(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 May 2001 (31.05.2001)

PCT

(10) International Publication Number
WO 01/39127 A1

(51) International Patent Classification[7]: G06T 11/20

(21) International Application Number: PCT/IB00/01757

(22) International Filing Date:
25 November 2000 (25.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9904283-0 25 November 1999 (25.11.1999) SE
200000011 4 January 2000 (04.01.2000) ES

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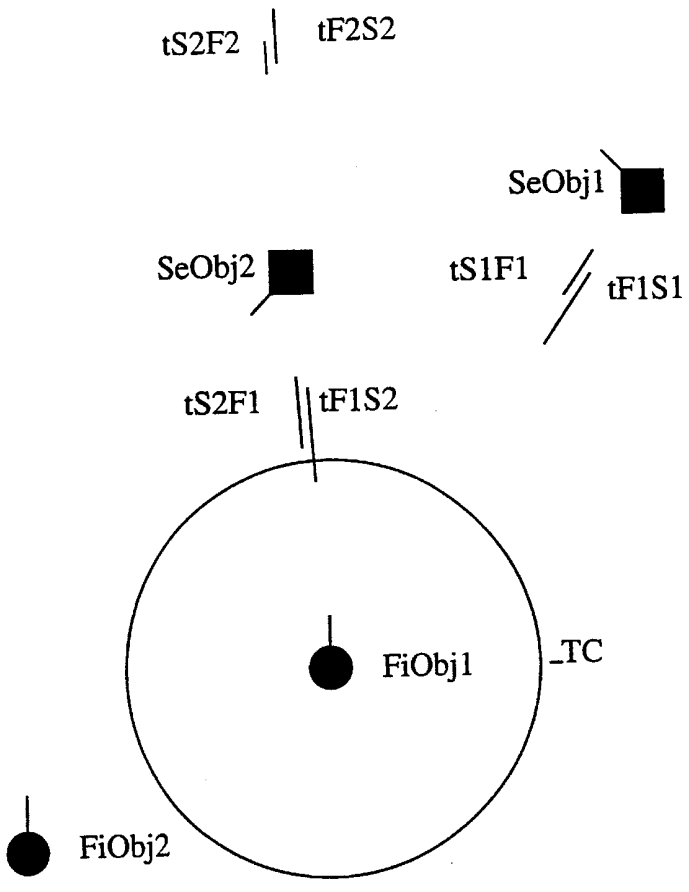
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*
— *With amended claims and statement.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD TO PRESENT THE THREAT SITUATION ON A DISPLAY



(57) Abstract: Method to present on a display at least one threat (tSF, tFS) between at least one pair of objects, (FiObj, SeObj), characterized by that only one threat circle, TC, is presented on the screen for all the first objects, FiObj, and all the second objects, SeObj. The threats (tSF, tFS) are marked with symbols placed, in relation to the threat circle, in radial direction from the centre of the threat circle, TC, to respective second object, SeObj, and /or first object, FiObj. The threat circle marks the boundary between the area inside the threat circle in which the threat exists and the area outside the threat circle in which the threat does not exist. The radial distance of the threat symbol, to the threat circle, constitute a measure, in suitable threat scale (time, length, etc.), of closeness to this transition.

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Method to present the threat situation on a display

The present invention is intended to present the threat situation on a display. The invention is intended to present civilian as well as military threats and others possible events to objects. An object can be an aircraft, an air-defence gun, a ship, an obstacle, etc. An example of a civilian threat is the risk for collision between aircraft. An example of a military threat is the risk for impact with a missile. An example of a military possible event is to get a sensor to lock on a target. Yet another civil possible event is the risk for a ship to collide with other ships and the risk to run aground.

We shall look now an important case, the threat between the two objects in a pair. The objects are divided into pairs i.e. assuming N objects, where N is at least 2, then there are N * (N -1) /2 pairs. In a military combat situation we consider a specific pair where the first object is called, FiObj, and the second object SeObj. It is now interesting to know how to present the threat (tSF) to the first object (FiObj) from the second object (SeObj) and the threat (tFS) to the second object (SeObj) from the first object (FiObj). Important information is the position in space of the object, their performance (speed and so on) and the range of their weapons and so on.

An unsophisticated way to present the situation of the threat is to reproduce the space with the first object situated at the origin in a system of polar co-ordinates, where the distance to the others objects are marked. The threat in the shape of the range of the robots (missiles) can be marked with circles around respective object. Such presentation is, at least in complicated situations with several objects, difficult to rapidly estimate.

The idea is to solve the mentioned problem so that the observer gets a rapid overview of the total situation of the threat. The observer should also at the same time be able to decide quickly whether or not he is superior or inferior to the threat. Theirs goals are met by my invention as specified in the first claim below. Suitable implementation of the invention gives in the others claims.

The invention is characterised by a common circle, called the threat circle, TC, for all the objects, in the general case called the circle of possible events, in relation to which all the threats are presented. This is the main idea. The threats tSF and tFS is marked with its own symbol located in the direction from the centre of the threat circle to the SeObj and / or the FiObj. The latter makes it possible to overlay the picture of the threat situation plane on the plane of

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location and in the same time presents the true location and the true threat situation of the different objects.

The threat circle, TC, marks the boundary between the area inside the threat circle in which the threat exists and the area outside the threat circle in which the threat does not exist. The distance of the threat symbol to the threat circle tells nothing about how close in time the threat symbol is from crossing the threat circle. This, however, is obtained from the radial dynamics of the threat symbol together with their position in the threat situation plane.

The invention makes it possible to easy present the uncertainty in forming judgement of the threat, witch normally is important to show. In practice there is a lot of uncertain facts. E. g. in a military situation you do not know if the antagonist shall discover the firing of your robot and run away or continue on the same course. Also, you do not have complete information of the robotic ranges of the antagonist, perhaps even insecurity on the range of your own robot. Knowledge on the position and velocity of the antagonist can also be insufficient. All this insecurity and others can, fundamentally, be taken over into the radial range of the symbol in the threat situation plane.

The invention makes it possible to change the scale of the location plane and/or the scale of the threat situation plane. It is also possible to move the centre of the threat circle to a suitable position in the location plane and at the same time present the real positions and situations of the threat of the different objects.

The situation of the threat, i.e. the radial distance of the threat symbol to the threat circle, can, at least, be computed in three ways, each of which gives a certain form of presentation. Namely presentations with respect to normalized distance, distance and time.

In the normalized distance presentation mode, tSF is computed as the quotient of the distance from FiObj to SeObj and the range of the missile of SeObj. A value of tSF less than one leads to a position of the threat symbol inside the threat circle, otherwise the position is outside.

In the distance presentation mode, tSF is computed as the difference of the distance between FiObj and SeObj and the range of the robot of SeObj. A value of tSF less than

zero leads to a position of the threat symbol inside the threat circle, otherwise the position is outside.

Finally, in the time presentation mode, tSF is computed as the time it takes for SeObj, with preserved velocity, to move the distance to FiObj minus the range of the robot of SeObj. If the range of the robot of SeObj is greater than the distance between FiObj and SeObj, the threat situation, tSF, is positioned inside the threat circle, otherwise the position is outside.

The analogous is valid for the threat situation, tFS, of the second object, SeObj, concerning the computation of the threat situation.

The different kinds of presentations have different advantages and are dependent of the current applications. It can be suitable to use just as a particular mode of presentation. It is convenient to make it possible for the presentation equipment to change between the alternative modes of presentation.

The invention is to be described in more detail using the figures of this document. We now briefly describe these figures.

Fig. 1 shows a picture of the presentation of location,
Fig. 2 shows a picture of the presentation of the threat situation,
Fig. 3 shows the threat situation according to fig. 2 superposed (overlaid) on a picture of presentation of location,
Fig. 4 shows a picture of the threat situation superposed on a picture of presentation of location with two first objects,
Fig. 5 shows a picture of an one-sided threat situation to the second objects, SeObj, from the first objects, FiObj,
Fig. 6 shows a picture of the threat situation with insecurity in the threat,
Fig. 7 shows a picture of the threat situation superposed on a picture of presentation of location with the second objects (SeObj1 and SeObj2) close to and nearly at the same bearing, and finally
Fig. 8 shows another form of a representation of the threat situation with the second objects close to and nearly at the same bearing.

Below follows a description of the invention from an application inside a combat aircraft. However it is clear that the invention can be used also in other situations, military as well

as civilian, for similar presentations and it is my propose that this invention shall cover such applications.

One can present the threat, using each of the 3 modes. However all modes have a common threat circle for all displayed objects. The figures in the examples are valid for an arbitrary choice of any of the three modes.

Fig. 1 shows a picture of the presentation of location that can be used together with the picture of the presentation of threat. In fig. 1 the current location of one first object, FiObj, and two seconds objects, SeObj1 and SeObj2, are presented on a monitor, for example a tactic indicator. Of course there could be several first objects and second objects. It is appropriate that the symbol for the first object is different from the symbol of the second object. Even the colour should be different.

Fig. 2 presents a situation where the threats (tFS, tSF) are located, in relation to the common threat circle, TC, in radial direction from the centre of the circle to each respective second object. We present here only two pairs, (FiObj, SeObj1) and (FiObj, SeObj2), but we could present also the third pair (SeObj1, SeObj2). The threat, tS1F, to FiObj from SeObj1 is marked with an unfilled ring in radial direction from the centre of the threat circle to SeObj1. The threat, tFS1, to SeObj1 from FiObj is also marked, with a filled ring, in radial direction from the centre of the threat circle to SeObj1. The circle tells us that the threat is imminent when the threat is inside the circle. In this case the object SeObj2 is a danger threat to the object FiObj, which is evident by the position of tS2F inside the threat circle. Fig. 2 shows also that FiObj is inferior to SeObj1 in the sense that tS1F is more close to the area inside TC, in which the threat exist, than tFS1.

A threat can be represented e. g. as a ring in the equipment of presentation. The threat can also be represented as a short line (bar). If you choose a bar instead of a ring to present the threat, you must decide on which end of the bar that indicates the threat position. In the case of rings as well as in the case of bars one may use different colours, for example blue for first threat situation, tSF, and red for second threat situation, tFS.

Fig. 3 shows that one may overlay fig. 1 and fig. 2 and at the same time represent both the true location and the threats for the different objects.

In the text above the threat has be represented for one first object, FiObj, and two second objects, (SeObj1, SeObj2). However, one may also represent the threat from several first

objects in the same presentation of threat. Fig. 4 presents the threat, tS2F1, to FiOb1 from SeObj2 and tF1S2 presents the threat to SeObj2 from FiObj1. The threat to FiObj2 from SeObj2 is denoted by tS2F2 and the threat to SeObj2 from FiObj2 is denoted by tF2S2. What restricts the number of objects is the fact that the display can be quite messy and difficult to interpret with many objects. It is, of course, possible to let a user choose which objects to display. After that the others are suppressed until new choices are made, after some time has passed or another simple criterion is fulfilled.

In fig. 4 the object FiObj2 is located deliberately at long range from SeObj1 in order to illustrate that its threat situation is not interesting and for that reason it is not necessary to be presented. It is evident from the figure that the threat, tF1S2, to SeObj2 from FiObj1 is imminent and that the same is valid for tS2F1. It is evident that SeObj2 is somewhat inferior to FiObj1 in the sense that tS2F1 is more close to the area outside TC, where the threat does not exist, than tF1S2. It is also evident that FiObj1 is somewhat inferior to SeObj1 in the sense that tS1F1 is more close to the area inside TC, where the threat exists, than tF1S1.

Likewise it is possible to allow the user to specify which threats shall be computed and presented, amongst a number of imaginable (thinkable) threats. The user can choose not to present some improbable threats, though they are possible, with the purpose of making the threat situation plane easy to interpret. An example of such a threat can be the threat from a long-range robot.

In the case that a picture of presentation of location shall be superposed, one must decide which of the first objects, if any, shall be located at the centre of the threat circle. There are several possibilities. Fig. 4 shows two first objects where none of them are placed at the centre of the threat circle. FiObj1 or FiObj2 could have been selected to lie at the centre or the centre could be selected to lie in some kind of mean value between the objects. Specially, in a case with a group of first objects that have weapons with larger ranges than the group spreading in space, it is appropriate to place the group in the centre of the threat circle. The equipment of presentation of threat can easily be designed so that relative transfer between the overlay pictures can be made.

Fig. 5 shows one-sided threat to second objects from first objects. It must be pointed out that there are two different scales in the same picture. One is the scale of the threat-situation plane and the other is the scale of the location plane of the objects. If, for example, in the threat situation plane 1 cm corresponds to 10 km then the threat, tF1S2,

to SeObj2 from FiObj1 is placed about 15 km inside the robot range of FiObj1. This is because the filled ring is placed about 1.5 cm from the threat circle inside it. In the plane of location 1 cm can, for example, corresponds to 5 km and consequently the distance between FiObj1 and SeObj2 is about 40 km.

If one wants to visualize the insecurity in the threat, which usually is important, then a short line (bar) is a suitable choose, where the length of the bar indicates the degree of insecurity. The insecurity of the threat can then be presented as a bar in radial direction where the probability that the threat is inside the threat circle is proportional to the quotient between the length of the part of the bar inside the threat circle and the length of the whole bar.

In fig. 6 the different lengths of the bars state the different degrees of insecurity. In the other figures equally long bars or rings are use meaning that the insecurity is either unknown or hidden. The threat, tF1S2, to SeObj2 from FiObj1 shows more insecurity than the threat, tS2F1, to FiObj1 from SeObj2 . The threat tF1S2 overlaps somewhat the area inside the threat circle, which means that there is a little probability that FiObj1 can impact SeObj2 when its missile is fired.

Normally, the threat, for example the threat from a missile by its range, is dependent of several factors like the flying altitude, the relative differences in altitude between aircraft, launch direction, etc. Fore those reasons the presentation is constantly changing with respect to the current threat distance, for example the range of the missile.

The presentation of the objects can be excellent as can be seen by the figures. The type of object is given by the symbol, which also gives the speed and direction of the speed vector, etc. In some cases with several objects and threats it is suitable, at least some time, to omit the objects to make the picture more easy to interpret. This can be done with an easy choice on the presentation.

If several others objects are lying near each other at almost the same bearing, it can be difficult to see witch symbol of threat belong to which object, as illustrated in fig 7. Fig. 8 shows how one may, by relative removal of the two pictures, render the presentation more clear. If the centre of the threat circle moves near SeObj1 and SeObj2, then the angle difference between the objects, as seen from the centre of the threat circle, is bigger and consequently threat bars are more separated in angle.

In order to more easily estimate the radial position of the different threats symbols on the display in relation to the threat circle (TC), one or more concentric circles, with respect to the threat circle, can be placed on the display.

It has in the beginning been mentioned that the invention can be used even for civilian air traffic. The reason for that is, of course, that every aircraft in the neighborhood of the own aircraft gives a potential risk of collision. Likewise the own aircraft is a potential risk of collision against nearby aircraft. Proximity to a stationary object constitutes also a risk, the closer the bigger.

The advantage with this presentation, apart from what already has been mentioned, is that one can define the meaning of the risk an aircraft can be exposed to. This risk can be different for different aircraft, and still have the same threat circle for all the aircraft involved.

Only threats between the two objects in a pair have been considered so far. Howewer also the more general case of one or more threats to one or more objects is of interest and can be treated in a similar fashion. In this last case the threat symbols are placed in the radial direction from the centre of the threat circle to respective object.

Ultimately, one must remember that the threat circle can, more generally, be called the event circle (TC). Inside the event circle it is assumed that possible events occur while outside it, possible events do not occur.

I claim:

1. Method to present on a display at least one threat (tSF, tFS) between at least one pair of objects, (FiObj, SeObj), characterized by that only one threat circle (TC) is presented on the screen for all the first objects, FiObj, and all the second objects, SeObj, and that the threats are marked with symbols placed, in relation to the threat circle, in radial direction from the centre of the threat circle to respective second object, SeObj, and / or first object, whereby the threat circle marks the boundary between the area inside the threat circle in which the threat exists and the area outside the threat circle in which the threat does not exist, and where the radial distance of the threat symbol, to the threat circle, constitute a measure, in suitable threat scale (time, length, etc.), of closeness to this transition.

2. Method according to claim 1, characterized by that one or more threats to one or more objects are placed in the radial direction from the centre of the threat circle to respective object.

3. Method according to any of the previous claims, characterized by that tSF and tFS are presented with different colours.

4. Method according to any of the previous claims, characterized by that the insecurity in the position of the threat, in relation to the threat circle (TC), is presented by a bar that states, with its radial range, where the threat is located.

5. Method according to any of the previous claims, characterized by a picture that with symbols shows the geographic position of first objects (FiObj) and second objects (SeObj) superposed on the threat situation plane.

6. Method according to any of the previous claims, characterized by that the threat situation is presented as a picture that presents the normalized distance to the threat circle.

7. Method according to any of claims 1 - 5, characterized by that threat situation is presented as a picture that presents the distance to the threat circle.

8. Method according to any of claims 1-5, characterized by that the threat situation is presented as a picture that presents the time to the threat circle.

9. Method according to any of the previous claims, characterized by that threat is a possible event and that the threat circle is an event circle (TC) that marks the boundary between the area inside the event circle in which the possible event happens and the area outside the event circle in which the possible event does not happen.

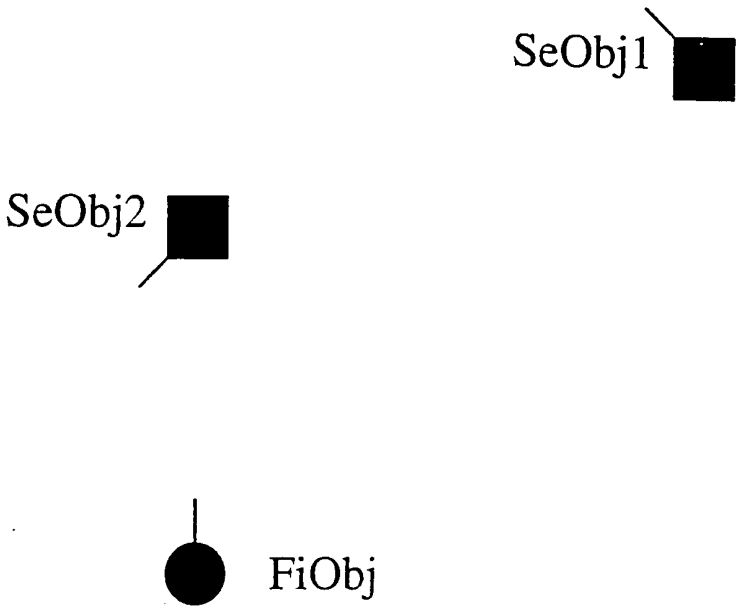

Fig 1

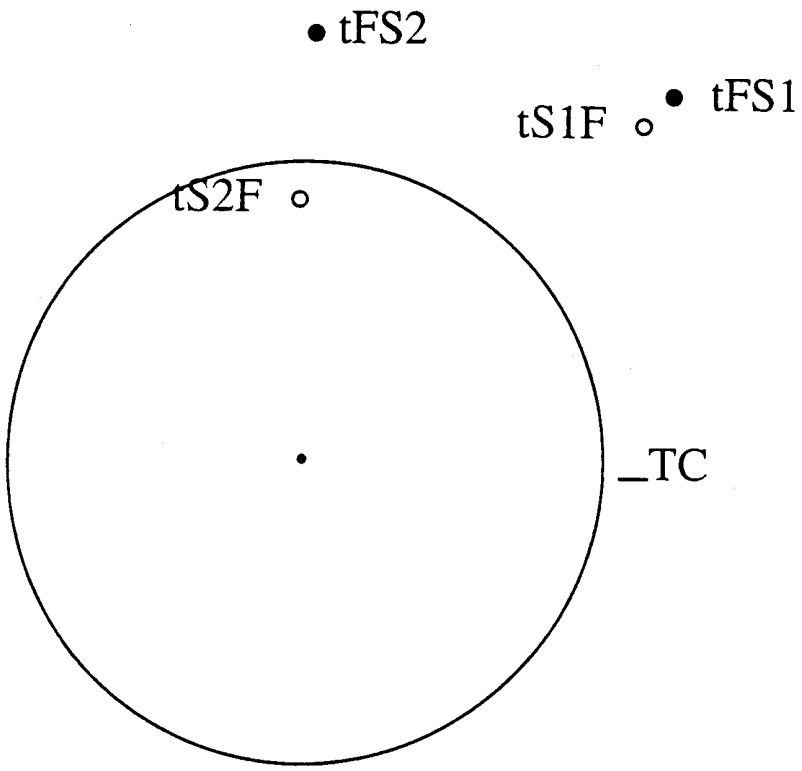

Fig 2

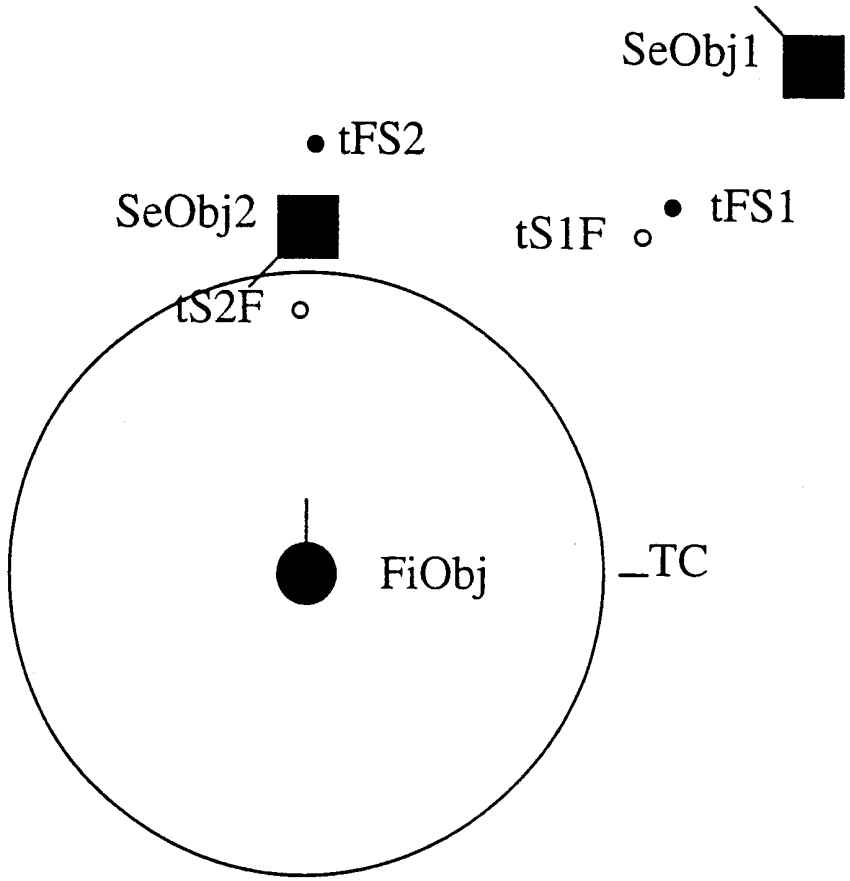

Fig 3

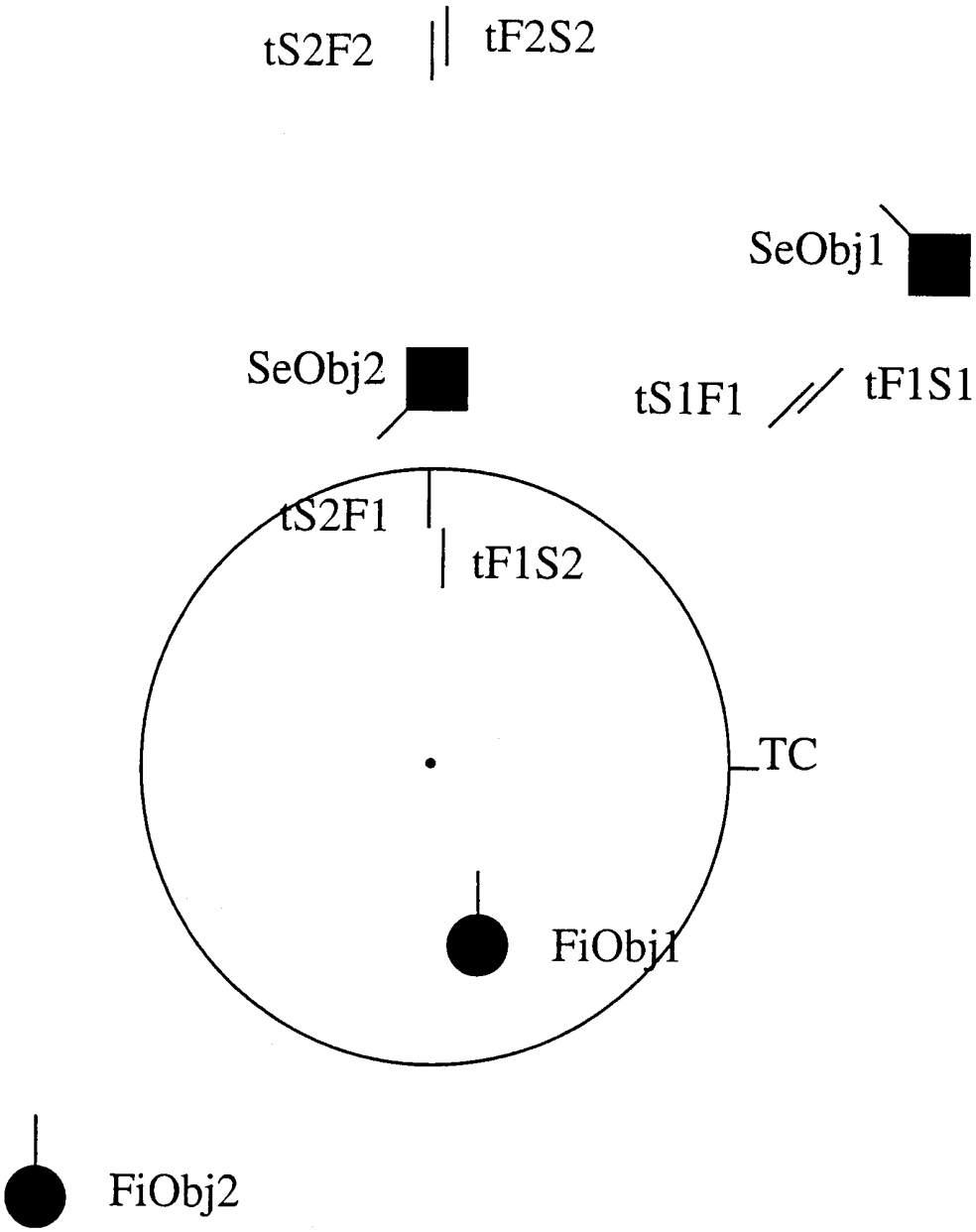
tS2F2
tF2S2
SeObj1
SeObj2
tS1F1
tF1S1
tS2F1
tF1S2
TC
FiObj1
FiObj2

Fig 4

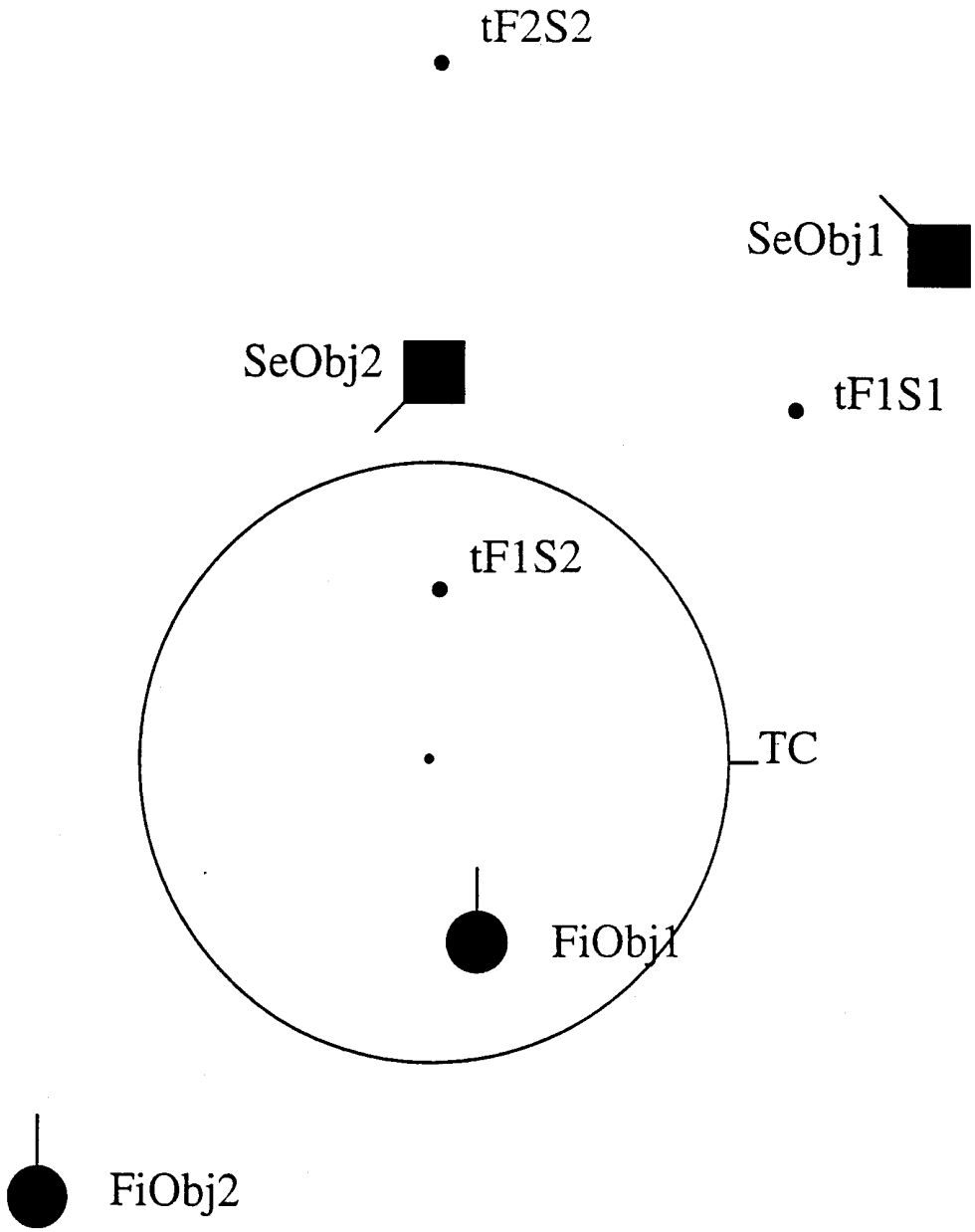

Fig 5

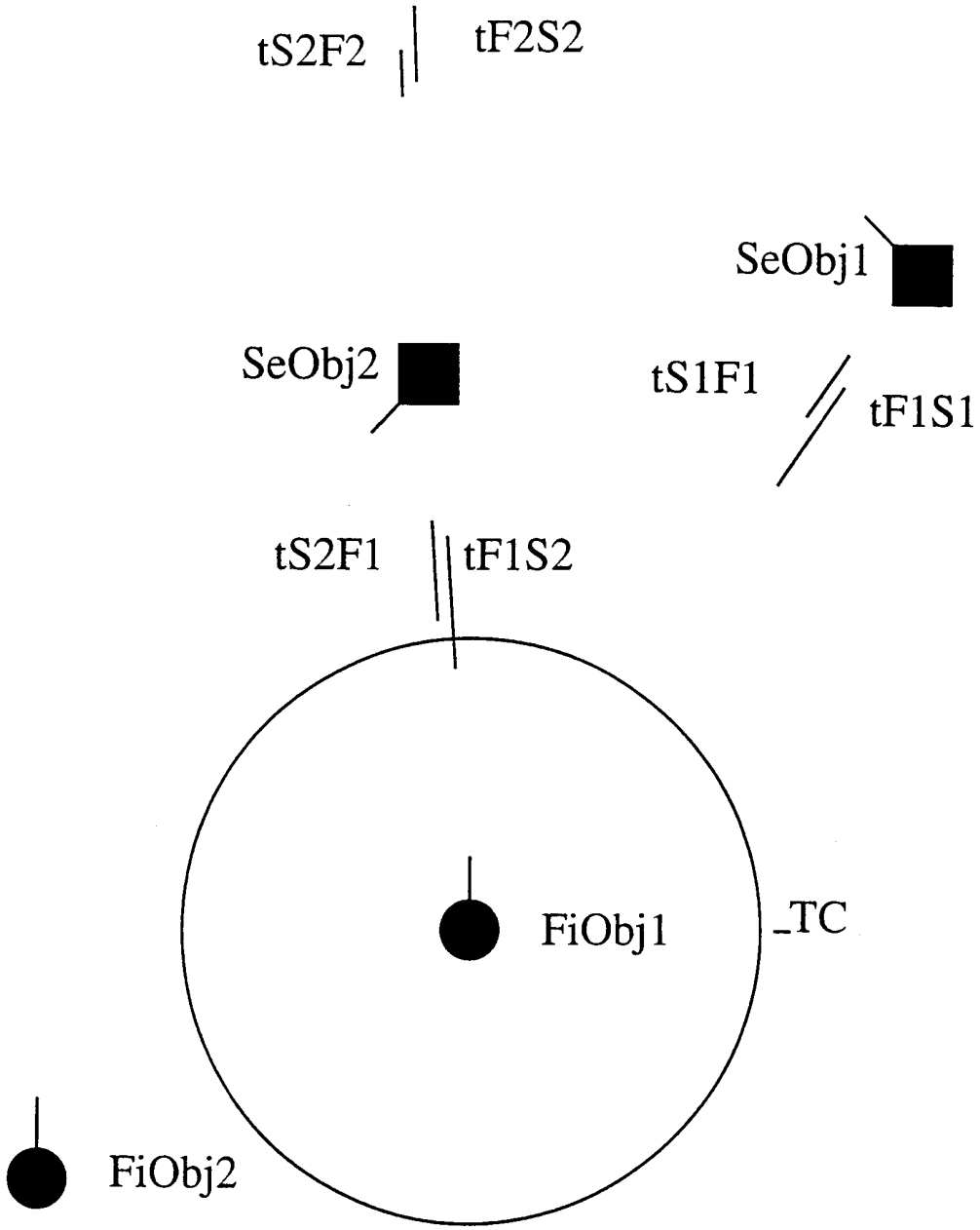
tS2F2
tF2S2
SeObj1
SeObj2
tS1F1
tF1S1
tS2F1
tF1S2
FiObj1
TC
FiObj2

Fig 6

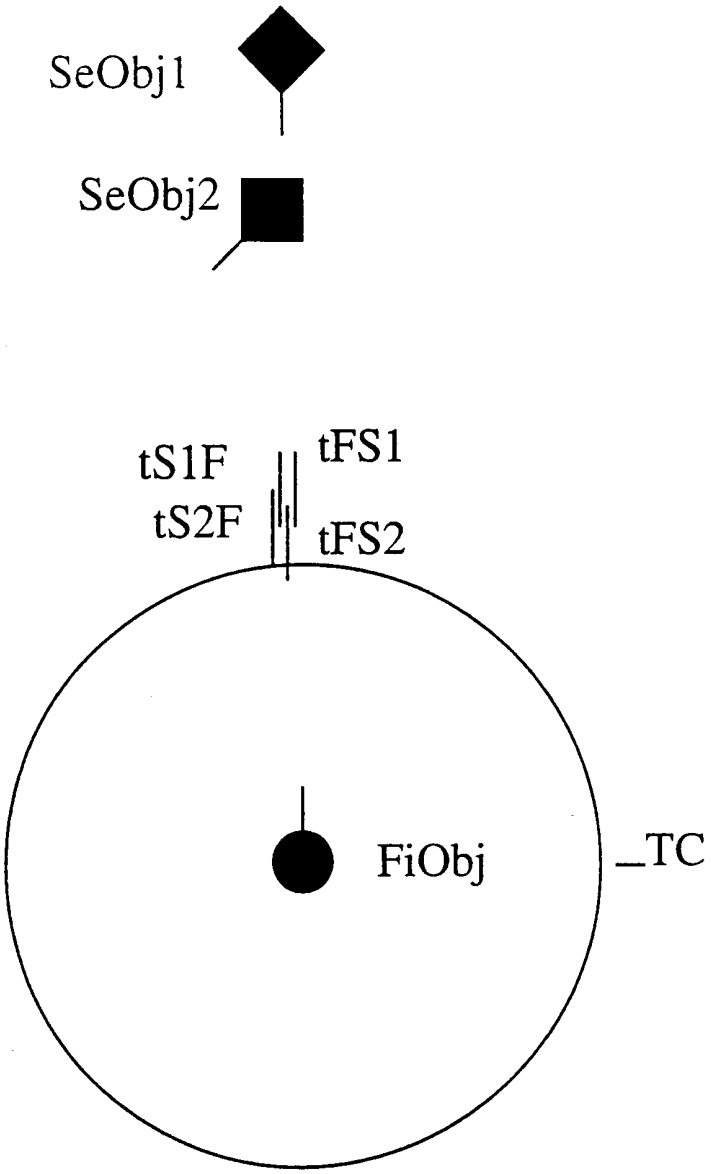

Fig 7

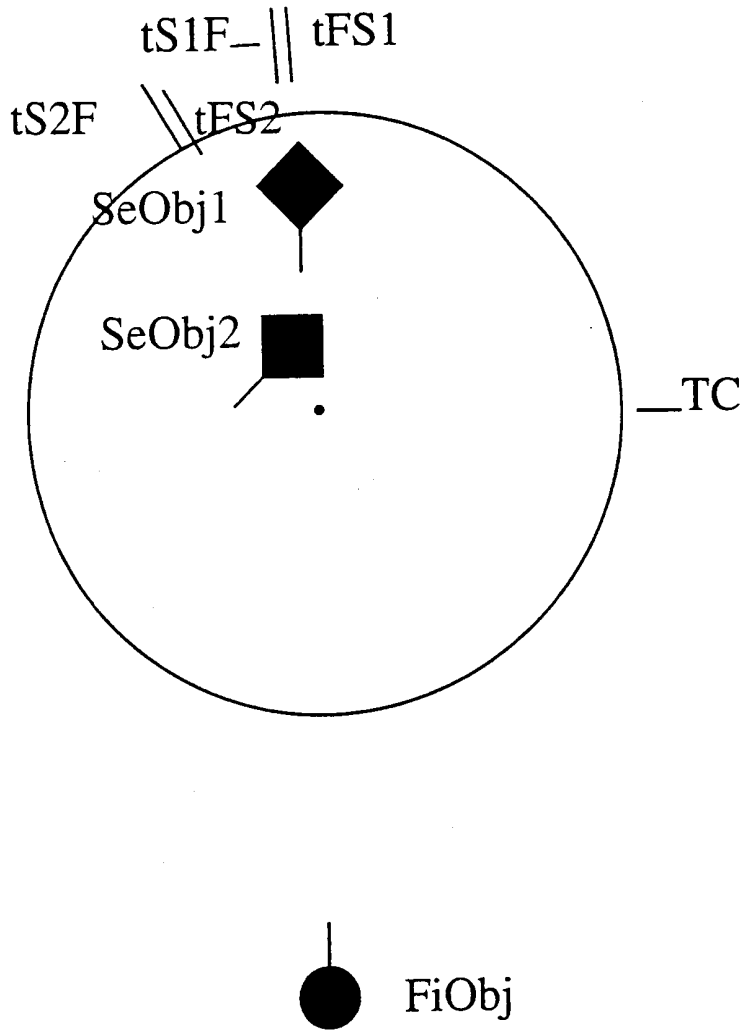

Fig 8

INTERNATIONAL SEARCH REPORT

Intern. ial Application No
PCT/IB 00/01757

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06T11/20

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 7 G06T

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 853 700 A (FUNATSU CHUHEI ET AL) 1 August 1989 (1989-08-01) claim 1; figures 5,6	1-9
A	EP 0 928 952 A (DASSAULT ELECTRONIQUE) 14 July 1999 (1999-07-14) claim 17	1-9
A	DEGRE T ET AL: "A new anti-collision system" NAVIGATION, OCT. 1980, FRANCE, vol. 28, no. 112, pages 412-425, XP000986511 ISSN: 0028-1530 page 421, paragraph 5 - paragraph 7; figure 4	1-9

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

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
6 April 2001	18/04/2001

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Intern. ial Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	HERTHER J C ET AL: "A fully automatic marine radar data plotter" JOURNAL OF THE INSTITUTE OF NAVIGATION, JAN. 1971, UK, vol. 24, no. 1, pages 43-49, XP000981890 ISSN: 0020-3009 page 47, paragraph 3 - paragraph 4 ---	1-9
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern ial Application No
PCT/IB 00/01757

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