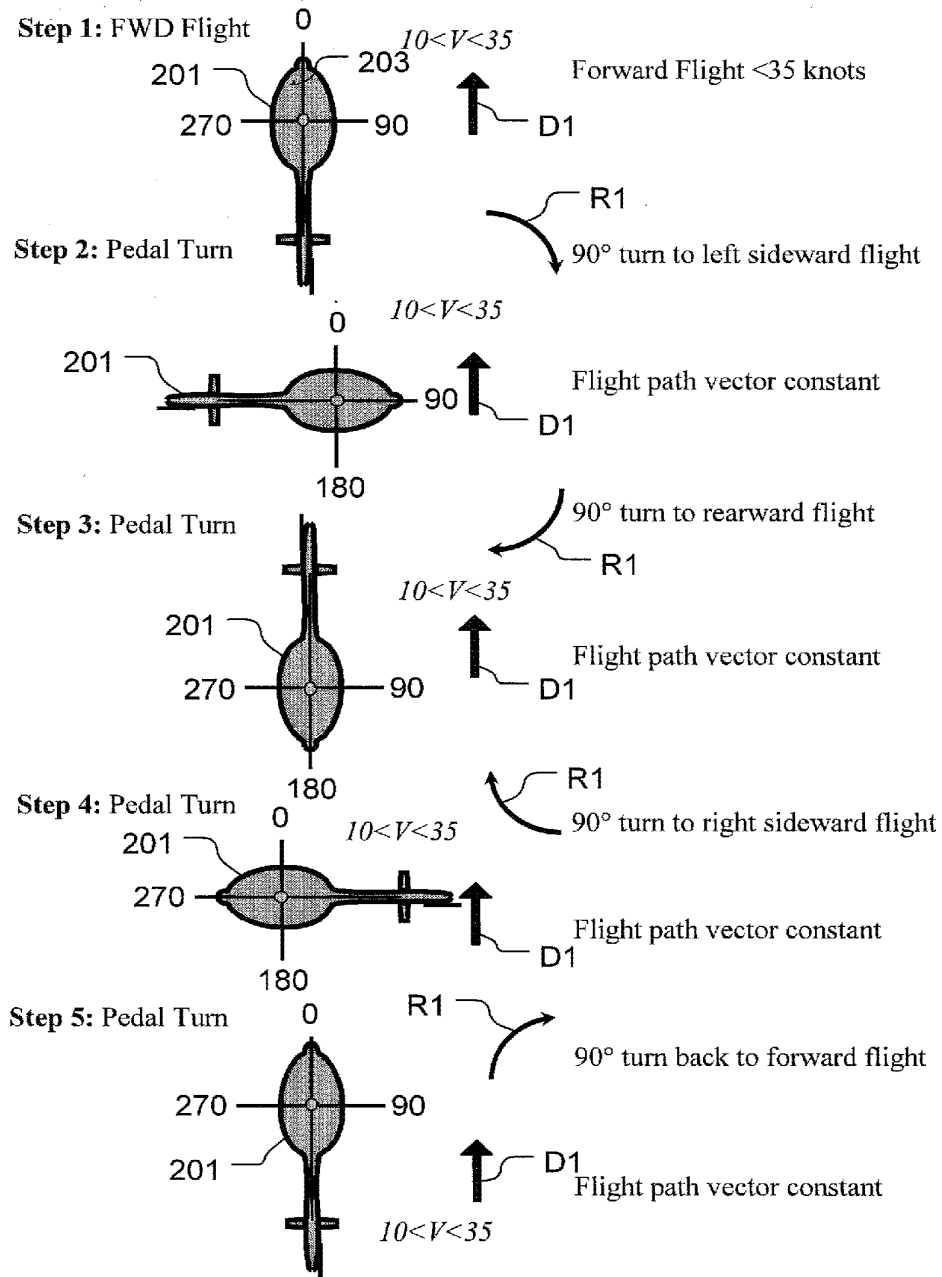


FIG. 2

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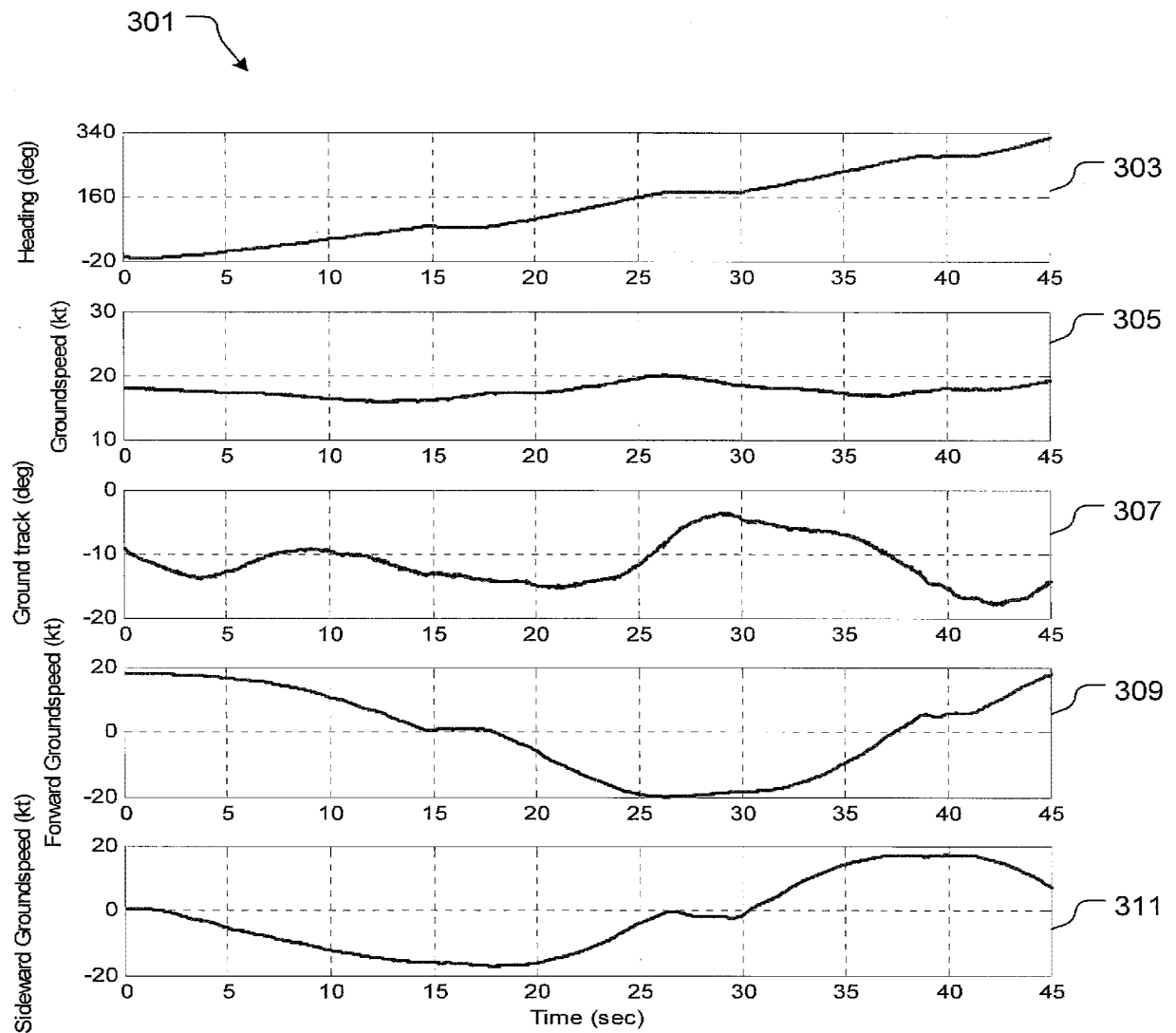


FIG. 3

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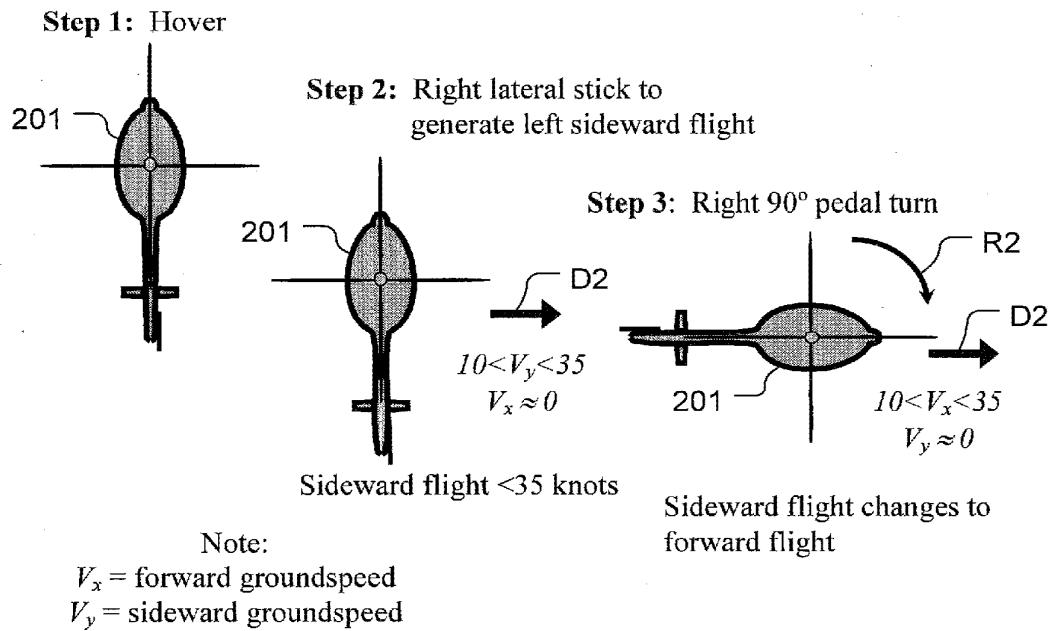


FIG. 4

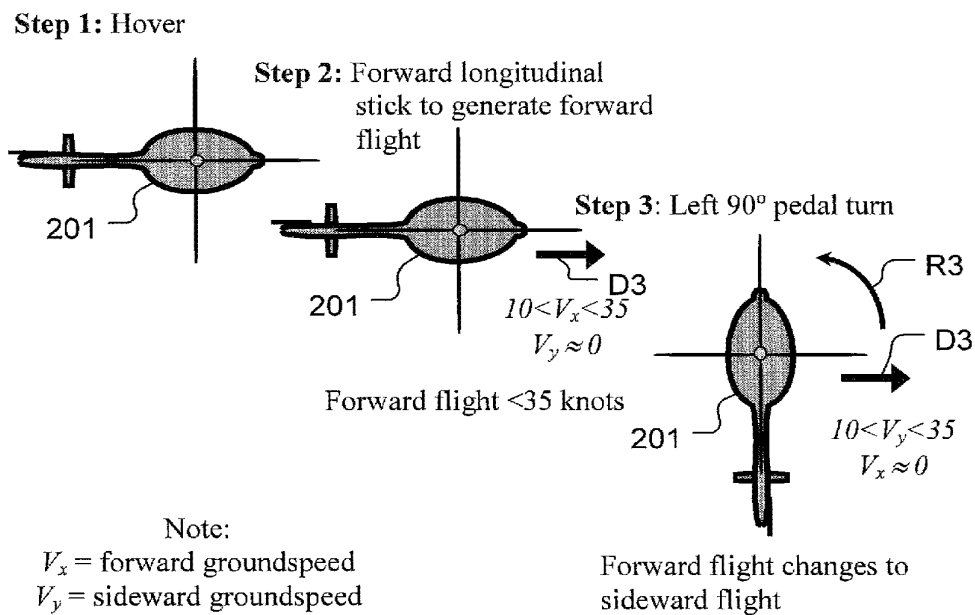


FIG. 5

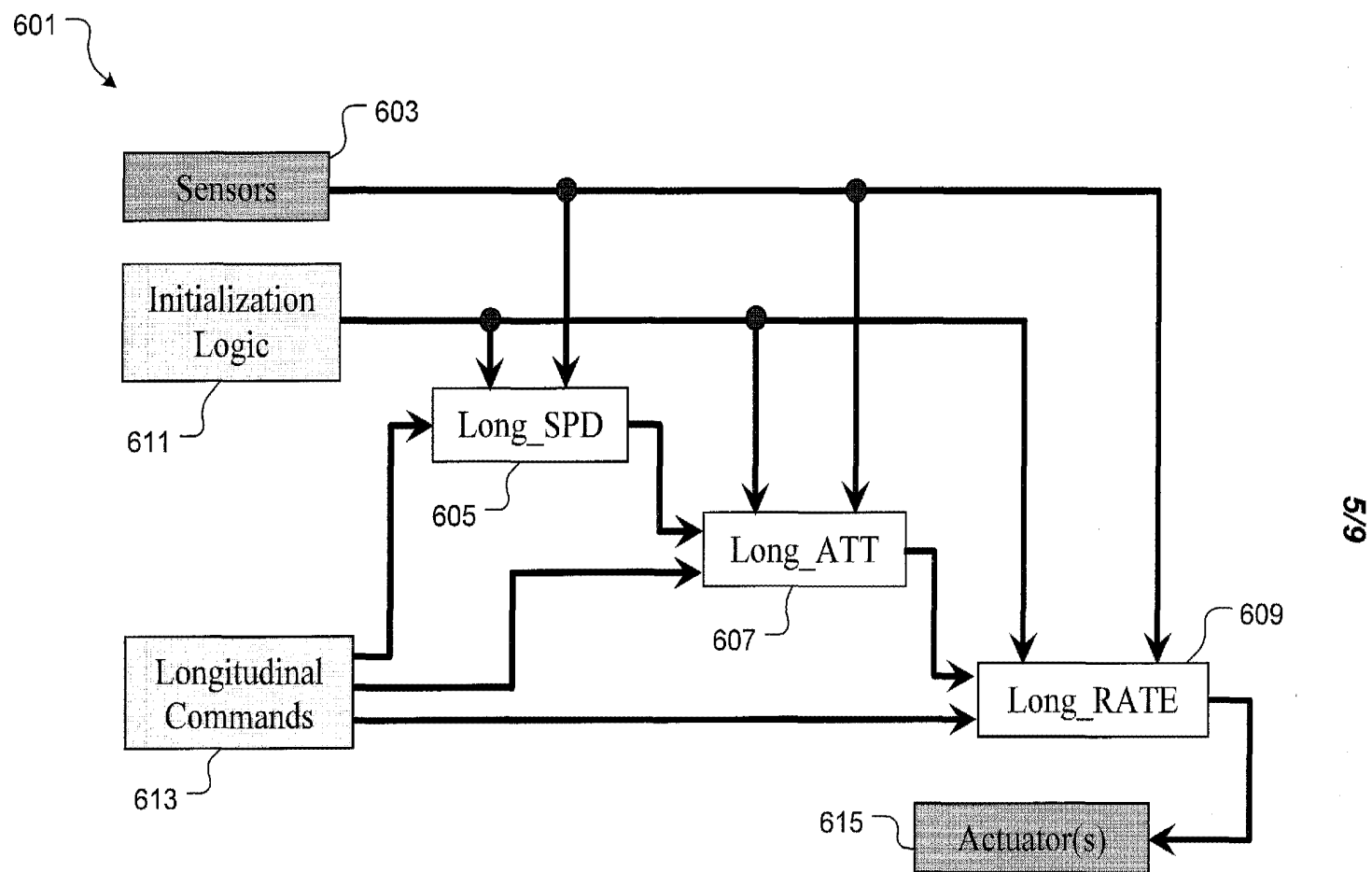


FIG. 6

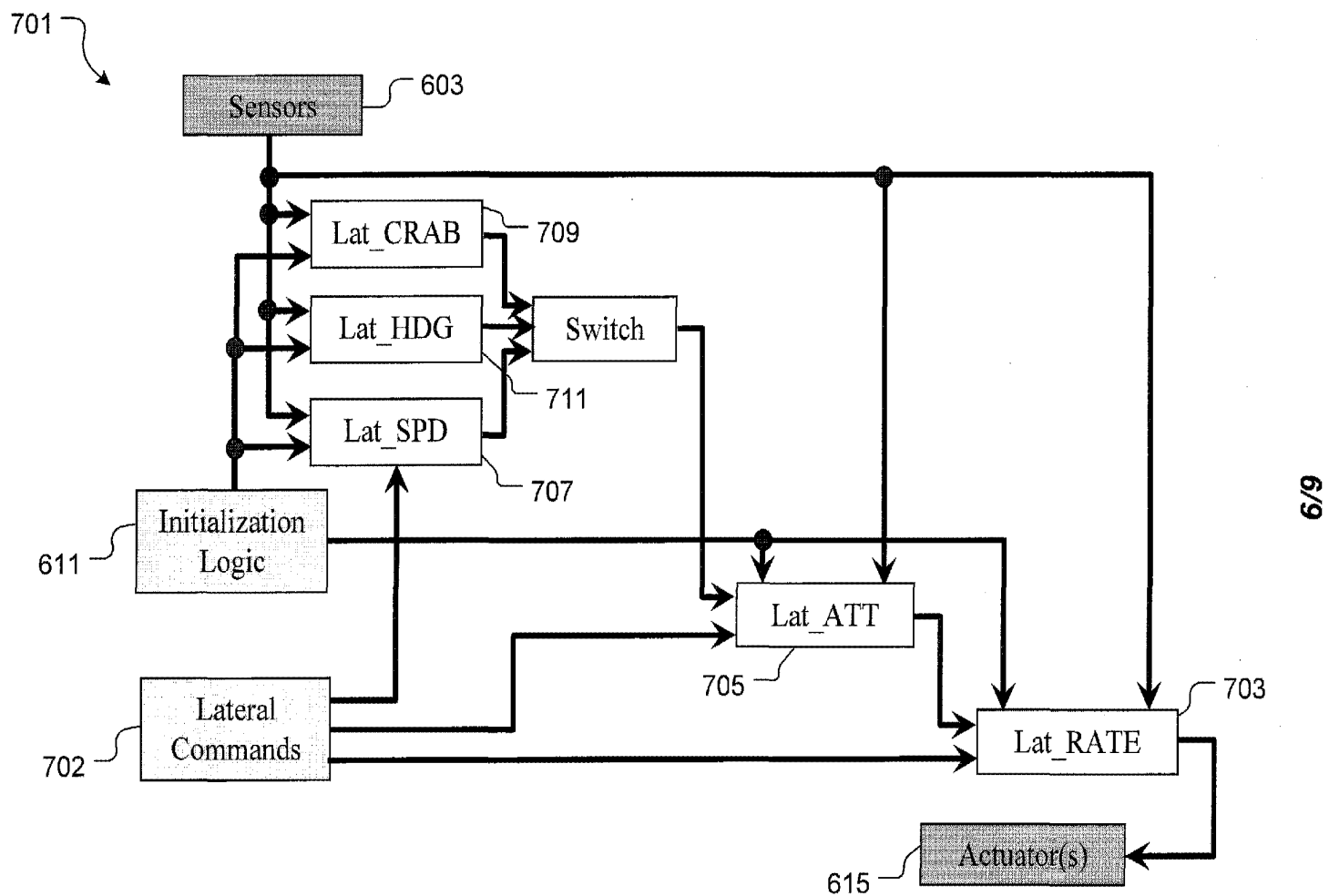


FIG. 7

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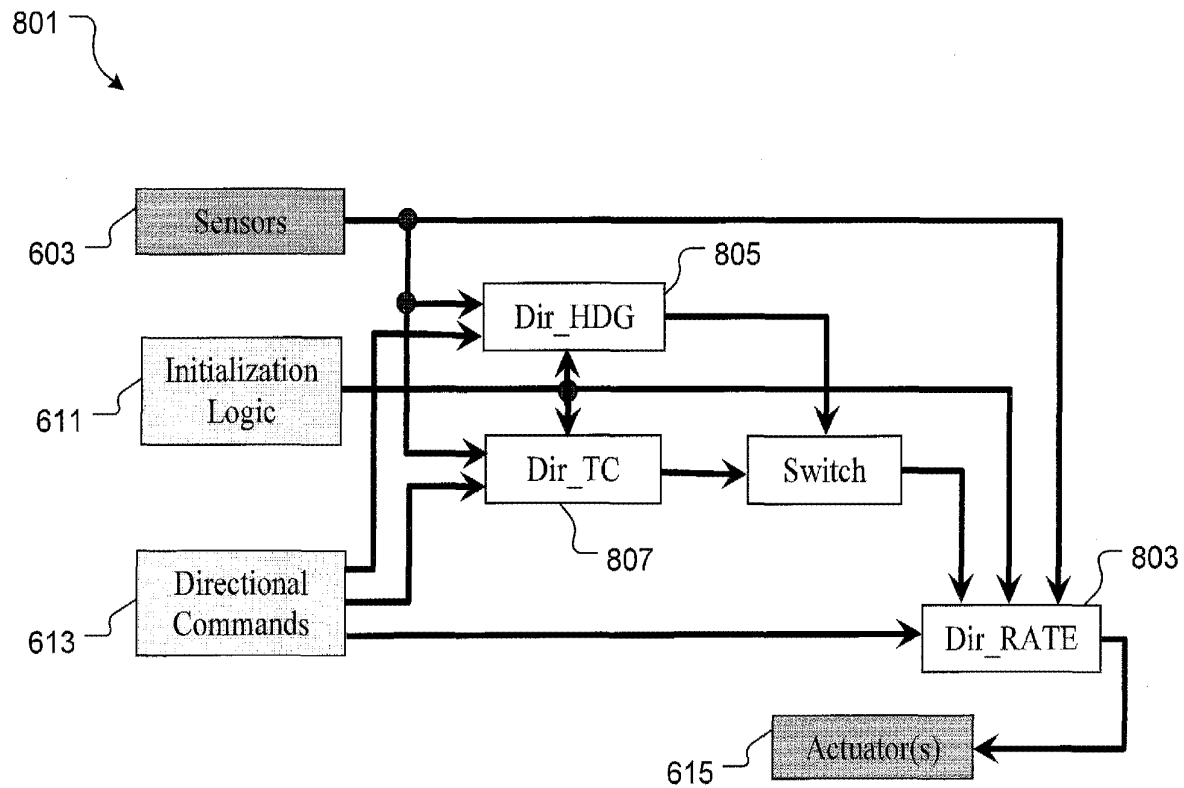


FIG. 8

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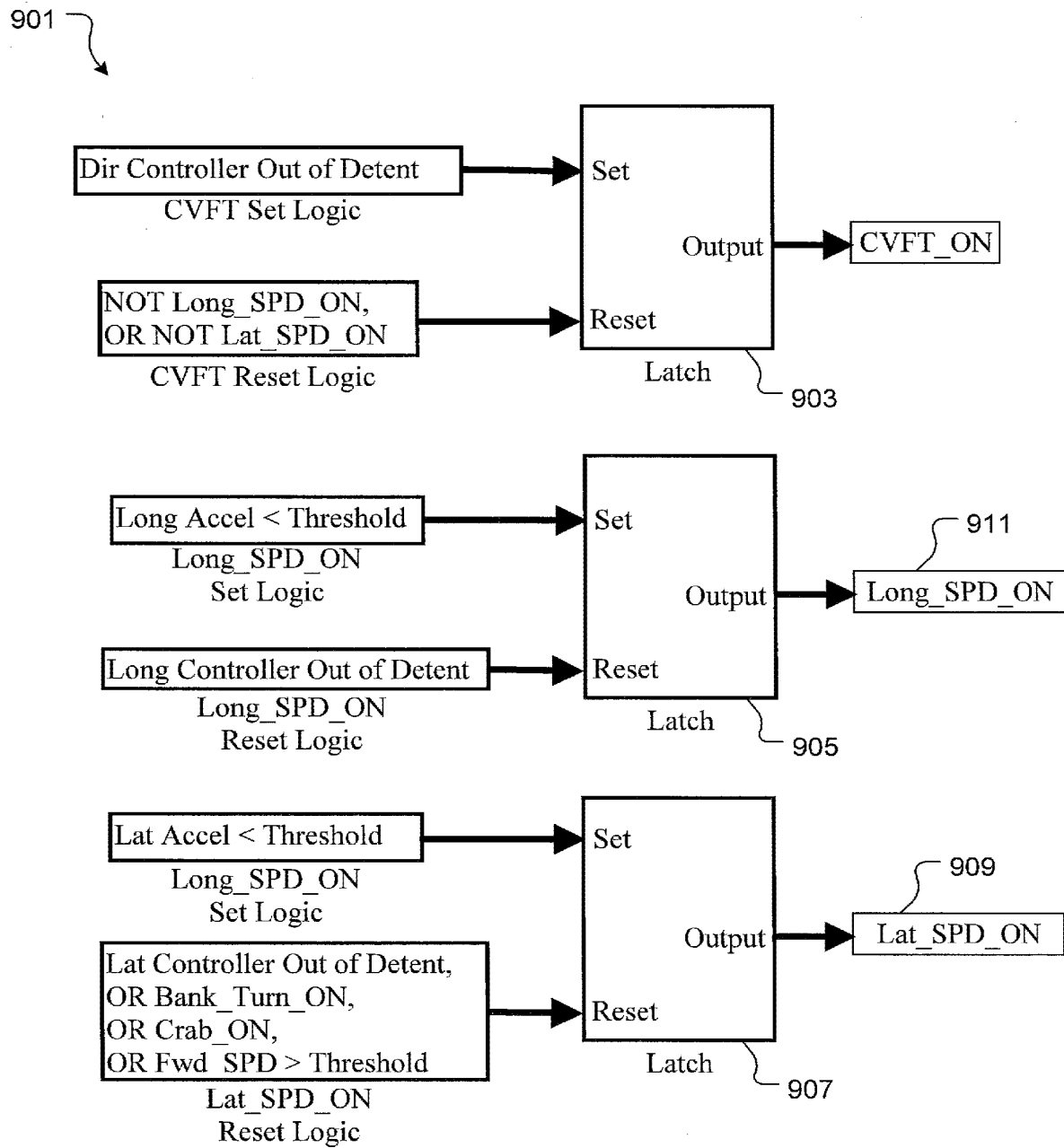


FIG. 9

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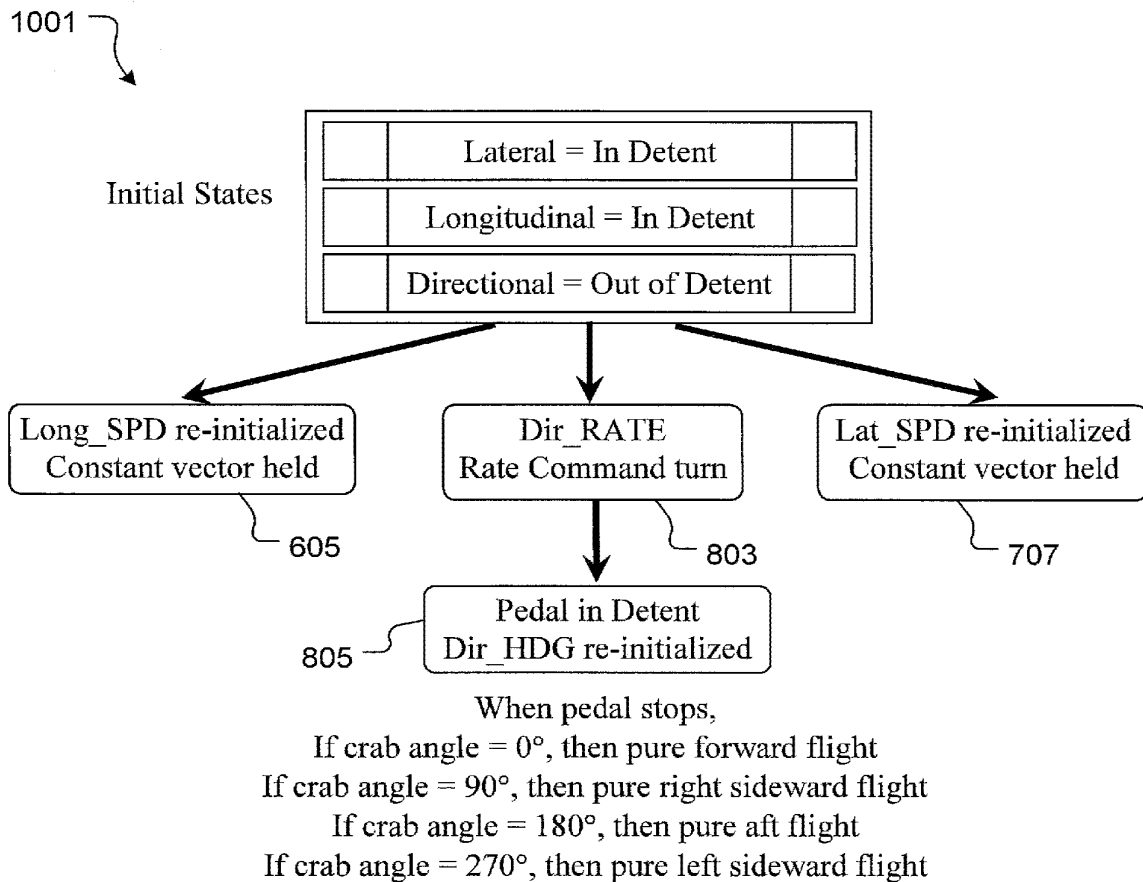


FIG. 10

REQUEST FOR PARTICIPATION IN THE PATENT COOPERATION TREATY – PATENT PROSECUTION HIGHWAY (PCT-PPH) PILOT PROGRAM IN A U.S. APPLICATION WHERE THE USPTO WAS THE ISA OR IPEA			
Application No.:	13391522	First Named Inventor:	Kevin T. Christensen
Filing Date:	02/21/2012	Attorney Docket No.:	0837RF-H793-US
Title of the Invention:	FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS		
THIS REQUEST FOR PARTICIPATION IN THE PCT-PPH PILOT PROGRAM ALONG WITH THE REQUIRED DOCUMENTS MUST BE SUBMITTED VIA EFS-WEB. INFORMATION REGARDING EFS-WEB IS AVAILABLE AT HTTP://WWW.USPTO.GOV/EBS/DFS_HELP.HTML.			
APPLICANT HEREBY REQUESTS PARTICIPATION IN THE PCT-PPH PILOT PROGRAM AND PETITIONS TO MAKE THE ABOVE-IDENTIFIED APPLICATION SPECIAL UNDER THE PCT-PPH PILOT PROGRAM.			
The above-identified application is (1) a national stage entry of the corresponding PCT application, or (2) a national stage entry of another PCT application which claims priority to the corresponding PCT application, or (3) a national application that claims domestic/ foreign priority to the corresponding PCT application, or (4) a national application which forms the basis for the priority claim in the corresponding PCT application, or (5) a continuing application of a U.S. application that satisfies one of (1) to (4) above, or (6) a U.S. application that claims domestic benefit to a U.S. provisional application which forms the basis for the priority claim in the corresponding PCT application.			
The corresponding PCT application number(s) is/are: <u>PCT/US11/30498</u>			
The international filing date of the corresponding PCT application(s) is/are: <u>03/30/2011</u>			
I. List of Required Documents:			
a. A copy of the latest international work product (WO/ISA, WO/IPEA, or IPER) in the above-identified corresponding PCT application(s) ☐ is attached. ☒ is <u>not</u> attached because the document is already in the U.S. application.			
b. A copy of all claims which were indicated as having novelty, inventive step and industrial applicability in the above-identified corresponding PCT application(s) ☐ is attached. ☒ is <u>not</u> attached because the document is already in the U.S. application.			
c. English translations of the documents in a. and b. above are attached (if the documents are not in the English language). A statement that the English translation is accurate is attached for the document in b. above.			
d. (1) An information disclosure statement listing the documents cited in the international work products (ISR, WO/ISA, WO/IPEA, IPER) of the corresponding PCT application. ☐ is attached. ☒ has already been filed in the above-identified U.S. application on <u>02/21/2012</u>			
(2) Copies of all documents (except for U.S. patents or U.S. patent application publications) ☐ are attached. ☒ have already been filed in the above-identified U.S. application on <u>02/21/2012</u>			

[Page 1 of 2]

This collection of information is required by 35 U.S.C. 119, 37 CFR 1.55, and 37 CFR 1.102(d). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

REQUEST FOR PARTICIPATION IN THE PCT-PPH PILOT PROGRAM IN A U.S. APPLICATION WHERE THE USPTO WAS THE ISA OR IPEA

(continued)

[illegible]

Signature <u>/jamesewaltonpat/</u>	Date <u>3/15/12</u>
Name (Print/Typed) <u>James E. Walton</u>	Registration Number <u>47245</u>

Electronic Acknowledgement Receipt

EFS ID:	12313619
Application Number:	13391522
International Application Number:	
Confirmation Number:	6391
Title of Invention:	Flight Control Laws for Constant Vector Flat Turns
First Named Inventor/Applicant Name:	Kevin T. Christensen
Customer Number:	38441
Filer:	James Edward Walton
Filer Authorized By:	
Attorney Docket Number:	0837RF-H793-US
Receipt Date:	15-MAR-2012
Filing Date:	
Time Stamp:	14:54:17
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no
------------------------	----

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		RequestPPH20120315.pdf	224410 1cb0604e878c10ee3ea00b3423f9046c4d2e9a71	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Miscellaneous Incoming Letter	1	2
	Petition to make Special under PCT-Patent Pros Hwy	3	4
Warnings:			
Information:			
Total Files Size (in bytes):		224410	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.			

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No. 0837RF-H793-US

In Re Application of:

KEVIN T. CHRISTENSEN, ET AL.

Serial No: 13/391,522

Filed: 21 FEBRUARY 2012

For: FLIGHT CONTROL LAWS FOR
CONSTANT VECTOR FLAT TURNS

§
§
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§
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§
§
§

Examiner: TO BE ASSIGNED

Art Unit: TO BE ASSIGNED

Conf. No.: 6391

TRANSMITTAL

Filed via EFS-Web

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

Please file the following enclosed documents in the subject National-Stage application:

1. This Transmittal with Certificate of Transmission; and
2. Request for Participation in the Patent Cooperation Treaty – Patent Prosecution Highway (PCT-PPH) Pilot Program (PTO/SB/20PCT-US).

CERTIFICATE OF TRANSMISSION UNDER 37 C.F.R. § 1.8(a)(1)(i)(C)

Date of Transmission: 3/15/12

I hereby certify that this correspondence is being transmitted to the U.S. Patent and Trademark Office (USPTO) via the USPTO electronic filing system (EFS-Web) on the date shown above.

By:

James E. Walton
James E. Walton

Transmittal

Attorney Docket No. 0837RF-H793-US

The above-listed documents are being filed via the U.S. Patent and Trademark Office's EFS-Web electronic filing system. No fees are deemed to be necessary; however, the Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayments, to **Deposit Account No. 502806**.

Respectfully submitted,

3/15/12
Date


James E. Walton
Registration No. 47,245
Law Offices of James E. Walton, P.L.L.C.
1169 N. Burleson Blvd., Suite 107-328
Burleson, Texas 76028
(817) 447-9955 (Voice)
(817) 447-9954 (Facsimile)
jim@waltonpllc.com (Email)

CUSTOMER NO. 38441

ATTORNEY FOR APPLICANTS



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

MAILED
MAY 23 2012
OFFICE OF PETITIONS

In re Application of	: DECISION ON REQUEST TO
Kevin T. Christensen	: PARTICIPATE IN THE PATENT
Application No.: 13/391,522	: PROSECUTION HIGHWAY
Deposited: February 21, 2012	: PROGRAM AND PETITION
Attorney Docket No.: 0837RF-H793-US	: TO MAKE SPECIAL UNDER
For: FLIGHT CONTROL LAWS FOR	: 37 CFR 1.102(a)
CONSTANT VECTOR FLAT TURNS	:

This is a decision on the request to participate in the PCT Patent Prosecution Highway (PCT-PPH) pilot program and the petition under 37 CFR 1.102(a), filed on March 15, 2012, to make the above-identified application special.

The request and petition are **GRANTED**.

Discussion

A grantable request to participate in the PCT-PPH pilot program and petition to make special require:

- (1) The U.S. application must have an eligible relationship to one or more PCT applications where the ISA or IPEA are the Australia, Austria, EPO, Finland, JPO, KIPO, NPI, Russia, Spain, Sweden, USPTO, or CHINA;
- (2) At least one claim in the PCT application has novelty, inventive step, and industrial applicability and must be free of any observations in Box VIII in the latest work product in the international stage or applicant must identify and explain why the claim(s) is/are not subject to the observation in Box VIII;
- (3) Applicant must submit a copy of the claim(s) from the PCT application(s) that have novelty, inventive step, and industrial applicability along with an English translation thereof and a statement that the English translation is accurate, if the claims are not in the English language;

(4) All the claims in the U.S. application must sufficiently correspond or be amended to sufficiently correspond to the claim(s) that have novelty, inventive step, and industrial applicability in the PCT application(s);

(5) Examination of the U.S. application has not begun;

(6) Applicant must submit a copy of the latest international work product from the PCT application indicating that the claim(s) have novelty, inventive step, and industrial applicability along with an English translation thereof and a statement that the English translation is accurate if the latest international work product is not in the English language;

(7) Applicant must submit an IDS listing the documents cited by the PCT examiner in the international work product along with copies of documents except U.S. patents or U.S. patent application publications.

The request to participate in the PCT-PPH pilot program and petition comply with the above requirements. Accordingly, the above-identified application has been accorded "special" status.

Telephone inquiries concerning this decision should be directed to the undersigned at (571) 272-3226. All other inquiries concerning the examination or status of the application is accessible in the PAIR system at <http://www.uspto.gov/ebc.index.html>.

This application will be forwarded to the examiner for action on the merits commensurate with this decision.

/Andrea Smith/
Andrea Smith
Petitions Examiner
Office of Petitions



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
13/391,522	Kevin Thomas Christensen	0837RF-H793-US

38441

LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

INTERNATIONAL APPLICATION NO.

PCT/US11/30498

I.A. FILING DATE	PRIORITY DATE
03/30/2011	

CONFIRMATION NO. 6391
371 ACCEPTANCE LETTER



Date Mailed: 05/29/2012

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office in its capacity as a Designated / Elected Office (37 CFR 1.495), has determined that the above identified international application has met the requirements of 35 U.S.C. 371, and is ACCEPTED for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

02/21/2012
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1),
(c)(2) and (c)(4) REQUIREMENTS

02/21/2012
DATE OF COMPLETION OF ALL
35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).* Once the Filing Receipt has been received, send all correspondence to the Group Art Unit designated thereon.

The following items have been received:

- Copy of the International Application filed on 02/21/2012
- Copy of the International Search Report filed on 02/21/2012
- Information Disclosure Statements filed on 02/21/2012
- Oath or Declaration filed on 02/21/2012
- Request for Immediate Examination filed on 02/21/2012
- U.S. Basic National Fees filed on 02/21/2012
- Assignee Statement for PGPUB filed on 02/21/2012

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

JOHN L ANDERSON

Telephone: (571) 272-0385

page 1 of 1



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
13/391,522	02/21/2012		380	0837RF-H793-US	20	2

CONFIRMATION NO. 6391

38441
LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

FILING RECEIPT



OC000000054450565

Date Mailed: 05/29/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Kevin Thomas Christensen, Plano, TX;
Shyhyng Jack Shue, Grapevine, TX;
Troy Sheldon Caudill, Burleson, TX;

Assignment For Published Patent Application

Bell Helicopter Textron Inc., Fort Worth, TX

Power of Attorney: The patent practitioners associated with Customer Number 38441

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/US11/30498 03/30/2011

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.)

If Required, Foreign Filing License Granted: 05/23/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/391,522**

Projected Publication Date: 10/04/2012

Non-Publication Request: No

Early Publication Request: No

Title

Flight Control Laws for Constant Vector Flat Turns

Preliminary Class**PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES**

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER**Title 35, United States Code, Section 184****Title 37, Code of Federal Regulations, 5.11 & 5.15****GRANTED**

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier

license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage, facilitate, and accelerate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 13/391,522				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	0.00			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	0.00			
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *			OR	x 60 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2	minus 3 = *				x 250 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00			
			TOTAL			TOTAL	380			
* If the difference in column 1 is less than zero, enter "0" in column 2.										
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET Substitute for Form PTO-1360 (For use with Form PTO/SB/06)							Application Number 13391522		Filing Date				
							Applicant(s) Kevin Christensen						
							* May be used for additional claims or amendments						
CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT			*		*		*	
	Indep	Depend	Indep	Depend	Indep	Depend		Indep	Depend	Indep	Depend	Indep	Depend
1	1												
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PLUS Search Results for S/N 13391522, Searched Tue Jul 10 15:22:10 EDT 2012

The Patent Linguistics Utility System (PLUS) is a USPTO automated search system for U.S. Patents from 1971 to the present PLUS is a query-by-example search system which produces a list of patents that are most closely related linguistically to the application searched. This search was prepared by the staff of the Scientific and Technical Information Center, SIRA.

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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NOTICE OF ALLOWANCE AND FEE(S) DUE

38441 7590 08/08/2012
LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

EXAMINER

NGUYEN, TAN QUANG

ART UNIT

PAPER NUMBER

3661

DATE MAILED: 08/08/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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13/391,522

02/21/2012

Kevin Thomas Christensen

0837RF-H793-US

6391

TITLE OF INVENTION: FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1740	\$300	\$0	\$2040	11/08/2012

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

38441 7590 08/08/2012
LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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13/391,522 02/21/2012 Kevin Thomas Christensen 0837RF-H793-US 6391

TITLE OF INVENTION: FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
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nonprovisional NO \$1740 \$300 \$0 \$2040 11/08/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
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NGUYEN, TAN QUANG 3661 701-003000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s); (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/391,522	02/21/2012	Kevin Thomas Christensen	0837RF-H793-US	6391

38441 7590 08/08/2012
LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

EXAMINER

NGUYEN, TAN QUANG

ART UNIT	PAPER NUMBER
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3661

DATE MAILED: 08/08/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No.	Applicant(s)	
	13/391,522	CHRISTENSEN ET AL.	
	Examiner	Art Unit	
	TAN Q. NGUYEN	3661	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 3/30/2011.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-20.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
 6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date ____.
 - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).**
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. ☒ Notice of References Cited (PTO-892) 2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948) 3. ☒ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date <u>2/21/2012</u> 4. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material | <ol style="list-style-type: none"> 5. ☐ Notice of Informal Patent Application 6. ☐ Interview Summary (PTO-413),
Paper No./Mail Date ____. 7. ☐ Examiner's Amendment/Comment 8. ☒ Examiner's Statement of Reasons for Allowance 9. ☐ Other ____. |
|---|--|

/TAN Q NGUYEN/
Primary Examiner, Art Unit 3661

EXAMINER'S STATEMENT OF REASONS FOR ALLOWANCE

1. This communication is an Examiner's reasons for allowance in response to application filed on March 30, 2011, assigned serial 13/391,522 and titled "FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS".

2. The following is the Examiner's statement of reasons for the indication of allowable subject matter:

a. After carefully reviewing the application in light of the prior art of record and the searches of all the possible areas relevant to the present application, a set of related prior art references has been found, but those prior art references are not deemed strong to make the application unpatentable. Thus, it is found that the application is now in condition for allowance.

b. Although the prior art disclose several claimed limitations, none of the references teaches an aircraft and method to control flat yawing turn of an aircraft while maintaining a constant vector heading across a ground surface which includes at least a sensor for sensing a directional movement of the aircraft, an actuator for controlling the directional movement of the aircraft, a control system in data communication with the aircraft sensor and operably associated with the actuator, wherein the control system having a model adapted to decouple the directional movement of the aircraft into a lateral equation of motion and a longitudinal equation of motion, a lateral control architecture in data communication with the model for utilizing the lateral equation of motion to control the lateral motion of the aircraft, a longitudinal control architecture in data communication with the model for utilizing the longitudinal equation of motion to control the longitudinal motion of the aircraft, and an initialization command logic in data communication with the lateral control architecture and in data communication with the

Art Unit: 3661

longitudinal control architecture, wherein the initialization command logic selectively activates the lateral control architecture for controlling the lateral motion of the aircraft and selectively activates the longitudinal control architecture for controlling the longitudinal motion of the aircraft, wherein the control system utilizes the lateral control architecture and the longitudinal control architecture to control speed variations of the aircraft while the aircraft maintains a constant vector heading across a ground surface (claims 1 and 11).

c. Claims 1-20 are allowable over the prior art of record.

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Tan Nguyen, whose telephone number is (571) 272-6966. The examiner can normally be reached on Monday-Thursday from 6:30 AM-5:00 PM

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas Black, can be reached on (571) 272-6956.

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks
Washington, D.C. 20231

or faxed to the Central Fax: (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

August 3, 2012

/TAN Q. NGUYEN/
Primary Examiner
Art Unit 3661

Application/Control Number: 13/391,522
Art Unit: 3661

Page 4

Notice of References Cited	Application/Control No. 13/391,522		Applicant(s)/Patent Under Reexamination CHRISTENSEN ET AL.	
	Examiner TAN Q. NGUYEN		Art Unit 3661	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2006/0186261 A1	08-2006	Unzicker, Stefan	244/012.1
*	B	US-2008/0234881 A1	09-2008	Cherepinsky et al.	701/7
*	C	US-2010/0308178 A1	12-2010	Gemmati et al.	244/230
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	100	("5908176" "3554469" "3556442" "3556444" "3558027" "3558082" "3559929" "3565370" "3568960" "3569690" "3570503" "3570786" "3570789" "3572612" "3572614" "3573587" "3574283" "3575363" "3576301" "3576302" "3578267" "3578268" "3578269" "3578270" "3580069" "3580996" "3581014" "3581073" "3584814" "3586267" "3586268" "3591050" "3591110" "3592417" "3592418" "3593092" "3593567" "3594757" "3596855" "3599904" "3599905" "3601733" "3603534" "3603697" "3604664" "3604908" "3608850" "3612075" "3614033" "3614036" "3614401" "3617020" "3618100" "3618878" "3618880" "3620488" "3622075" "3623682" "3624364" "3624366" "3626163" "3627237" "3627238" "3632065" "3633849" "3636321" "3636324" "3638092" "3640137" "3640183" "3643258" "3644928" "3645474" "3648720" "3651583" "3655151" "3657719" "3658280" "3659173" "3660977" "3662974" "3662976" "3662978" "3666213" "3666887" "3666929" "3668623" "3670148" "3670995" "3675880" "3676818" "3678256" "3678285" "3679157" "3679956" "3680164" "3681871" "3682417" "3682498" "3684177").pn.	US-PGPUB; USPAT	OR	ON	2012/07/28 15:36
S2	2	("20080234881" "20030191561").pn.	US-PGPUB; USPAT	OR	ON	2012/07/28 15:44
S3	1962	(aircraft\$3 airplan\$3) and direction\$6 near3 control\$6 and lateral\$6 and longitudinal\$3 and speed\$3	US-PGPUB; USPAT	OR	ON	2012/07/28 15:46
S4	654	S3 and yaw\$6 and (ground\$3 land\$3)	US-PGPUB; USPAT	OR	ON	2012/07/28 15:47
S5	252289	("701"/\$ "340"/\$ "244"/\$).ccls.	US-PGPUB; USPAT	OR	ON	2012/07/28 15:47
S6	520	S4 and S5	US-PGPUB; USPAT	OR	ON	2012/07/28 15:47
S7	60	S6 and constant\$3 near3 (speed velolcity)	US-PGPUB; USPAT	OR	ON	2012/07/28 15:48

7/ 29/ 2012 9:52:09 AM
C:\ Users\ nguyen2\ Documents\ EAST\ Workspaces\ 13-391522 Flight control with lateral and longitudinal.wsp

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	98	(aircraft\$3 airplan\$3) same direction\$6 same lateral\$6 same longitudinal\$3 same speed\$3	US-PGPUB; USPAT; UPAD	OR	ON	2012/07/29 10:18
L4	4	3 same model\$3	US-PGPUB; USPAT; UPAD	OR	ON	2012/07/29 10:18

7/ 29/ 2012 10:18:42 AM
C:\ Users\ tnguyen2\ Documents\ EAST\ Workspaces\ 13-391522 Flight control with lateral and longitudinal.wsp

Issue Classification 	Application/Control No. 13/391,522	Applicant(s)/Patent under Reexamination CHRISTENSEN ET AL.
	Examiner TAN Q. NGUYEN	Art Unit 3661

ISSUE CLASSIFICATION														
ORIGINAL					INTERNATIONAL CLASSIFICATION									
CLASS		SUBCLASS			CLAIMED					NON-CLAIMED				
701		3			G	05	D	1	/08	G	06	F	7	/00
CROSS REFERENCES									/					/
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)													
701	4	14							/					/
244	180								/					/
340	979								/					/
									/					/
									/					/

-----		/TAN Q NGUYEN/ July 29, 2012		Total Claims Allowed: 20	
(Assistant Examiner)	(Date)			O.G. Print Claim(s)	O.G. Print Fig.
(Legal Instruments Examiner)	(Date)	(Primary Examiner)	(Date)	1	7

☒ Claims renumbered in the same order as presented by applicant										☐ CPA		☐ T.D.		☐ R.1.47		
Final	Original		Final	Original		Final	Original		Final	Original		Final	Original		Final	Original
	1			31			61			91			121			151
	2			32			62			92			122			152
	3			33			63			93			123			153
	4			34			64			94			124			154
	5			35			65			95			125			155
	6			36			66			96			126			156
	7			37			67			97			127			157
	8			38			68			98			128			158
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	27			57			87			117			147			177
	28			58			88			118			148			178
	29			59			89			119			149			179
	30			60			90			120			150			180
																210

Search Notes

Application/Control No.

13/391,522

Examiner

TAN Q. NGUYEN

Applicant(s)/Patent under
Reexamination

CHRISTENSEN ET AL.

Art Unit

3661

SEARCHED

Class	Subclass	Date	Examiner
701	3,4,7,10 14	7/10/2012	TN
340	979	7/28/2012	TN
244	180,181	7/28/2012	TN
244	197,230	7/28/2012	TN

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner
701	3,4,14	7/29/2012	TN
244	180	7/29/2012	TN
340	979	7/29/2012	TN

**SEARCH NOTES
(INCLUDING SEARCH STRATEGY)**

	DATE	EXMR
PLUS SEARCH	7/10/2012	TN
EAST SEARCH	7/28/2012	TN
Interference Search History Printout	7/29/2012	TN

02/21/2012

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (07-09)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		13/391,522	
	Filing Date		02/21/2012	
	First Named Inventor	KEVIN T. CHRISTENSEN		
	Art Unit			
	Examiner Name			
	Attorney Docket Number		0837RF-H793-US	

U.S. PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
/TN/	1	20080234881	A1	2008-09-25	Cherepinsky, Igor	
/TN/	2	20030191561	A1	2003-10-09	Vos, David	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² j	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
/TN/	1	2007018572	WO	A2	2007-02-15	Shue, Shyhyng Jack		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

/Tan Q. Nguyen/

07/10/2012

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		
First Named Inventor	KEVIN T. CHRISTENSEN	
Art Unit		
Examiner Name		
Attorney Docket Number	0837RF-H793-US	

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
/TN/	1	International Search Report and the Written Opinion of the International Searching Authority mailed by ISA/USA, U.S. Patent and Trademark Office on 26 August 2011 for corresponding International Patent Application No. PCT/US2011/030498, 7 pages.	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/Tan Q. Nguyen/	Date Considered	07/10/2012
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

Index of Claims



Application/Control No.

13/391,522

Examiner

TAN Q. NGUYEN

Applicant(s)/Patent under Reexamination

CHRISTENSEN ET AL.

Art Unit

3661

✓	Rejected
=	Allowed

—	(Through numeral) Cancelled
÷	Restricted

N	Non-Elected
I	Interference

A	Appeal
O	Objected

Claim		Date									
Final	Original	7/23/12									
1	1	=									
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BIB DATA SHEET

CONFIRMATION NO. 6391

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.	
13/391,522	02/21/2012	701	3661	0837RF-H793-US	
RULE					
APPLICANTS Kevin Thomas Christensen, Plano, TX; Shyhyng Jack Shue, Grapevine, TX; Troy Sheldon Caudill, Burleson, TX; ** CONTINUING DATA ***** This application is a 371 of PCT/US11/30498 03/30/2011 ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 05/23/2012					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /TAN QUANG NGUYEN/ Acknowledged Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY TX	SHEETS DRAWINGS 9	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 2
ADDRESS LAW OFFICES OF JAMES E. WALTON, PLLC 1169 N. BURLESON BLVD. SUITE 107-328 BURLESON, TX 76028 UNITED STATES					
TITLE Flight Control Laws for Constant Vector Flat Turns					
FILING FEE RECEIVED 380	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/391,522	02/21/2012	Kevin Thomas Christensen	0837RF-H793-US

CONFIRMATION NO. 6391

PUBLICATION NOTICE



OC000000056917996

38441
LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

Title: FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

Publication No. US-2012-0253558-A1

Publication Date: 10/04/2012

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <http://pair.uspto.gov/>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** Mail Stop ISSUE FEE
Commissioner for Patents
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Alexandria, Virginia 22313-1450
or **Fax** (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

38441 7590 08/08/2012
LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLERSON BLVD.
SUITE 107-328
BURLERSON, TX 76028

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below. *via EFS-web.*

James E. Walton (Depositor's name)
James E. Walton (Signature)
7 November 2012 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/391,522	02/21/2012	Kevin Thomas Christensen	0837RF-H793-US	6391

TITLE OF INVENTION: FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1740	\$300	\$0	\$2040	11/08/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, TAN QUANG	3661	701-003000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

- 1 James E. Walton
2 Richard G. Eldredge
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

Textron Innovations Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Providence, Rhode Island

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☒ Payment by credit card. Form PTO-2038 is attached. - Paid via EFS-Web.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 502806 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature *James E. Walton*
James E. Walton
Typed or printed name

Date 7 November 2012
Registration No. 47,245

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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Electronic Patent Application Fee Transmittal				
Application Number:		13391522		
Filing Date:		21-Feb-2012		
Title of Invention:		FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS		
First Named Inventor/Applicant Name:		Kevin Thomas Christensen		
Filer:		James Edward Walton		
Attorney Docket Number:		0837RF-H793-US		
Filed as Large Entity				
U.S. National Stage under 35 USC 371 Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1770	1770
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				2070

Electronic Acknowledgement Receipt

EFS ID:	14174457
Application Number:	13391522
International Application Number:	
Confirmation Number:	6391
Title of Invention:	FLIGHT CONTROL LAWS FOR CONSTANT VECTOR FLAT TURNS
First Named Inventor/Applicant Name:	Kevin Thomas Christensen
Customer Number:	38441
Filer:	James Edward Walton
Filer Authorized By:	
Attorney Docket Number:	0837RF-H793-US
Receipt Date:	07-NOV-2012
Filing Date:	21-FEB-2012
Time Stamp:	17:22:53
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$ 2070
RAM confirmation Number	4471
Deposit Account	502806
Authorized User	WALTON, JAMES E

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	PTOL-85-20121107.pdf	148562 0446f76de29b2c553638051553cd2da8c68704d0	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	31892 b536deecd485c6d0cddd2fbed4e116785e18b8f2	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			180454		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/391,522	12/11/2012	8332082	0837RF-H793-US	6391

38441 7590 11/21/2012
LAW OFFICES OF JAMES E. WALTON, PLLC
1169 N. BURLESON BLVD.
SUITE 107-328
BURLESON, TX 76028

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Kevin Thomas Christensen, Plano, TX;
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The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas, Marshall Division on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.);

DOCKET NO. 2:22-cv-00351-RWS-RSP	DATE FILED 9/9/2022	U.S. DISTRICT COURT Eastern District of Texas, Marshall Division
PLAINTIFF Textron Innovations Inc.		DEFENDANT SZ DJI Technology Co., Ltd., DJI Europe B.V., SZ DJI Baiwang Technology Co. Ltd., and iFlight Technology Company Ltd.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,275,950	4/30/2019	Textron Innovations Inc.
2 8,332,082	12/11/2012	Textron Innovations Inc.
3 8,682,505	3/25/2014	Textron Innovations Inc.
4 11,288,972	3/29/2022	Textron Innovations Inc.
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE
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Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy