

Research on Target Recognition and Tracking Based on Data Fusion

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Abstract: Based on the limitations of single-sensor (radar or infrared) systems, a target recognition and tracking system based on multi-sensor (radar and infrared) signal fusion is proposed, which can utilize data complementarity and redundancy of different sensors. Feature layer fusion can be utilized the target characteristic signals provided by other sensor modules improve the target detection probability and reduce the false alarm probability; the decision layer fusion can correct the servo tracking loop of the sensor module that loses the target tracking ability due to interference and the like, and improve the anti-interference.

1. Introduction

Target recognition and tracking is an important research content in the field of pattern recognition. Since single sensor systems usually only provide partial information to identify tracking objects, multi-sensor systems use data fusion technology to overcome single-sensor defects from different sources. The sensor system utilizes data complementation and redundancy of different sensors to obtain information from their respective independent measurement spaces. Different sensors provide more accurate data for identifying different features of the tracking object. For example: Radar provides highly accurate range distance information and is initially available at the missile. The information provided during the flight phase is more accurate; the infrared sensor provides high-resolution shape image information and provides more accurate information during the missile's approach to the target phase. For most cases, external conditions affect one type of sensor and are relatively non-interfering with other sensors. For example: Infrared images are more disturbed when cloud, rain, and snow are blocked; while radar signals are less affected by atmospheric attenuation than infrared images, but are more affected by other electromagnetic fields. In addition, redundancy is achieved by using different sensors. Information improves target recognition tracking Robust stability of the system; a signal error does not result in a sensor error of the entire system and therefore, multi-sensor data fusion has become the object recognizing and tracking essential part.

Multi-sensor data fusion can be divided into three categories according to the level of information representation: data layer fusion, feature layer fusion, decision layer fusion. Data layer fusion is usually used for multi-source image composite; feature layer fusion can be divided into Target state information fusion, target feature fusion; target state information fusion mainly applies multi-sensor target tracking domain. Target feature fusion is feature layer joint recognition. The basic concept of decision-making layer fusion is that different types of sensors observe the same target, each sensor the processing is completed locally to establish a preliminary conclusion on the observed target; then the joint inference result is finally obtained through the association processing and the decision layer fusion judgment.

2. Feature layer based signal fusion

When the radar sensor is not interfered, the radar sensor's signal is transmitted to the infrared imaging analysis module, which helps to provide heuristic information for target search and recognition for infrared imaging analysis: (1) radar sensor target motion trajectory prediction helps The infrared imaging analysis module uses target and motion trajectory prediction to perform target

search in imaging, thereby effectively improving the efficiency in target search. At the same time, the target or multi-target of infrared imaging can be identified according to the target trajectory prediction. (2) The radar sensor signal (target relative distance ΔR) helps the infrared imaging analysis module to estimate the number of pixels in the infrared imaging based on ΔR , so that it can be combined with the identification intelligent model of the infrared imaging analysis module to distinguish the target and the cloud layer. Or other sources of interference. (3) The radar sensor signal (ΔR , high and low angle hY , azimuth hZ) helps the infrared imaging analysis module to combine image-based features (target pixel area, etc.) to identify the position of the missile relative to the target. (attack, tail attack, side attack), so as to determine the best attack point. (4) Radar sensor letter (ΔR) helps the infrared imaging analysis module to determine the best fuze detonation time based on ΔR and image-based features (target pixel area and attack orientation, etc.) (attack, tail attack, side attack), thus determining the most Good attack point. (4) The radar sensor signal (ΔR) helps the infrared imaging analysis module to determine the best fuze detonation time based on ΔR and image-based features (target pixel area and attack orientation, etc.).

When the infrared imaging sensor is not interfered, the infrared imaging sensor's signal is transmitted to the radar target recognition and tracking module, which helps to provide heuristic information for target search and recognition for radar target recognition and tracking: (1) when the target is relative for the tangential flight of the missile, the target Doppler frequency is zero. At this time, the speed information of the infrared imaging sensor can be used (can be obtained by the target motion trajectory information in the infrared sequence image). (2) When radar and infrared imaging When the sensor simultaneously tracks the target, the target emits interference, and both the radar and the infrared imaging sensor can detect the target and the interferer, but the radar accepts the point target information, so it is difficult to distinguish the true and false target in a short time, and the infrared The imaging sensor can use the image features of the previous real target to quickly distinguish the true and false targets and guide the radar to target recognition and tracking.

Target recognition based on feature fusion is to comprehensively utilize the target feature information provided by radar and the feature information obtained by infrared imaging analysis for target recognition. Target recognition process based on infrared imaging is composed of signal preprocessing (signal detection, denoising), image segmentation and The recognition of the segmentation object consists of three parts. Image segmentation is to segment the bright regions in the infrared imaging. This paper uses the insect method to segment the image. The segmentation object is divided into the point target and the surface target according to the pixel area of the segmentation object. Recognition, generally the pixel area of the segmented object is less than or equal to 3×3 can be regarded as a point target; otherwise, it can be regarded as a surface target.

3. Decision-level based signal fusion

The system consists of 5 acoustic sensors and 1 depth sensor. The 3 acoustic sensors (1#, 2#, 3# respectively) are in the horizontal plane and are equilateral triangles. They are mainly used for target positioning, and 2# acoustic sensors are used. Target recognition; 3#, 4# and 5# acoustic sensors are equally spaced perpendicular to the horizontal plane for target detection. The data fusion model uses a hybrid fusion structure, as shown in Figure 1. The hybrid data fusion model can be distributed. The advantages of structure and centralized structure, its main functions are: to realize the data exchange function within the system; to control the system working sequence; to target classification according to the target model set; calculate according to the azimuth and elevation angle parameters provided by the system State parameters such as target heading, speed and distance.

The target detection model adopts a linear equidistant ternary equidistant line array. In order to improve the target detection capability of the fusion system as much as possible, a distributed quantitative detection fusion system is adopted. First, the received signals of each sensor are quantized and then quantized. The quantitative information is transmitted to the fusion center for spatial information fusion processing to obtain spatial gains against noise and reverberation interference, so as to improve the accuracy of detection and reduce the false alarm rate of the

system. At the same time, the fusion center utilizes a beamforming mechanism to detect the target. At the same time, the spatial position information of the target is obtained, and the information is used for target tracking. The acoustic target recognition belongs to the decision level fusion, and its essence is to extract the feature information in the sound waves emitted by different sound sources, and process and process the feature information to use the data. The database and knowledge base of the fusion system are combined with certain reasoning mechanism to realize the recognition of the target. The grey relational analysis in the system grey theory can be used for target recognition under grey information conditions\ . The model uses the gray correlation degree to analyze the target noise signal. Similarity to the spectral structure of the target model set in the data fusion system . Logo recognition by gray relation analysis target identification, the following steps: (1) determining the sequence comparison a reference sequence; (2) find gray correlation coefficient; (3) calculating a reference gray association with the sequences compared sequences.

The decision layer fusion of the radar/infrared imaging dual-mode system signal is based on the feature layer fusion. As the decision-making layer information of the dual-mode system, the signal indicating the change of the line-of-sight rate is mainly considered. The radar system and the infrared imaging system respectively The signal of the change of the line-of-sight rate of the target is obtained. The decision-making layer fusion of the signal of the dual-mode system is the process of the fusion of the decision-making layers of the above two signals. (2) In the later stage of the missile flight (close to the target distance, In view of the fact that the infrared imaging information is more reliable than the radar information when the distance is very close, and the image analysis can determine the location of the target, ie CFIR=1), the decision information of the infrared sensor is highly reliable, and only the infrared sensor is used. Decision information to control the missile's flight path to attack the target. (3) In the middle of the missile flight (close to the target distance, the infrared sensor begins to detect the target until the infrared module can start independent detection and tracking target, ie $0 < CFIR < 1$): 1 When the radar sensor is subjected to electromagnetic interference, the target tracking signal of the infrared imaging module is used to control the bomb. The direction of the aircraft, and guide the radar servo control system to track the target; 2 when the infrared sensor is interfered by the cloud layer, the radar signal target tracking decision signal is used to control the direction of the missile aircraft, and the servo control system of the infrared sensor is guided to track the target; When both the radar sensor and the infrared sensor are not interfered, the tracking decision signal for controlling the direction of the missile is formed by the fusion of the tracking decision signals of the radar and infrared modules.

4. Conclusion

The above analysis shows that the feature layer fusion of radar and infrared sensor signals can improve the target detection probability of each sensor module and the entire target recognition and tracking system, reduce the false alarm probability of each sensor module and the entire target recognition and tracking system, and improve tracking. Decision accuracy. Decision-level layer fusion of radar and infrared sensor signals can improve the target tracking accuracy of the entire target recognition and tracking system, and correct the servo tracking loop of the sensor module that loses the target tracking ability due to interference and other reasons, so as to restore the target. Tracking capability and improve the flexibility, anti-interference, and robust stability of the entire target recognition tracking system. The entire target recognition tracking system can be implemented in hardware using a DSP chip.

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