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Application of Computer Image Processing Technology in Intelligent Monitoring System

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Abstract: With the continuous progress of science and technology and the rapid development of society, intelligent surveillance systems are gradually emerging in the field of security and other related fields, and have become a key tool for ensuring public safety and improving efficiency. Intelligent monitoring system with computer vision and image processing technology as the core, with the help of advanced hardware equipment and intelligent algorithms, can be efficiently processed and deeply analysed image information in real-time monitoring. This paper provides a strong support to build a safer and more efficient society by studying in depth the application of image processing technology in intelligent surveillance system with the goal of comprehensively promoting the technological innovation of intelligent surveillance system.

Keywords: Intelligent surveillance system; Computer image processing technology; Data processing

Foreword

Problems faced by traditional surveillance systems, such as monitoring blind zones, human errors, and data processing bottlenecks, make the demand for smarter and more efficient surveillance systems increasingly urgent. The continuous innovation of computer image processing technology provides strong support for the development of intelligent surveillance systems [1]. From the initial simple motion detection to today's target recognition, classification and real-time image processing, the continuous evolution of technology makes the surveillance system is no longer limited to passive data collection and monitoring, but transformed into an active perception and intelligent analysis tools. In terms of real-time decision-making and emergency response, the application of computer image processing technology endows surveillance systems with stronger intelligence and adaptive capabilities.

1. Overview of computer image processing technology

With the rapid development of computer science and technology, image processing technology has been widely used in various fields, including medical imaging, artificial intelligence, computer vision, image recognition and so on. Its core goal is to make images with higher interpretability, better quality, and richer information by digital representation and algorithmic processing of images.

For one thing, image acquisition is the starting stage of image processing, in which image information in the real world is captured through sensors, cameras, or other devices, and converted into digital form to build the basis of digital images. Image acquisition includes not only static images, but also dynamic image forms such as video streams, thus providing source data for subsequent processing. Secondly, image processing technology involves a series of algorithms and methods for performing various operations on digital images, such as denoising, sharpening, transforming, filtering, etc. The above processing steps are aimed at improving the quality of the image and enhancing specific features to meet the needs of different application scenarios [2]. In addition, in computer image processing, commonly used techniques include linear and nonlinear filtering, edge detection, colour space conversion, etc. The selection and optimization of the above methods directly affect the visual effect and information expression ability of the final image. Thirdly, through image processing technology, the computer can automatically understand and interpret the content in the image, and achieve object recognition, target tracking, face recognition and other functions, which not only has a wide range of applications in the fields of security monitoring, automatic driving, medical imaging, etc., but also promotes the development of artificial intelligence technology, enabling the computer to process and analyse visual information more intelligently.

2. Basic Framework of Intelligent Monitoring System

The basic framework of the Intelligent Surveillance System (ISS) is a complex and highly integrated system covering a number of key components to achieve comprehensive sensing, intelligent analysis and immediate response to the surveillance area. Its basic component modules are as follows:

(1) Perception module: including all kinds of sensors, cameras and other data acquisition devices, responsible for real-time acquisition of multimodal information in the monitoring area.

(2) Data pre-processing module: The data pre-processing module is used for filtering, noise reduction, correction and other processing of raw data to improve the quality and accuracy of data.

(3) Computer Image Processing Module: the computer image processing module covers a number of subfields such as target recognition and classification, motion detection and tracking, and real-time image processing. The target recognition and classification module intelligently identifies and classifies targets in the surveillance area through advanced algorithms such as deep learning and convolutional neural networks, to achieve automated identification of people, vehicles and other targets [3].

(4) Intelligent Analysis Module: The Intelligent Analysis Module is the brain of the whole system, which, with the help of machine learning and artificial intelligence technology, performs in-depth analysis and pattern recognition of the perceived information to achieve intelligent discrimination of abnormal behaviours, threats and abnormal events. The module not only provides real-time monitoring results, but also provides intelligent decision-making support for system users, such as automatically issuing alarms and triggering emergency responses.

(5) Response module: Responsible for providing a reasonable response to the results of system analyses, including alarm notification, automation control and data storage. In terms of alarm notification, the system is able to send notifications to relevant personnel in time so that measures can be taken quickly. The automation control enables the system to autonomously perform a series of operations based on the analysis results, such as adjusting the monitoring focus and activating the defence mechanism. The data storage module is responsible for storing and managing the monitoring data in a reasonable manner, so as to facilitate future retrospection and analysis.

3. Intelligent monitoring system in the computer image processing technology application strategy

3.1 Target identification and classification

In the intelligent surveillance system, target recognition and classification is particularly important as a computer image processing technology, and in the process of specific implementation, the system needs to adopt efficient target recognition algorithms, such as convolutional neural networks (CNN) and other deep learning models, in order to achieve accurate and rapid detection of various types of targets appearing in the surveillance area, such as the human body, vehicles, and so on. Specifically, by training on large-scale labelled data, the system is able to learn rich feature representations and thus has the ability to discriminate different targets.

On the one hand, the target classification strategy further refines the recognition results so that the system can accurately classify the detected targets, e.g., to distinguish between different identities of personnel, types of vehicles, etc. In this process, the reasonable selection of the network structure of the model, the optimisation algorithms and the training dataset have a decisive impact on improving the accuracy and generalisation of target recognition and classification. On the other hand, the system can also introduce techniques such as migration learning to migrate the knowledge gained from training in one domain to another, thus improving the performance of the system in the case of data scarcity or imbalance.

3.2 Motion Detection and Tracking

The motion detection strategy aims to identify the motion changes in the surveillance picture through sensitive algorithms, and capture the moving objects appearing in the static background in a timely manner. By selecting motion detection algorithms applicable to different scenes, such as those based on interframe difference and optical flow method, the system can achieve instant perception of the target and improve the timely detection of abnormal events. In order to ensure the robustness of the monitoring system, the strategy should also consider the adaptive adjustment to environmental factors such as light, weather, etc., in order to improve the stability and accuracy of motion detection. By adopting effective target tracking algorithms, such as those based on Kalman filtering, multi-target tracking, etc., the system is able to real-time update the target's positional information, ensure the smooth transition of the target between different frames, and thus enhance the integrity and coherence of the monitoring system for dynamic scenes. The system is able to update the target position information in real time and ensure the smooth transition between different frames, so as to improve the integrity and coherence of the surveillance system for dynamic scenes. Optimising the tracking strategy also requires comprehensive consideration of the balance between computational efficiency and accuracy to ensure scalability in large-scale surveillance systems [4]. In addition, in order to optimise the efficiency of practical applications, the introduction of deep learning techniques, such as target tracking models based on Siamese networks, can be considered to improve the robustness and accuracy of tracking by learning the target's visual features, and the multi-sensor fusion strategy can be adopted to combine multi-source information, such as video, infrared, etc., to enhance the identification and tracking capability of the target, especially under low-light or bad weather conditions.

3.3 Real-time image processing

In the intelligent surveillance system, the real-time image processing technology application strategy plays a key role, dedicated to improving the sensitivity and processing efficiency of the surveillance system for immediate scene changes, the system needs to adopt advanced image processing algorithms, such as fast filtering, edge detection and histogram equalisation, etc., in order to ensure the efficient processing of the image in the process of real-time surveillance, the need to accurately select the appropriate algorithms and parameter configurations. The system is able to maintain image quality while rapidly extracting key information to achieve immediate response to the surveillance picture.

In practice, in order to cope with different scenarios and demands, the real-time image processing strategy also needs to flexibly adjust the resolution and frequency of image processing. By analysing the needs of different monitoring areas, the system can adjust the precision of image processing according to the importance of a particular scene to achieve high-resolution processing of key areas, while moderate downsampling is performed for auxiliary areas, thus reducing the computational burden while ensuring monitoring effectiveness.

In addition, in order to improve the real-time performance of the system, the use of parallel computing and hardware acceleration and other technologies is also a strategy that cannot be ignored. By using hardware resources such as multi-core processors and GPUs, the system is able to process multiple image frames at the same time, achieving efficient processing of multi-channel surveillance and improving the overall system performance [5]. Reasonable use of the parallel computing capability of hardware resources can effectively shorten the response time of image processing, thus achieving instant analysis of monitoring frames. At the same time, while ensuring real-time, the real-time image processing strategy also needs to consider the accuracy and stability of image processing. Optimising algorithm parameters, applying different image processing techniques, and considering environmental factors such as light and shadow are all key steps to ensure the reliability of real-time processing results. In addition, the introduction of prediction algorithms and caching techniques can better handle continuous video streams and ensure the smoothness and continuity of real-time image processing.

4. Conclusion

In summary, with the continuous progress and development of computer image processing technology, in the intelligent surveillance system, through the target recognition and classification strategy, the system is able to accurately identify various types of targets in the surveillance area, such as the human body, vehicles, etc., to provide key information for real-time decision-making. The motion detection and tracking strategy improves the perception and tracking ability of the dynamic scene, which ensures the efficient monitoring of the system in complex environments. The real-time image processing strategy maintains image quality while enabling the system to respond quickly to changes through parallel computing and hardware acceleration to achieve instant analysis of the monitoring screen. The above technical optimization strategies work in concert with each other to make the intelligent monitoring system not only capable of efficiently processing large-scale monitoring data, but also more intelligent and reliable in terms of identifying, tracking, and alarming, providing practical and feasible applications in the field of security. It provides practical solutions for security applications.

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