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THESIS – BACHELOR'S DEGREE PROGRAMME
TECHNOLOGY, COMMUNICATION AND TRANSPORT

STUDY OF KEY TECHNOLOGIES FOR INTELLIGENT MONITORING AND FACE RECOGNITION SYSTEMS

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THESIS
Abstract

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Abstract

The purpose of this paper is to study the key technologies related to video surveillance and face recognition systems. These systems enable many functions of a smart city and public safety.

This thesis employs a literature review to study intelligent video surveillance systems and their relationship to Internet of Things technology. In addition, it explores practical application scenarios of this technology.

The main finding of this paper is that video surveillance can be made more intelligent through IoT technology. This in turn enables faster and more accurate detection of people, vehicles, and potential hazards. On the other hand, development of intelligent video surveillance technology also brings many challenges, such as potential information leakages, legal, and privacy issues. Adoption of this technology varies between countries depending on their privacy laws.

Keywords
IOT, Video Surveillance, Cloud, 5G, Big Data, Face recognition, Smart city

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1 INTRODUCTION

When discussing the thesis on smart campus with classmates, that smart campus contains many components be founded, the part about monitoring tracking management and face recognition is very interesting. With the development of related technologies, the current monitoring system should be able to combine Internet of Thing (IoT) technology to do more things in various fields and enrich its functions. Related application fields are not limited to smart campuses, and more practical applications are tried in various public security, hospitals, smart transportation and other fields. For example, in terms of intrusion detection and alarm, the traditional method is generally composed of detectors (or sensors), control parts, sound and light alarm circuits, power supplies and related auxiliary circuits. In practical applications, there are many types of detectors. Generally, infrared, ultrasonic, microwave, photoelectric switch, vibration and other sensors are used for one or more combined detections. There are various types of equipment and rich system components. To a certain extent, these systems have problems such as poor stability, environmental restrictions on installation, and high false alarm rate. With the development of the Internet of Things industry and technology, many related problems can be solved based on the Internet of Things technology, so that related industries have broader prospects and application space. This thesis analyzes the possible and current uses of surveillance tracking management and face recognition in various scenarios and their possible impact on the future, whether it is currently possible to use this device and possible solutions for the current industry. In general, surveillance tracking management and face recognition is attracting attention as a way to solve various safety and efficiency problems. Many companies have already begun to try related businesses. There are still many problems to be solved, such as legal issues, application environment and technical immaturity.

2 VARIOUS TECHNICAL MODULES AND DEVELOPMENT HISTORY OF VIDEO SURVEILLANCE AND FACE RECOGNITION

2.1 Video Surveillance Technology

Video surveillance technology is a means of obtaining video information by relying on image sensor-based equipment. Video surveillance technology is divided into three stages according to the development process of equipment and technology: analog video surveillance, digital video surveillance, and intelligent video surveillance. The first is analog video surveillance. In the era of analog video surveillance, the first-generation video surveillance system is also called closed-circuit television surveillance system, or CCTV (Close Circuit Television) for short, which was invented in the 1970s. (Bryan 2022)

The analog monitoring system consists of the following equipment:(1) Video acquisition equipment(mainly includes cameras, lenses, protective covers, brackets, decoders, and video distributors).(2)Signal transmission equipment(mainly include various cables and connectors, signal transceivers, and signal amplifiers).(3)Switching control equipment(mainly consists of a matrix, a control code generator, a keyboard, and a man-machine interface).(4)Display and recording equipment(mainly multi-screen processors, multi-screen splitters, monitors, tape recorders). For example, Figure 1 shows the structural diagram of the world's first video surveillance system. (Zhao 2009)

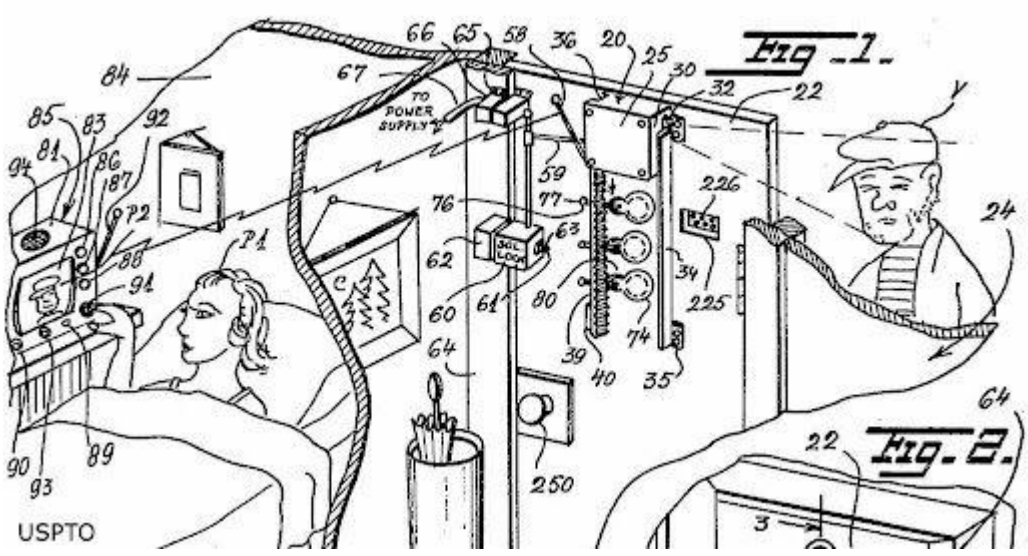

Figure 1 The First Video Home Security System (Bryan 2022)

Later, with the advancement of technology, it entered the era of digital video surveillance. The iconic product of the era of digital video surveillance is the hard disk video recorder, referred to as DVR (Digital Video Recorder), which was invented in the 1999s. DVR is a video recorder or digital hard disk recorder, which are used to call hard disk recorder. Artical disk video recorder is a set of computer systems for image storage and processing. It has the functions of long-term video

recording, recording, remote monitoring and control of images/voices. DVR integrates video recorders, screen splitters, lens control, alarm control, and network transmission. The recording setting and playback function are combined into one. The technology of recording without video tape is relatively mature, and it also facilitates the dissemination of video on the Internet (such as YouTube). One device can replace the functions of a large number of devices in the analog monitoring system. The main features of hard disk video recorder (DVR) include long recording time, support a large number of audio and video channels, recording quality will not decline over time, more functions than before, can be networked, and multiple video recorders can be networked to form a large system. At the same time, the structure of the video surveillance system is simplified. Figure 2 shows the first IP (internet protocol) camera. (Bryan 2022)(Thompson 2009)

Figure 2 the first IP (internet protocol) camera—the Axis NetEye 200 (Bryan 2022)

With the emergence of IPV6 technology and the development of related technologies of the Internet of Things, intelligent video surveillance technology has begun to gain opportunities for development and application in recent years. Intelligent video surveillance is the use of artificial intelligence trained in big data to process, analyze and interpret video signals. Without the need for manual labor, it automatically analyzes images and locates, recognizes and tracks changes in the monitoring scene, and analyzing and judging the behavior of the target can send out an alarm or provide useful information in time when an abnormal situation occurs, effectively assisting personnel in dealing with crises, and minimizing false positives and missed negatives. At present, the main research institutes of intelligent monitoring system include University of Technology Sydney (UTS), Queen Mary University of London (QMUL), etc. (Huang 2015)

2.2 Object Detection Technology/Information Extraction Technology of Screen Structure

Screen structure information extraction technology is mainly realized through deep learning. Deep learning refers to the technology that the machine imitates the human brain mechanism to learn, judge and make decisions. A lot of citing or inputting relevant information to allow AI to extract the commonality of these information and recognize it the next time it encounters it, like a vaccine. It

has applications in face recognition, speech recognition, image recognition and other fields. (Yang 2019)

The face recognition AI trained by deep learning has greatly improved the recognition accuracy. After identifying a large number of face data of different lights, different genders and characteristics in different environments, after a lot of learning and calculation, the machine can distinguish different people according to facial point feature modeling. (Jebur 2023)

A method for structurally and accurately describing objects of interest such as people, vehicles, and objects in videos, this is inseparable from deep learning algorithms. In view of the fact that the human brain can analyze unstructured and semi-structured video resources, scientists simulated the information processing flow of the human brain, abstracted the deep learning algorithm under the neural network architecture, and realized the structured analysis of video images. Deep learning imitates the learning mechanism of the human brain by constructing a neural network that simulates the human brain for analysis and learning, thereby identifying and interpreting unstructured or semi-structured video resources. (Yang 2019)

Deep learning algorithms need deep learning through a large amount of input training data, so at the same time, this technology is also closely related to big data. It needs to rely on big data to extract a large amount of relevant information for training, and continuously improve the accuracy and efficiency of the algorithm. At the same time, the deep learning algorithm has a strong generalization ability, even if the same type of object is in different sizes, different viewing angles, different lighting, occlusion and other conditions, it can accurately identify it. The two core factors that affect the accuracy and efficiency of deep learning algorithms are: the size of the training data and the structure of the algorithm model. Among them, the algorithm model adopts the most advanced deep learning algorithm under the neural network architecture constructed by simulating the human brain. (Jebur 2023)

Through the video image structuring technology, the required information can be accurately extracted from the entire monitoring screen, and the extraction of key video information is transformed from manual sampling inspection to intelligent extraction, and the extracted information can be automatically transmitted for processing, saving it eliminates manpower and liberates people from the labor of watching, and AI with video image structuring technology will be more accurate and faster than manual work.

That is to find the position, length and width information of the target in a given image, video or scene, and at the same time judge the category of the target. Target detection generally needs to solve the two problems of where the target object is and what it is. Target detection is widely used in practical problems. Especially with the rapid development of deep learning technology, object detection technology is also developing rapidly. Compared with traditional object detection methods, object detection based on deep learning greatly improves the efficiency of object detection. Object detection based on deep learning has been widely used, including lesion detection in medical imaging, handwriting recognition in banking systems, pedestrian and vehicle detection in traffic monitoring, object recognition in robot vision systems, real-time object monitoring in digital cameras

And autofocus, road condition detection in satellite and other scenarios, etc., can be regarded as an application method of related technologies.

The application scenarios of target detection technology are rich, but the actual application scenarios are complex. The technology faces many challenges, including target deformation, noise interference, light intensity changes, and similar target interference. Traditional target detection and recognition mainly use Scale-invariant Feature Transform (SIFT), Histogram of Oriented Gradient (HOG), Speeded Up Robust Features (SURF)) and other methods. (Qi 2019)

Traditional target detection algorithms typically involve two key steps: feature extraction and target recognition. Feature extraction algorithms, such as the scale-invariant feature transformation matching algorithm, the directional gradient histogram feature algorithm, and the accelerated robust feature algorithm, are commonly used in this process. However, in recent years, there has been a shift towards utilizing deep learning in target detection algorithms, driven by the rapid advancements in computer vision and image processing technology. Deep learning enables end-to-end object detection, combining recognition and classification.

Currently, two main categories of target detection methods are widely used. The first category is region proposal-based target detection algorithms, including R-CNN, Fast R-CNN, and Faster R-CNN. These algorithms generate potential regions of interest and then perform object detection within those regions. The second category is regression-based target detection algorithms, such as YOLO (You Only Look Once) and SSD (Single Shot MultiBox Detector). These algorithms directly predict the bounding boxes and class labels of objects in a single pass. Both of these categories of algorithms have significantly improved the detection accuracy of traditional object detection methods.

To illustrate the workings of the R-CNN (Region-based Convolutional Neural Network), Figure 3 provides a visual representation.

In summary, traditional target detection algorithms involve feature extraction and target recognition. However, with the advancement of deep learning, deep learning-based algorithms have become the mainstream approach in recent years. Commonly used methods include region proposal-based algorithms like R-CNN and regression-based algorithms like YOLO and SSD. These algorithms have greatly enhanced the accuracy of object detection. Figure 3 illustrates the functioning of R-CNN.(Yang 2019)

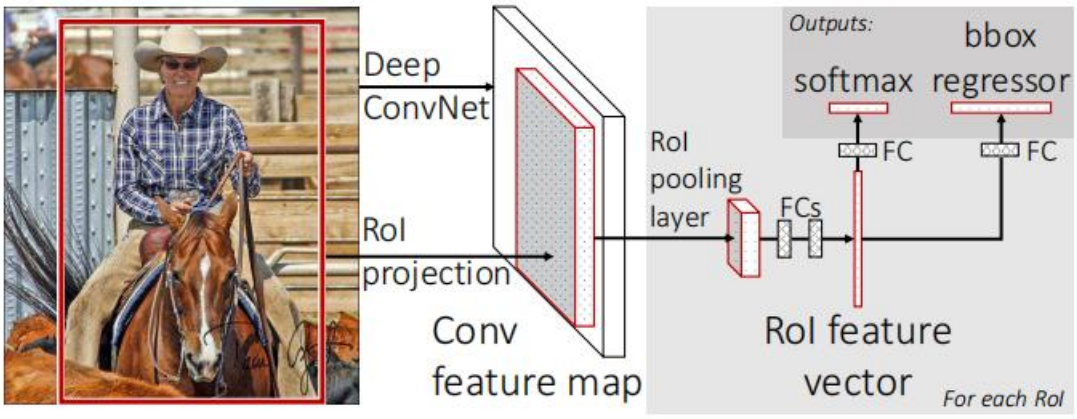

Figure 3 Fast R-CNN architecture (Girshick 2015)

2.3 Cloud

The term "cloud" refers to a range of server-based services offered by cloud service providers over the internet, including cloud computing and cloud storage. These services can be accessed from anywhere and at any time, providing convenience and flexibility. The concept of the cloud is often used as a metaphor for the internet itself.

Cloud computing, in a narrower sense, refers to the way IT infrastructure is interacted with and utilized. It involves acquiring resources through the network in an on-demand and scalable manner, allowing for the provision of various services. These services can include IT and software services, internet-related services, and other types of services. Essentially, it means that computing power can be treated as a commodity that is accessible and shareable via the internet. Examples of cloud-based services include cloud computing, cloud storage, cloud search, cloud engine, cloud services, cloud websites, and cloud disks.

Cloud technology and virtualization are significantly impacting the foundation of enterprise infrastructure. The cloud introduces a new computing paradigm that revolutionizes storage and processing. By decoupling network services from physical hardware, it presents cost-saving opportunities, particularly for startups exploring network virtualization. Many companies now opt for hybrid cloud environments, where IT departments assess the advantages of on-premises solutions versus off-premises cloud solutions. Cloud services also provide testing and development environments for new applications. (Amazon Web Services)

In summary, the cloud encompasses a range of server-based services delivered by cloud service providers over the internet. It offers flexibility, scalability, and cost-saving opportunities. Cloud computing, virtualization, and hybrid cloud environments are reshaping the IT landscape, transforming storage, processing, and network services. Cloud services also support testing and development of new applications. Cloud services allow any authorized employee to access company data from anywhere, improve communication through better social collaboration tools, speed up business operations, and make work no longer confined to one location. IT, on the other hand, is burdened with security, compliance, and rapid change. Therefore, cloud and various virtual services are one of the most important members in the field of intelligent development. (Bagga 2022)

Amazon is one of the giants in cloud technology. Amazon Web Services (AWS) is one of the world's largest and most used cloud services, offering many services from data centers around the world. Small businesses, large enterprises, and government agencies of all kinds use AWS to reduce costs and increase operational efficiency. From the provision of basic services such as cloud computing, cloud storage and databases to the related applications of technologies such as deep learning, artificial intelligence, big data analysis and the Internet of Things, Amazon provides various services and functions. Just about anything you can think of is made faster, easier and more cost-effective. Figure 4 shows how Amazon Web Services works. (Amazon Web Services)

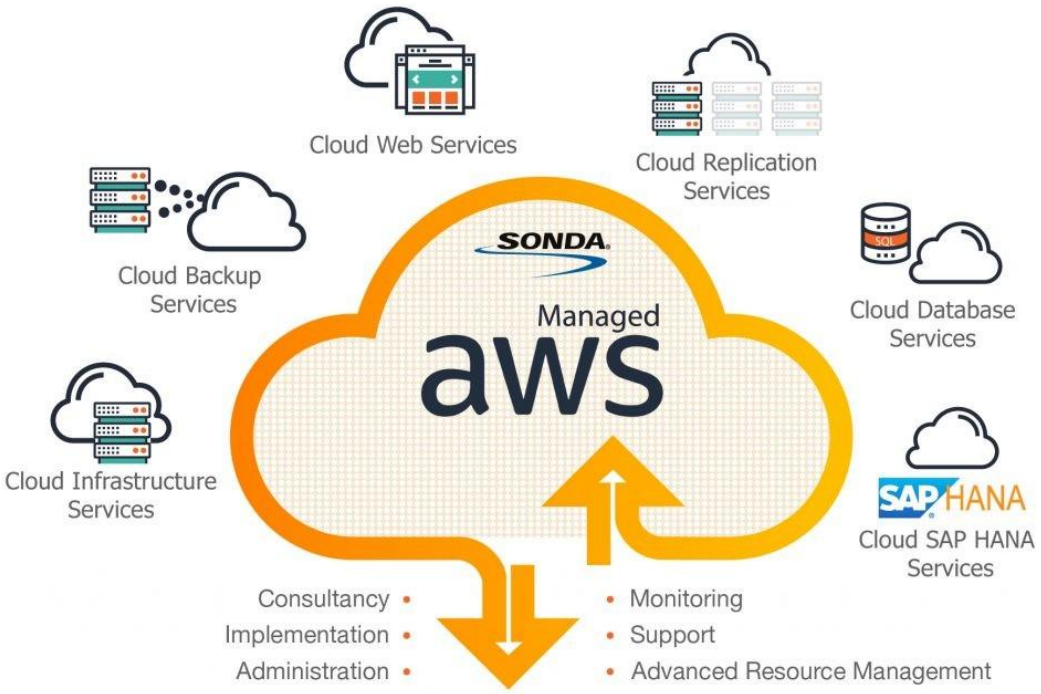

Figure 4 Amazon Cloud Service (Tale 2021)

2.4 Big Data

Big data has become a driving force in today's digital world, demanding a new approach to data processing. To effectively utilize the vast and rapidly growing pool of diverse information, organizations need a processing model that enhances decision-making, provides valuable insights, and optimizes processes. The McKinsey Global Institute defines big data as a collection of data that surpasses the capabilities of traditional database software in terms of acquisition, storage, management, and analysis.

Big data exhibits four key characteristics. First, it involves massive volumes of data, exceeding what traditional systems can handle. Second, the data flows at a high speed, requiring real-time or near real-time analysis to keep up with its velocity. Third, big data encompasses various types of data, ranging from structured to unstructured, and from text to images or sensor data. Lastly, the value

density of big data is relatively low, meaning that not all data within the collection holds equal significance. The challenge lies in extracting meaningful insights from this vast pool of information.

The true essence of big data technology lies in its ability to extract valuable data for further processing, rather than simply having a large quantity of information. If we compare big data to a machine, the crucial component is the enhancement of data analysis capabilities. Having more valid and relevant data is akin to possessing more wealth in this context.

In summary, big data necessitates a novel processing model to accommodate its massive scale, rapid flow, diverse types, and low value density. The primary focus of big data technology is to extract meaningful data from the vast collection, enabling organizations to gain insights, optimize processes, and make informed decisions. The more adept the analysis of valid data, the greater the potential wealth that can be derived from big data. (Soraya 2018)

From a technical point of view, the relationship between big data and cloud computing is inseparable. Big data is too large to be processed by a single computer. Most people lack the hardware conditions to use big data and must use the storage and computing power provided by cloud services. It is characterized by distributed data mining for massive data. But must rely on the distributed processing of cloud computing, distributed database and cloud storage, virtualization technology.

With the advent of the cloud era, big data is getting more and more attention. It takes too much time and money for a single company to download big data to a database for analysis. It is not as good as using cloud computing with other customers, which can also save a lot of hardware and software resources, otherwise you have to use a supercomputer to calculate. (Subudhi 2019)

Big data presents a unique challenge due to its massive size and the need for efficient processing over extended periods of time. To address this challenge, specialized techniques and technologies have emerged. These include massively parallel processing (MPP) databases, data mining, distributed file systems, distributed databases, cloud computing platforms, the Internet, and scalable storage systems.

These technologies enable the handling of big data by distributing the processing across multiple machines or nodes, allowing for parallel execution and faster processing times. They also facilitate the storage and retrieval of large volumes of data in a scalable and efficient manner.

The applications of big data are diverse and have brought about significant improvements in various fields. For instance, the collaboration between the Los Angeles Police Department and the University of California leverages big data to predict and prevent crimes. By analyzing vast amounts of historical data, patterns and trends can be identified, aiding law enforcement agencies in allocating resources and implementing proactive measures.

In another example, MIT utilizes big data by analyzing cell phone location data and traffic data to develop urban plans. This data-driven approach helps in understanding traffic patterns, population density, and other factors crucial for urban planning and resource allocation.

Overall, big data technologies and techniques have revolutionized various sectors, offering efficiency gains and valuable insights. By leveraging the power of big data analytics, organizations and institutions can make informed decisions, improve operations, and drive innovation.

2.5 Face recognition

The exploration of face recognition systems traces back to the 1960s, and it experienced significant advancements following the 1980s, thanks to the progress in computer technology and optical imaging. By the late 1990s, face recognition systems had successfully transitioned into primary applications. Emphasizing technological implementation, the key determinant of a face recognition system's success lies in the incorporation of cutting-edge core algorithms that yield practical recognition rates and swift processing speeds. Such systems encompass a fusion of artificial intelligence, machine recognition, machine learning, model theory, expert systems, and video image processing, among other specialized technologies. Moreover, it is crucial to effectively combine theoretical foundations with practical implementation during the intermediate value processing stage. (Adamo 2012)

The traditional face recognition technology mainly relies on ordinary photos and images for face recognition, which is also the current mainstream recognition method. At present, most face recognition is carried out through ordinary cameras, which can also be used on mobile phones, which is very convenient. However, when the ambient light is not good enough or the camera is blurred, foggy or the clarity is not enough, recognition errors will occur. Generally, there are high requirements on the camera and processor, as well as a unique face recognition algorithm. The mainstream face recognition research directions in the future are 3D modeling face recognition and thermal imaging face recognition, but these two technologies are far from mature, and the recognition effect is not much different from traditional recognition methods. (Adamo 2012)

Another solution is multi-light source face recognition technology based on infrared images, which is developing rapidly. This recognition method with multiple light sources or using its own light source can avoid the influence of light changes and can work normally in most environments. The multi-light source face recognition technology of infrared images surpasses traditional methods in terms of accuracy, stability and recognition speed. This technology has developed rapidly with the Internet of Things technology in recent years. Combined with the progress of hardware, face recognition technology has officially entered the public life. (Liu 2015)

A person's face is unique like other biometrics such as fingerprints and irises. Face recognition can take pictures actively or directly acquire face images unconsciously. The user does not need to contact the device directly, and can also analyze multiple faces appearing in the screen at the same time. The operation is simple, the results are intuitive, and the concealment is good. With the maturity of the technology, the loopholes such as using photos to impersonate have also been filled. Of course, in many places such as the European Union, it is illegal to obtain face images without permission. This sampling method is immoral. You can see figure 5 show the principle of face recognition.

The face recognition system is mainly composed of four steps: detect and mark the face in the image, extract the face clearly, extract the face feature and establish a 3D bitmap model, compare with the face information in the database and match.

Face image collection is to collect different face images through the camera, usually a frontal photo, occasionally blinking, mouth opening and other actions, different postures, different expressions, etc. need to be collected and sampled. When the user actively uses the face recognition function, such as unlocking the mobile phone, when the face is in the lens of the camera, the camera will automatically recognize the face area and focus, and then obtain the face image. (Liu 2015)

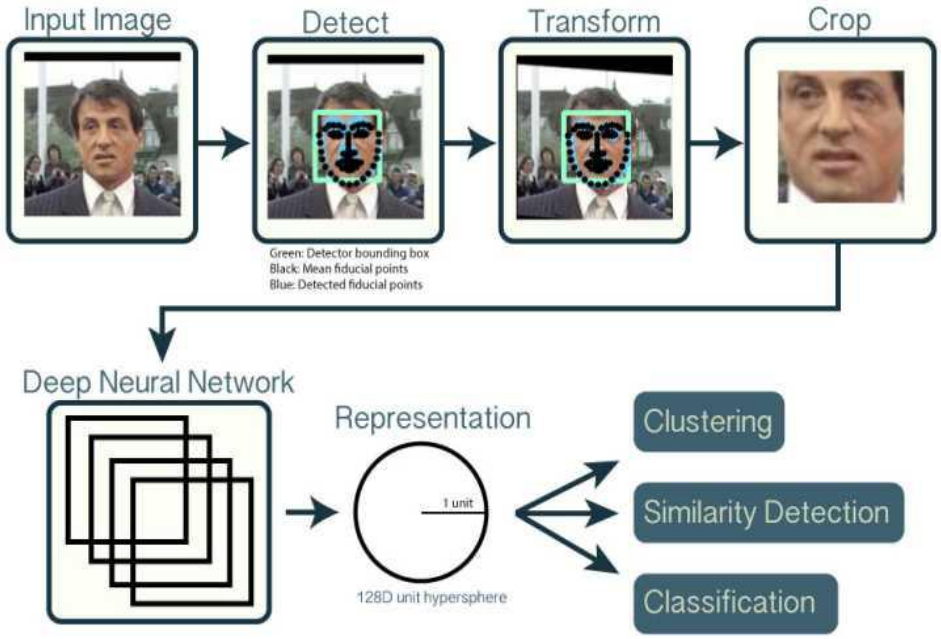

Figure 5 Principle of Face Recognition(Xiao Song Shi Ne 2020)

In practice, face detection is mainly used in the previous step of face recognition. First, the face is marked with a box in the picture. The pattern features of face images include histogram features, color features, template features, structural features, Haar features, etc. Face detection is to lock the face first and then proceed to the next step of calculation. For example, when you take a photo, the camera automatically locks your face and focuses on it, which is also a related application. (Song 2020)

Because of the above reasons, the current face detection method generally uses the Adaboost learning algorithm. This is primarily a classification approach designed to convert weak classifications into strong classifications. In the process of face detection, this algorithm can first identify and combine the face with rough rectangles and triangles into a simple 3D model (weak classifier), and then pass the common features of the face obtained by deep learning training. To optimize and refine this model to obtain strong classification, and then train the resulting strong classifiers and connect them in series, which can improve the recognition speed and accuracy very well. (chun 2016)

Face image preprocessing is to clear and standardize the frame containing the face in the image detected by the face and the face information in it, so as to facilitate the feature extraction in the next step, and then perform face recognition. Due to various dust, light, environment, camera quality, signal and other factors in actual use, the images captured by the camera cannot be directly recognized. Before face recognition, the interference factors and useless information in the image must be removed before processing. For face images, the preprocessing process mainly includes illumination compensation, gray scale transformation and sharpening of face images.

The main features of the face used by the face recognition system generally include directly seen features, bitmap model features, muscle image transformation features, face digital features, etc., and the face recognition system is based on certain features of the face. Extract and identify. Facial feature extraction is mainly the process of identifying, extracting and summarizing facial features. The methods of face feature extraction can be classified into two categories: one is the method of recognition based on visual and facial features; the other is the method of recognition according to the 3D model and digital features of the face. (Liu 2015)

Generally, the method of recognition through visual and facial features is mainly based on the state description of facial organs (such as nose, eyes, mouth, etc.) and the distance between them to judge and help face classification. Relevant features are unique to each person and generally do not change unless you have had a facial accident or plastic surgery. The human face is composed of facial features and various muscles and bones. The distance between these parts and the 3D structural characteristics of the bumps can be used as geometric digital features for face recognition. Knowledge-based face representation mainly includes methods based on geometric features and bitmap matching.

Search and match the extracted facial lattice 3D model with the stored feature templates. Figure 6 shows an example of a 3D model. When the similarity reaches a certain level, it is judged that the recognition is successful. The way of face identification is to compare the newly captured face with the face feature information stored in the database, and judge the identity information of the face according to the degree of similarity. This process is divided into two categories: one is to confirm identity, for example, you use your face to unlock your phone; the other is to identify, which is to compare and identify you in the database based on your facial features to see who you are. (Liu 2015)

The advantage of face recognition lies in its naturalness and the characteristics of not being noticed by the individual being tested. But remember, face recognition without consent is illegal in many countries.

The so-called naturalness means that the identification method is the same as the biological characteristics of a person. For example, in daily life, human beings also distinguish and confirm identities by observing and comparing facial features, but it is affected by the degree of intimacy, and it is more difficult to judge the influence of factors such as fat and thin. At the same time, natural recognition also includes voiceprint recognition, skeleton recognition, etc., but fingerprint recognition, iris recognition, etc. do not belong to natural recognition, because under normal

circumstances, creatures do not and generally do not have the conditions to distinguish individuals through such biometric recognition.

A covert feature is also important for identification methods because it is less noticeable, so it is less likely to be deliberately masked and less likely to be deceived. Face recognition has this function. It fully uses visible light to obtain face image information. Unlike fingerprint recognition or iris recognition, it requires the use of electronic pressure sensors to capture fingerprints, or the use of infrared light to capture iris images. There are special tricks to cover up these special collection methods. Of course, you should also pay attention to local laws when collecting facial data. Similar behaviors may be illegal in many countries.

Face recognition is mainly used for identity recognition, such as mobile phone unlocking, mobile payment and other scenarios. Due to the rapid popularization of video surveillance, many video surveillance applications urgently need a remote rapid identification technology in the non-cooperative state of the user (under legal circumstances), so as to quickly confirm the identity of the visitor and judge the relevant situation. When it is necessary to quickly understand a person's identity information, the use of face recognition technology is the best choice at present. The face is found from the surveillance video image and compared with the face information in the identity information database to achieve rapid identification. identify. Figure 6 shows how facial recognition makes this 3D model. (Mattoo 2023)

Figure 6 Face Recognition (Mattoo 2023)

3 THE MAIN IOT TECHNOLOGIES RELATED TO THE DEVELOPMENT OF VIDEO SURVEILLANCE AND FACE RECOGNITION TECHNOLOGY

3.1 Artificial intelligence and deep learning

Artificial intelligence technology is one of the most popular technologies at present, and it is mainly used to cultivate electronic information operations that can replace humans in repetitive or less complex operations. Artificial intelligence is generally trained through deep learning, and artificial intelligence is trained to extract common points and features by investing a large number of operational examples. With the continuous development of related technologies such as cameras and networks, video cameras have also changed from simple front-end equipment to the current transmission equipment such as switches to transmit video to the central computer room for centralized storage, and cooperate with relevant intelligent analysis and processing servers at the back-end to form related systems. In addition, various video and AI smart manufacturers are also integrating functions into the camera for front-end intelligent analysis by embedding related chips in the front-end camera. But no matter what kind of deployment, it is undergoing continuous technological reform, and its functions are becoming more and more powerful. For today's behavior analysis field, the biggest limitation is that the accuracy rate cannot meet the requirements, the false alarm rate is high, and it cannot fully achieve pure automation control, and relevant security personnel still need to conduct a second confirmation. Video surveillance technology combined with AI engineering combines video surveillance system and computer vision, so that the computer can replace the human eye to observe, identify, and analyze things. Compared with ordinary IPC systems, it has better environmental adaptability. Information such as personnel, vehicles, and objects appearing in the video has better resolution capabilities, such as the intelligent light supplement, target detection, and abnormal analysis of current manufacturers' front-end cameras, combined with front-end sound and light alarms or background display alarm information, Real-time alarm feedback. Technically, the video and image information collected by the front end needs to go through several steps of preprocessing, target detection, target classification, intelligent analysis, and abnormal behavior detection. The important part of this is intelligent analysis and behavior detection. (Jebur 2023)

Since AI artificial intelligence entered the practical field, it has gradually played a positive role in varying degrees in industries such as security, finance, art, and intelligent question answering. For example, the video surveillance system of Beijing Daxing International Airport, which has just been put into use, conducts intelligent analysis on the live streams of thousands of front-end cameras installed in important areas, and uses the front-end cameras to cooperate with the intelligent analysis server deployed in the computer room to perform statistics including people counting and abnormal behavior. (Rahman 2020)

Analysis, face recognition and other real-time analysis and summary; parking lot access and billing parking system, also through the license plate recognition of vehicles passing through the gate, recording the time when the vehicle entering the area, and automatically calculating the charging amount and leaving At the gate, a fee is given to release; the monitoring system cooperates with AI to deploy face recognition front-end to collect people's facial information, and cooperates with the

fugitive data image library to perform face threshold comparison, which can confirm suspects and arrest criminals faster. With the continuous maturity of technology and the continuous implementation of projects, the combination of AI and video surveillance technology plays an increasingly important role in all aspects of life. (Krishnan 2021)

Judging from the current research level, AI-based action recognition based on continuous video sequences has made great progress, and the recognition accuracy has reached a relatively high value. However, due to various uncertainties in the actual application process, the accuracy of smart video monitoring will be affected. For example, hardware defects and inaccurate intelligent artificial intelligence may identify errors and false positives. There are certain differences between theory and actual application scenarios. The current artificial intelligence is not intelligent enough, and the program and computing power are not perfect enough. In terms of research direction, there is still a lot of room for improvement in the combination of AI and video surveillance technology in the future. Figure 7 shows how AI helps in feature extraction, detection, and face recognition.

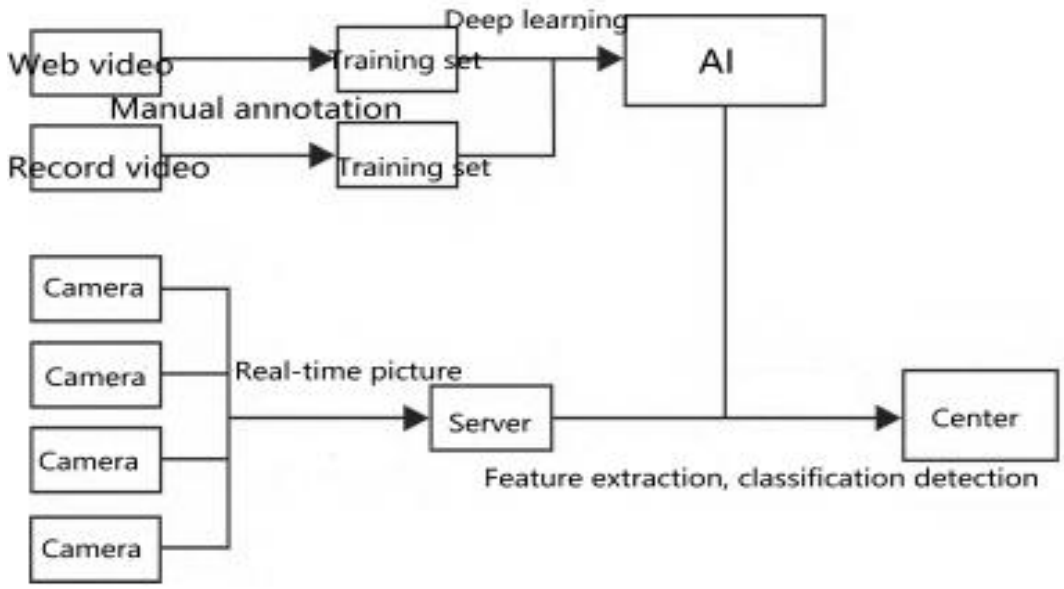

Figure 7 Real-time AI-based video surveillance system (Li 2022)

3.2 Application of big data in surveillance system

With the development of big data technology, in the video surveillance system, the application of big data technology will replace the manual processing of huge data streams, screen out useless data, extract high-value data for visual presentation, and use the establishment of video surveillance system to Important resources and data such as smart cities and smart campuses are reviewed and summarized to form a huge data network. (Narayan 2019)

In the process, a large amount of data has been generated, which has shown exponential growth. In order to collect and select data, it is necessary to establish an effective analysis model, which is also one of the key research contents of video surveillance technology at this stage. Big data processing technology can convert unstructured data information such as related videos and images into structured data recognizable by computer systems, and analyze the relevant characteristics of

the data set to obtain valuable information data. Data analysis technology, deeply mining the resource value of various information. Establish training and examination video monitoring and early warning system

The video data set mainly obtains relevant video materials by crawling online videos and live videos, and trains AI to extract the common points of these information through deep learning for AI through a large number of related videos. The application of large data processing technology of capturing network video can assist staff to obtain effective information from a large amount of video surveillance data, and then provide data support for the implementation of various decisions. With the application of video surveillance big data technology, the big data system will replace humans to complete basic and complex tasks such as data collection, correlation analysis, archiving, predictive analysis, dynamic simulation, etc., and provide data support for command and dispatch, operation management and other work. (Narayan 2019)

The application of big data technology, combined with other technologies such as artificial intelligence, can deeply tap the potential value of data information through interactive analysis, logical reasoning and other tasks. In the video surveillance system, the application of big data technology can not only significantly improve the system operation efficiency and comprehensive management level in a short period of time, but also change the traditional operation mode and management methods, and gradually improve the original model. Form a set of Internet of Things system that matches the smart city, and solve practical problems such as inefficient management and chaotic management. (Badri 2019)

3.3 Sensor

The combination of various sensors and video surveillance technology will also be one of the main development directions in the future. There are many types of traditional sensors, generally infrared sensors (temperature sensors), ultrasonic sensors, microwave sensors, photosensitive sensors, vibration sensors, sound sensors and other sensors One or more combined detections can be combined with video surveillance technology to form a variety of systems.

For example, the combination of sound sensors and mobile video surveillance platforms can achieve a system that uses sound to track the location and make the camera turn to the corresponding direction, and an intrusion alarm system built with infrared sensors. In places that are dangerous or require manual labor instead, you can choose to use corresponding sensors and video surveillance platforms to form an automatic alarm system. For example, in warehouses where dangerous chemicals or petroleum are stored, of temperature sensors, water level sensors, or chemical sensors combined with the analysis of the video monitoring screen can preliminary and automatically judge whether there is a dangerous situation and automatically alarm, and then transmit the corresponding screen and data to the system and make a second judgment and confirmation manually. In this way, related data collection can be increased to provide more and more accurate data available for analysis and improve use efficiency.

3.4 Application of cloud in surveillance system

What is cloud technology is introduced in section 2.3, and now how cloud technology is applied in intelligent video surveillance system will be introduced. With the development of video surveillance and technology and corresponding hardware, the acquired videos are becoming more and more high-definition, the data is getting larger and larger, and the pressure on storage and data calculation has also increased exponentially. To better meet the needs of intelligent video surveillance systems for data storage capacity, system scalability, computing speed, and reliability, the cloud provides customers with two performance services. One is computing resource services, which use computing power as a service provided to customers. The second is storage services, which provide storage functions as services to customers, which is called cloud storage. (Marinescu 2023)

Using cloud storage technology and cloud computing and other cloud service technologies combined with video surveillance systems saves the operation of purchasing and frequently clearing hard drives, saves computing costs for video analysis, and reduces system construction and maintenance costs. The cloud storage intelligent video surveillance system can store files in blocks, and distribute video data files in different physical storage devices to improve the speed of data reading and writing. At the same time, it cooperates with technologies such as load balancing and automatic migration to achieve efficient access to the storage system. After passing the identity authentication, you can view the files and materials within the scope of authority, and perform operations such as file editing, transmission, and local downloading. The cloud platform has excellent data processing capabilities, adopts a distributed computing method, decomposes the received complex processing tasks into several small programs, sends the small programs to the corresponding server for independent calculation, and then summarizes the calculation results. Completing the data processing task in a short time is conducive to improving the operating efficiency of the video surveillance system, and can also make better use of redundant computing power. This is the development trend of the future intelligent video surveillance system. Now cloud services provided by various suppliers have been widely used in various fields. (Li 2021)

The application method of cloud in video surveillance technology is to transmit the video data captured by the camera to cloud storage, and the cloud service data management center is responsible for the integrated operation and maintenance of cloud storage resources such as automatic monitoring, management, and scheduling. Then compression, backup, distribution, and other function management, and then perform different operations on related data according to requirements. (Li 2021)

However, the cloud service has certain requirements for its own video surveillance technology and hardware level. The key information is then downloaded and analyzed from the cloud by relevant staff. Figure 8 shows how cloud video surveillance architecture working. (Palak 2022)

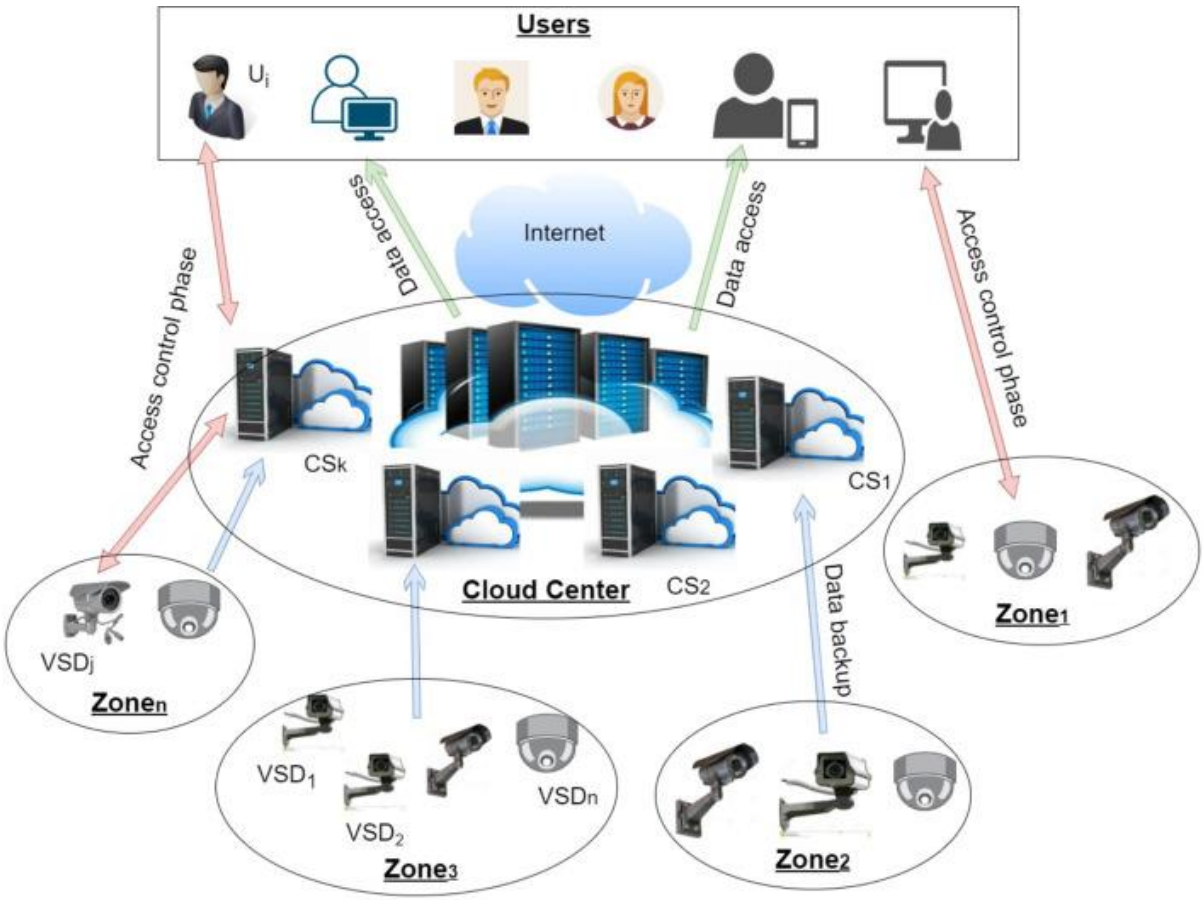

Figure 8 Cloud Video surveillance architecture (Palak 2022)

3.5 5G

Thanks to the development of various hardware and related technologies, today's video surveillance technology supports more high-definition, and if possible, it is equipped with multiple sensors to transmit multiple information. More information can provide more accurate analysis results and analysis range, avoid situations where nothing can be done after the video surveillance system is equipped. However, the huge data flow almost firmly connects the video surveillance system platform with the line. Although there is also a wireless video surveillance system, there are generally problems such as lag, delay, and blurred information. However, after the current communication technology enters the 5G era, many problems can be solved. (Axis 2022)

5G mobile communication technology has the characteristics of large bandwidth, high speed, low latency, high system capacity and large connection. It is mainly used in three types of scenarios, namely eMBB (enhanced mobile broadband scenario), uRLLC (high reliability, low latency communication scenarios) and mMTC (massive Internet of Things device communication scenarios), which can effectively support high-definition video, massive Internet of Things device connections, and multi-dimensional data aggregation applications that cannot be satisfied by the previous network in terms of speed and delay. Intelligent video surveillance belongs to the application scenarios of eMBB and mMTC, which mainly requires a large amount of data transmission and multi-device support scenarios. (Axis 2022)

One of the important basic technologies for the transformation of smart city and automation technology construction. After using the 5G network, the monitoring video platform can get rid of the limitation of cables, reduce deployment costs and management costs, and can be easily moved after deployment. It is suitable for use in environments such as complex terrain and difficult construction, and can also avoid cable Scenarios where the line is cut or a fault occurs causing failure. At the same time, the high-bandwidth, high-speed, and low-latency 5G technology can also support the transmission of high-definition video and large amounts of data, and can timely transmit information to the cloud platform for intelligent analysis and calculation, and timely feedback to the user end. (Axis 2022)

4 APPLICATION SCENARIOS AND EXAMPLES OF VIDEO SURVEILLANCE AND FACE RECOGNITION TECHNOLOGY

4.1 Smart City

In the construction of smart cities, the main application of video surveillance technology is to act as the "eyes" of the entire smart city, responsible for collecting a large amount of data. A large number of video surveillance platforms need to be deployed in various places such as roads, public facilities, shopping malls, and residential communities throughout the city to provide a large amount of various information generated by the operation of the entire city. To do this, it is necessary to integrate all departments in the entire city at the city level, and enter all relevant information into a common public system. It is necessary to strengthen the construction of relevant infrastructure, expand transmission channels and unify specifications, open up various types of networks to gather resources on the cloud, and have performance requirements such as high concurrency and low latency, so as to lay a solid foundation for smart city applications. (Ezzat 2021)

On the basis of the video surveillance system, it is necessary to combine the intelligent application of artificial intelligence, big data and other related technologies of the Internet of Things to obtain the value of feature elements such as face recognition, vehicle license plate recognition, and behavior in the whole city, and establish various types of classified storage such as people and vehicles. Of course, this is based on the fact that the Chinese government can uniformly control and centrally dispatch all aspects of people's identity information. In the unified ID card, people's face and fingerprint information will be collected, and the license plate can also point to Owners, this cannot be achieved in other countries, such as the EU based on GDPR(General Data Protection Regulation). The big data platform for analysis displays the operating status of smart cities in multiple dimensions, providing support for various types of upper-level intelligent applications. Unify the construction of a city-integrated artificial intelligence analysis center, connect large-scale, multi-source, and multi-type data to cloud services, build access to cloud service nodes on the network in different regions of the city, and connect the front-end to various devices and back-end Connect to various systems. Specifically, it is to set up nodes in different blocks of the city to collect and unify all kinds of information collected by the intelligent video surveillance system or other various front-end equipment in the block and use cloud service information with the information of other blocks. The processing and storage are uploaded to the unified urban artificial intelligence analysis center, and the various systems of the urban artificial intelligence analysis center analyze at the back end and then send instructions to each block for processing. And integrate transportation, police, education and other departments and social units to participate in the construction, and at the same time integrate smart campus, smart transportation and other systems into the smart city system. But in EU, law enforcement does not have unlimited access to such data in EU. Explain differences. Also different authorities may not be permitted to share information without permission from the people. Therefore, the development of relevant intelligent systems in different countries needs to be calculated separately. Here, only China is taken as an example. It can enhance the operating efficiency, safety and convenience of the entire smart city, and will become an important part of the

smart city system. The future city monitoring system that may appear in the movie is no longer far away from us. (Socha 2020) (Ezzat 2021) (EUR-Lex 2016)

One example of this kind of system is an Internet of Things "one-network unified management" smart city project jointly conducted by Suzhou City, China and Huawei, which may be held at the China International Internet of Things Expo on July 13, 2023. (China International Internet of Things Expo 2023)

Show some related results. This project started in 2021, making full use of cutting-edge technologies such as 5G, big data, artificial intelligence, Internet of Things, and blockchain to identify and solve problems. Video surveillance is the most direct grasp and presentation of the city's operating conditions. Therefore, the networking and sharing of video surveillance needs to be directed at the entire city level to achieve a single network in the city. Through infrastructure construction, unified transmission channels, and opening up various types of networks, resources Converging listed government clouds, with performance requirements such as high concurrency, low latency, high availability, and anti-strike, lays a solid digital foundation for smart cities. Video surveillance fully combines the basic intelligent application of advanced technologies such as artificial intelligence and big data to obtain the value of characteristic elements such as portraits, vehicles, and behaviors in the city, and build various big data platforms such as people and vehicles to display the real city operating status. (Liu 2022)

At the same time, with the help of various display methods such as 2D and 3D, the city's global surveillance images can be viewed through phone applications and computers. It gathers 500,000 channels of video image networking platform, 2,000 channels of concurrent shared application capabilities, and supporting Security O&M infrastructure. A total of more than 2,056 deadbeats were arrested; through docking with the civil affairs department, 143 mentally handicapped, mentally ill, and lost people who were stranded in the relief station were successfully found and returned to their families. And developed the mobile app "Suzhou Netcom", on which you can preview the video of the place you want to go, you can also review the images of the places you have been to, and you can also search which part of the city the background of this photo is in through the picture place. After the smart city system is more perfect in the future, you can even find out where a certain car or a certain person is now through photos (if you can determine that you have a certain relationship with it or obtain permission). The police can also quickly conduct suspicious portrait comparisons, compare the photos of suspicious persons with the database to find their information, and can also be used to find lost persons. It can identify the license plate to find the owner's information, so that you can contact the owner when your car is blocked by a parked car and needs to be moved. At the same time, it also includes application function modules such as basic information collection to provide early warning information release, clue push and other services for map labeling and operation and maintenance management. Figure 9 shows Suzhou Smart City Operation Management Center.

Figure 9 Suzhou Smart City Operation Management Center (China International Internet of Things Expo 2023)

4.2 Smart Campus

The possible application scenarios of the video surveillance system in the smart campus are mainly to provide certain information and early warning functions for the entire system. In many cases, the campus needs to strictly control the internal and external personnel to ensure the order and safety of the entire campus. The smart campus uses a series of facilities including student cards to ensure that the approximate location of the students can be known and certain areas are only Members of the school can enter to ensure the safety of the lives and properties of teachers and students. The traditional security and wall protection may not be able to take into account all aspects, and the video surveillance system can be an effective supplement. With the development of the Internet of Things technology, the video surveillance system in the smart campus can be combined with a series of environmental safety sensor systems such as face recognition systems, temperature, and infrared rays to ensure that the entire smart campus can respond quickly when an emergency occurs. Improve the security work efficiency of the smart campus and reduce security costs. Many tasks, such as intruder alerts or abnormal behavior detection, can be done by intelligent video surveillance systems, without the need for security personnel to patrol or look at the surveillance screen all the time. It is also possible to use video surveillance technology to only identify vehicles entering the school and decide whether to let them go, whether there are suspicious people breaking into the campus, etc. (Huo Yuqiao 2020)

Of course, the application scenarios of the video surveillance system in the smart campus are not limited to this. Through some existing conflict and abnormal behavior detection technologies

realized through the video surveillance system, physical conflicts, accidents and even possible behaviors among students can be identified to a certain extent(like bullying). It can also be used in classrooms to detect possible cheating behaviors, strengthen student management and reduce teachers' vigor consumption. It can greatly increase the operating efficiency of the entire smart campus. (Rashmi 2021)

4.3 Public safety field

In the field of public security, with the acceleration of urbanization, the scale of cities continues to expand, and a large number of new floating populations influx, which puts forward higher requirements for public security management. In the traditional security system, security can only be guaranteed by security personnel and access control systems. Even if traditional video surveillance is used, due to the limitations of the times and insufficient technology and hardware, it is only possible to arrange personnel to observe and replay the video data in real time. It is difficult to find all public safety problems and emergencies in the first place. Video data occupies a large amount of hard disk space, generally the hard disk needs to be cleared every once in a while, resulting in some problems that cannot be queried due to the time limit. (Socha 2020)

However, with the advancement of related technologies and the application of the Internet of Things, intelligent perception technology based on video surveillance has become an important direction for the development of security surveillance. In the video surveillance system, the application of big data technology, cloud services, and AI will replace manual processing of huge data streams, screen out useless data, help managers quickly discover emergencies and security incidents, save hard disk space and can Retrieve relevant information, reserve sufficient space for follow-up work, and save a lot of time, manpower, material resources, financial resources and other resources. (Bagga 2022)

Through big data training AI deep learning, it can give early warning for some emergencies, judge whether there is an abnormal situation, and submit an alarm signal after discovering the abnormal situation. After some situations happen, you only need to input relevant information in the cloud system, and you can quickly extract data from the huge data stream to achieve the purpose of video forensics. For example, with the application of face recognition technology and big data technology, combined with the facial feature information of suspects uploaded in the public security system, it can recognize and automatically call the police and lock the video containing the facial feature information of suspects when they appear within the scope of the video surveillance system. However, this function needs to be implemented by the country to uniformly save the personal information of citizens. The regulations on this are different in each country, at least not allowed in the European Union at present. Public places are densely populated and have a large flow of people, which is an area with a high incidence of abnormal events. In the field of public security prevention, making full use of the abnormal behavior detection of the intelligent video surveillance system can reduce the safety hazards caused by abnormal behavior in public places. The intelligent video surveillance system can perform real-time detection and early warning of abnormal behaviors in

public places such as airports, subways, buses, railway stations, and bus stations. At the same time, it can automatically detect abnormal behaviors inside public facilities and public buildings and automatically plan escape routes. Keep people out of dangerous or prohibited areas. It can also track the route of suspected vehicles and crowds in similar situations, reducing the difficulty of police work. Abnormal behavior detection technology can also be used to avoid possible terrorist attacks and ensure public safety. (Socha 2020) (Braeken 2016)

At present, smart video surveillance system has been applied in many places. For example, major international airports have basically begun to be equipped with corresponding facilities. During the last renovation, Beijing Daxing International Airport replaced the monitoring facilities on a large scale with a new IoT intelligent monitoring system, which further improved the airport's security. (Qi 2019)

Of course, similar systems can also be used in many smaller scenarios, such as the EasyCVR platform product(see Figure 10), which integrates AI detection and intelligent recognition technologies into various video application scenarios, such as: security monitoring, face detection in videos, and traffic flow Statistics, detection and identification of dangerous behaviors (climbing, falling, pushing, etc.). EasyCVR turns surveillance video into more valuable information. Combining with big data and cloud computing technology, it can form a huge resource information library, providing powerful information support and auxiliary decision support for work. Figure 10 show the EasyCVR Video platform. (TSINGSEE 2022)

Figure 10 EasyCVR Video platform(TSINGSEE 2022)

4.4 Smart transportation

The use of video surveillance technology combined with big data and other Internet of Things related technologies can effectively relieve urban traffic pressure in the future and improve the operational efficiency of ground public transportation and rail transit systems. Extract, classify and process vehicle description information, vehicle operation information, traffic conditions of each road

section, etc. from video image information, to help managers grasp the overall situation of urban traffic, and provide decision-making basis for the formulation of scheduling and management plans. For example, after an accident occurs on a certain road section, the video surveillance system judges and sends relevant warnings to the cloud, and related applications such as GPS navigation automatically issue a warning and re-plan the route to bypass the accident road section. Or when excessive traffic flow may lead to traffic jams, it can automatically judge the traffic flow density and judge the public transportation demand based on it, reasonably arrange the number of vehicles to avoid traffic jams due to too many vehicles, or waste roads due to too few vehicles resource. (He 2020)

In the intelligent transportation organization scenario, the distribution of passenger flow and passenger flow in the future is predicted based on the image data analysis results of the video surveillance system, which is used as the basis for the formulation of transportation plans, and the transportation capacity and passenger flow are accurately planned. In the train operation scene, the system can use cameras and sensors to capture video image data and collect on-site monitoring signals to remotely grasp the train operation situation, including real-time operation parameters and environmental conditions, and compare the monitoring results with video content to provide double guarantees for the safe operation of the train , such as through video surveillance combined with corresponding sensors to check whether there are abnormal sounds, open flames, smoke and other abnormal conditions. Figure 11 shows the method for vehicle identification using a video surveillance system. (He 2020)

In the traffic scene, if there is a violation of traffic rules, it will be automatically recorded and the relevant information will be uploaded to the traffic police. In the field of smart travel, the application scenarios of video surveillance big data include smart parking, establishment of traffic status induction coils, 3D visual navigation, and multi-mode route navigation. First of all, in the smart parking scene, relying on the cameras arranged in various places, the use of open-air parking lots and underground parking lots in various places can be mastered, and the remaining number of parking spaces can be counted and updated in real time. or vacant parking spaces scattered around. In this way, it can greatly reduce traffic congestion and accidents, help smart transportation to speed up urban operation, and ensure operational efficiency and order. (He 2020) (Shepelev 2020)

Another very important application scenario of intelligent video surveillance system in the field of intelligent transportation is in the field of automatic driving vehicles, which is one of the most difficult application methods to realize at present. At least 5G transmission speed and lower latency are required to provide reaction time to process and respond to information collected by video surveillance systems and other vehicle systems. The video surveillance system has a lot of application space in the automatic driving system. The first is to collect information about the surrounding vehicles and road conditions, as well as pedestrians and blind spots around the vehicle. Then when the vehicle is started, face recognition can be used to verify the driver's identity, confirm the driver's identity, realize car start, seat position memory adjustment, enter the matching multimedia system, etc., and also record the driver, passengers and vehicle conditions during

driving. It can be used as evidence in the event of an accident. Figure 11 shows the method for vehicle identification using a video surveillance system. (Jing 2022)

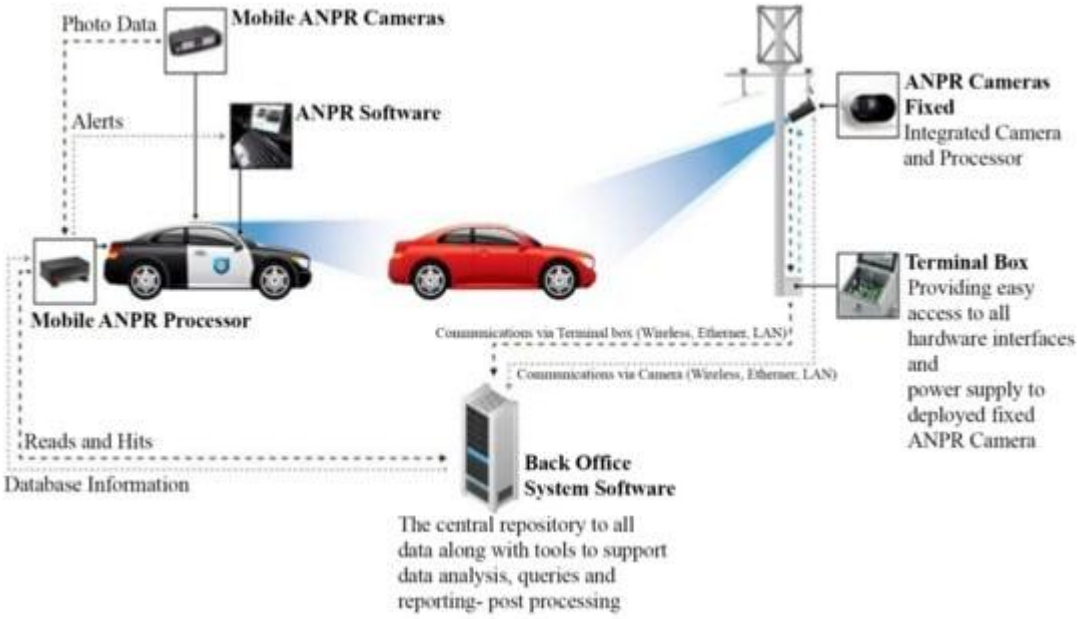

Figure 11 Automatic Number Plate Recognition(Lubna 2021)

4.5 Home security

In the past, video surveillance systems were generally used in some public places or places that required security, but with the current technological development the video surveillance system can be used in homes. (Przybylo 2014) There is also room for use in the scene. Many times you may not be at home for various reasons, there may be various accidents or thieves at home, or something happens to the children or the elderly at home. Using a video surveillance system can help you understand the relevant situation and deal with it in the first place. You don't need to stare at the screen all the time, you can watch the real-time monitoring content by using the client on your smartphone or computer when necessary. In the event of an emergency, such as an intrusion, the AI system of deep learning will remind through a pre-set channel, such as a mobile phone text message. (Cheng Tai) And now there are also reactive monitoring systems using video surveillance to detect falls of the elderly or patient monitoring, which can let you know that there is an accident at home and notify the ambulance or rush back to deal with it. (Goel 2020) Subsequent home video surveillance systems will have more and more precise functions to protect the safety of users' lives and property. Of course, it may also become an integral part of smart housekeeping robots with the development of technology. (Braeken 2016) (Goel 2020)

HUAWEI CLOUD's products are relatively excellent among the current related products like Figure 12. HUAWEI CLOUD home video surveillance includes several parts: front-end camera, online cloud infrastructure, and AI-related capabilities. The front-end camera can be a normal camera or one that supports AI. The cloud provides rich computing and storage resources, and more importantly, it provides a series of standard AI services, including face recognition, motion detection, human figure recognition, voice recognition and other capabilities. It only needs to build Various possible

scenarios need to be set in advance to connect these AI capabilities. It can quickly provide a variety of value-added services for home video surveillance, such as stranger alarm, elderly care, infant care, etc. If users lack the ability to manage platforms, they also provide cooperation solutions, professional video surveillance platform suppliers provide platforms, and front-end Device docking supports the rapid launch of services. Figure 12 shows HUAWEI CLOUD Home Video Surveillance system. (Huawei Cloud)

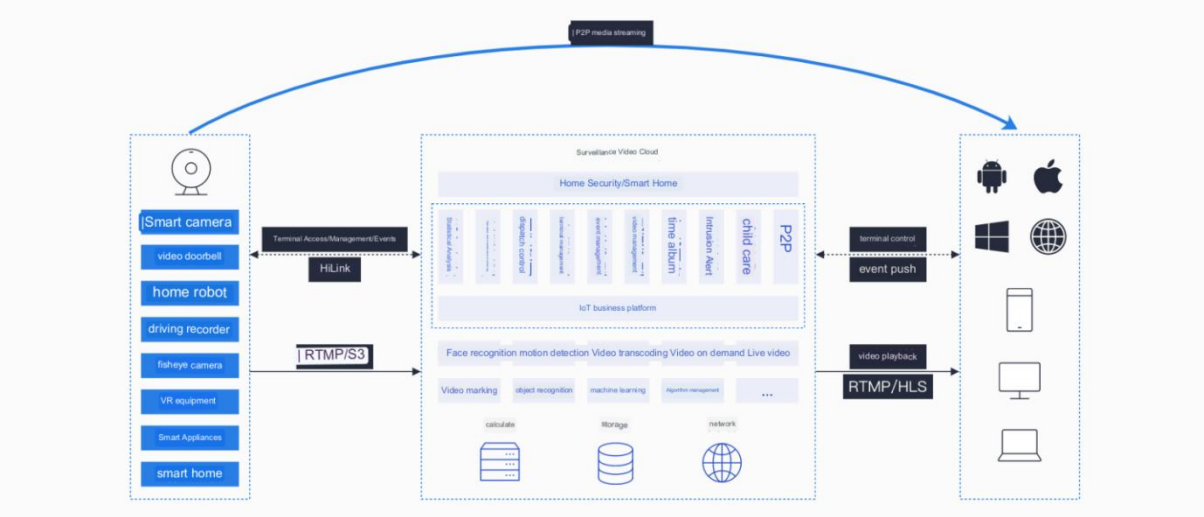

Figure 12 HUAWEI CLOUD Home Video Surveillance(Huawei Cloud)

5 CHALLENGES FACED IN THE CONSTRUCTION OF VIDEO SURVEILLANCE AND FACE RECOGNITION TECHNOLOGY

Although video surveillance technology is very beneficial in the long run and as an important part of systems such as smart cities and smart campuses, it will surely develop together with the Internet of Things technology in the future. But at the same time, video surveillance systems and face recognition technology also face many challenges, which will limit or affect the development of this technology.

First, video surveillance cameras are a part of our lives these days, perhaps not so intelligently, but equally facing significant legal and social ramifications. By processing images of people, video surveillance violates the legally protected privacy of individuals, as the use of video surveillance records may involve the processing of personal data, among other things. It involves not only the observation and recording of images, but also the transmission of images in the network, the analysis, storage and archiving of storage devices, and the destruction of records or entire storage devices. Different countries today either have no precise legislation in this regard, or have only a single law stipulating the relevant rules, strictly prohibiting or actively permitting both. The General Data Protection Regulation, abbreviated as GDPR, is a regulation of EU law on data protection and privacy for all EU individuals, involving the export of personal data outside Europe. Business processes that process personal data must have data protection built in by design and by default, and personal data must be stored using anonymization and by default using the highest possible privacy settings. Any personal data where the data controller or processor has obtained express opt-in consent from the data owner unless it is done on a lawful basis as stipulated by regulation. The data owner has the right to revoke this authorization at any time. Personal data processors must clearly disclose any data collection, stating the lawful basis and purpose of the data processing.The Chinese government's attitude towards this aspect is very positive, because there is no doubt that the development of video surveillance technology and the proliferation of CCTV can increase the operational efficiency of cities and effectively curb illegal and criminal activities. In the future, video surveillance systems will surely fill every corner of our lives, and any device with a camera may become a part of it. Of course, violations of privacy rights and some related laws, as well as some people's opposition to this will not stop. (Karthikeswaran 2019)

Second, the security system of today’s video surveillance system is not perfect, and there are widespread security risks such as weak passwords, theft of root privileges, high-risk system vulnerabilities, camera botnets, and functional failures. "broiler", and public regional video surveillance data breaches and other incidents. In addition, with the development of technology, the video surveillance system also faces the requirements of anti-tampering and anti-counterfeiting. Moreover, video surveillance itself is often located in relatively remote places, and sometimes how to ensure the safety of the camera itself is a problem. Moreover, with the increasing application of video surveillance in daily life, the leakage of video-related content has become unstoppable, and the ensuing privacy issues are enough to make people anxious, especially in terms of major leakage of cloud storage information. (Huang 2015)

Third, the intelligent video surveillance system is just starting now, and many related technologies are being developed and not yet perfected. The overall lack of unified standards and insufficient hardware and software technology have hindered the development of the overall system. The future development and application of the system will be firmly bound to the development of related technologies of the Internet of Things. At least the current system is not perfect enough and prone to various problems.

Fourth, it is difficult to avoid the two sides of anything at the moment of its birth. Just like nuclear fission technology, it can be used as a power generation technology to provide cheap clean energy, and it may also be applied to nuclear bombs. Technology itself is not at fault, but it cannot prevent some people from using this technology in bad ways. For example, some people will use video surveillance systems to combine Pinhole camera technology for peeping, stealing secrets. Even today, in fields such as warfare, this technology is very quickly available. (Iman 2023)

All in all, today's video surveillance technology is facing various challenges, but I think that with the development of smart cities, people's needs will inevitably promote the development of this technology, and related problems will inevitably find ways to overcome them.

6 DISCUSSION

In general, in recent years, security video surveillance has ushered in major technological progress in both software and hardware. With the development of various technologies related to the Internet of Things, related technologies such as video surveillance and face recognition will surely achieve leapfrog development. The application of smart cameras and AI analytics is a market trend and the market is embracing the potential of these powerful edge sensors that can handle complex analytics. The deep integration with various other IoT technologies in the future will bring many new usage scenarios for this technology and penetrate into all aspects of life. In the global intelligent surveillance market, the value of China's video surveillance market has exceeded 25 billion US dollars in 2023. As the world's large-scale events gradually begin to adopt intelligent surveillance systems, the demand in Europe also grows rapidly every week. It is expected that in the next five years, airports, ports, railways, and schools will all become the main markets for video surveillance systems. This will generate a large number of jobs related to the Internet of Things industry. In the past, the main market for intelligent monitoring was mainly in public places such as banks and public security systems. However, with the gradual enhancement of people's self-protection awareness, the intelligent monitoring system market is no longer limited to special industries. Many people have also begun to install video surveillance systems at home to protect their property and lives. And as the birth rate decreases and countries begin to age, the safety of the elderly at home sometimes becomes a worrying issue, which has spawned a huge home monitoring market. (China Business Industry Research Institute 2023)

Because of the popularity of network applications, intelligent monitoring is gaining more and more attention in the market, and the emergence of 5G wireless monitoring technology has brought a lot of room for development to the intelligent monitoring market. With the integration of other Internet of Things technologies Combined, perhaps the smart home robots in science fiction movies will not be far away. However, due to the imperfection of today's technology and hardware, as well as many technical and ethical issues, it poses certain challenges to the development of this technology, and this technology may also be used in various inappropriate places. But I believe that these problems can be overcome through relevant laws and research, develop and lead people to live a smarter and more convenient life. The intelligent monitoring of the Internet of Things will definitely become an important part of life and has a good development prospect. It will also provide a large number of jobs and technological breakthroughs for the rapidly developing Internet of Things industry.

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