IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Murphy et al.	§	Filed: May 2, 2013
	§	
	§	Group Art Unit: 3646
Serial No.: 13/875,749	§	
	§	Examiner: Frank Mcgue
Confirmation No.: 6872	§	

For: DEVICE, SYSTEM AND METHODS USING ANGLE OF ARRIVAL MEASUREMENTS FOR ADS-B AUTHENTICATION AND NAVIGATION

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May 24, 2016	/ Jennifer A. WEAVER/
Date	Jennifer A. Weaver

RESPONSE TO OFFICE ACTION DATED MARCH 21, 2016

In response to the Office Action dated March 21, 2016, having a shortened statutory period for response set to expire on June 21, 2016, please enter this response and reconsider the claims pending in the application for reasons discussed below. While no fees are believed due, the Commissioner is hereby authorized to charge counsel's Deposit Account No. 20-0782 / 12-1366 (071631)/ GGM for any fees, including extension of time fees or excess claim fees, required to make this response timely and acceptable to the Office.

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper. Remarks/Arguments begin on page 11 of this paper.

IN THE CLAIMS:

Please amend the claims as follows:

1. (Previously Presented) An aircraft receiver for Automatic Dependent Surveillance Broadcast (ADS-B) verification of a target aircraft, comprising:

a first input for receiving ADS-B flight tracking information from the target aircraft at the receiver, the ADS-B flight tracking information including indicated positional information of the target aircraft;

a second input for receiving positional information and heading information indicating the location and orientation of a multi-element array antenna configured to be attached to the receiver;

a processing module operative to:

generate a measured bearing derived from angle of arrival data, and

generate an expected bearing of the target aircraft derived from the indicated positional information of the target aircraft and the positional information and heading information defining the receiver location and orientation;

a comparator for comparing the expected bearing to the measured bearing and verifying the ADS-B flight tracking information of the target aircraft; and

an output device for outputting an indication of authenticity based on verifying the ADS-B flight tracking information of the target aircraft.

2. (Original) The aircraft receiver according to claim 1, wherein the processing module being further operative to compute a vector from the receiver location to the target aircraft based on the indicated positional information,

wherein computing the vector being based on receiving the positional information from a Global Navigation Surveillance System (GNSS) indicating the location of the multi-element array antenna.

3. (Original) The aircraft receiver according to claim 2, wherein the processing module being further operative translate the vector from an earth reference frame to an airplane reference frame based the heading information including pitch, roll and heading data generated from an Inertial Reference Unit (IRU) indicating the orientation of the multi-element array antenna.

4. (Original) The aircraft receiver according to claim 1, wherein the processing module being further operative generate the measured bearing based on measuring a relative phase of a carrier signal identified in the first input.

5. (Original) The aircraft receiver according to claim 1, further comprising an Analog-to-Digital (A/D) converter for processing signals received on the first input,

wherein the A/D processing transmits a synchronizing signal to a commutating multiple-element array antenna that feeds the signals to the first input.

6. (Previously Presented) A receiver for Automatic Dependent Surveillance Broadcast (ADS-B) verification, comprising:

a processing module receiving an ADS-B signal from a target aircraft including indicated positional data, and operative to:

generate a measured bearing derived from detection of an angle of arrival of the ADS-B signal, and

generate an expected bearing of the target aircraft derived from the indicated positional data of the ADS-B signal, and positional and heading information of a location and orientation of a multi-element array antenna configured to be attached to the receiver;

a comparator for comparing the expected bearing to the measured bearing and for verifying the ADS-B indicated positional data of the target aircraft; and

an output device for outputting an indication of authenticity based on verifying the ADS-B indicated positional data of the target aircraft.

7. (Original) The receiver according to claim 6, wherein the processing module being further operative to compute a vector from the receiver location to the target aircraft based on the indicated positional data,

wherein computing the vector being based on receiving the positional information from a Global Navigation Satellite System (GNSS) indicating the location of the multi-element array antenna.

8. (Original) The receiver according to claim 7, wherein the processing module being further operative to translate the vector from an earth reference frame to an airplane reference frame based the heading information including pitch, roll and heading data generated from an Inertial Reference Unit (IRU) indicating the orientation of the multi-element array antenna.

9. (Original) The receiver according to claim 6, wherein the processing module being further operative to generate the measured bearing based on measuring a relative phase of a carrier signal of the ADS-B signal from the target aircraft.

10. (Original) The receiver according to claim 6, further comprising an Analog-to-Digital (A/D) converter processing ADS-B signals received from the target aircraft,

wherein the A/D processing is synchronized to a commutating multiple-element array antenna feeding the ADS-B signals to the receiver.

11. (Previously Presented) A system for automatic dependent surveillance broadcast (ADS-B) verification, comprising:

an antenna array assembly having a multiple-element antenna array for receiving ADS-B signals from a target aircraft, the ADS-B signals including indicated positional data; and

a receiver configured to receive the ADS-B signals from the antenna array assembly and to measure an angle of arrival of the ADS-B signals relative to the orientation of the antenna array assembly, wherein the receiver comprises:

a first input for receiving ADS-B flight tracking information from the target aircraft at the receiver, the ADS-B flight tracking information including indicated positional information of the target aircraft;

a second input for receiving positional information and heading information indicating the location and orientation of the receiver;

a processing module operative to:

generate a measured bearing derived from angle of arrival data, and

generate an expected bearing of the target aircraft derived from the indicated positional information of the target aircraft and the positional information and heading information defining the receiver location and orientation; and

a comparator for comparing the expected bearing to the measured bearing and verifying the ADS-B flight tracking information of the target aircraft; and

an output device for outputting an indication of authenticity based on verifying the ADS-B flight tracking information of the target aircraft.

12. (Original) The system according to claim 11, where the antenna array assembly further comprises a commutating solid state switch that cycles between each antenna element of a multi-element array antenna.

13. (Original) The system according to claim 12, where the receiver further comprises an analog-to-digital (A/D) converter that receives the ADS-B signals and controls the cycling of the commutating solid state switch with a synchronization signal.

14. (Currently Amended) The system according to claim 11, wherein the processing module being further operative to decode the indicated positional data from the target transmitter from one discrete digital data stream for a single antenna element of the [[multi]] multiple-element antenna array ~~antenna~~ via an ADS-B signal demodulation process; and

determine an expected AOA of the target transmitter derived from the decoded indicated positional data from the target transmitter, and positional information defining a location of the receiver and heading information defining an orientation of the antenna array assembly.

15. (Original) The system according to claim 14, wherein the processing module being further operative to compare the expected AOA to the measured AOA to verify the indicated positional data from the target transmitter in the received ADS-B signal; and

provide an indication of authenticity based on verifying the indicated positional data from the target transmitter.

16. (Withdrawn) A method of measuring an Angle of Arrival (AOA), comprising:

cycling a commutating solid state switch between each antenna element of a multi-element array antenna based on a synchronization signal received from a receiver system;

receiving at least one signal at the multi-element array antenna so that a time multiplexed RF signal is received at an output of the commutating solid state switch;

converting the time multiplexed RF signal at an analog-to-digital (A/D) converter based on the synchronization signal into a plurality of antenna element specific digital samples for each discrete signal;

de-multiplexing the plurality of antenna element specific digital samples into discrete digital data streams for each antenna element of the multi-element array antenna; and

determining a measured AOA of the at least one signal based on measuring a relative phase of a carrier signal identified in each discrete digital data stream of the respective antenna elements of the commutating multi-element array antenna.

17. (Withdrawn) The method according to claim 16, where the signal comprises an ADS-B signal including indicated positional data from a target transmitter.

18. (Withdrawn) The method according to claim 17, further comprising:

decoding the indicated positional data from the target transmitter from one discrete digital data stream for a single antenna element of the multi-element array antenna via an ADS-B signal demodulation process;

determining an expected AOA of the target transmitter derived from the decoded indicated positional data from the target transmitter, and positional information defining a location of the receiver system and heading information defining an orientation of an antenna subsystem of the receiver system;

comparing the expected AOA to the measured AOA to verify the indicated positional data from the target transmitter in the received ADS-B signal; and

providing an indication of authenticity based on verifying the indicated positional data from the target transmitter.

19. (Withdrawn) The method according to claim 16, where the at least one signal comprises a plurality of signals from at least two emitters of signals of opportunity.

20. (Withdrawn) The method according to claim 19, further comprising:

retrieving an identity for each respective emitter from a database;

determine a location for each emitter based on the identity for each respective emitter from the database;

determining AOAs for each signal from the respective emitters based on measuring the relative phase of the carrier signal identified in each discrete digital data stream of the respective antenna elements of the commutating multi-element array antenna; and

compute an independent position fix of the antenna subsystem of the receiver system based on the AOAs locations and each respective emitter location.

REMARKS

This is intended as a full and complete response to the Office Action dated March 21, 2016, having a shortened statutory period for response set to expire on June 21, 2016. Please reconsider the claims pending in the application for reasons discussed below.

Claims 1-20 are pending in the application. Claims 1-15 remain pending following entry of this response. Claims 16-20 are withdrawn. Claim 14 has been amended. Applicant submits that the amendments do not introduce new matter.

Further, Applicant is not conceding in this application that those amended claims are not patentable over the art cited by the Examiner, as the present claim amendments are only for facilitating expeditious prosecution of the claimed subject matter. Applicant respectfully reserves the right to pursue these pre-amended claims and other claims in one or more continuations and/or divisional patent applications.

Statement of Substance of Interview

On My 24, 2016, a telephonic interview was held between Carleton Clauss ((attorney – Reg. No. 66230) and Examiner Frank McGue. The parties discussed the cited references including *Andersson*. The independent claims were discussed.

During the interview, Applicant argued that *Andersson* does not teach generating measured and estimated bearings. Examiner McGue agreed that *Andersson* did not appear to teach each element of the independent claims but stated that further search and consideration are required.

Claim Rejections - 35 U.S.C. § 112

Claim 14 stands rejected under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Applicant has amended "multi-element array antenna" to "multiple-element antenna array" which has proper antecedent basis in claim 11, and thus, requests that this rejection be withdrawn.

Claim Rejections - 35 U.S.C. § 102

Claims 1-3, 6-8 and 11 stand rejected under 35 U.S.C. § 102(a)(2) as being anticipated by *Andersson et al.*, U.S. Publication No. 2011/0163908 (hereinafter *Andersson*).

Applicant respectfully traverses this rejection.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim. *In re Bond*, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

In this case, *Andersson* does not disclose "each and every element as set forth in the claim". For example, *Andersson* does not disclose, as is recited in claim 1:

- generat[ing] a measured bearing derived from angle of arrival data, and
- generat[ing] an expected bearing of the target aircraft derived from the indicated positional information of the target aircraft and the positional information and heading information defining the receiver location and orientation.

The Office asserts that these two claim elements are taught in paragraphs [0018-19]. *Office Action*, p. 4. These paragraphs state in their entirety:

> estimating the distance between the receiving unit and the radio source based on the time of flight for a signal travelling there between at known speed;
>
> calculating an estimated position of the radio source based on the estimated bearing and the estimated distance.

To provide additional context, *Andersson* teaches:

> a radio direction finding antenna arrangement of a receiving unit receives a signal carrying positional data indicating an alleged position of a vehicle transmitted from a radio source. The bearing from the receiving unit to the radio source is estimated utilizing the radio direction finding antenna arrangement and the received signal. The distance between the receiving unit and the radio source is estimated based on the time of flight for a signal travelling there between at known speed. An estimated position of the radio source is calculated based on the estimated bearing and the estimated distance. *Abstract.*

Andersson further explains that estimating the bearing from the receiving unit to the radio source is "performed by receiving the signal with a directional antenna connected to a transceiver circuitry which is adapted to determine the bearing to the radio source based on the output from the directional antenna." ¶ [0024]. Once the host aircraft estimates the bearing to the emitting radio source (step S2 of Figure 3) and estimates the distance to the radio source (step S3 of Figure 3), the aircraft calculates an estimated position (P_{EST}) of the radio source using the estimated bearing and distance (step S4 of Figure 3). The estimated position is compared to the position of the radio source provided in the ADS-B transmission to determine if the ADS-B transmission is reliable. ¶ [0086].

Andersson, however, does not teach generating a measured bearing derived from angle of arrival data and generating an expected bearing derived from the indicated positional information of the target aircraft. Instead, *Andersson* generates only one estimate of the bearing for each radio source, and this estimate is generated using the same method – i.e., based on the output from the directional antenna. ¶ [0024]. Put differently, *Andersson* does not disclose using two different bearing measurements which are then compared to verify "the ADS-B flight tracking information of the target aircraft." Instead, *Andersson* generates an estimated position of the radio source (which is derived using one estimated bearing) which is compared to the received position of the radio source provided in the ADS-B transmission to determine if the ADS-B transmission is reliable. ¶ [0086]. Because *Andersson* does not teach generating and comparing a measured bearing to an expected bearing, for at least this

reason, Applicants submit *Andersson* does not teach each and every element of claim 1.

Furthermore, *Andersson* teaches that the bearing is estimated using "means of a radio direction finding antenna arrangement capable of estimating the bearing to the emitting radio source" and by "analyzing the signal received with the radio direction finding antenna arrangement in known ways" ¶ [0082-83]. However, claim 1 recites "generating a measured bearing derived from angle of arrival data." Angle of arrival is not even mentioned in *Andersson*. The only technical details for estimating the bearing provided in *Andersson* is that a radio direction finding antenna must be used, but this general disclosure does not specifically (or inherently) teach generating the measurement using angle of arrival data. Thus, for at least this reason, Applicants submit *Andersson* does not teach each and every element of claim 1.

Further still, even assuming *arguendo* that the mere disclosure of the radio direction finding antenna in *Andersson* does teach generating a "measured bearing derived from angle of arrival data," claim 1 recites that the expected bearing is "derived from the indicated positional information of the target aircraft and the positional information and heading information defining the receiver location and orientation." There is no teaching in *Andersson* of using the position of the radio source or the host aircraft to derive the expected bearing. Instead, *Andersson* teaches that the bearing is needed to estimate the position of the radio source. *See* Figure 3. Thus, for at least this reason, Applicants submit *Andersson* does not teach each and every element of claim 1.

Independent claim 6 recites:

- generat[ing] a measured bearing derived from detection of an angle of arrival of the ADS-B signal,
- generat[ing] an expected bearing of the target aircraft derived from the indicated positional data of the ADS-B signal, and positional and heading information of a location and orientation of a multi-element array antenna configured to be attached to the receiver.

As explained above, *Andersson* does not teach generating a measured bearing and an expected bearing. As such, *Andersson* does not teach each and every element of claim 6.

Independent claim 11 recites:

- generat[ing] a measured bearing derived from angle of arrival data,
- generat[ing] an expected bearing of the target aircraft derived from the indicated positional information of the target aircraft and the positional information and heading information defining the receiver location and orientation

As explained above, *Andersson* does not teach generating a measured bearing and an expected bearing. As such, *Andersson* does not teach each and every element of claim 11.

Therefore, the claims are believed to be allowable, and allowance of the claims is respectfully requested.

Claim Rejections - 35 U.S.C. § 103

Claims 4-5, 9-10 and 12-15 stand rejected under 35 U.S.C. § 103 as being unpatentable over *Andersson* in view of *Wild et al.*, U.S. Publication No. 2012/0223811 (hereinafter *Wild*).

The rejection to claims 4-5, 9-10 and 12-15 incorporate the rejection to independent claims 1, 6, and 11, respectively. As stated above, the rejection to independent claims 1, 6, and 11 is believed to be overcome. Accordingly, the rejection to claims 4-5, 9-10 and 12-15 is also believed to be overcome. Therefore, the withdrawal of the rejection to these claims is respectfully requested.

Conclusion

Having addressed all issues set out in the office action, Applicant respectfully submits that the claims are in condition for allowance and respectfully requests that the claims be allowed.

Respectfully submitted, and
S-signed pursuant to 37 CFR 1.4,

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