Through Wall Tracking of Moving Targets by M-Sequence UWB Radar

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Abstract. In this paper, the trace estimation method for through wall moving target tracking by M-sequence UWB radar is described as a complex procedure consists of such phases as raw radar data pre-processing, background subtraction, detection, time of arrival estimation, wall effect compensation, localization and tracking itself. The significance of the particular phases will be firstly given and then, a review of signal processing methods, which can be applied for the phase task solution, will be presented. The trace estimation method performance is demonstrated based on UWB radar signal processing obtained for scenario represented by through concrete wall tracking of single moving target. The obtained results confirm the excellent performance of the method. In the contribution, the extension of the trace estimation method for multiple target tracking is also outlined.

1 Introduction

Electromagnetic waves occupying a spectral band below a few GHz show reasonable penetration through most typical building material, such as bricks, wood, dry walls, concrete and reinforced concrete. This electromagnetic wave penetration property can be exploited with advantage by UWB radars operating in a lower GHz-range base-band (up to 5 GHz) for through wall detection and tracking of moving and breathing persons [2]. There are a number of practical applications where such radars can be very helpful, e.g. through wall tracking of moving people during security operations, through wall imaging during fire, through rubble localization of trapped people following an emergency (e.g. earthquake or explosion) or through snow detection of trapped people after an avalanche, etc.

There are two basic approaches of through wall tracking of moving target. The former approach is based on radar imaging techniques, when the target locations are not calculated analytically but targets are seen as radar blobs in gradually generated radar images [1]. For the radar image generation, different modifications of back-projection algorithm can be used [10], [4], [19]. With regard to fundamental idea of

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the method - the radar image generation based on raw radar data, the method is sometimes referred as imaging method. In order to detect, localize and track the moving target, the methods of image processing have to be applied in the case of imaging method.

The later approach of through wall tracking of moving target by using M-sequence UWB radar equipped with one transmitting and two receiving antennas has been originally introduced in [14]. Here, target coordinates as the function of time are evaluated by using time of arrival (TOA) corresponding to target to be tracked and electromagnetic wave propagation velocity along the line transmitting antenna-target-receiving antenna. According [14], moving target tracking, i.e. determining target coordinates as the continuous function of time, is the complex process that includes following phases-tasks of radar signal processing: raw radar data pre-processing, background subtraction, detection, TOA estimation, localization and tracking itself. Because TOA values taken on the corresponding observation time instances form so-called target trace [14], this method is referred as the trace estimation method.

The rough comparison of the imaging and trace estimation method performance has shown that the both methods can provide almost the same precision of through wall tracking of moving target. For target tracking, the imagining method uses 2D signal processing methods (image processing) mostly, whereas the trace estimation method is based on 1D signal processing. Therefore, the similar precision of both methods is reached at cost of the higher complexity of imagining method in comparison with that of trace estimation method.

With regard to these facts, we consider the estimation method of through wall target tracking to be new and very perspective. In [14], the basic principle of this method has been outlined only. Therefore, the key intention of this contribution is to provide a clear and fundamental description of trace estimation method as the promising approach for through wall tracking of moving target. Besides, method fundamental outlined in [14] will be extended by a wall effect compensation method and target tracking by using linear Kalman filters.

In order to fulfill this intention, our contribution will have the following structure. In the next section, a real through wall scenario of single target tracking will be described. As the radar device considered for the scenario, M-sequences UWB radar equipped with one transmitting and two receiving antennas will be used [2], [17]. In the Sections 3-9, the particular phases of trace estimation methods (i.e. raw radar data pre-processing, background subtraction, detection, TOA estimation, wall effect compensation, localization and tracking itself) will be described. In these sections, the significance of the particular phases will be given firstly and then, a review of signal processing methods, which can be applied for the phase task solution, will be presented. Finally, the outputs of the particular phases will be subsequently illustrated by processing of real raw radar data obtained according to the scenario outlined in the Section 2. Because of the limited range of the contribution, the detail descriptions of the signal processing algorithms used within Sections 3-9 will not be presented. Instead of them, a number of source references devoted to particular algorithms will be given. We believe, that this approach can help readers to see trace estimation inside very clearly and then by using the references, a reader can understand the proposed radar signal processing methods in details. Conclusions and final remarks concerning the next research in the field of through wall tracking of moving target by UWB radar will be drawn in Section 10.

2 Basic Scenario of through Wall Tracking of Moving Target

The basic scenario analyzed in this contribution is outlined in Fig. 1. The target has been represented by a person walking along perimeter of rectangular room with size 3.9 m x 2.6 m, from Pos. 1 through Pos. 2, Pos. 3 and Pos. 4 to Pos. 1. The walls of the room (Fig. 2b) were concrete with thickness of 0.5 m and 0.27 m, relative permittivity $\varepsilon_r = 5$ and relative permiability $\mu_r = 1$.

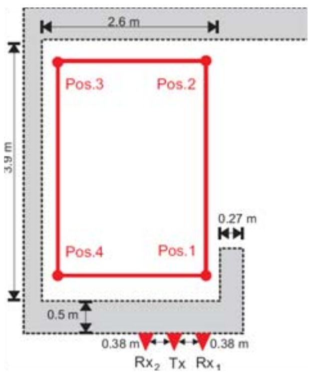


Fig. 1. Measurement scenario. A person was walking along perimeter of the room from Pos.1 through Pos. 2, Pos. 3 and Pos. 4 back to Pos. 1

The raw radar data analyzed in this contribution were acquired by means of M-sequence UWB radar with one transmitting and two receiving channels [2], [17], [18]. The system clock frequency for the radar device is about 4.5 GHz, which results in the operational bandwidth of about DC-2.25 GHz. The M-sequence order emitted by radar is 9, i.e. the impulse response covers 511 samples regularly spread over 114 ns. This corresponds to an observation window of 114 ns leading to an unambiguous range of about 16 m. 256 hardware averages of environment impulse responses are always computed within the radar head FPGA to provide a reasonable data throughput and to improve the SNR by 24 dB. The additional software averaging can be provided by basic software of radar device. In our measurement, the radar system was set in such a way as to provide approximately 10 impulse responses per second. The total power transmitted by radar was about 1 mW.

The radar has been equipped by three double-ridged horn antennas placed along line (Fig. 2a). Here, one transmitting antenna has been located in the middle between two receiving antennas. During measurement, all antennas were placed 1.25

m elevation above the floor and there was no separation between the antennas and the wall. The distance between adjacent antennas was set to 0.38 m (Fig. 1).

Raw radar data obtained by measurement according to above described scenario can be interpreted as a set of impulse responses of surrounding, through which the electromagnetic waves emitted by the radar were propagated. They are aligned to each other creating a 2D picture called radargram, where the vertical axis is related to the time propagation (t) of the impulse response and the horizontal axis is related to the observation time (τ).

(a) (b)

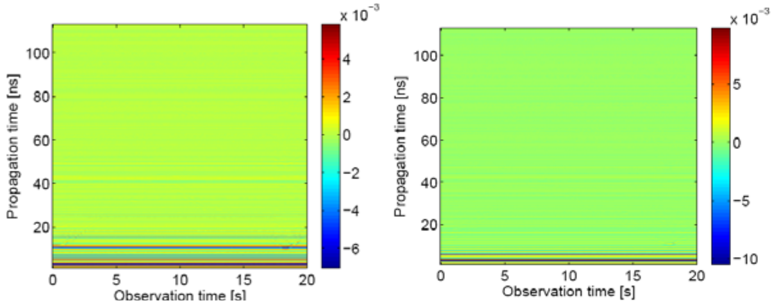
Fig. 2. (a) Experimental M-sequence UWB radar system, (b) Measurement room interior

3 Raw Radar Data Pre-processing

The intention of the raw radar data pre-processing phase is to remove or at least to decrease the influence of the radar systems by itself to raw radar data. In our contribution, we will focus on time-zero setting.

In the case of M-sequence UWB radar, its transmitting antenna transmits M-sequences periodically around. The exact time instant at which the transmitting antenna starts emitting the first elementary impulse of M-sequence (so-called chip) is referred to as time-zero. It depends e.g. on the cable lengths between transmitting/receiving antennas and transmitting/receiving amplifiers of radar, total group delays of radar device electronic systems, etc., but especially on the chip position at which the M-sequence generator started to generate the first M-sequence. This position is randomly changed after every power supply reconnecting. To find time-zero means rotate all received impulse responses in such a way as their first chips correspond to the spatial position of the transmitting antenna. There are several techniques for finding the number of chips needed for such rotating of impulse responses. Most often used method is that of utilizing signal cross-talk [27]. The significance of the time-zero setting follows from the fact that targets could not be localized correctly without the correct time-zero setting.

The examples of radargrams obtained by the measurement according to scenario given in the Section 2.1 with correct time-zero setting utilizing signal cross-talk method are given for the first receiving channel (Rx_1) and the second receiving channel (Rx_2) in Figs. 3a and 3b, respectively.



(a) (b)

Fig. 3. Pre-proccessed radargram. (a) Receiving channel Rx_1, (b) Receiving channel Rx_2

4 Background Subtraction

It can be observed from Figs. 3a and 3b, that it is impossible to identify any target in the radargrams. The reason is the fact, that the components of the impulse responses due to target are much smaller than that of the reflections from the front wall and cross-talk between transmitting and receiving antennas or from other large or metal static object. In order to be able to detect, localize and track a target, the ratio of signal scattered by the target to noise has to be increased. For that purpose, background subtraction methods can be used. They help to reject especially the stationary and correlated clutter such as antenna coupling, impedance mismatch response and ambient static clutter, and allow the response of a moving object to be detected.

Let us denote the signal scattered by the target as $s(t,\tau)$ and all other waves and noises are denoted jointly as background $b(t,\tau)$. Let us assume also that there is no jamming at the radar performance and the radar system can be described as linear one. Then, the raw radar data can be simply modeled by following expression:

$$h(t,\tau) = s(t,\tau) + b(t,\tau), \tag{1}$$

As it is indicated by the name, the background subtraction methods are based on the idea of subtracting of background (clutter) estimation from pre-processed raw radar data. Then, the result of the background subtraction phase can be expressed as

$$h_b(t,\tau) = h(t,\tau) - \hat{b}(t,\tau) = s(t,\tau) + [b(t,\tau) - \hat{b}(t,\tau)], \quad (2)$$

where $h_b(t,\tau)$ represents a set of radargram with subtracted suppressed background and

$$\hat{b}(t,\tau) = [h(t,\tau)]_{\tau_1}^{\tau 2} \quad (3)$$

is the background estimation obtained by $h(t,\tau)$ processing over the interval $\tau \in < \tau_1, \tau_2 >$.

In the case of the above outlined scenario, it can be seen very easily, that $s(t,\tau)$ for $t = const.$ represents a non-stationary component of $h(t,\tau)$. On the other hand, $b(t,\tau)$ for $t = const.$ represents a stationary and correlated component of $h(t,\tau)$.. Therefore, the methods based on estimation of stationary and correlated components of $h(t,\tau)$ can be applied for the background estimation.

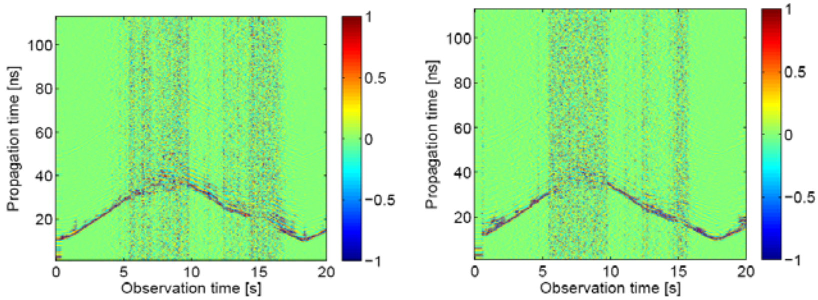
Following this idea, the methods such as basic averaging (mean, median) [11], exponential averaging [28], adaptive exponential averaging [28], adaptive estimation of Gaussian background [26], Gaussian mixture method [20], moving target detection by FIR filtering [9], moving target detection by IIR filtering [10], prediction [25], principal component analysis [24], etc. can be used for background subtraction. These methods differ in relation to assumptions concerning clutter properties as well as to their computational complexity and suitability for online signal processing.

Because of simplicity of the scenario discussed in this contribution, a noticeable result can be achieved by using e.g. the simple exponential averaging method where the background estimation is given by

$$\hat{b}(t,\tau) = \alpha \hat{b}(t,\tau - 1) + (1-\alpha) h(t,\tau) \quad (4)$$

where $\alpha \in (0,1)$ is a constant exponential weighing factor controlling the effective length of window over which the mean value and background of $h(t,\tau)$ is estimated.

The results of background subtraction by using exponential averaging method applied for raw radar data processing given in Figs. 3a and 3b are presented in Figs. 4a and 4b. In these figures, high-level signal components representing signal scattered by moving target can be observed. In spite of that fact, there are still a number of impulse responses where it is difficult or impossible to identify signal components due to electromagnetic wave reflection by a moving target.



(a) (b)

Fig. 4. Radargram with subtracted background. (a) Receiving channel *Rx_1*, (b) Receiving channel *Rx_2*

5 Detection

Detection is the next step in the radar signal processing which comes after background subtraction. It represents a class of methods that determine whether a target is absent or present in examined radar signals.

The solution of target detection task is based on statistical decision theory [8], [12], [23]. Detection methods analyze the radargram with subtracted background $h_b(t,\tau)$ along a certain interval of propagation time $t \in= t_1, t_1+1, \ldots, t_2$ and reach the decision whether a signal scattered from target $s(t,\tau)$ is absent (hypothesis H_0) or it is present (hypothesis H_1) in $h_b(t,\tau)$. The hypotheses can be mathematically described as follows:

$$H_0 \; : \; h_b(t,\tau) = n_{BS}(t,\tau) \tag{5}$$

$$H_1 \; : \; h_b(t,\tau) = s(t,\tau) + n_{BS}(t,\tau) \tag{6}$$

where n_{BS} represents residual noise obtained by $h(t,\tau)$ processing by a proper background subtraction method. Following expressions (1) and (2), $n_{BS}(t,\tau)$ can be expressed as follows

$$n_{BS}(t,\tau) = b(t,\tau) - \hat{b}(t,\tau) \tag{7}$$

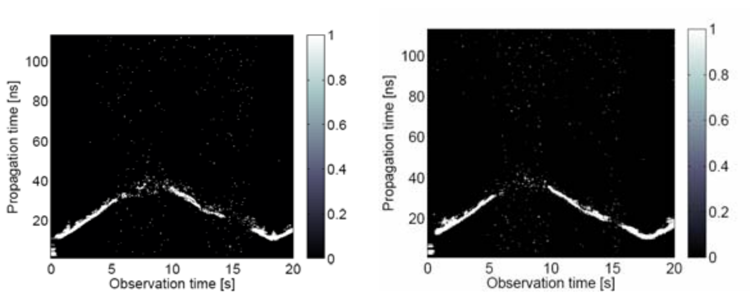
A detector discriminates between hypotheses H_0 and H_1 based on comparison testing (decision) statistics $X(t,\tau)$ and threshold $\gamma(t,\tau)$. Then, the output of detector $h_d(t,\tau)$ is given by

$$h_d(t,\tau) = \begin{cases} 0, & \text{if } X(t,\tau) \le \gamma(t,\tau), \\ 1, & \text{if } X(t,\tau) > \gamma(t,\tau) \end{cases} \tag{8}$$

The detailed structure of a detector depends on selected strategy and optimization criteria of detection [8], [12], [23]. The selection of detection strategies and optimization criteria results in a testing statistic specification and threshold estimation methods.

The most important groups of detectors applied for radar signal processing are represented by sets of optimum or sub-optimum detectors. Optimum detectors can be obtained as a result of solution of an optimization task formulated usually by means of probabilities or likelihood functions describing detection process. Here, Bayes criterion, maximum likelihood criterion or Neymann-Pearson criterion are often used as the bases for detector design. However a structure of optimum detector could be extremely complex. Therefore, sub-optimum detectors are also applied very often [23].

For the purpose of target detection by using UWB radars, detectors with fixed threshold, (N,k) detectors, IPCP detectors [23] and constant false alarm rate detectors (CFAR) [3] have been proposed. Between detectors capable to provide good and robust performance for through wall detection of moving target by UWB radar, CFAR detectors can be especially assigned. They are based on Neymann-Person optimum criterion providing the maximum probability of detection for a given false alarm rate.



(a) (b)

Fig. 5. CFAR detector output. (a) Receiving channel Rx_1, (b) Receiving channel Rx_2

There are a number of varieties of CFAR detectors. For example, the CFAR detector developed especially for UWB radar signal processing has been proposed in [3]. In spite of its simple structure and the assumption of Gaussian model of clutter, it has proved very good and robust performance for a lot of scenarios of through wall detection of single moving target. The illustration of its performance is given in Figs. 5a and 5b. Here, we can see the CFAR detector outputs obtained by signal processing represented by radargrams with subtracted background given in Figs. 4a and 4b.

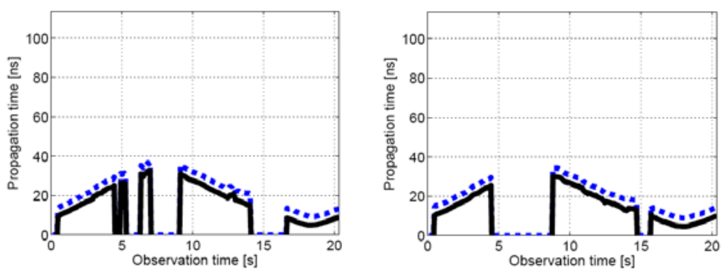
6 TOA Estimation

If a target is represented by only one non-zero sample of the detector output for observation time instant $\tau = \tau_k$, then the target is referred as a simple target. However in the case of the scenario analyzed in this contribution, the radar range resolution is considerably higher than the physical dimensions of the target to be detected. It results in that the detector output for $\tau = \tau_k$ is not expressed by only one non-zero impulse at $\tau = TOA(\tau_k)$ expressing the target position by TOA for observation time τ_k , but the detector output is given by a complex binary sequence $h_d(t, \tau_k)$ (Figs. 5a-5b). The set of non-zero samples of $h_d(t, \tau_k)$ represent multiple-reflections of electromagnetic waves from the target or false alarms. The multiple-reflections due to the target are concentrated around the true target position at the detector outputs. In this case, the target is entitled as the *distributed target*. In the part of $h_d(t, \tau_k)$ where the target should be detected not only non-zero but also zero samples of $h_d(t, \tau_k)$ can be observed. This effect can be explained by a complex target radar cross-section due to the fact that the radar resolution is much higher than that of target size and taking into account different shape and properties of the target surface. The set of false alarms is due to especially weak signal processing under very strong clutter presence.

Because of the detector output for a distributed target is very complex, the task of distributed target localization is more complicated than for a simple target. For that purpose, an effective algorithm has been proposed in [14]. Here, the basic idea of distributed target localization consists in substitution of the distributed target with a proper simple target. Then a distributed target position can be determined by using the same approach as for a simple target.

Let us assume the scenario with one moving target. If the distributed target is substituted by one simple target, the target trace is defined as a sequence $h_T(\tau)$ where $h_T(\tau_k)$ expresses TOA of a simple target substituting a distributed target in such a way as the simple target is located at the propagation time instant $t = TOA(\tau_k)$ for the observation time instant $\tau = \tau_k$. It follows from this idea, that TOA corresponding to a simple target should be estimated based on detector outputs.

The TOA estimation algorithm applied in this radar signal processing phase has been originally introduced in [14]. Its punctual description can be found in [18]. Finally, a new version of TOA estimation algorithm capable to overcome the algorithm has been proposed in [16]. Its performance is illustrated in Figs. 6a and 6b, where the target traces for Rx_1 and Rx_2 are presented. It can be observed from theses figures, that target traces are represented by simple curves expressing TOA for particular observation time instants. However, it can be seen from these figures also there are some "missing" parts of the target traces. This imperfection of the trace estimation is due to high level of noise presented in raw radar data along corresponding intervals of observation time. This problem will be solved within target tracking phase by using prediction method.



(a) (b)

Fig. 6. Target traces. Dotted curve – estimated TOA without correction, Solid curve – TOA after wall effect compensation. (a) Rx_1, (b) Rx_2

7 Wall Effect Compensation

In the case of target localization by trace estimation method, target coordinates are evaluated by using TOA corresponding to target to be tracked as well as electromagnetic wave propagation velocity along the line transmitting antenna-target-receiving antenna. In many applications of target tracking, it can be assumed that the environment, through which the electromagnetic waves emitted by the radar are radiated, is homogenous (usually air). This is not true for through wall moving target localization because the wall is medium with different permittivity and permeability than that of the air and therefore, the electromagnetic wave propagation velocity in the air and wall are different. Besides mentioned quantities, wall thickness (d_w) has also strong influence on target location precision. This effect, which is sometime referred to as wall effect, displaces targets outside of their true positions, if the target localization is based on frequently used simplified assumption for through wall scenario that the electromagnetic wave propagation velocity is constant and equal to velocity of light. With regard to these facts, the precision of through wall target location can be improved if additional information such as permittivity, permeability and thickness of the wall (so-called wall parameters) are used for target position computation.

For that purpose, so-called wall effect compensation methods can be applied. These methods are based on estimation of time difference, referred to as delay time $(t_{delay}(\tau))$, which is applied for target trace correction by using expression [22], [15]:

$$h(\tau) = h_T(\tau) - t_{delay}(\tau) \tag{9}$$

For trace estimation method, two methods of that kind referred to as target trace correction of the 1st and 2nd kind have been proposed in [15]. The target trace correction of the 1st kind is based on a simplified assumption that the electromagnetic waves emitted and received by radar propagate always in the perpendicular way with regard to wall plane. Then, the delay time can be determined by

$$t_{delay}(\tau) = \frac{d_w}{c}(\sqrt{\varepsilon_r \mu_r} - 1) \tag{10}$$

for all possible position of the target and observation time instant. The target trace correction of the 2nd kind does not use this simplified assumption, i.e. for different position of the target different delay time can be evaluated. Here, delay time is obtained as a time difference between TOA obtained by UWB radar signal processing and TOA corresponding to the same target position under assumption that no wall is located between radar and target [15].

In order to illustrate the wall effect compensation significance, we have determined the correction of target traces given in Figs. 6a and 6b by solid lines. For that purpose, we have used the target trace correction of the 2nd kind including (9). The resulting traces of the target are given in Figs. 6a and 6b by dash lines. It is difficult to observe any impact of the wall compensation effect from these figures. However, its significance will be demonstrated very clearly by target trajectory estimation.

8 Localization

The aim of the localization task is to determine target coordinates in defined coordinate systems. Target positions estimated in consecutive time instants create target trajectory.

Let us assume, that TOA_k is the sample of the corrected trace of the target taken at the observation time instant τ for Rx $_k$ and c is light propagation velocity. Then, the distance among Tx, target (T) and Rx $_k$ is given by

$$d_k = cTOA_k \tag{11}$$

For arbitrarily placed transmitting antenna Tx=[x_r, y_r] and receiving antennas Rx_k=[x_k, y_k], the most straightforward way of estimation of target position, i.e. determining of its coordinates T=[x,y], is to solve a set of equations created by using 11 taking into account the known coordinates of the transmitting and receiving antennas. Then, the following set of nonlinear equations can be built up based on measurements for the scenario with one transmitting and two receiving antennas [21], [5].

$$d_k = c.TOA_k = \sqrt{(x-x_t)^2 + (y-y_t)^2} + \sqrt{(x-x_k)^2 + (y-y_k)^2} \quad for\ k = 1,2 \tag{12}$$

Each range d_k and the pairs $Tx = [x_t, y_t]$ and $Rx_k = [x_k, y_k]$ $k = 1,2$ form two ellipses $k = 1,2$ with the foci $Tx = [x_t, y_t]$ and $Rx_k = [x_k, y_k]$ $k = 1,2$ and with the length of the main half-axis $a_k = \frac{d_k}{2}$ (Fig. 7).

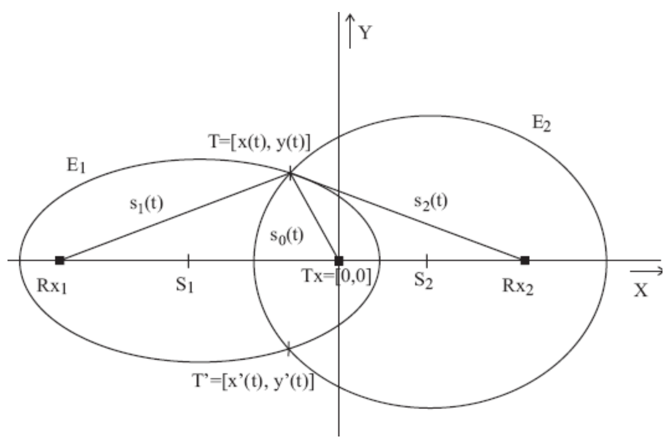


Fig. 7. Simple target localization for the scenario with one transmitting and two receiving antennas

It can be seen from this figure, that the target $Tx = [x, y]$ $(Tx' = [x', y'])$ lies on the intersection of these ellipses. Because of the ellipses are expressed by the polynomials of the second order, there are two solutions for their intersections. However, there is the only solution determining the desirable true coordinates of the target. Therefore, one of the obtained solutions has to be excluded for the scenario with one moving target. Usually, it can be done based on knowledge of a half-plane where the target is located. One of the solutions can be eliminated also if the solution (target coordinates) is beyond the monitored area or it has no physical interpretation (e.g. complex roots of (12)). For the solution of (12), so-called direct calculation method can be used. The detail description of direct calculation method is extensive and therefore beyond this contribution. Its punctual description can be found e.g. in [21] or [5]. In Fig. 8, the true target trajectory and target trajectory estimation by the described localization method for the scenario outlined in the Section 2 is presented. For the target trajectory estimation, the target traces given in Figs. 6a and 6b has been used. It can be observed from Fig. 8 that the target trajectory estimation by localization method is similar to true target trajectory, but large errors of target position estimation can be also found for many target positions. With regard to that fact, the target trajectory estimation should be significantly improved. For that purpose, target tracking and wall effect compensation methods can be used.

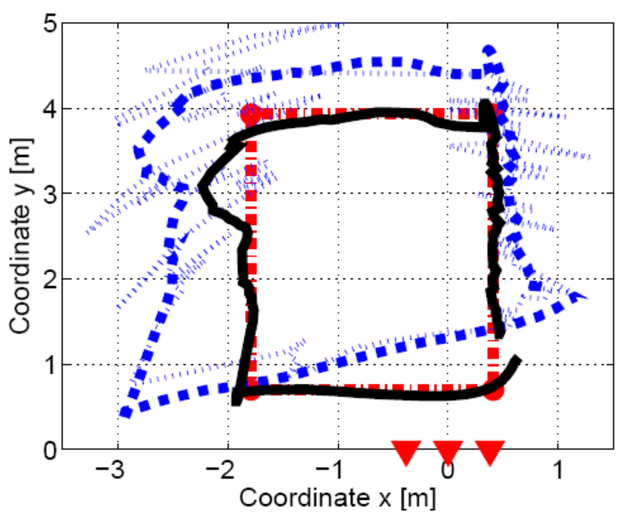


Fig. 8. Target trajectories. Dashdot curve – true target trajectory, thin dotted curve – estimated target trajectory after localization, thick dotted curve – estimated target trajectory after Kalman filtering, solid curve – estimated target trajectory after Kalman filtering with wall effect compensation

9 Tracking

Target tracking provides a new estimation of target location based on its foregoing positions. Usually, the target tracking will result in the target trajectory error decreasing including trajectory smoothing. The most of tracking systems utilize a number of basic and advanced modifications of Kalman filters as e.g. linear, nonlinear and extended Kalman filters and particle filters [13], [6]. Besides Kalman filter theory, further methods of tracking are available. They are usually based on smoothing of the target trajectory obtained by the target localization methods. Here, the linear least-square method is also widely used (e.g. [7]).

The significance of target tracking and wall effect compensation is illustrated in Fig. 8. For the moving target tracking, linear Kalman filter has been used. The missing samples of the target traces (Figs. 6a and 6b) have been completed through using of their predictions [6]. The final estimations of target trajectories by using Kalman filters are given in Fig. 8. The thick dotted curve presents the target trajectory estimation based on non-corrected target traces whereas the solid curve expresses the target trajectory estimation with application of target trace correction of the 2nd kind. The obtained results have shown that the application of Kalman filtering as tracking algorithm and the wall effect compensation can improve the target trajectory estimation in a significant way. The average localization error of the moving target obtained by that approach (Kalman filtering and the wall effect compensation method) for the scenario considered in this contribution is 0.16 m.

Conclusions

In this contribution, the trace estimation method for through wall tracking of moving target has been described. Firstly, we have outlined the theoretical base of the particular phases of trace estimation method and then we have presented an overview of signal processing methods, which can be applied within corresponding phase. The trace estimation method including its particular phases has been illustrated by real UWB radar signal processing. The obtained results expressed by the comparison of the true trajectory of the target and target trajectory estimations have shown, that the proposed method can provide excellent results for through wall tracking of single moving target.

With regard to this fact, it would be useful, if the proposed trace estimation method could be extended also for through wall tracking of multiple targets. For this scenario, one can reveal the following new effects connected with multiple target tracking. In the case of multiple targets tracking, the level of signal components scattered by the different targets will be usually different. For example, the target located close to radar antenna system is able to produce very strong reflection, but the second target located far from antenna system will reflect only very weak signals. In order to solve the effect of coincidental presence of targets reflected strong and weak signals, the advanced methods of background subtraction and target detection have to be developed and applied. Besides, the effect of mutual shadowing due to multiple targets can be presented. It can result in target disappearing from radargrams. Similar effects can be observed if the target is moved with stopping. For the purpose of temporary disappearing of target, more efficient methods of target trace estimation and multiple target trackers have to be used. In the case of direct calculation method for multiple target localization at the scenario with one transmitting and two receiving antennas, the so-called ghost effect can be reveal, too. It means e.g. that in the case of two targets tracking, four "potential targets" can be identified at the localization phase. They will be expressed by four intersections of two pairs of ellipses located in the same half-plane of scanned area. Two "potential targets" will correspond to true targets however the remainder "potential targets" will represent so-called ghosts. In order to separate true targets and ghosts, a suitable true target identification algorithm should be included into target tracking procedure. Preliminary analyse of the ghost identification problem has indicated that an analyses of the target trace properties could be very strong tool for true target identification. The above outlined effects and problems due to multiple target presence and possible bases for their solution has shown that the trace estimation method described in this contribution for single target tracking could be extended for multiple target tracking, too. The extension of the method will consist in application of advance signal processing methods for particular phases of target tracking procedure and in insertion of true target identification phase into discussed process of UWB radar signal processing. The solution of these tasks will be the subject of the next research of ours.

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