Application Research of Infrared Imaging Guidance Technology

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Keywords: Infrared imaging; Guidance technology; Application analysis

Abstract. With the continuous improvement of science and technology, infrared imaging guidance technology emerges as the times require. The application of this technology in weapon manufacturing industry has achieved good results. On the basis of technology introduction and summary of technology types, this paper focuses on the specific application of infrared imaging guidance technology, so as to expand the application scope of technology, thus providing theoretical support for technical researchers and practical guidance for technical users.

1. Introduction

Nowadays, it is extremely necessary to deeply analyze the application of infrared imaging guidance technology to narrow the gap between China and developed countries in the research of guidance technology, so as to provide reliable technical support for the sustained and steady development of the guidance industry and ultimately improve the guidance technology level of China. Thus it can be seen that the realistic significance of this thesis is more significant, and the thesis is explored as follows.

2. Technology Introduction

Infrared imaging guidance technology came into being in the 1970s, which was developed on the basis of infrared optical system and infrared focal plane detector. With the continuous improvement of optical system and detection equipment, infrared imaging guidance technology was improved accordingly. Based on the foreign perspective, this technology has gone through two stages: optical-mechanical scanning imaging system and electronic self-scanning imaging system. Nowadays, the precision and resolution of advanced imaging guidance have been greatly improved, which provides an opportunity for the integration of *MEMS* technology and *ASIM* technology[1].

This technology is applied to the guidance industry, and the staring imaging system is optimized according to the requirements of missile use, so that the missile can meet the requirements of high precision, strong anti-interference ability and high sensitivity, so as to optimize the guidance effect. The infrared optical-mechanical scanning imaging is to obtain temperature distribution information by driving optical elements with mechanical motion. During this period, parallel scanning and serial scanning are combined to expand the field of view of the system. In order to give full play to the technical advantages, parameters such as pupil caliber, instantaneous field of view, total field of view, frame period, scanning efficiency, frame frequency and dwell time should be set properly.

3. Technology Types

3.1 Window Refrigeration Technology

In the course of missile movement, aero-optical and thermal effects are easily generated in the warhead position, which should be restricted by window refrigeration technology. To show the technical efficiency, the properties and sizes of the window materials should be strictly controlled and adjusted flexibly according to the refrigeration mode, so as to improve the technical effectiveness.

3.2 Target Recognition Technology

The technology has intelligent characteristics and strong applicability, which can accomplish automatic and active identification tasks by itself. With the increasingly upgrading of advanced

  DOI: 10.25236/ciais.2019.008

technology, spectral identification technology and spatial filtering technology are improved accordingly, which can invisibly form a technical force, thus providing technical support for the application industry.

3.3 Infrared Focal Plane Array Technology

Nowadays, the increasing quality of technical components means that technical performance is optimized accordingly. Based on the research field of high temperature superconductivity, high performance materials are collected in a wide range to improve the technical sensitivity. In the meantime, technical researchers use theoretical knowledge to expand the scope of research and promote technical research activities to move forward in a direction[2].

3.4 Quick-Acting Processing Technology

This technology focuses on image and signal. Specifically, time constraints are carried out by referring to frame period. Meanwhile, coordinate transformation is carried out by means of side window detection technology to speed up image transmission. In this process, the intelligent system is used to achieve the comprehensive processing of signal and circuit. Due to the increasingly optimized technology level, it is extremely necessary to comprehensively apply parallel processing technology and integrated circuit, which can improve the processing efficiency of computer equipment to a certain extent.

3.5 Seeker Optical System Technology

The configuration of the seeker is shown in Fig.1. The optical characteristics of this technology are summarized as follows: optimizing imaging quality based on image quality correction; resisting interference factors and greatly enhancing nuclear radiation resistance by means of micro-mirror technology; optimizing seeker performance by means of micro-scanning technology.

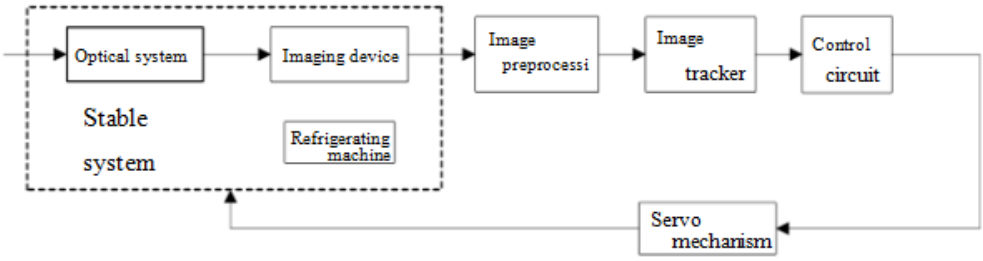

Figure 1. Seeker Component

4. Application of Technology

4.1 Application Performance

4.1.1 Application to Air-to-Air Missile

The main countries using infrared imaging guidance technology in air-to-air missile development activities are Germany, France, South Africa, the United States and so on. In this view of field, the technical characteristics are summarized as follows: the tracking range of the seeker is $\pm 90°$, and the array used by the seeker mainly includes the area array and the two-color array, among which the area array size is 325×235 elements and the linear array size is 100 elements. With the assistance of strapdown inertial navigation technology, the application range of the missile is expanded accordingly.

4.1.2 Application to Air-to-Surface Missile

In the development of air-to-surface missiles, infrared imaging guidance technology has been widely used. At present, the countries participating in this research include Italy, the United States, Japan and France. With the continuous improvement of air-to-surface missile application requirements, seeker improvement activities are advancing dynamically. At the same time, related software is upgraded to meet the needs of air-to-surface missile launching. At present, infrared imaging guidance technology has been widely used in terminal guidance activities of air-launched cruise missiles, and achieved good results in technical practice[3].

4.1.3 Application to Surface-to-Air Missile

Compared with the above two kinds of missile development activities, the application frequency of infrared imaging guidance technology is less during the development of surface-to-air missile. In the design of the seeker of American *THAAD* missile weapon system, the total reflection Kosk optical system is used, and the stability is measured by the laser gyro inertial strategy device, so as to shorten the response time of the system and play the role of missile interception.

4.1.4 Application to Anti-ship Missile

During the development of radar-guided anti-ship missile, infrared imaging guidance technology is used effectively to improve the hit rate of missile by improving the performance of tracker software and enhancing the ability of automatic target recognition. Nowadays, Israel, Russia and other countries have deeply explored the application skills of infrared imaging guidance technology in anti-ship missiles, and combined radar composite technology to enhance anti-ship missile performance[4].

4.1.5 Application to Anti-Tank Missile

To apply the infrared imaging guidance technology to the third-generation missile, in order to achieve the goal of “not needing management after launch”, the technical practitioners should grasp the technical advantages objectively and make the technical performance fully prominent. For example, the infrared imaging seeker of the long-range Trigat anti-tank missile achieves the purpose of precise tracking and accurate detection with the help of this technology, and the United States “Javelin” anti-tank missile uses 64×64 elements detector staring imaging and uses CCD method to obtain information. In the first test, the javelin missile passed the test successfully.

4.2 Tendency of Application

4.2.1 Intelligent Trend

At present, artificial intelligence technology is widely used. The application of this technology in infrared imaging guidance technology can make up for the shortcomings of the previous imaging guidance technology. At the same time, it can also meet the diverse needs of automatic detection, automatic tracking and so on. During this period, the intelligent seeker plays a key role and has a high spatial resolution [5]. In view of the complexity of the battlefield environment in the future, it is necessary to follow up the intelligent technology, and improve the matching intelligent detection technology, tracking technology, search technology, and processing technology, so as to better meet the high-precision needs of missile production.

4.2.2 Compatible Guidance Trend

In order to develop the precise guidance system successfully, it is necessary to follow the principle of compatible guidance to enrich the function of missile and make it be used flexibly in battlefield. Specifically, designers should set up the global consciousness, deeply explore the millimeter guided wave seeker, and enrich the guidance system to make it inheritable and developable, so as to promote the missile development activities[6]. Based on this, technical researchers should put this work on the agenda in order to better achieve the purpose of low-cost and short-period guidance system development.

4.2.3 Trend of Compound Homing

In the new area, the war form changes dynamically. In order to gain an active position in the war and control the war cost effectively, the compound homing guidance technology should be actively explored to make it be used effectively in harsh environment. After the successful development of compound homing guidance technology, the application subject of technology can achieve the goal of not needing management. In the meantime, the technology has the advantages of rapid response, multi-function shooting, anti-interference ability, all-weather ability and so on. Therefore, it is necessary and urgent to study and apply the compound homing guidance technology effectively. To improve the performance of compound homing guidance technology comprehensively and make it possess the photoelectric complementary efficiency, infrared imaging and millimeter wave composite technology should be combined to improve the practicability of compound homing guidance technology. Nowadays, foreign developed countries have gained rich experience in this field. Therefore, China, a developing country, should take the initiative to learn from developed

countries the research experience of compound homing guidance technology based on the specific domestic situation.

5. Conclusions

In summary, infrared imaging guidance technology is widely used nowadays, which can not only provide reliable technical support for guidance industry, but also accelerate the process of industrialization in China, so as to achieve the goal of strengthening the army and revitalizing the country. This paper briefly analyzes the connotation and principle of infrared imaging guidance technology, then summarizes the existing technology types, and finally explores the specific application of this technology and predicts the future development trend of technology, which will promote the wide spread of infrared imaging guidance technology and the sustainable development of guidance industry in China.

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