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SYSTEM AND METHOD FOR WIRELESS LOCATION OF AN OBJECT

The present invention relates to a system and method for wirelessly locating an object using passive reflectors which do not consume power. The invention is especially, although not exclusively, suited to applications such as handwriting digitization with a pen-like device or locating the position of a robot in a room or other predetermined frame of reference.

Background of the Invention

Various wireless positioning methods are known. They can be roughly divided into four distinct classes. They may be classified according to the "reference means" used for signifying the spatial co-ordinates, namely: 1) transmitters at fixed locations; 2) receivers at fixed locations; 3) transponders at fixed locations; and 4) reflectors (passive references) at fixed locations.

For the first type of system, fixed stations transmit positioning signals and mobile terminals determine their position relative to the stations by analyzing the received signal from the stations. GPS may be regarded as an example of such a system. The GPS receiver is the object, the position of which is to be determined. The satellites which the receiver locks onto are in predetermined geostationary orbits (i.e. are in known positions) and thus effectively constitute the "reference means".

The second type is a kind of "surveillance" system (one example is disclosed in US-A-5,977,958). The object to be positioned is equipped with a transmitter which continuously transmits signals and a plurality of receivers (normally interconnected) determines the position of the object by analyzing the signal at each receiver.

The third type of system requires a transceiver be attached to the object of interest. This transceiver continuously transmits signals and receives the signals re-transmitted by the "transponders" (i.e. transceivers arranged such that when each detects a signal from the mobile transceiver, it adds a predetermined delay and then transmits a signal to be received by the transceivers), at the reference positions. By analyzing the signals from several transponders, the position of the object can be determined at the transceiver side.

The fourth and last type of system makes use of passive "reference means" which reflects the signal with a signal strength well above background noise. The transceiver attached to the object of interest keeps transmitting "probing" signals and detecting the "echo" signals from these passive references. By analyzing the "echo" signals, the real-time position of the object can be determined.

In the first three types of method referred to above, active devices need to be placed at reference positions. Their requirement of power supplies and possible inter-connections causes difficulties in deployment and maintenance. On the other hand, the reference means used in the fourth type of system consume no power and need no inter-connections. Thus, this can be easily deployed and maintained. In the user's point of view, the positioning is done in a "stand-alone" manner. The system and method of the present invention fall into this category.

Within the fourth, i.e. passive-reference means category (also known as self-localization in the field of robotics), there exist a division of methods based on using purposely deployed references or utilizing the static/quasi-static surroundings as the implicit references. The methods of the latter type require no infrastructure and are based on the correlation between "echo" pattern and

the two-dimensional (2D) position within a predetermined environment. They normally need "training" or other information such as floor plan. They also require heavy computing resources and do not work well in a dynamic environment. A review of such systems can be found in Singapore patent application no. SG-A-2003/07132-1, unpublished at the priority date of this application.

With several passive reference means (for 2D positioning, at least two passive references are needed) deliberately employed, the correspondence between the range data of the "echo" component and its corresponding passive reference means (reflector) has first to be determined because otherwise the ranging information cannot be associated with the already-known co-ordinates of the reflectors in the position calculations. In most existing systems of this kind, this is achieved by two kinds of methods: 1) use of a directional antenna and a rotating mechanism; and 2) the different patterns of the reflected signal from each reference means. The first one requires the system to keep a record of relative orientation with regard to the passive reference means. The second type requires that the echo from each reference means has a distinct pattern (amplitude, polarity or shape) in the received signal. One example is to utilize reflectors made of materials with different reflection efficiency rate and differentiate echoes from them by different amplitudes. However, both these methods add complexity to the system or difficulty in deployment.

The method and system of the present invention uses reflectors and omni-directional antenna and utilize the inherent geometric constraints based on the configuration of passive reference means to build up this correspondence. This can reduce the system complexity and simplify the deployment of the passive references.

By using the transceiver with an omni-directional antenna, the environment surrounding the transceiver can be probed by transmitting a short pulse and receiving the bounced back signals. The received "echo" signal is sampled and digitized as the input to our positioning algorithm. From the digitized waveform, the distance between the transceiver and passive "reference means" such as a reflector can be determined by measuring the time delay or "time-of-flight" (time difference between the emitted signal and received signal) of each echo component. However, due to the nature of omni-directional antennae, the reflections from various directions intermingle with each other. Thus, the range data are aligned (with ascending order) to form a "distance vector" and the correspondence information (with which reference, each range value is associated, or in other words, from which reference each respective reflection comes) is lost. However, the findings which are disclosed in SG-A-2003/07132 show that with proper configuration of the reflectors, there is a one-to-one mapping between this vector and spatial position. This mapping is solely determined by the configuration of the passive reference means and can be pre-stored in the system. By applying this mapping to the distance vector detected in real-time, the position of the transceiver can be determined.

Unlike most of the existing systems methods, no directional information is required in the positioning. This enables a simple hardware implementation which can use a single omni-directional antenna which facilitates design and obviates the need for several antennae, which would normally be arranged in a ring type arrangement) or mechanical/electrical rotating mechanism when a single directional antenna is used.

Definition of the Invention

The present invention relates to a system and method for positioning an object wirelessly with a set of passive references. A transceiver attached to

the object transmits short pulses via an omni-directional antenna and receives the signal bounced back from the surroundings via the same antenna. By analyzing the digitized received signals and with the pre-known position of the passive references, the position of the object can be determined.

A first aspect of the present invention therefore provides a system for determining the spatial position of an object with respect to a frame of reference, the system comprising a wireless transceiver having an omni-directional antenna to be attached to the object, a plurality of reflectors at pre-set positions relative to the frame of reference and a signal processing unit for receiving signals reflected by the reflectors and received by the transceiver, for determining said spatial position.

A second aspect of the present invention provides a method for determining the spatial position of an object with respect to a frame of reference, the method comprising the steps:-

- (a) providing a wireless transceiver having an omni-directional antenna attached to the object;
- (b) providing a plurality of reflectors at pre-set positions relative to the frame of reference;
- (c) providing a signal processing unit for receiving signals transmitted by the transceiver, reflected by the reflectors and received again by the transceiver; and
- (d) transmitting signals from the transceiver via the antenna, to be reflected by the reflectors and received again by the transceiver and in the signal processing unit, determining the spatial position of the object from said received signals.

Detailed Description of the Invention

Preferred embodiments of the present invention utilize a one-to-one mapping between the distance vector and the 2D coordinates. If one regards the correspondence between a certain position and the reflected signal collected at that position with an omni-directional antenna within a static environment as a mapping, the positioning problem is just the inverse of this mapping. Such mapping is preferably as disclosed in Singapore Patent Application No. SG-A-2003/07132-1, where it is described in detail. Generally speaking, the mapping techniques disclosed in SG-A-2003/07132-1 may be used to advantage in the present invention. As explained in the latter document, the mapping is one-to-one as long as certain conditions are met for the surrounding geometry. The mapping is also found to show “regional” behavior within the geometry. The method disclosed in SG-A-2003/07132-1 is based on the assumption that no information concerning the surrounding environment is available and the mapping is learned from “training”. The need for such “training” is a significant disadvantage of such a method in real applications.

With the knowledge of position of several passive references, this transformation is pre-determined and can be stored in the memory of the system.

As described in SG/A-2003 07132-1, for a geometry as illustrated in Figure 1 of the accompanying drawings, there exists a one-to-one transformation between the distance vector $((d_1, d_2, d_3))$ where $d_1 \leq d_2 \leq d_3$ and the 2D coordinates of the transceiver $((x_p, y_p))$ as described by Equation 1.

$$\begin{bmatrix} d_1^2 - d_2^2 \\ d_1^2 - d_3^2 \end{bmatrix} = T_{2 \times 3, I} \begin{bmatrix} x_p \\ y_p \\ 1 \end{bmatrix} \quad (I = 1, 2, \dots, 6) \quad (1)$$

The transformation exhibits a “regional” behavior and can be explicitly expressed by six matrices listed in Table 1, with the knowledge of the passive references’ position.

Further, as described in SG-A-2003/07132-1, Equation 2 can be used to classify an input distance vector into one of the six regions by finding the best-fitting matrix $B_{1 \times 6, I}$. In the training-based method proposed in SG –A-2003/07132-1, the six possible choices of $B_{1 \times 6, I}$ are learnt from training data, but with the knowledge of the passive references’ position, these values can be explicitly calculated.

$$d_1^2 = B_{1 \times 6, I} \begin{bmatrix} (d_1^2 - d_2^2)^2 \\ (d_1^2 - d_3^2)^2 \\ (d_1^2 - d_2^2)(d_1^2 - d_3^2) \\ (d_1^2 - d_2^2) \\ (d_1^2 - d_3^2) \\ 1 \end{bmatrix}$$

(2)

The left-hand-side of Equation 2 is actually:

$$(x_p - x_I)^2 + (y_p - y_I)^2 = x_p^2 + y_p^2 - 2x_I x_p - 2y_I y_p + (x_I^2 + y_I^2)$$

(3)

where $I=A, B$ or C depending on which region (x_p, y_p) belongs to.

Region (I)	Distance Vector	Transformation ($T_{2 \times 3, I}$)
1	(d_A, d_B, d_C)	$\begin{bmatrix} 2(x_B - x_A) & 2(y_B - y_A) & (x_A^2 + y_A^2 - x_B^2 - y_B^2) \\ 2(x_C - x_A) & 2(y_C - y_A) & (x_A^2 + y_A^2 - x_C^2 - y_C^2) \end{bmatrix}$
2	(d_A, d_C, d_B)	$\begin{bmatrix} 2(x_C - x_A) & 2(y_C - y_A) & (x_A^2 + y_A^2 - x_C^2 - y_C^2) \\ 2(x_B - x_A) & 2(y_B - y_A) & (x_A^2 + y_A^2 - x_B^2 - y_B^2) \end{bmatrix}$
3	(d_B, d_A, d_C)	$\begin{bmatrix} 2(x_A - x_B) & 2(y_A - y_B) & (x_B^2 + y_B^2 - x_A^2 - y_A^2) \\ 2(x_C - x_B) & 2(y_C - y_B) & (x_B^2 + y_B^2 - x_C^2 - y_C^2) \end{bmatrix}$
4	(d_B, d_C, d_A)	$\begin{bmatrix} 2(x_C - x_B) & 2(y_C - y_B) & (x_B^2 + y_B^2 - x_C^2 - y_C^2) \\ 2(x_A - x_B) & 2(y_A - y_B) & (x_A^2 + y_A^2 - x_A^2 - y_A^2) \end{bmatrix}$
5	(d_C, d_A, d_B)	$\begin{bmatrix} 2(x_A - x_C) & 2(y_A - y_C) & (x_C^2 + y_C^2 - x_A^2 - y_A^2) \\ 2(x_B - x_C) & 2(y_B - y_C) & (x_C^2 + y_C^2 - x_B^2 - y_B^2) \end{bmatrix}$
6	(d_C, d_B, d_A)	$\begin{bmatrix} 2(x_B - x_C) & 2(y_B - y_C) & (x_C^2 + y_C^2 - x_B^2 - y_B^2) \\ 2(x_A - x_C) & 2(y_A - y_C) & (x_C^2 + y_C^2 - x_A^2 - y_A^2) \end{bmatrix}$

Table 1 Transformation for different regions

On the other hand, due to Equation 1, (x_P, y_P) can be expressed in terms of

$(d_1^2 - d_2^2)$ and $(d_1^2 - d_3^2)$. If transformation matrix $T_{2 \times 3, I} = \begin{bmatrix} T_{11, I} & T_{12, I} & T_{13, I} \\ T_{21, I} & T_{22, I} & T_{23, I} \end{bmatrix}$ is

one of the six possible values listed in Table 1, substituting into Equations 1 and 3, we have:

$$\begin{aligned}
\begin{bmatrix} x_P \\ y_P \end{bmatrix} &= \begin{bmatrix} T_{11,I} & T_{12,I} \\ T_{21,I} & T_{22,I} \end{bmatrix}^{-1} \left(\begin{bmatrix} d_1^2 - d_2^2 \\ d_1^2 - d_3^2 \end{bmatrix} - \begin{bmatrix} T_{13,I} \\ T_{23,I} \end{bmatrix} \right) \\
&= \begin{bmatrix} a_{11}(d_1^2 - d_2^2) + a_{12}(d_1^2 - d_3^2) - a_{11}T_{13,I} - a_{12}T_{23,I} \\ a_{21}(d_1^2 - d_2^2) + a_{22}(d_1^2 - d_3^2) - a_{21}T_{13,I} - a_{22}T_{23,I} \end{bmatrix}
\end{aligned}
\tag{4}$$

where it's defined $\begin{bmatrix} T_{11,I} & T_{12,I} \\ T_{21,I} & T_{22,I} \end{bmatrix}^{-1} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$.

Substituting Equation 4 into Equation 3 and comparing the result to Equation 2, following equation is obtained:

$$B_{1 \times 6, I}^T = \begin{bmatrix} a_{11}^2 + a_{21}^2 \\ a_{12}^2 + a_{22}^2 \\ 2(a_{11}a_{12} + a_{21}a_{22}) \\ -2((a_{11}T_{13,I} + a_{12}T_{23,I} + x_I)a_{11} + (a_{21}T_{13,I} + a_{22}T_{23,I} + y_I)a_{21}) \\ -2((a_{11}T_{13,I} + a_{12}T_{23,I} + x_I)a_{21} + (a_{21}T_{13,I} + a_{22}T_{23,I} + y_I)a_{22}) \\ (a_{11}T_{13,I} + a_{12}T_{23,I} + x_I)^2 + (a_{21}T_{13,I} + a_{22}T_{23,I} + y_I)^2 \end{bmatrix} \tag{5}$$

Thus the six possible choices of $B_{1 \times 6, I}$ can be actually calculated base on Equation 5 using the look-up table of Table 1, if the position information of the passive references are known.

With these results, an input distance vector (detected from the received echo) can be classified into one of the six regions by choosing the index I that gives the minimum value of:

$$abs(d_1^2 - B_{1 \times 6, I} \begin{bmatrix} (d_1^2 - d_2^2)^2 \\ (d_1^2 - d_3^2)^2 \\ (d_1^2 - d_2^2)(d_1^2 - d_3^2) \\ (d_1^2 - d_2^2) \\ (d_1^2 - d_3^2) \\ 1 \end{bmatrix}) \quad (6)$$

After the classification, the according transformation listed in Table 1 can be chosen to calculate the 2D coordinate using Equation 4.

The main source of positioning errors in this method is the ranging accuracy (how accurately the time-of-arrival can be measured) achievable in real practice. The achievable positioning accuracy heavily depends on this parameter. Different medium/circuits shall be chosen for different applications. For example, for handwriting digitization, ultrasound may be a good choice since ranging accuracy of 0.5mm can be easily achieved with current technology.

Another source of error is the “overlapping effect”. Due to the resolution limit of the wireless medium (theoretically limited by the wavelength of the medium), some of the echo components cannot be detected because of overlapping effect as illustrated in Figure 2. Instead, the range data corresponding to this component can only be “filled-in” with the value of the preceding adjacent detectable signal component. For example, with a waveform illustrated in Figure 2, the distance vector used in calculation is (d_1, d_1, d_2) , which is different from its exact value.

Due to these practical issues, there are inevitably errors in the positioning result. Sporadic big errors exist in certain regions (where the classifying is prone to be wrong) determined by the configuration of passive references and the above two parameters (ranging accuracy and ranging resolution). A

filtering mechanism can be used to filter out “sudden changes” in two consecutive positioning output to remove such large errors (if one knows the limit of the object’s moving speed and the update rate of the positioning output, a threshold value for this purpose can be set).

Simulation to emulate handwriting using a stylus and writing block was done to predict performance in practice. The writing tablet was assumed to have an A4 size writable surface with three reflectors. Ultrasound was chosen as the wireless medium. The assumed range accuracy was 0.5mm and the resolution, 8.5mm (the wavelength of 40KHz ultrasound). Simulation was conducted as follows:

At a given stylus position, the respective distances to each of the three reflectors was calculated, based on the known geometry. These values were then perturbed using an AWGN noise vector (with 0.5mm standard deviation). This was done to simulate the effect of practical ranging accuracy. Then, the overlap effect (see above) was simulated as the kind of “fill-in” which occurs when two distance values are below the resolution limit. For example, if input distances are 22.52cm, 23.24cm and 54.60cm respectively, then the “filled-in” result is 22.52cm, 22.52cm and 54.60cm . Last, the resulting distance vector was input to the positioning algorithm to output the estimated position.

Figure 3 shows the real input and the positioning result which was obtained using a very simple filtering algorithm: if the current calculated position is more than 5cm away (assuming that the sampling frequency is 200Hz and the writing speed is at most, 10m/s, then the maximum possible movement within a sampling period is 5cm) from the previous calculated value, the current output is replaced by the previous result and the positioning algorithm continues to the next sampling period. As shown in the left hand part of this figure, the real input was obtained by capturing the movement of a mouse

(sampled by mouse click) to trace handwriting 1 relative to a frame of reference 3 by linking adjacent points with straight lines. In the right hand part of the figure, the positioning result is illustrated, as was obtained in the same way by joining calculated coordinates of those sampled data by straight lines. It is clear that handwriting can be correctly captured with such a configuration with such a method. Statistical analysis further showed that a root-mean-square error (RMSE) of 0.6mm is achievable.

Although the above discussion is based on use of three passive reference means for 2D positioning (with the method of the present invention at least three such reference means are needed), configurations with more references can be handled similarly. Also, it is straightforward to extend the method to 3D positioning where at least four references are needed. The reflectors are not necessarily to be of "point" type, but can also be "planar" reflectors (the positioning method needs to be slightly changed due to discussions in SG-A-2003/07132-1). To increase the reflected signal's power level and working beamwidth, the point reflectors may be implemented in the form of corner reflectors or any other form (e.g. Luneberg lens).

The present invention provides a wireless positioning system and method that consists of a transceiver with omni-directional antenna and several passive references. The position of the transceiver can be calculated from the distance vector detected from the real-time received echo, without any directional information. This novel system and method features simple hardware and easy deployment of the references, which can make the solution cheaper and more user-friendly (to the user, the system is somewhat "stand-alone") when compared to other systems.

It will be deduced from the foregoing that one suitable application is a "writing tablet" to digitize the user's handwriting with a stand-alone pen-like device (with the transceiver) and a "tablet" embedded with hidden passive references

in the form of reflectors. Since passive reference means in the form of reflectors are used, such a writing tablet can be manufactured with low cost and having a user-friendly configuration (because no connections are needed, the user may not even realize reflectors are present). One possible form of "writing tablet" for commercial application may be one which is configured as a disposable mousepad.

In the system and method according to the present invention, a plurality of reflectors is disposed in predetermined positions relative to the frame of reference, e.g. around the periphery thereof. In general terms, for a N-dimensional frame of reference, there should be at least $N+1$ reflectors. The reflectors should be chosen of a material capable of reflecting the wireless signal used by the transceiver. This signal may be, for example a radio frequency signal such as in the microwave range, e.g. 3.1 – 10.6GHz, ultrasound or infrared. The reflectors will of course be designed so as to be able to reflect the chosen signal type.

The omni-directional antenna should be omni-directional in the sense that when attached to the object of interest, it may receive the reflections from all of the reflectors. The transceiver may also be attached to the object or it may be attached to the omni-directional antenna (which must be located on the object) by wireless or even in some cases, hard-wire means.

In preferred embodiments, the signal processing unit comprises means for pre-processing the received reflected signals, means for calculation of distance vector values based on time delays of (preferably pulses) of the received reflected signals, means for classifying and storing the calculated distance vectors and means for applying to the stored distance vectors, a set of pre-stored transformation matrices.

Preferred embodiments also provide in said pre-processing means, means for sampling and digitizing the reflected signals, means for averaging over several transmission-reception cycles to reduce noise (preferably means for averaging time delays between emission and reception of pulses) and most preferably, further noise reduction means such as a filter arrangement, eg a digital filter.

Preferred embodiments also provide that the signal processing unit comprises means for identifying the number of reflected pulses, means for calculating the time delays of the reflected signal pulses and means for building vector elements with sequential magnitudes proportional to the time delay of the reflected signals.

Brief Description of the Drawings

The present invention will now be explained in more detail by way of the following description of preferred embodiments and with reference to the accompanying drawings, in which:-

Figure 1 shows a co-ordinate system as used by the prior proposal described in SG-A-2003/01732-1;

Figure 2 is a graphical depiction of overlap error which may occur in the system described in SG-A-2003/07132-1;

Figure 3 shows the correlation between hand movement and position output using a simulation of a writing tablet application employing the present invention;

Figure 4 shows a block diagram of a wireless transceiver for use in a writing tablet embodiment according to the present invention;

Figure 5 shows the location of the reflectors in the embodiment of Figure 4;

Figure 6 shows a block diagram of a signal processing unit suitable for use in systems and methods according to the present invention.

Description of Preferred Embodiments

Figure 4 illustrates a positioning device for use in one preferred embodiment of the present invention. It comprises wireless transceivers and a signal processing unit 7. The transceiver's function is to repeatedly transmit a short time-period RF pulse from a pulse generator 9 via a coupler 11 and antenna 13 and then receive & digitize the reflected signal within a certain time period. The antenna 13 is an omni-directional antenna, which is easier to fabricate than a directional antenna, especially for high bandwidth RF signals e.g. ultra wideband. The pulse generator 9 is controlled by a central clock or timing control 15. Reflected signals from the reflectors (as described below) received by the antenna 13 are passed via the coupler 11 to an A/D converter 17 which also received clock signals from the timing control 15. In this way, the time delay between transmission and reception of a pulse may be determined electronically.

The signal processing unit 7 can be integrated into the circuits of the transceiver 5 as described in this embodiment, or it may be positioned at a different physical location where the received reflected signal can be processed. The processed output may also be transmitted wirelessly to other processing devices via the wireless transmitter.

Figure 5 shows how the transceiver of Figure 4 may be employed in a "writing tablet" application. This arrangement comprises the positioning device (transceiver 5 with omni-directional antenna) and three reflectors 19, 21, 23. The square 25 illustrates an area for the inputting device to work. Two of the reflectors 19, 21 are situated at adjacent corners of the square 25. The third reflector 23 is situated approximately one third of the distance along the side 27 of the square 25 opposite the side 29 joining the first two reflectors 19, 21. Other positions of these reflectors are possible but it is important to note that the three reflectors cannot be located such as to define corners of an isosceles triangle. The user uses a special pen (carrying the transceiver with its antenna, which transmits wireless signal and detects the pulse signals reflected by these reflectors 19, 21, 23 when pushed against the tablet) for handwriting input. With this system (tablet and pen), any piece of paper can be put onto the tablet (or even writing without any paper and ink) and the written content (with or without normal ink) will be stored as the digitized pen movement in the memory within the pen, which can be further transmitted to a computing device for processing such as character recognition. Although in this embodiment, a 2D arrangement is described, and equivalent three dimensional version may be provided.

Figure 6 shows the block diagram of the signal processing unit 7. The number of references is N and the possible permutations of the distance vector is M (e.g. in the embodiment described above, using three reflectors, $N=3$ and $M=6$). The signal from A/D converter 17 is processed by a pre-processing unit 31. The purpose of pre-processing is to increase the signal-to-noise ratio (SNR) of the received signal and various methods can be applied. For example, a simple way is to average the output of 17 among several sampling periods.

The output of pre-processing unit 31 is acted upon by a processing block 33 to extract times of arrival (TOA) from the reflected signal waveforms and compute the distance vectors accordingly. This may be done by leading edge detection (LED) algorithms, which determine an exact pulse time-of-arrival (TOA) values for each received component. The distance values are calculated by multiplying the TOAs with the propagation speed of the wireless medium and divided by 2 (two paths from transmission to reception).

Due to the ranging resolution limit, the number of components may be less than the number of the reflectors (overlapping effect illustrated in Figure 2). In such cases, the number of reflected signal pulses has to be determined and the “missing” distance information needs to be filled-in using the distance information of the component that overshadows it. These distance values are in ascending order by their nature (because the nearer reflection returns earlier) and the vector formed by them is referred to herein as the distance vector.

With distance vectors obtained from block 33, equation (6) and pre-stored values of matrix, $B_{1 \times 6, I}$ is used to classify it into one of the M groups (as discussed previously, each group corresponds to a different permutation of the elements within a distance vector and accordingly a different matrix value in Table 1). Lastly, the proper matrix value of $T_{2 \times 3, I}$ is chosen from the M possibilities (according to the result of block 33) to calculate the 2D position due to equation (4).

CLAIMS

1. A system for determining the spatial position of an object with respect to a frame of reference, the system comprising a wireless transceiver having an omni-directional antenna to be attached to the object, a plurality of reflectors at pre-set positions relative to the frame of reference and a signal processing unit for receiving signals reflected by the reflectors and received by the transceiver, for determining said spatial position.
2. The system of claim 1, wherein the signal processing unit comprises means for pre-processing the received reflected signals; means for calculation of distance vector of range values based on time delays of the received reflected signals, means for classifying and storing the calculated distance vectors and means for applying to the stored distance vectors, a set of pre-stored transformation matrices.
3. The system of claim 2, wherein the pre-processing means comprises means for sampling and digitizing the received reflected signals, means for averaging over several transmission-reception cycles to reduce noises and further noise reduction means.
4. The system of claim 1, wherein the signal processing unit comprises means for identifying the number of reflected pluses, means for calculating the time delays of the reflected signal pulses and means for building vector elements with sequential magnitudes proportional to the time delay of the reflected signals.
5. The system of claim 1, wherein the wireless transceiver is a radio frequency transceiver.

6. The system of claim 1, wherein the wireless transceiver is an ultrasound transceiver.
7. The system of claim 1, wherein the wireless transceiver is an infrared transceiver.
8. The system of claim 1, wherein the object is an object for defining a writing path.
9. A method for determining the spatial position of an object with respect to a frame of reference, the method comprising the steps:-
 - (a) providing a wireless transceiver having an omni-directional antenna attached to the object;
 - (b) providing a plurality of reflectors at pre-set positions relative to the frame of reference;
 - (c) providing a signal processing unit for receiving signals transmitted by the transceiver, reflected by the reflectors and received again by the transceiver; and
 - (d) transmitting signals from the transceiver via the antenna, to be reflected by the reflectors and received again by the transceiver and in the signal processing unit, determining the spatial position of the object from said received signals.
10. The method of claim 9, wherein the position of the object is determined from the time delay between transmission and reception of pulses in said signal.
11. The method of claim 9, wherein the signal processing unit comprises means for pre-processing the reflected received signals, means for calculation of distance of vector values based on time delays of the reflected signals,

means for classifying and storing calculated distance vector values and means for applying to the stored distance vector values, a set of pre-stored transformation matrices.

12. The method of claim 11, wherein the pre-processing means comprises means for sampling and digitising the reflected signals, means for averaging the time delays over several transmission-reception cycles to reduce noise and further noise reduction means.

13. The method of claim 9, wherein the signal-processing unit comprises means for identifying the number of reflected pulses, means for calculating the time delays of the reflected signal pulses and means for boarding vector elements with sequential magnitudes proportional to the time delay of the reflected signals.

14. The method of claim 9, wherein the reflected signals are radio frequency signals.

15. The method of claim 9, wherein the reflected signals are ultrasound signals.

16. The method of claim 9, wherein the reflected signals are infrared signals.

17. The method of claim 9, wherein the object is in object for defining a writing path.