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Multi-projectiles Target Data Association Algorithm Based on D-S Evidence Theory

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ABSTRACT In the process of accuracy measurement of multi-projectile intersection target, aiming at the problem of multi-projectile target matching on two imaging planes of linear CCD（Charge Coupled Device）, a Time-Dimension ICP(iterative closest point) iterative optimization data association algorithm is designed, and a data association decision algorithm based on D-S(Dempster-Shafer evidence theory) evidence reasoning is proposed. By analyzing the correlation error of multi-projectile target matching, the measure function of ICP iteration optimization is given. According to the basic principle of D-S evidential reasoning and the constraint relationship between two imaging surfaces of a multi-projectile online array camera, the design method of the basic probability assignment function of the number of data association, the mean value of absolute error and the consistency of error are given. According to D-S combination probability distribution, different data association results are reasoned and decided. By designing the distance error function from the point to the polar line, the method is extended to the area array high-speed photographic intersection measurement system. The simulation results show that the proposed algorithm can make effective judgments and give reliable data association results when the projectile data is missing, the projectile data is noisy and the projectile catches up.

INDEX TERMS D-S evidence theory; data association; multiple projectiles targets; data fusion

I. INTRODUCTION

The space coordinates measurement of flying target [1] [2], such as bullets, shells and missiles is significant for weapon system test. The intersection imaging coordinate measurement system [3] calculates the spatial coordinates of the projectile passing through the target through the triangle intersection measurement principle. It overcomes the disadvantages of the original measurement method, such as heavy workload, lag in the coordinate giving, and low measurement accuracy. It is of great significance to improve the level of weapon identification and testing in the shooting range. The imaging equipment is mainly wired CCD array and plane array high-speed photography [4]. As projectiles are high-speed flying, small size and non-luminous targets, their contrast with the background is very low, and the acquisition signal-to-noise ratio is very low, there is the phenomenon that the projectile target cannot be captured. At the same time, the two imaging devices are arranged for intersection [5], and the background and lighting conditions are completely different, so there is inconsistency in the acquisition of projectile target, which results in wrong correlation of projectile target data in the intersection image. In addition, the outdoor environment is complex, the light through the leaves shaking in the background will form multiple moving targets, which will interfere with the projectile target. At the same time, the shaking of grass, the movement of clouds in the sky, the flight of mosquitoes and so on will interfere with the projectile target, so the target detected in the intersection image also contains interfering targets. It is not easy to eliminate the interference target by single image detection, which results in the wrong correlation of projectile target data in the intersection image. Moreover, there is a certain distance between the projectile launching point and the measurement surface, and there exists the phenomenon of catching up with the projectile, which also affects the accuracy of data association of projectile targets in the intersection image. The key of the intersection imaging coordinate measurement system is the correct data association of the target in the two images [6]. So in this paper studies the data association algorithm of the

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projectile target in the image acquired by the intersection imaging, so as to lay a foundation for the subsequent acquisition of the projectile spatial coordinates.

Data association between multiple projectile targets in two imaging cameras is actually a point matching problem. From the point of view of existing algorithms, they all solve the problem from the two most basic relationships between point modes - spatial transformation and matching. The algorithm based on spatial transformation relation solves the problem of point pattern matching by estimating the spatial transformation parameters between point sets and restoring the transformation between point patterns with this parameter, which is also called the algorithm based on transformation parameter estimation. At present, these algorithms mainly include iterative closest point (ICP) algorithm [7] [8] [9]], soft assignment-based algorithm [10], particle swarm optimization-based algorithm [11] and so on. The algorithm based on matching relationship solves the problem of point pattern matching by extracting the feature of point concentration and then using matching recognition method to obtain the matching relationship between point patterns, or more vividly called feature-based matching algorithm [12]. At present, such algorithms mainly include graph-based method [13], shape descriptor-based method [14], SIFT-based method [15].

Based on the above review, the data association of multi-projectiles targets between two imaging planes can be solved based on the algorithm based on the estimation of transform parameter. But the location of the imaging projectiles target intersection measuring system with dual liner CCD does not fully satisfy the spatial transformation relationship, and there are outliers，so the data association is asymmetrical [16]. ICP may have many kinds of data association results because of the difference of initial value. For this uncertain problem, this paper use D-S evidence theory [17] [18] [19] to evaluate and judge the results of data association, and the data association algorithm for projectiles target based on D-S evidence theory is proposed.

II. MODELING AND ALGORITHM DESIGN FOR THE PROBLEM OF THE DATA ASSOCIATION OF PROJECTILES TARGET

The paper assume that the target set of projectiles detected in the image collected by CCD1 is Q , the target set of projectiles detected in the image collected by CCD2 is P . Each projectiles object in target sets contains coordinates (x, y) in which x indicates the position of row in the image of target y indicates the position of column in the image of target. The time of projectiles target is t . Collection line rate is f_c . So the relationship between t and f_c is $t = x / f_c$. The data association of projectiles targets is to establish the relationship in the image position. Because there are only polar geometric constraints between the two linear cameras, there is correlation in the time dimension and no constraint relationship in the position dimension.

A. THE ANALYSIS OF DATA ASSOCIATION IN TEMPORAL DIMENSION

The paper assume the target time series of Q is: $t_1^Q, t_2^Q \cdots t_m^Q$,the target time series of P is: $t_1^P, t_2^P \cdots t_n^P$. Two synchronous linear CCD cameras aim at each other, and when the detection surfaces coincide the imaging time is the same when the target passes through the two linear array CCD. If the i^{th} projectiles target in Q is associated with the j^{th} projectiles target in P . It can be written by formula (1):

$$t_i^Q = t_j^P \quad (1)$$

Considering the error of the system position, if the two detection surfaces are parallel, the imaging time difference between the two cameras can be considered in a known range which we describe it is Δt . If the i^{th} projectiles target in Q is associated with the j^{th} projectiles target in P . It can be written by formula (2):

$$t_i^Q = t_j^P \pm \Delta t \quad (2)$$

The time difference Δt is related to the velocity of the projectiles and can be determined by means of measurement. Assuming the distance between the two parallel detection surfaces is $\triangle d$, the flying speed of the projectiles target is v , the relationship between the time difference and the speed of bullet can be expressed by formula(3)：

$$\Delta t = \frac{\triangle d}{v} \quad (3)$$

But when the two linear array CCD detection surfaces are not parallel, the distance between the two detection surfaces is changed, which can be expressed by $\triangle d + \varepsilon_d$ .Meanwhile the flying speed of each projectiles target is also changed which can be expressed by $v + \varepsilon_v$ .In this situation the time difference have a minor change with the change of target position and the speed of the bullet .It can be expressed by formula (4):

$$\Delta t' = \frac{\triangle d + \varepsilon_d}{v + \varepsilon_v} \approx \Delta t + \varepsilon_{\Delta t} \quad (4)$$

For the projectiles target fired continuously, the radio frequency between the two shots sometimes varies greatly when it reaches the detection surface due to the difference in the speed of the bullets and the slight change in the direction of flight [20]. That is, the time interval of imaging on camera sometimes varies greatly, but it has order, that is, two linear array CCD data cannot be intersected, which can also be used as a criterion of data association.

B. THE DATA ASSOCIATION BASED ON TEMPORAL DIMENSION

According to the formula (2)and (4) t_i^Q can be expressed by formula (5):

$$t_i^Q = t_j^P + \Delta t + \varepsilon_{\Delta t} = f\left(t_j^P\right) + \varepsilon_{\Delta t} \quad (5)$$

Assuming the matching matrix between the target point

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set P and Q is $M=[M_{ij}]$. M_{ij} is to be expressed the relationship between t_i^Q and t_j^P . When the matching is successful M_{ij} can be 1 ,otherwise it is 0. Then the relationship between the two target points sets is expressed by formula (6):

$$Q = Mf(P) + \varepsilon_{\Delta t} \quad (6)$$

In the formula (6), $f(\cdot)$ is a linear function. When the specific function $f(\cdot)$ is unknown, associating the date of the points set, and the solution can be transformed into the optimization problem expressed by the formula (7):

$$\arg\{\min E_0(M,f)\} \quad (7)$$

That is, when the matching matrix M and the time transformation f are correct, the measure function $E_0(M,f)$ reaches the minimum value. However, when there are outliers, it is difficult to describe the matching between points only by the measure function of the matching points. Therefore, it is necessary to add the constraint to describe the lattice point. The measure function can be defined as:

$$E(M,f) = E_0(M,f) + \sum_{i=1}^{m}\alpha_i E_Q\left[g_Q(M,f)\right] + \sum_{j=1}^{n}\beta_j E_P\left[h_P(M,f)\right] \quad (8)$$

$E_0(M,f)$ represent the measure function of perfectly matched points. f is a transformation relationship. $E_i[g_i(M,f)]$ is the penalty function for the outliers in the target set Q , $E_j[h_j(M,f)]$ is the penalty function for the outliers in the target set P .and α_i and α_j are the penalty factor.

Because of the imprecise transformation relation between t_Q and t_P , the method of solving the exact solution of the equation between the two sets can not be used, which needs to be realized by ICP iteration repeatedly. But because of the asymmetry of the two sets, the iterative method would be affected by the initial value and the end condition of the iteration and then fall into the local extreme. Therefore, several initial values are used to iterate separately, and the sequential search ICP data association algorithm can be summarized as the following four steps:

1) Calculating the coordinate of the center position of the two point sets, the result of the coordinates are O_P and O_Q .And the new point sets Q' and P' are generated by centralizing the point sets;

2) The initial value of the translation vector Δt is determined by the center of gravity difference of the two points sets;

3) Associating data in the range of the neighborhood, if there are more than two associated data, the nearest one would be taken. The measure function is calculated according to formula (8), and the absolute value of the difference of continuous measure is taken as the iterative judgment value.

4) The ICP registration algorithm stops the iteration when the measure difference is less than 0.01. Otherwise it repeats 1 to 3 steps until the iteration times are satisfied.

We can obtain a variety of data association results through the above iterative process, and then use evidence theory to judge multiple data association results.

C. THE DATA ASSOCIATION DECISIONS BASED ON EVIDENCE-BASED THEORY

When two projectiles target point sets are associated with data, the number of data correlation points satisfying local extreme points will be less, and the number of data association points satisfying global extreme points will be more. The paper use the number of data association points as one of the evidences to judge. C_k is assumed to be the number of data associations of type k . Defining the number of data associations assigned to the basic probability of each data association $m_1(A_k)$:

$$m_1(A_k) = \frac{C_k}{\sum_{i=1}^{k} C_k} \quad (9)$$

In projectiles targets data association, projectiles targets correlated in two linear CCD satisfy the situation that the average value of the absolute value of time error is minimum. And the basic probability assignment of the minimum average value of the absolute value of time error is $m_2(A_k)$:

$$m_2(A_k) = 1 - \frac{\dfrac{\sum_{i=1,j=1}^{m,n}\left|t_{i,k} - t_{j,k}\right|}{C_k}}{\dfrac{\sum_{i=1,j=1}^{m,n}\left|t_{i,1} - t_{j,1}\right|}{C_1} + \dfrac{\sum_{i=1,j=1}^{m,n}\left|t_{i,2} - t_{j,2}\right|}{C_2}} \quad (10)$$

In projectiles target data association, the data of projectiles target time error is consistent in two linear array CCD due to the target surface formed by intersection arrangement. And the basic probability assignment of the consistency of each data association is $m_3(A_k)$:

$$m_3(A_k) = 1 - \frac{\dfrac{\sum_{i=1,j=1}^{m,n}\left(\left|t_{i,k} - t_{j,k}\right| - \dfrac{\sum_{i=1,j=1}^{m,n}\left|t_{i,k} - t_{j,k}\right|}{C_k}\right)^2}{C_k}}{\left(\sum_{r=1}^{2}\dfrac{\sum_{i=1,j=1}^{m,n}\left(\left|t_{i,r} - t_{j,r}\right| - \dfrac{\sum_{i=1,j=1}^{m,n}\left|t_{i,r} - t_{j,r}\right|}{C_r}\right)^2}{C_r}\right)}$$

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(11)

There are two results with different initial values. According to D-S evidence theory, establishing a recognition framework: $U=\{A_1,A_2,A_3\}$ .The basic probability assignment based on the above features is used for evidence theory.

TABLE I
BASIC PROBABILITY ASSIGNMENT

Evidence	Matching quantity $m_1(\ )$	Average Value of Absolute Error $m_2(\ )$	Error Consistency $m_3(\ )$	Combination probability $m(\ )$
Data Association A_1	$m_1(A_1)$	$m_2(A_1)$	$m_3(A_1)$	$m(A_1)$
Data Association A_2	$m_1(A_2)$	$m_2(A_2)$	$m_3(A_2)$	$m(A_2)$

The normalized constant of the basic probability assignment in Table I is expressed by formula (12):

$$K=\sum_{B\cap C\cap D\neq\varnothing} m_1(B)\cdot m_2(C)\cdot m_3(D)=m_1(A_1)\cdot m_2(A_1)\cdot m_3(A_1)+m_1(A_2)\cdot m_2(A_2)\cdot m_3(A_2) \quad (12)$$

Combinatorial probability allocation of data association A_k $(k=1,2)$:

$$(m_1\oplus m_2\oplus m_3)(A_k)=\frac{1}{K}\sum_{B\cap C\cap D=A_k} m_1(A_k)\cdot m_2(A_k)\cdot m_3(A_k) \quad (13)$$

Taking the corresponding relation of the data association with high combinatorial probability as the data association relation of projectiles target collected by two-linear array CCD and obtaining the optimal data association of projectiles target uniquely.

III. MODELING AND ALGORITHMIC DESIGN OF DATA ASSOCIATION PROBLEM OF PROJECTILE TARGET BASED ON HIGH-SPEED PHOTOGRAMMETRIC INTERSECTION MEASUREMENT

A. DATA ASSOCIATION BASED ON TWO-DIMENSIONAL LOCATION

For the collected projectile target, suppose that the set of projectile targets detected in the image collected by high-speed photography 1 is Q, and the set of projectile targets detected in the image collected by high-speed photography 2 is P. Each projectile target in the two target sets contains (x, y) coordinates. Data Association of projectile targets is to establish the relationship between them from the image position. Because of the existence of the basic matrix f with opposite geometric constraints between the targets detected by two-plane array high-speed photography, the epipolar set l of the target set Q is computed:

$$l=FQ \quad (14)$$

And the matching point set P of the target set Q is on the epipolar set l. Because of the error in target detection and extraction, the matching point set P of the target set Q is not strictly on the epipolar set L. Therefore, the time-distance error $\varepsilon_{\Delta t}$ of linear array target matching is transformed into the distance error $\varepsilon_{\Delta d}$ of calculating the distance between the target set P and the target set Q-polar L：

$$\varepsilon_{\Delta d}=\sum_{j=1}^{n}\left(\frac{1}{(FQ_j)_1^2+(FQ_j)_2^2}+\frac{1}{(F^TP_j)_1^2+(F^TP_j)_2^2}\right)\left(P_j^TFQ_j\right)^2 \quad (15)$$

Let the matching matrix of P and Q of projectile target point set be $M=[M_{ij}]$, M_{ij} represents the matching relationship between Q and P, the matching time is 1, otherwise 0. Then the relationship between two target point sets is expressed as:

$$Q=Mf(P)+\varepsilon_{\Delta d} \quad (16)$$

$f(\cdot)$ is a non-linear function. When the specific function $f(\cdot)$ is unknown, the point set is correlated with data, and its solution can be transformed into an optimization problem of formula (7).The basic matrix F can be solved according to the ICP data association method of linear CCD. Through the iteration process, a variety of data association results can be obtained, and then multiple data association results can be judged by evidence reasoning.

B. DATA ASSOCIATION DECISION BASED ON EVIDENCE REASONING

In the calculation of the data correlation quantity information, the minimum mean of the absolute error value and the error consistency information, the quantity information formula (9) remains unchanged, and the time error $|t_{i,1}-t_{j,1}|$ in the absolute error formula (10) and the error consistency information formula (11) is changed to the distance error between the point and the polar line, such as formula (17), formula (12) and (13) remain unchanged.

$$\left(\frac{1}{(FQ_j)_1^2+(FQ_j)_2^2}+\frac{1}{(F^TP_j)_1^2+(F^TP_j)_2^2}\right)\left(P_j^TFQ_j\right)^2 \quad (17)$$

IV. SIMULATION OF DATA ASSOCIATION OF PROJECTILES TARGET

The essence of ICP is an optimal registration method based

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on least square method. The algorithm repeats the corresponding registration of the data, calculates the optimal transformation until it meets the convergence accuracy requirements of the correct registration, and obtains the optimal registration method. Because of the different initial values, the ICP algorithm may have a variety of data association results. For this uncertainty, D-S evidence theory is used to achieve the optimal registration of data association.

In the actual situation, projectiles target data often miss and be disturbed by noise [21]. The paper carries out the simulation of data association for these two cases and the case of the projectiles pursuit.

A. DATA ASSOCIATION IN THE ABSENCE OF PROJECTILES DATA

The projectiles target timing sequence of the set P and Q collected by two-line array CCD shown in Table II. And the correct registration data in set P corresponding t_1^Q is missing.

TABLE II

THE TARGET TIMING SEQUENCE OF THE SET P AND Q

T(ms)	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10
P	2.2	12.1	22.9	36.7	43.5	59.5	70.4	90	95	110.5
Q	13.7	24.3	35.2	45.3	62	68	88.6	96.2	108	126.7

Using the ICP algorithm to handle the data in table II. Firstly, assuming the initial translation is -1 then the translation can be obtained by the ICP algorithm which is 0.08. And the set P turn to P_1 after the ICP transform. The result of data association between P_1 and Q is A_1 shown in Table III:

TABLE III

A_1 IN THE SITUATION OF THE INITIAL TRANSLATION OF -1

P	12.1	22.9	36.7	43.50	59.5	70.4	90	95	110.5	—
P_1	12.18	22.98	36.78	43.58	59.58	70.48	90.08	95.08	110.58	
Q	13.70	24.3	35.2	45.3	62	68	88.6	96.2	108	126.7

Secondly assuming the initial translation is 10 then the translation can be obtained by the ICP algorithm which is 12.52. And the set P turn to P_2 after the ICP transform. The result of data association between P_2 and Q is A_2 shown in Table IV:

TABLE IV

A_2 IN THE SITUATION OF THE INITIAL TRANSLATION OF 10

P	2.2	12.1	22.9	36.7	43.5	59.5	70.4	90	95	110.5
P_2	14.72	24.62	35.42	49.22	56.02	72.02	82.92	102.52	107.52	123.02
Q	13.7	24.3	35.2	45.3	62	68	88.6	96.2	108	126.7

According to the D-S evidence theory, establishing the identification framework $U=\{A_1, A_2\}$, and calculating the basic probability assignment which is based on the above characteristics. The results are filled in the table as shown in Table V.

TABLE V

THE BASIC PROBABILITY ASSIGNMENT

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Evidence	Matching quantity $m_1(\ )$	Average Value of Absolute Error $m_2(\ )$	Error Consistency $m_3(\ )$	Combination probability $m(\ )$
A_1 Data Association	0.47	0.6371	0.9535	0.9696
A_2 Data Association	0.53	0.3629	0.0465	0.0304

The result from Table 5 is as follows $m(A_1) = 0.9696$ $m(A_2) = 0.0304$.

Taking the corresponding relation of the data association with high combinatorial probability A_1 as the correct data association relation of projectiles target collected by two-linear array CCD. Meanwhile confirming the optimal data association of projectiles target. According to the evaluation and the judgment of the correlation result by D-S evidence theory, D-S evidence theory can make reasonable judgment on the data association of projectiles target in the absence of projectiles data.

B. DATA ASSOCIATION WITH NOISE DATA

The projectiles target timing sequence of the set P and Q collected by two-line array CCD shown in Table VI. The noise data in the data of collection is t_8^P.

TABLE VI

THE TARGET TIMING SEQUENCE OF THE SET P AND Q

T(ms)	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	
P	2.2	12.1	22.9	36.7	43.5	59.5	70.4	85	90	96	110.5
Q	13.7	24.3	35.2	45.3	62	68	88.6	96.2	108	126.7	—

Using the ICP algorithm to handle the data in table VI. Firstly, assuming the initial translation is -1 then the translation can be obtained by the ICP algorithm which is 0.03. And the set P turn to P_1 after the ICP transform. The result of data association between P_1 and Q is A_1 shown in Table VII:

TABLE VII

A_1 IN THE SITUATION OF THE INITIAL TRANSLATION OF -1

P	12.1	22.9	36.7	43.50	59.5	70.4	90	96	110.5
P_1	12.07	22.87	36.67	43.47	59.47	70.37	89.97	95.97	110.47
Q	13.7	24.3	35.2	45.3	62	68	88.6	96.2	108

Secondly assuming the initial translation is 10 then the translation can be obtained by the ICP algorithm which is 12.47. And the set P turn to P_2 after the ICP transform. The result of data association between P_2 and Q is A_2 shown in Table VIII:

TABLE VIII

A_2 IN THE SITUATION OF THE INITIAL TRANSLATION OF 10

P	2.2	12.1	22.9	36.7	43.5	59.5	70.4	90	96	110.
P_2	14.67	24.57	35.37	49.17	55.97	71.97	82.87	102.47	108.47	122.47

Q	13.7	24.3	35.2	45.3	62	68	88.6	96.2	108	126.7

According to the D-S evidence theory, establishing the identification framework $U=\{A_1,A_2\}$, and calculating the basic probability assignment which is based on the above characteristics. The results are filled in the table as shown in Table IX.

TABLE IX
THE BASIC PROBABILITY ASSIGNMENT

Evidence	Matching quantity $m_1(\ )$	Average Value of Absolute Error $m_2(\ )$	Error Consistency $m_3(\ )$	Combination probability $m(\ )$
A_1 Data Association	047	0.6525	0.9241	0.9530
A_2 Data Association	0.53	0.3475	0.0759	0.0470

The result from Table IX is as follows $m(A_1)=0.9530$ $m(A_2)=0.0470$.

Taking the corresponding relation of the data association with high combinatorial probability A_1 as the correct data association relation of projectiles target collected by two-linear array CCD. Meanwhile confirming the optimal data association of projectiles target. According to the evaluation and the judgment of the correlation result by D-S evidence theory, D-S evidence theory can make reasonable judgment on the data association with noise data.

C. DATA ASSOCIATION IN PROJECTILES PURSUIT

The projectiles target timing sequence of the set P and Q collected by two-line array CCD shown in Table X.The timing sequence between t_8^P and t_9^P is very small so does the timing sequence between t_7^Q and t_8^Q.

TABLE X
THE TARGET TIMING SEQUENCE OF THE SET P AND Q

T(ms)	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10
P	2.2	12.1	22.9	36.7	43.5	59.5	70.4	85	87.5	110.5
Q	13.7	24.3	35.2	45.3	62	68	88.6	91.1	108	126.7

Using the ICP algorithm to handle the data in table X. Firstly, assuming the initial translation is -1 then the translation can be obtained by the ICP algorithm which is 0.9. And the set P turn to P_1 after the ICP transform. The result of data association between P_1 and Q is A_1 shown in Table XI:

TABLE XI
A_1 IN THE SITUATION OF THE INITIAL TRANSLATION OF -1

P	12.1	22.9	36.7	43.5	59.5	70.4	85	87.5	110.5	—
P_1	13	23.8	37.6	44.4	60.4	71.3	85.9	88.4	111.4	—
Q	13.7	24.3	35.2	45.3	62	68	88.6	91.1	108	126.7

Secondly assuming the initial translation is 10 then the translation can be obtained by the ICP algorithm which is 13.26. And the set P turn to P_2 after the ICP transform. The result of data association between P_2 and Q is A_2 shown in Table XII:

TABLE XII

A_2 IN THE SITUATION OF THE INITIAL TRANSLATION OF 10

P	2.2	12.1	22.9	36.7	43.5	59.5	70.4	85	87.5	110.5
P_2	15.46	25.36	36.16	49.96	56.76	72.76	83.66	98.26	100.76	123.76
Q	13.7	24.3	35.2	45.3	62	68	88.6	91.1	108	126.7

According to the D-S evidence theory, establishing the identification framework $U=\{A_1, A_2\}$, and calculating the basic probability assignment which is based on the above characteristics. The results are filled in the table as shown in Table XIII.

TABLE XIII
THE BASIC PROBABILITY ASSIGNMENT

Evidence	Matching quantity $m_1(\ )$	Average Value of Absolute Error $m_2(\ )$	Error Consistency $m_3(\ )$	Combination probability $m(\ )$
A_1 Data Association	047	0.6682	0.8102	0.8840
A_2 Data Association	0.53	0.3318	0.1898	0.1160

The result from Table VIII is as follows $m(A_1)=0.8840$ $m(A_2)=0.1160$.

Taking the corresponding relation of the data association with high combinatorial probability A_1 as the correct data association relation of projectiles target collected by two-linear array CCD. Meanwhile confirming the optimal data association of projectiles target. According to the evaluation and the judgment of the correlation result by D-S evidence theory, D-S evidence theory can make reasonable judgment on the data association in projectiles pursuit.

The simulation results show that the data association algorithm for projectiles target based on D-S evidence theory is effective in the case of the absence of projectiles data, the data with noise and projectiles pursuit [22]. The optimal data registration of projectiles target is determined accurately.

V. CONCLUSION

The paper aims at the problem of multi-projectile target data association in intersection measurement system, a data association algorithm based on D-S evidence reasoning is proposed. Firstly, the time dimension of image target collected by linear array camera is analyzed by data association. Considering the mismatching points, the time dimension-based data association measure function and sequential search ICP iterative optimization algorithm are given to obtain multiple data association results. Then, the basic probability distribution functions of the number of data association, the average value of absolute error and the consistency of error are designed, and the judgment and reasoning are carried out according to the D-S synthesis formula. Finally, the distance dimension from the point to the epipolar line is correlated, and the average absolute error value and the basic probability distribution function of error consistency are designed to achieve accurate data association of multi-projectile targets. The experimental results show that the ICP iteration algorithm can get multiple data associations under different initial values, and can make effective judgments when the projectile data is missing, the projectile data is noisy and the projectile catches up, so as to accurately determine the optimal data association of the projectile target.

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