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# Design and Realization of Computer Image Intelligent Recognition System

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## Abstract

The use of intelligent image recognition technology is rapidly expanding in various aspects of life. This technology has found significant applications in the fields of computer and multimedia. With the increasing demand for information processing, the research of machine vision systems has become more mature. This article aims to provide an in-depth analysis of the fundamental concepts of digital images based on computer technology. It covers the basic knowledge of digital images, including their characteristics, types, and properties. Additionally, the article explains the fundamental concepts of image filtering, which involves the manipulation of images to enhance their quality or extract specific information. Furthermore, this article discusses the image recognition algorithms that form the backbone of intelligent image recognition systems. These algorithms involve the use of mathematical models and techniques to identify and classify objects and patterns in digital images. Finally, the article explores the design and implementation of computer image intelligent recognition systems. This involves combining various techniques such as image acquisition, image processing, feature extraction, and classification to develop a robust and efficient recognition system. Overall, this article highlights the importance of intelligent image recognition technology in modern society and provides readers with a comprehensive understanding of the underlying concepts and techniques that drive this technology.

*Keywords:* Image Recognition, Digital Image, Recognition System

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## 1. Introduction

The rapid advancement of computer technology has led to the digitization of information, and this has ushered human society into the information age. The combination of information technology and networking has created an environment where information is readily accessible, and communication is possible at unprecedented levels. This has led to the emergence of new technologies that have transformed the way we live and work [1]. In this context, image recognition has emerged as one of the most important and complex technologies in the field of intelligent remote sensing systems. Image recognition has a wide range of applications and offers great practical value and potential. It is a key technology in fields such as medicine, security, transportation, and manufacturing. It has the ability to analyze vast amounts of visual data, identify patterns and anomalies, and make informed decisions.

One of the key advantages of image recognition technology is its ability to process large volumes of data quickly and accurately. This is critical in applications such as security and surveillance, where real-time monitoring is necessary. Image recognition algorithms can detect and classify objects, track movements, and recognize patterns of behavior. This makes it an invaluable tool in maintaining public safety and detecting potential threats [2]. Another significant advantage of image recognition technology is its ability to automate repetitive tasks. In manufacturing, for example, image recognition can be used to monitor the production line, detect defects, and sort products. This can significantly reduce the time and cost of quality control processes, improve efficiency, and increase productivity.

Design and Realization of Computer Image Intelligent Recognition System is a field of study that focuses on developing software systems capable of automatically recognizing and identifying objects, patterns, and structures within digital images. This involves the use of advanced algorithms and machine learning techniques to analyze large amounts of visual data and extract relevant features and patterns. The system can be applied in various fields, including medical imaging, surveillance, robotics, and automation, where the ability to accurately and quickly process visual information is critical. The design and realization of such systems require interdisciplinary knowledge in computer science, mathematics, statistics, and image processing. In conclusion, image recognition technology is a

vital component of the intelligent remote sensing system. Its versatility and practicality have made it a valuable tool in a wide range of fields. As computer technology continues to evolve, image recognition technology is poised to become even more powerful and transformative. The potential applications of this technology are limitless, and its impact on society is likely to be profound.

## 2. Principles of intelligent recognition based on computer images

### 2.1. Basic knowledge of image filtering

Image filtering is a critical process in digital image processing that involves modifying or enhancing digital images. The primary goal of image filtering is to improve image quality, reduce noise, or extract specific information from an image [3], [4]. Understanding the basic concepts of image filtering is essential for anyone working with digital images. When entering intelligent image recognition through a computer, the computer cannot directly recognize the image, so the computer needs to first convert the image into a digital image. One of the most basic concepts of image filtering is convolution. Convolution involves applying a filter kernel to an image, which modifies the image's pixel values based on the values of the filter kernel. The resulting image is a filtered version of the original image, and the type of filter kernel used determines the type of filter applied to the image. Another important concept in image filtering is spatial domain filtering. Spatial domain filtering involves manipulating the pixel values of an image based on their location within the image. Spatial domain filtering can be used to smooth an image, sharpen an image, or detect edges in an image. Common spatial domain filters include mean filters, median filters, and Gaussian filters [5].

Frequency domain filtering is another fundamental concept of image filtering. Frequency domain filtering involves converting an image from the spatial domain to the frequency domain using a Fourier transform. In the frequency domain, the image's pixels are represented as a sum of sine and cosine waves, which can be modified using frequency domain filters [6]–[8]. Common frequency domain filters include low-pass filters, high-pass filters, and band-pass filters. In conclusion, image filtering is a critical process in digital image processing that involves modifying or enhancing digital images. The basic concepts of image filtering, such as convolution, spatial domain filtering, and frequency domain filtering, are essential for anyone working with digital images. Understanding these concepts is crucial for selecting the appropriate filtering technique and achieving the desired image quality or information extraction. As digital image processing continues to evolve, image filtering will remain an important tool for improving image quality and extracting valuable information from images. In this way, the computer can recognize the image by recognizing the number. The basic knowledge of digital image is as follows:

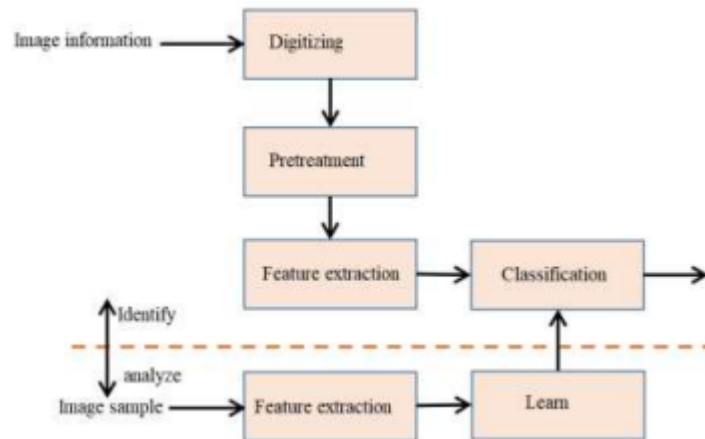
- 1) Classification of image noise. Based on the relationship between image and signal, image noise has two different types: additive noise and multiplicative noise [9].
- 2) Filter performance evaluation standard. Generally speaking, there are three considerations for evaluating the effect of filtered images: the degree of noise attenuation, the degree of edge preservation, and the degree of regional smoothness. In order to evaluate the filtering performance reasonably, people mainly divide the evaluation methods into two types: objective evaluation and subjective evaluation [10]–[12].

### 2.2. Computer image intelligent recognition algorithm

Computer image intelligent recognition algorithms are essential in various fields of study, including computer vision, image processing, and pattern recognition. These algorithms aim to teach computers to recognize patterns in images and interpret them [13]–[15]. They are based on machine learning techniques, which involve training the computer using large sets of data to enable it to identify patterns accurately. The first step in developing a computer image intelligent recognition algorithm is to acquire a large dataset of images with labels indicating the object or feature of interest. The algorithm will then analyze the dataset to extract meaningful features, such as color, texture, and shape. These features are used to build a model that can accurately recognize patterns in the images.

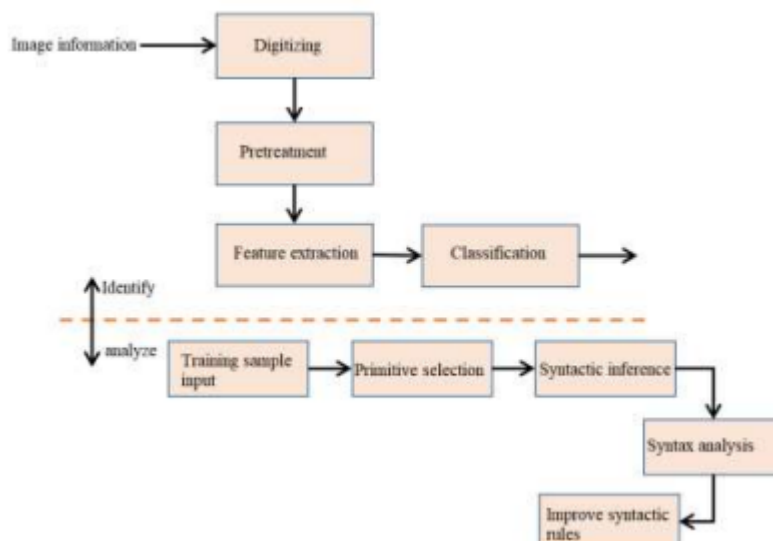
Once the model is developed, it is tested on a separate set of images to evaluate its performance. The performance of the model can be measured using metrics such as accuracy, precision, and recall. The algorithm can then be refined and optimized to improve its accuracy and generalization capabilities. Computer image intelligent recognition

algorithms have numerous applications, such as in facial recognition systems, medical image analysis, autonomous vehicles, and robotics [16]–[19]. These algorithms can identify objects in images and videos, track their movements, and make predictions based on the observed data. In conclusion, computer image intelligent recognition algorithms are critical tools in modern-day computing. They enable machines to perform tasks that were previously thought to be exclusive to humans, such as recognizing faces, identifying objects, and detecting anomalies in medical images [20]–[22]. As research in this field continues, we can expect more breakthroughs that will lead to more advanced and capable algorithms. Statistical pattern recognition. There are two main modes of statistical recognition: training and recognition. The realization process of statistical pattern recognition is shown in Figure 1 [4].



**Figure. 1.** Flow chart of statistical pattern recognition

Structural pattern recognition. Structural pattern recognition can also be called syntactic pattern recognition. The basic idea is to accurately represent a complex pattern with several simple sub-patterns. And the sub-pattern can be divided into several simpler primitives, which transforms complex pattern recognition into simple primitive recognition. The realization process of structural pattern recognition is shown in Figure 2.



**Figure. 2.** Structural pattern recognition flow chart

Artificial neural network pattern recognition. Artificial neural networks are developed based on biological neural networks. The basic unit of the biological neural network is the neuron. A neuron mainly includes the cell body, dendrites and axons. The artificial neuron structure is shown in Figure 3.

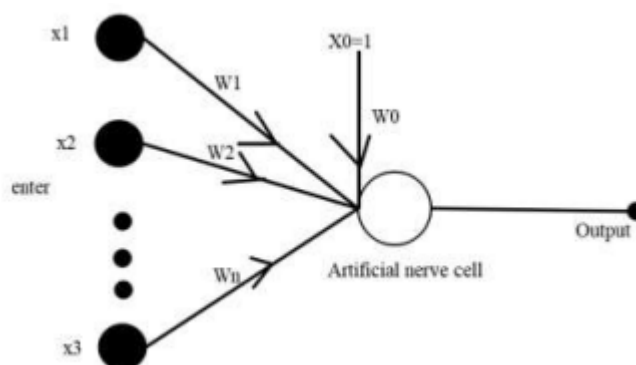


Figure. 3. Artificial neuron structure

Artificial neural networks are formed by connecting artificial neurons and other neurons. According to the different connection methods, neural networks are divided into feedforward neural networks and feedback neural networks [23]–[25]. Feedforward neural networks are currently widely used. The outputs of layers of neurons are fed forward to their next layer until the final output of the entire network is obtained [5]. A typical artificial neural network neuron is shown in Figure 4.

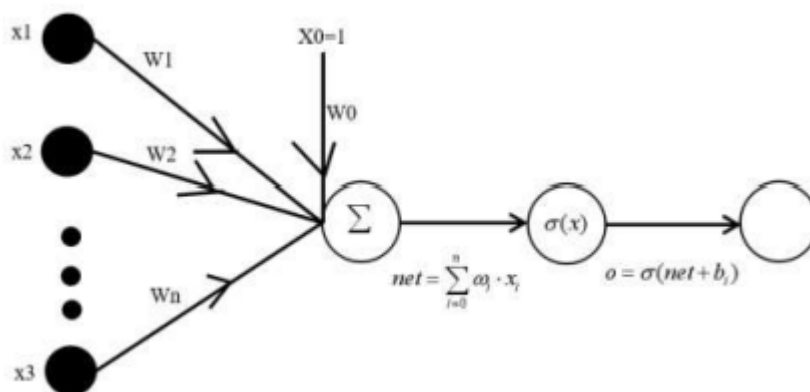


Figure. 4. Artificial neuron

It can be seen from the figure that the input and output of the neuron have gone through two calculation processes. First, the input signal is accumulated and integrated to obtain the signal net, and then the net signal is sent to the excitation function  $\sigma$  to obtain the final output  $y$ . The specific calculation formulas are shown in formulas (1) and (2):

$$net = \sum_{i=0}^n x_i \cdot \omega_i = x \cdot \omega \tag{1}$$

$$o = \sigma(net + b_i) \tag{2}$$

### 3. The key link of intelligent image recognition

#### 3.1. Image information acquisition

Image information acquisition refers to the process of obtaining relevant data from images, which can be used for various purposes such as identification, analysis, and interpretation. This process involves the use of various imaging techniques and technologies to capture and extract information from digital or physical images. Image information acquisition plays a crucial role in a variety of fields, including medicine, engineering, and computer science. The acquisition of image information can be achieved through various techniques such as imaging sensors, digital

cameras, and scanners. Imaging sensors, such as CCD and CMOS sensors, are commonly used in digital cameras and smartphones to capture images. These sensors convert the light energy from the scene into electrical signals, which are then processed by the camera's image processing software to produce a digital image.

In addition to imaging sensors, scanners are also commonly used to acquire image information from physical documents or images. Scanners use a series of sensors to capture the image and then convert it into a digital format that can be saved and analyzed. This technology is commonly used in the medical field for capturing X-ray and MRI images. Image information acquisition is also an important part of machine learning and computer vision. In these fields, images are analyzed and processed to extract relevant information, which can be used for various applications such as object recognition and autonomous navigation. This process involves the use of various algorithms and techniques such as edge detection, feature extraction, and deep learning. In conclusion, image information acquisition is a crucial process for obtaining relevant data from digital or physical images. It is used in a variety of fields such as medicine, engineering, and computer science, and involves the use of various imaging techniques and technologies such as sensors, cameras, and scanners. With the continued advancement of technology, image information acquisition is likely to play an increasingly important role in many fields, paving the way for new discoveries and applications.

Under natural circumstances, computers cannot directly recognize and analyze images. The computer can only recognize and process numbers, it cannot directly recognize and process images. Therefore, the intelligent recognition system first needs to digitally process the recognized image, so that the computer can process the digital form of the image. Image acquisition is the basis of digital image processing, and its main function is to convert the recognized image into a corresponding number through a digitizer. This number is the image data that the computer can directly count [6]. The main expression method is to use data collectors, image conversion cards and digital cameras to convert information such as optical signals, analog signals, and physical data into digital image information. The collected physical data can be displayed in 2D or 3D, and images in various formats will be converted to a 24-bit RGB image format.

### 3.2. Image preprocessing

Image preprocessing is a critical step in computer vision applications that aims to improve the quality and usefulness of images for further analysis. Preprocessing techniques may include several operations such as noise removal, contrast enhancement, color correction, image resizing, and geometric transformations. The goal of image preprocessing is to extract relevant features from images that can be used for object recognition, image segmentation, or other computer vision tasks. Moreover, preprocessing can help reduce the computational complexity of algorithms and improve the accuracy of machine learning models. One of the most common techniques used in image preprocessing is noise removal. Noise can be caused by a variety of factors such as sensor noise, transmission noise, or compression artifacts. Noise removal algorithms aim to reduce the effects of noise on image quality without losing important image details. Common noise reduction techniques include median filtering, Gaussian smoothing, and bilateral filtering. These techniques are widely used in medical imaging, surveillance, and remote sensing applications.

Another important aspect of image preprocessing is contrast enhancement. Contrast enhancement techniques aim to improve the visibility of details in images by increasing the difference between the lightest and darkest parts of the image. Contrast enhancement can help to make images more informative and easier to interpret. Common techniques used for contrast enhancement include histogram equalization, adaptive histogram equalization, and contrast stretching. Image resizing is another essential preprocessing technique used to adapt images to specific tasks or requirements. Image resizing involves changing the size of an image while preserving its aspect ratio. Image resizing is used in several applications, such as video streaming, web development, and mobile applications. Moreover, image resizing can help reduce the computational cost of image processing algorithms by reducing the size of large images.

Geometric transformations are also an important aspect of image preprocessing. Geometric transformations involve altering the shape, size, or orientation of an image. These transformations can be used to correct for perspective distortion, align images, or transform images into a specific coordinate system. Common geometric transformations include scaling, rotation, translation, and perspective transformation. In conclusion, image preprocessing plays a crucial role in improving the quality and usefulness of images for computer vision applications. It involves several techniques such as noise removal, contrast enhancement, image resizing, and geometric transformations. By applying

these techniques, images can be made more informative, easier to analyze, and computationally efficient. Therefore, image preprocessing is an essential step in the image processing pipeline for achieving accurate and reliable results in computer vision applications.

Image preprocessing mainly includes image smoothing, transformation, enhancement, restoration, filtering and other functions. Specific algorithms and techniques include grayscale, binarization, binary open editing, binary closed editing, gray open editing, gray closed editing, median filter, mean filter, Gaussian filter, Gabor filter, wavelet analysis, etc [7]. The results of image preprocessing of these technologies are different, but the purpose of image preprocessing is only one, that is, it should provide sufficient, complete and compact image information for obtaining characteristic parameters.

### 3.3. Image feature extraction and selection

Image feature extraction and selection are critical steps in computer vision and image processing applications. These processes aim to extract the most relevant and informative features from an image, which can be used for various purposes such as image classification, object detection, and recognition. Feature extraction involves extracting meaningful information from raw image data, whereas feature selection is the process of selecting the most relevant features among the extracted ones. Feature extraction techniques are used to extract meaningful information from raw image data. One of the most commonly used techniques is the extraction of local features, such as SIFT, SURF, and ORB. These techniques are based on detecting local keypoints in an image and extracting their descriptors. Local features are robust to changes in image scale, rotation, and illumination, making them suitable for various computer vision applications.

Feature selection is the process of selecting the most relevant features from a large set of extracted features. This is important because using all extracted features can lead to overfitting and reduce the performance of the model. Several feature selection methods are available, including filter methods, wrapper methods, and embedded methods. Filter methods evaluate the relevance of features based on statistical measures, whereas wrapper methods use a classifier to evaluate the relevance of features. Embedded methods incorporate feature selection as part of the model training process. Image feature extraction and selection are critical for various computer vision applications. For example, in image classification, feature extraction techniques are used to extract informative features from an image, which are then used to train a classifier. In object detection, local features are used to detect objects in an image, and feature selection is used to select the most relevant features for the task.

In conclusion, image feature extraction and selection are critical steps in various computer vision and image processing applications. These processes involve extracting informative features from raw image data and selecting the most relevant features among them. The selection of the most relevant features is critical for improving the performance of the model and avoiding overfitting. Various feature extraction and selection techniques are available, and their choice depends on the specific application and the characteristics of the input data. Image feature extraction is to filter the original data of the image in the measurement space, and then extract the features that best reflect the essence of the classification [8].

### 3.4. The design of the classifier

The design of a classifier refers to the process of developing a model that can accurately predict the class labels of new observations. The success of a classifier model is determined by its ability to correctly classify new data points based on patterns and relationships learned from the training data. The design of a classifier is a crucial step in machine learning, and it requires careful consideration of several factors, such as data preprocessing, feature selection, algorithm selection, and model evaluation. One of the key steps in designing a classifier is data preprocessing, which involves cleaning, transforming, and scaling the raw data to make it suitable for modeling. This includes handling missing values, removing outliers, normalizing the data, and encoding categorical features. Proper data preprocessing is essential for improving the accuracy and reliability of the classifier, as it reduces noise and biases in the data and enhances the discriminatory power of the features.

Another important aspect of classifier design is feature selection, which involves selecting a subset of the most relevant and informative features from the available set. The goal of feature selection is to improve the classifier's performance by reducing the dimensionality of the data, minimizing the risk of overfitting, and improving the interpretability of the model. Various methods can be used for feature selection, such as filter methods, wrapper methods, and embedded methods. Algorithm selection is also a critical component of classifier design, as it

determines the type of machine learning algorithm used to build the model. The choice of algorithm depends on the nature of the problem, the size and complexity of the data, and the performance requirements of the application. Common types of classification algorithms include logistic regression, decision trees, random forests, support vector machines, and neural networks.

Finally, the evaluation of the classifier model is an essential step in designing a classifier, as it determines the model's performance on new and unseen data. Model evaluation involves assessing the accuracy, precision, recall, and F1 score of the classifier on a test set, as well as using techniques such as cross-validation and ROC curves to assess the model's robustness and generalizability. The results of the evaluation help to identify any weaknesses or limitations in the model and guide further improvements in the design of the classifier. The design of the classifier is to correctly analyze and classify the samples that need to be identified by establishing a template library. The classification methods mainly include statistical methods, structural methods and fuzzy methods. Statistical methods are divided into supervised classification and unsupervised classification. Supervised classification is to accurately understand the corresponding categories according to learning examples, determine the distribution range of different categories in the function space, and then classify the identified objects on this basis. In supervised classification, the classification of learning samples is one of the key factors that affect the quality of the final classification. The classification result largely depends on the accuracy of the learning sample classification. Unsupervised classification means that when the distribution of learning samples cannot be determined in advance, similar samples are classified into one category based on the similarity of the samples themselves, so as to determine the distribution range of different types in the feature space [9].

#### 4. Design and implementation of computer image intelligent recognition system

##### 4.1. The hardware design of the system

The hardware device structure of the embedded platform mainly has the following parts: the embedded microprocessor of the central module, the file carrier memory, the general device interface for connecting peripherals, and the IO interface for information transmission. The control function of the processor is mainly realized by the clock circuit. The development board used in this article is ARM9 mini2440, which includes a wealth of hardware devices [10]. The hardware modules used mainly include the following parts, as shown in Figure 5:

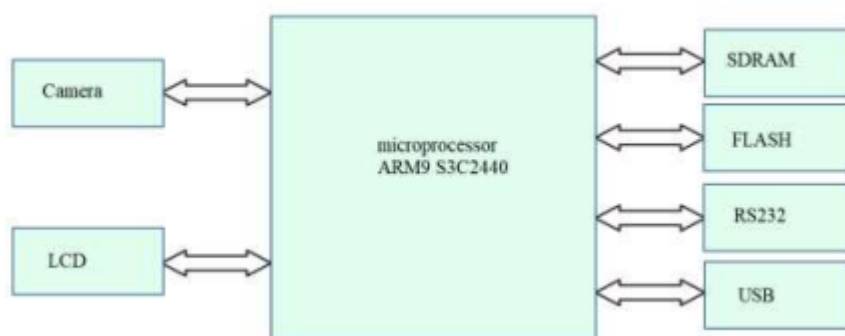
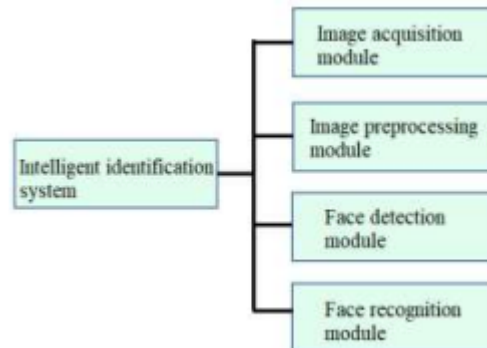


Figure. 5. Overall block diagram of system hardware

## 4.2. System function module design

The functional module design of the system is shown in Figure 6.



**Figure 6.** System function modules

## 5. Conclusion

As society advances, so does the continuous development of science and technology. One particular technology that has gained increasing attention is image recognition technology. With its high-tech capabilities, the intelligent image recognition system has become a widely used tool in various fields. In fact, it has become the mainstream of the times. As computer technology continues to evolve and emerging technologies emerge, the intelligent image recognition system will only become more advanced. With the aid of artificial intelligence and machine learning, the system can learn from vast amounts of data and improve its accuracy in identifying images. This progress will lead to more efficient and effective recognition of images, allowing for better decision-making processes and outcomes.

The benefits of intelligent image recognition technology can be seen in various industries, from medical diagnoses to self-driving cars. It has the potential to greatly improve the accuracy and speed of image recognition tasks, which in turn can lead to increased safety, efficiency, and productivity. With the continuous development of technology, it is likely that the intelligent image recognition system will become an essential tool for many industries in the future. As intelligent image recognition systems become more advanced, it will also become more accessible and user-friendly. This means that it can be used by individuals who do not necessarily have a technical background or expertise in image recognition technology. This could potentially lead to the democratization of image recognition technology and allow for greater utilization of this powerful tool. Overall, the progress of society and the development of technology have led to the increasing use and importance of intelligent image recognition systems. As technology continues to evolve, it is likely that these systems will become even more advanced, leading to further benefits and opportunities in various industries.

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