



## Reference-free positioning system with suppression of blocking effects

### Field of the invention

The present invention relates to a reference-free positioning systems, and methods employed by the system.

### 5 Background of Invention

There are many applications in which an apparatus has to determine its position. Examples include robot control, fire fighting, and certain entertainment systems.

10

Currently, most positioning methods are based on one or more external references [1], [3] at pre-known locations. In some methods the references are active transmitters and/or receivers. In other methods, they are passive reflectors. Such methods calculate the position of the apparatus by measuring  
15 the distance from the references to the device (e.g. based on the echo delay time of a signal transmitted from the references, and reflected from the apparatus), and/or the direction from the reference to the device. Such methods perform well, but in certain applications presetting the references is not convenient, or even impossible.

20

Other types of self-positioning devices [2] do not employ external references, but instead find their own location using one or more of the following components carried within the device: a compass (to detect the direction north), an inertial position sensor, a velocimeter, or an odometer. Such  
25 devices are convenient in some respects, but suffer from the problem that any errors they make in determining their position tend to accumulate. As a consequence, they are accurate enough for certain applications.



In reference [5] (which was unpublished at the priority date of the present application, but the disclosure of which is incorporated herein by reference), we proposed a reflection-based reference-free self-positioning method. This positioning method relies on reflections of transmitted RF signals from objects  
 5 in a positioning area.

The basic concept of [5] is illustrated in Fig. 5. An apparatus 62 includes a directional transmitter antenna for transmitting an RF (typically a UWB) signal, an a directional receiver antenna for receiving reflections from planar RF-signal reflectors at the borders of a two-dimensional region 60 (in Fig. 5 this  
 10 region happens to be an irregular pentagon). The two antennas are rotated about a vertical axis (normal to the region 60), in sync, and the transmitter antenna emits a signal at each of a series of angular positions so that the receiver antenna receives a reflection from each of the sides of the region 60  
 15 in turn, at the time that the two antennas point in a direction which is normal to that side. Thus, the receiving antenna picks up reflections at up to 5 angular positions. The apparatus includes a timing circuit for measuring the echo time of the reflections, and in this way determines the respective distances to the sides of the region 60.

20

Initially, the apparatus is at a position 64, which is referred to as the origin. At this point, the measurement described above provides the apparatus with the set of distances  $l_1, l_2, l_3, l_4$ , and  $l_5$ .

25 Subsequently, the apparatus is moved to another position 66. The measurement process this time determines that there are reflections from reflectors at respective distances  $l'_1, l'_2, l'_3$  (note that two boundaries of the region do not produce reflections in position 66). Optionally, the apparatus includes a direction finding device (such as a compass) to that the angular  
 30 positions at which these reflections are received can be determined relative to

an absolute angular position, so that it can be immediately established which of the reflectors caused which of the reflections (i.e. the determination that  $l_1'$ ,  $l_2'$ ,  $l_3'$  were produced by the same reflectors are  $l_1$ ,  $l_2$ ,  $l_3$ , respectively). Alternatively, in other embodiments the RF signals themselves may be examined to obtain this correspondence (this could be done, for example, by comparing the spacing between the angular positions corresponding to  $l_1'$ ,  $l_2'$ ,  $l_3'$  with the spacing between the angular positions those corresponding to  $l_1$ ,  $l_2$ ,  $l_3$ ,  $l_4$ , and  $l_5$ ). In either case, once the correspondence is know, it is straightforward to find the position of the apparatus, relative to the origin.

10

Note that to determine a position in [5], the device has to receive at least two reflections from respective planes, and it must have received reflections from those same two planes (and therefore from the same directions) when the device was in the origin position. Moreover, the two reflections cannot be parallel. Provided these conditions are met, the method of reference [5] can build a coordinate system and estimate the location of the device in the coordinate system.

15

This technique makes it necessary to determine with some accuracy the direction from which the reflections are coming. In practice the directional transmitter antenna used in [5] will produce signals within a first narrow angular range, while the receiver antenna will be sensitive to signals received from within a second narrow angular range, so that a reflected signal will be received even when the transmission/reception direction of the two antennas is not exactly normal to any of the surfaces. The amplitude of the received reflected signal is expected to be a Gaussian function of the difference between the transmission/reception direction of the two antennas and the actual normal direction of the antenna (the so called direction of arrival, DOA). As the two antennas scan the angular range (in angular steps which should not be greater than the two narrow angular ranges) there will be several

25

30

angular positions at which signals reflected from a given reflector will be received, with different magnitudes according to the Gaussian function. The plurality of amplitudes can be used by a curve fitting algorithm to produce a Gaussian function which best fits the measured amplitudes. The peak of the  
5 derived Gaussian function is a best fit estimate of the DOA.

In reference [6] we presented a technique to estimate more accurately reflection directions, which is applicable in the system of Fig. 5. The disclosure of reference [6] also is here incorporated by reference. A  
10 fundamental concept in [6] is that the curve fitting algorithm described above is modified by performing the estimate of the DOA based on a mathematical function in which logarithmic power amplitudes from the respective measurement angles are weighted by different weight factors. The weight factors are higher for signals of higher amplitude. In fact, the weight factors  
15 may be the amplitudes themselves. The invention is motivated by the observation that reflections having a higher amplitude also have a higher signal-to-noise ratio, and therefore intrinsically provide more information about the position of the peak.

20 In the environments in which the RF signals are not liable to be blocked, it is easy to satisfy the requirements listed above for the technique of reference [5] to function, and hence a correct positioning result can be obtained. However, if the environment from which the device receives reflections includes several blocking bodies, a critical reflection may be blocked. The problem is  
25 particularly acute if the blocking objects are human bodies, since a reflection which has been blocked by a human body is likely to fall below the amplitude threshold at which the device registers received RF signals as reflections. In this case the positioning result based on the method in [5] may be wrong.

### Summary of the Invention

The present invention aims to provide new and useful methods and systems for position detection, and in particular methods and systems which at least partially overcome the problem mentioned above.

5

In general terms, the present invention proposes that an apparatus, which is intended to derive its own position within a region (e.g. within a two-dimensional region), includes both a directional RF transceiver and also an IR sensor. The RF transceiver and IR sensor are swept through an angular  
10 range (typically  $360^\circ$ ) around a common axis. The RF sensor transmits RF signals (such as ultra-wideband (UWB) signals) and receives RF reflections, to enable a positioning algorithm to occur. The IR sensor is used to identify likely instances of human blocking of the RF signals, and to modify the positioning algorithm to reduce the likelihood of the positioning algorithm  
15 failing.

Thus, the present invention makes it possible to provide a positioning device which is more robust in an environment where human blocking can occur (such as an indoor environment), as compared with a common positioning  
20 method which is based on one kind of signals.

The positioning algorithm is preferably the positioning algorithm of reference [5], and is accordingly both free of the need for external references, and does not require a training or learning process within an environment defined by fixed planar RF reflectors. In this case, the modification proposed by the  
25 method may be to modify the algorithm for detecting reflection of RF signals from the reflectors, in respect of angular positions in which the algorithm determines that it is likely that any received reflected RF signal is likely to be weaker, due to the RF signal having passed through a human body.

This modification of the algorithm be done by removing from consideration in the positioning algorithm one or more components of the received RF signal which are estimated to be due to reflections from a human body. For example, the positioning algorithm may be modified by including an extra (usually initial) step of removing from the signal received by the RF transceiver a component due to a reflection from the human body. In this way the effects of the reflection are, at least to some extent, mitigated.

Additionally, or alternatively, the modification of the algorithm may comprise modification of the process by which the apparatus detects whether a component of the received RF signal is due to a reflection from one of the reflectors. The modification take into account the changed properties of the received RF signal due to that signal passing through the human body.

For example, if the unmodified process identifies reflections by identifying peaks in the reflected signal (in the time domain) which are above a certain threshold, the modification may be to reduce the threshold. The reduced threshold may optionally be obtained based on the respective amplitudes of at least one component of the received signal at a plurality of angular positions at which the presence of a human body is detected.

In some embodiments of the invention, at least one property of the received RF signal is used in the determination of whether a human body is present at a given sector. Specifically, if for a certain sector the IR sensor indicates the presence of a warm object, but the received signal for that sector is too strong to be consistent with this warm object being a human body, then the modification proposed by the invention to take into account the presence of a human body, is not performed. In other words, one might say that the decision of whether to modify the positioning algorithm is a three-stage process in which: (i) it is determined using data from the IR sensor whether a first criterion is met; (ii) it is determined using data from the RF transceiver

whether a second criterion is met; and (iii) it is determined using the results of the first *and* second criteria whether the positioning algorithm should be modified.

As compared to prior art techniques, preferred embodiments of the invention  
5 have improved positioning performance in a human blocking environment. This permits a more practical approach to reference-free self-positioning in an indoor environment.

#### Brief Description of The Figures

Preferred features of the invention will now be described, for the sake of  
10 illustration only, with reference to the following figures in which:

Fig. 1 illustrates schematically the operation of a system which is an embodiment of the present invention;

15 Fig. 2 illustrates how, in the embodiment of Fig. 1, there is compensation of the amplitude of a received UWB signal in relation to its echo delay time;

Fig. 3 illustrates schematically a situation in which, in the embodiment of Fig. 1, a human body blocks a plurality of angular sectors;

20

Fig. 4 is a flow diagram of the method performed by the embodiment of Fig. 1; and

Fig. 5 illustrates the operation of a previous technique proposed by the  
25 present inventors.

#### Detailed Description of the embodiments

Referring firstly to Fig. 1, an apparatus which is an embodiment of the invention is illustrated schematically. The apparatus includes a RF transmitter antenna 13 (which can be a UWB transmitter) for transmitting signals, and an RF receiver antenna 15 for receiving the signals. At least one, and typically  
5 both, of the transmitter antenna 13 and receiver antenna 15, are directional.

If both are directional, the transmitter antenna 13 and receiver antenna 15 are both rotated in sync together around a vertical axis 11, through a 360 angular range. In this case, the antennas 13, 15 may be mechanically coupled to each  
10 other (e.g. formed as a one-piece unit), with their respective axes aligned. If only one is directional, then that one directional antenna is rotated, and the other may be either rotated or not. Optionally, the apparatus includes a direction finding device (e.g. a compass) to calibrating the angular position of the antennas 13 and/or 15 to some absolute direction.

15

In either case, the transmitter antenna 13 and the receiver antenna 15 can thus be considered here as a single directional RF transceiver, having a single direction (within the angular range) of maximum transmission amplitude/reception sensitivity. The term "directional transceiver" is also used  
20 in this document to cover a case in which a single directional antenna plays the role of both the antennas 13, 15.

The angular range is partitioned into  $M$  sectors, each centered on a respective angular position. In each of these sectors the apparatus transmits a signal  
25 using the transmitter antenna 13, and receives a reflected signal using the receiver antenna 15. Typically, the transmitted signal is a single UWB pulse, and this pulse is transmitted in only one direction within the sector.  
(Alternatively, the pulse may be transmitted multiple times, and the corresponding received signals averaged).

30

The apparatus further includes a directional IR sensor 17, which is rotated together with the directional antenna(s) 13, 15, so that the IR sensor 17 is always parallel to the transmission/reception direction of the directional antenna(s). (Note that in principle, the IR sensor could be scanned through  
 5 the angular range slightly in advance of, or slightly behind, the RF transceiver, provided that the difference between the time that the RF transceiver and the IR sensor 17 are directed at a given sector is less than the typical time taken by a human body to move in or out of that sector).

10 The IR sensor 17 can detect a warm object (i.e. a body having a temperature higher its surroundings, e.g. by a certain temperature detection threshold) such as human body, and determinate the distance of the apparatus from the warm object. The apparatus generally further includes a processor (e.g. one or more micro-processing devices) arranged (e.g. programmed) to find the  
 15 position of the apparatus within an environment, based on the signals received by the antenna 15 and the IR sensor 17, as described below.

Let us assume that, as illustrated in Fig. 1, the apparatus is within an environment including walls 5, 7, 9. In this case, when the directional  
 20 antenna(s) are directed successively towards the walls 5, 7, the RF signals will be transmitted from the transmitter antenna 13, reflected from the wall 5 or 7, and received by the receiver antenna 15. At these times the IR sensor 17 does not detect the presence of a human body, and the apparatus accordingly performs a positioning algorithm, in the manner illustrated in Fig. 5.

25

Fig. 2(a) illustrates the amplitude of the signal picked up by the receiver antenna 15 as a function of time when the antennas 13, 15 are directed at one of the walls 5 or 7. It has two peaks: a first peak 41 indicating the received direct-path signal from the transmitter to the receiver, and a second later peak  
 30 43 indicating the signal reflected from the wall 5 or 7. Note that there may be

other peaks between these two, due to reflections from other objects (not shown in Fig. 1) between the apparatus and the wall, but these peaks are neglected. The peak 43 is the peak received with the maximum delay, indicating that it is the furthest object in the environment.

5

Naturally, the peak 43 is lower according to the distance of the apparatus from the wall 5, 7. The received signal strength is compensated for this by multiplying it by a compensation factor which depends upon the distance along the time axis. The compensation factor is the inverse of the distance  
 10 attenuation (assuming that the attenuation constant for UWB signal propagation in the space is known by pre-investigation). The product of the peak 43 and the compensation factor is illustrated as the peak 45. After compensation, the reflection signal strength of the peak 45 is independent of the distance between the apparatus and the wall 5 or 7, and related only to the  
 15 absorption and blocking from the objects.

In dealing with sectors where the IR sensor 17 does not detect a human body, the apparatus employs a threshold  $\xi_c$  (here referred to as the common threshold). Any received signal with a peak amplitude lower than this threshold  
 20 is neglected. The threshold  $\xi_c$  can be determined as

$$\xi_c = \alpha(A_p - A_m) + A_m \quad (1)$$

where  $A_p$  is the maximum signal amplitude (after strength compensation) in all sectors and during one complete rotation of the antennas,  $A_m$  is the average signal amplitude in all sectors and all time (after strength compensation), and  
 25  $\alpha$  is a constant ( $0 \leq \alpha \leq 1$ ).

However, referring again to Fig. 1, when the directional antenna(s) are directed to the sector  $m$  (where  $m$  is an integer in the range 1 to  $M$ ) which

contains the normal direction to a wall 7, the IR sensor 17 detects the presence of a human body 21. The transmitted RF signal 31 intersects with the human body 21, and only a small proportion of RF signal 31 propagates through the body 21, and continues as beam 32. This beam 32, once reflected  
 5 from the wall 9, again encounters the human body 21, and only a small proportion of the beam passes through the human body 21, to propagate as the beam 33 towards the receiver 15.

We now turn to the positioning algorithm performed in the case that the IR  
 10 sensor 17 has detected a warm object in the sector  $m$ . Note that it is possible for the IR sensor 17 to detect the presence of a warm object without that object being a human body 21. To distinguish a human body from that of other warm objects, the received UWB signal is continuously monitored. A human body absorbs most of UWB signal, and also blocks most of the energy  
 15 of the UWB reflection from the wall 9. Thus, if there is a human body 21 in this direction, the received UWB reflection signal 33 will be very weak, and typically smaller than the common case threshold.

The embodiment assumes that there is a human body 21 blocking reflections  
 20 in this direction whenever the IR sensor 17 detects a warm object and the amplitude of the reflection is smaller than the common threshold  $\xi_c$ .

Note that the human blocking may affect several neighbouring sectors, namely the IR sensor may detect this human body blocking in several  
 25 sequential sectors (shown in Fig.3 as  $m-2$ ,  $m-1$ ,  $m$ ,  $m+1$ ,  $m+2$ ). For all sequential blocked sectors the embodiment uses a reduced threshold  $\xi_b$ , given by:

$$\xi_b = \alpha(A_{pb} - A_{mb}) + A_{mb} \quad (2)$$

where  $A_{pb}$  is the maximum signal amplitude (after strength compensation) in the sequential sectors affected by this human blocking, and  $A_{mb}$  is the average signal amplitude in the sequential blocked sectors (after strength compensation).

5

The reduced threshold is not used in all sectors through which the antennas 13, 15 rotate, because an unnecessarily low threshold will admit much interference into the system and confuse the reflection detection.

- 10 When the UWB reflection is blocked by a human body, the reflection from the wall can be very weak, and comparable with the tiny reflection from the human body, although the human body gives very little reflection. In this case, the embodiment may perform IR ranging in this direction to test the distance from the human body to the device. Using this additional information,
- 15 estimated effects of the UWB reflection from the human body can subtracted from the signal received by the antenna 15, and so be neglected in UWB distance and angle estimations.

- Note that processing described above (in the case that the embodiment has
- 20 determined that a human body is present) might generate a false (pseudo) reflection when there is a human body in a direction sector but no object behind the human body to generate reflections. This does not matter because the positioning algorithm used in [5] can ignore it. This is because the false reflection will not correspond to any of the reflections from the objects tested
- 25 when the apparatus was at the origin point, and hence will be ignored.

If the UWB reflection signal is strong (larger than the common threshold  $\xi_c$ ), the embodiment deduces that warm object is not human body. In this case,

the reflection process for angle and distance estimations will be carried out in the same way as in the case that no warm object was detected.

Note that since the embodiment uses the UWB signals to make a  
 5 determination about whether a given warm object is a human body or not, it is able to interpret the significance of the reflected IR signals reliably. It would be much harder to handle the blocking issues of IR ranging and positioning without the assistance of another type of signals, such as UWB signals, because an IR signal hardly passes through a human body.

10

The algorithm explained above for modifying the positioning algorithm described in [5] is summarized in Fig. 4. Starting from an initial state 51, the apparatus first scans the antennas 13, 15, 17 around itself, typically with all three being directed in the same direction at any given time (step 52). In step  
 15 53 the results are compensated using the compensation factor shown in Fig. 2(b).

In each sector, in step 54 it is determined whether the IR sensor has detected a warm object. If not, the common threshold is used to process the received  
 20 UWB signal for this sector (step 55). If so, the process passes to step 56 in which it is determined whether the received UWB signal is weaker than the common threshold. If not (i.e. the warm object is determined not to be a human body), the process again passes to step 55. It is to be understood that steps 54 to 56 are performed in turn for each of the sectors.

25

In the case that a plurality of sectors were found for which the determination in step 56 was positive, the embodiment in step 57 uses the UWB reflection amplitudes for those sectors to obtain the reduced threshold  $\xi_b$  from eqn. (2). If there are two human bodies at different angular positions (each indicated by

a series of sectors in which the IR signal indicates a warm body) the embodiment calculates a different reduced threshold  $\xi_b$  for each of the bodies.

- 5 In parallel to step 57, in step 58 the embodiment uses IR ranging to determine the distance to the warm object identified as a human body. In step 59, the embodiment uses the range to calculate what UWB reflection is expected to be received from a human body at this distance, and removes that estimated signal from the signal actually received by the antenna 15, to produce a  
10 corrected received signal.

In step 60, the apparatus uses the threshold obtained in step 57, to process the corrected received signal, to obtain an indication of the reflection from the wall in that sector.

15

- Thus, in summary, in steps 55 and 60, the embodiment identifies the component of the signal received by the antenna 15 which is due to the reflection from a fixed object. Step 55 does this in the case of sectors for which there is no warm object (or a warm object which is identified as non-  
20 human), while step 60 does this for sectors where the presence of a human body has been detected.

- Using the data produced in this way for all the  $M$  sectors, in step 61 the embodiment estimates the distances to the walls 5, 7, 9, and the angular  
25 positions of the walls 5, 7, 9 (i.e. the angular position around the apparatus of lines which are normal to those walls). This can be done using the method of [6], for example.

- In step 62, the embodiment uses the result to obtain an estimated position of  
30 the apparatus. This can be done using the method of [5], for example.

In step 63, the method terminates. The sequence of steps shown in Fig. 4 may be performed periodically, and/or whenever the apparatus is translated and/or rotated.

5

Although only a single embodiment of the invention has been described in detail, many variations are possible within the scope of the invention as will be clear to a skilled reader.

## References

[1] Snyder David M., Baych Leslie D., Melick Bruce D: "Integrated positioning  
5 system and method." US patent 6,707,424.

[2] McCall Hiram, Lin Ching-Fang: "Vehicle self-carried positioning method  
and system thereof." US patent 6,671,622.

10 [3] Syrjarinne Jari, Turunen Seppo: "System and devices for positioning a  
receiver." US patent 6,646,596.

[4] <http://mathworld.wolfram.com/NonlinearLeastSquaresFitting.html>

15 [5] Ma Yugang, Sun Xiaobing, Jin Xu and Kanzo Okada, "A system & method  
for determining position based on reflected signals." Singapore patent  
application no. 200403720-6.

[6] Ma Yugang, Kanzo Okada, Sun Xiaobing and Xu Jin, "Weighted Fitting  
20 Method for Direction Estimation, and Apparatus employing the Method."  
Singapore patent application no. 200500140-9.

### Claims

1. An apparatus for determining its own position within a region having a plurality of planar RF-signal reflective boundaries, the apparatus comprising:
  - a directional RF transceiver;
  - 5 an IR sensor;
  - a rotation mechanism for rotating the RF transceiver and IR sensor through a series of angular positions within an angular range; and
  - a processor arranged to receive (i) first data from the RF transceiver indicative of RF signals received by the RF transceiver at each of the angular
  - 10 positions and (ii) second data indicative of the IR radiation received by the IR sensor, and to perform a positioning algorithm using the first data to estimate the position of the apparatus within the region,
  - the processor further being arranged to modify the positioning algorithm in dependence on the second data.
- 15 2. An apparatus according to claim 1 in which the processor is arranged to identify a warm object and extract distance information from the second data, the distance information being indicative of the distance from the apparatus to the warm object.
- 20 3. An apparatus according to claim 2 in which the modification includes removing from the first data a component due to reflections from a human body at a distance from the system indicated by the distance information.
- 25 4. An apparatus according to any preceding claim in which the positioning algorithm includes:
  - (i) for each angular position, determining whether the first data indicates that the RF transceiver received a reflection from a boundary at that angular position, and

(ii) for such angular positions, obtaining distance data indicating the distance of the boundary which caused the reflection, and

(iii) using the distance data and the corresponding angular position, to estimate the position of the apparatus within the region.

5

5. An apparatus according to claim 4 in which step (i) of the positioning algorithm includes identifying peaks in the reflected signal which are above a first threshold, and the modification includes reducing the first threshold to a modified threshold in respect of angular positions for which the second data suggests that the received RF signals are partially blocked by a human body.

10

6. An apparatus according to claim 5 in which the modified threshold is obtained based on the respective amplitudes of at least one component of the received signal at a plurality of angular positions for which the second data suggests that the received RF signals are partially blocked by a human body.

15

7. An apparatus according to claim 4 or claim 5 in which, if the first data indicates that, in respect of a given angular position the received RF signals have an amplitude above the first threshold, the positioning algorithm is not modified in respect of that angular position.

20

8. An apparatus according to any preceding claim in which the processor is arranged to modify the first data to increase the amplitudes of RF signals received by the RF transceiver with increasing echo delay.

25

9. An apparatus according to any preceding claim in which the RF transceiver comprises an RF transmitter antenna and a separate RF receiver antenna, at least one of the antennas being a directional antenna.

10. An apparatus according to any preceding claim in which the RF transceiver comprises a single directional antenna which operates by time division as a transmitter antenna and as a receiving antenna.
- 5 11. An apparatus according to any preceding claim in which the RF transceiver is arranged to emit UWB pulses.
12. A method for determining the position of an apparatus within a region having a plurality of RF-signal reflective boundaries, the apparatus
- 10 comprising:
- a directional RF transceiver;
  - an IR sensor; and
  - a rotation mechanism for rotating the RF transceiver and IR sensor through a series of angular positions within an angular range;
- 15 the method including performing a positioning algorithm performed on first data indicative of RF signals received by the RF transceiver at each of the angular positions, to estimate the position of the apparatus within the region,
- wherein the positioning algorithm is modified in dependence on second data indicative of the IR radiation received by the IR sensor, and to perform a
- 20 positioning algorithm.
13. A method according to claim 12 including identifying a warm object and extracting distance information from the second data, the distance information being indicative of the distance from the apparatus to a warm object.
- 25
14. A method according to claim 13 in which the modification includes removing from the first data a component due to reflections from a human body at a distance from the system indicated by the distance information.

15. A method according to any of claims 12 to 14 in which the positioning algorithm includes:

(i) for each angular position, determining whether the first data indicates that the RF transceiver received a reflection from a boundary at that angular position, and

(ii) for such angular positions, obtaining distance data indicating the distance of the boundary which caused the reflection, and

(iii) using the distance data and the corresponding angular positions, to estimate the position of the apparatus within the region.

16. A method according to claim 15 in which step (i) of the positioning algorithm includes identifying peaks in the reflected signal which are above a first threshold, and the modification includes reducing the first threshold to a modified threshold in respect of angular positions for which the second data suggests that the received RF signals are partially blocked by a human body.

17. A method according to claim 16 in which the modified threshold is obtained based on the respective amplitudes of at least one component of the received signal at a plurality of angular positions for which the second data suggests that the received RF signals are partially blocked by a human body.

18. A method according to any of claims 16 or 17 in which, if the first data indicates that, in respect of a given angular position the received RF signals have an amplitude above the first threshold, the positioning algorithm is not modified in respect of that angular position.

19. A method according to any of claims 12 to 18 including modifying the first data to increase the amplitudes of RF signals received by the RF received with increasing echo delay.

20. A method according to any of claims 12 to 19 in which the RF transceiver transmits UWB pulses.