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Application of Case-based Teaching in Computer Vision with OpenCV and Python

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***Abstract*—** *In recent years, with the rapid development of big data and artificial intelligence, computer vision technology has been employed in the process of the development of the computer, and also has a certain application in mechanized production. In this paper, the overviews of OpenCV and Python are presented. Additionally, image processing methods are introduced, such as image enhancement and restoration, image edge sharpening, image segmentation and recognition, and image transformation. Finally, we introduce some applications of computer vision technology.*

***Keywords*—** *Computer vision technology; OpenCV; Python; Case-based Teaching.*

I. INTRODUCTION

Recently, with the development of computer technology, computer vision technology is through the computer to simulate human visual observers and analyze the process of image visual [1]. It requires that the computer in the process of artificial intelligence can possess the surrounding environment to make use of image perception of ability, the process simulation of the human visual function, then the relevant images intelligent processing. Computer vision technology is an artificial intelligence technology, it is to simulates the process of human perception of the environment, so this technology integrates multiple disciplines and technologies, including image processing, artificial intelligence, digital technology and so on [2-4]. This technology has a very important role in the development of computers, especially in modern society, people need computers to complete more intelligent behaviour, instead of human to solve some special environment work [5-8].

In addition, computer vision technology has been employed in the process of the development of the computer, also has a certain application in mechanized production, in the production of mechanical automation in the future, be able to use the technology to extract image objective things, and then used for the detection and control of the technology in the process of production, compared with the traditional automatic control, more information and functions of control [9-11]. Therefore, computer vision is an important part in the field of artificial intelligence, and its research goal is to make the computer have the ability to recognize three-dimensional environment information through two-dimensional images. Computer vision is based on image processing technology, signal processing technology, probability statistical analysis, computational geometry, neural network, machine learning theory and computer information processing.

II. OVERVIEW OF OPENCV

The source code for the computer vision library OpenCV was developed at Intel's research [12]. To consider the speed of computation, most image processing software packages are written in C/C++, and OpenCV is no exception. It is a library composed of more than 300 C functions and C++ classes, developed on the basis of IPL (Image Processing Library). Therefore, the characteristics of this paper can be paper summarized as follows:

(1) Good cross-platform. OpenCV is composed of cross-platform high-level API, provides programmers can be applicable to many platforms on the portability of good algorithm base operation, good support for Windows, Linux, Unix and MacOS and other operating systems, can be in most C/C++ compiler work, such as MSVC++6.0, MSVC++.net 2003, MSVC++.net 2005, Borland C++Builder and Ubuntu can be ideal tools for secondary development.

(2) Good independence. Contains more than 30 C functions and C++ classes, independent of external libraries, can run independently, can also run using other external libraries.

(3) Fast processing speed. The algorithm in OpenCV is based on the dynamic data structure with high flexibility encapsulated in IPL, based on the optimized code developed by Intel processor instruction set, all processing speed is quite fast. It also provides some constructs for other loci such as Eic, Ch, MatLab, etc. These interfaces are located in the Opencv/Interaces directory after their installation.

(4) It has rich image processing functions. OpenCV contains lists, queues, collections, graphs and other basic data structures; Finding eigenvalues, singular values, etc. Matrix and vector and linear algebra operations; Image filtering, edge detection, corner detection, mathematical morphology operation and other basic digital image processing; It also includes advanced image processing, such as feature detection and tracking, motion analysis, target segmentation, and recognition, 3D reconstruction and other applications.

(5) Openness. OpenCV is free to commercial or non-commercial, and its code is also open, researchers can modify its source code, can also put their own research and development of the new class library, so that their code can be widely used by others, speed up the upgrade efficiency of the code. OpenCV library can be used to write simple and efficient code to solve the problems in digital image

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processing and computer vision programming. This not only reduces the difficulty of programmers to develop programs, but also shortens the development cycle of relevant programs.

III. Overview of Python

Python is a free, open-source, cross-platform advanced dynamic programming language [13]. It supports various programming methods and has a large number of powerful built-in objects, standard libraries, and extension libraries. Powerful programming functions can be realized by directly calling the built-in functions or standard libraries. Learners can also learn the source code, deepen the understanding of the principle and algorithm, effectively improve the programming ability and code quality. By its nature, Python is both an "object-oriented" language and an "interpreted" language [14]. Python is relatively easy to get started. Its syntax is similar to That of English, and programs can be executed directly through the interpreter, but it consumes a lot of hardware resources.

On the application side, Python's powerful and rich libraries and data analysis capabilities make it well suited for the field of artificial intelligence. Matplotlib is a 2D graphics library for drawing arrays in Python [15], with powerful data visualization and drawing functions. It comes from the mathematical software Matlab and has unique advantages. Matplotlib is open source and free. Although it is an extension module of Python language, it inherits the features of Object-oriented readable and easy maintenance of Python language. Matplotlib provides the submodule PyPlot, which encapsulates a set of matLAB-like imperative plotting functions and provides an interface for programming developers. Developers can quickly plot and set up various requirements for charts by calling functions in the PyPlot module, which contains a set of functions for quickly generating basic charts such as histograms, bar plots, box plots, and radar plots. Additionally, Pandas is an open-source tool for manipulating complex two-dimensional and three-dimensional arrays and for manipulating data in relational databases [16]. Pandas is a numpy-based data analysis module that incorporates a large number of libraries and standard data models, and provides fast and efficient Series and DataFrame objects with default and custom indexes. Data can be read and written in memory data structures and different file formats and can be processed quickly and easily to generate visual charts.

In the areas of neural networks and deep learning, Python can find mature packages to call. And Python is an object-oriented, dynamic language for scientific computing, which makes Python a favourite for artificial intelligence. The power of scientific computation remains Python's strongest competitiveness in the field of AI and Big Data. Python aims to train students to make use of Python language in the application of their major and plays an important role and position in the curriculum system and major construction of machine learning, pattern recognition, computer vision, and so on. The language is an interpretive, object-oriented computer programming language for data statistics, analysis, visualization, and other tasks, as well as machine learning, artificial intelligence, and other fields.

To sum up, the introduction of the pre-class targeted preview method in the course of big data analysis and application effectively promotes the development of classroom teaching; In the course of teaching system theory, small cases of Python are integrated to deepen students' understanding and mastery of relevant theoretical knowledge. Students are required to conduct data mining and analysis for applications in aviation, e-commerce, public service, power, and other industries. Compared with the traditional single theoretical teaching mode, the mixed teaching mode gives full play to the students' main role and awareness of classroom participation, forms a good classroom interaction, greatly stimulates students' interest in learning, improves their hands-on ability, enhances the teaching effect, and achieves the expected teaching objectives.

IV. Image Processing Methods in Computer Vision

1. Image enhancement and restoration

Image enhancement technology refers to the process of image processing [17]. Image enhancement refers to the modification and processing of the original image by means of a series of algorithms, so as to change the various information in the original image and provide better visual effects for human beings. The most common image enhancement application is what people call beauty function, which is to use a series of image enhancement means to continuously process the original image, and then present a more beautiful beauty effect for human beings. In order to meet the specific needs of human beings, image enhancement technology is also developing towards a more intelligent direction, but people's definition of beauty is different from person to person, so in the process of image enhancement application, the use of computer algorithms to enhance the image function is very variable.

On the other hand, image restoration [18] is also known as image link. This technology is easily understood by people. It is to improve the quality of images by means of image information processing and restore the original high-definition appearance of images. In the specific application process of image restoration, the corresponding algorithm should be adopted to reduce the interference of digital images in the acquisition process of relevant image capture equipment and reduce the impurities caused by the acquisition equipment itself. The means taken by image restoration is to establish the corresponding computer model and then apply the model to analyse and deduce the original image, using specific computer algorithms to evaluate the degree of image restoration, in the process of continuous repetition to achieve the final effect of image restoration.

2. Image edge sharpening

Image edge sharpening [19-21] refers to the use of certain technical means to make the contour and edge of various information in the image become more obvious, modify various details of the image, and then make the object of the image have obvious boundaries. In this way, a specific object in the image can be separated from the image, and then the object surface and related information can be detected in the

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process of data processing. Image edge sharpening is an important means of image information collection. Only by sharpening the object in the image can the intelligent computer system quickly obtain various parameters and information of the object, and then carry on further analysis and calculation, providing effective data processing for human beings.

Additionally, image edge sharpening mechanism is to use the filter to contrast the objects in the image, make a particular object on the edge of the contrast is becoming more apparent, this can present a clear boundary on the vision, it is not only in the process of data collection is very common, but also conducive to the image processing and the observation of human beings.

3. Image segmentation and recognition

Image segmentation [22] is to segment the image to form a number of characteristic regions. Image segmentation is the key step of computer vision technology to realize image analysis. In the process of segmentation, the threshold value of the image, the edge of the region and other computer specific theory are used for segmentation, and then the different regions of the digital image have different characteristics. In the process of further analysis of the image, the position and content of the object in the image can be well recognized. Generally speaking, image segmentation is usually to achieve the association between region segmentation and the actual image information extraction task, so that the corresponding relationship between specific objects and images can be establish, so that the computer can further analyze the physical properties or other parameters of the objects in the image.

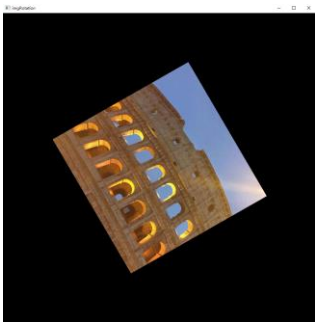
Image recognition [23] is one of the most commonly contacted computer vision technology, it refers to the use of relevant algorithms and identification methods, for the content of the image classification recognition, machine intelligence instead of human eye recognition, to achieve the purpose of real-time automatic monitoring of the image. The scheme of image classification and recognition can make the content in the image more efficient in further recognition and processing, which is an important content to realize the intelligent development of computer vision technology

4. Image transformation

Image transformation [24] is a basic content of computer vision technology in image processing, which is to realize the rapid processing and analysis of images. This requires the image from the original specific space into a linear function of the way, in another space and form of presentation, and then with the help of the unique algorithm of the computer image processing, and then the image transformation to the original image space, after processing and modification of the image to present a specific effect. In a more concise way, it refers to the use of functions to transform all kinds of information in the image into information that is convenient for computer calculation and processing. It includes not only two-dimensional processing of three-dimensional information in the image, but also the conversion of color space and gray space.

In short, it is a technology that appears in order to enable computers to better analyze and process the data in the image. Only under the premise of this technology can the computer recognize and process the image information.

```
import cv2
img=cv2.imread('bee.jpg')
cv2.imshow('img',img)
height=img.shape[0]
width=img.shape[1]
dsize=(width,height)
m=cv2.getRotationMatrix2D((width/2,height/2),-60, 0.5)
img2=cv2.warpAffine(img,m,dsize)
cv2.imshow('imgRotation',img2)
cv2.waitKey(0)
```



V. Application of Computer Vision Technology

1. Application of automatic production

The rapid development of computer vision technology brings the biggest change is the change of the traditional industry, the traditional industry in the process of automation development in order to achieve a high degree of automation, it must be integrated into the image analysis technology, the use of intelligent computer vision technology, the production process of products to complete monitoring and control [25]. First of all, the process of image identification through computer vision technology can complete the positioning and parts identification of products in the automated assembly line, so that in the further processing process, it can provide relevant image information for the control system, and then complete a series of automatic production work.

Secondly, after the product is processed, image recognition technology can also be used to complete the quality inspection of the product, especially in the processing industry, the quality inspection of parts needs to be accurate enough to meet specific standards and requirements [26]. Using the traditional manual way to detect or need to consume a lot of manpower and material resources, or can not achieve a comprehensive product detection, but with the help of computer vision technology, can accurately complete the quality inspection work for each product.

Finally, the most basic characteristic of machine vision system is to improve the flexibility and automation of production. Machine vision is often used to replace artificial vision in some dangerous working environments that are not suitable for manual operation or where artificial vision is difficult to meet the requirements. At the same time, in the process of mass repetitive industrial production, machine

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vision inspection method can greatly improve the efficiency and automation of production.

2. Application of self-driving car

Computer vision has been applied to existing intelligent connected vehicles [27]. Intelligent networked vehicle refers to a new generation of vehicles equipped with advanced on-board sensors, controllers, actuators and other devices, and integrating modern communication and network technologies to realize intelligent information exchange and sharing between vehicles and people, roads, and background, so as to realize safe, comfortable, energy-saving, efficient driving, and ultimately replace people to operate. Computer vision enables cars to make sense of their surroundings. Smart cars have many cameras that capture video from different angles and send it as input to computer vision software. The system will process the video in real-time and detect road markings, objects near the car (such as pedestrians or other vehicles), traffic lights and other objects.

Currently, developed some of the visual system, can use the camera to track the driver's facial expression, issued a warning signal, such as the driver may be very tired, and is likely to fall asleep while driving, etc., according to the survey, up to 25% of the fatal and serious traffic accidents caused by this factor, as a result, the technology and measures can be better to save lives. The technology is already used in commercial vehicles such as freight trucks, and is expected to enter the private sector by 2022. Other possible uses for computer vision in cars include monitoring whether passengers are wearing seat belts or even leaving their keys and phones behind when getting out of the car.

3. Application in other industries

Because of its intelligent development direction, computer vision technology has more or less applications in all walks of life. In the traffic industry, the use of computer vision technology can achieve effective monitoring of vehicles and pedestrians, which can effectively maintain traffic order and follow-up treatment of traffic accidents. In the public security enterprise, the use of computer vision technology can realize the monitoring of criminal suspects, can increase the control of criminal incidents, reduce the occurrence of criminal incidents from the root, in addition to help the missing person inquiry, increase the efficiency of public security work. In the medical profession, computer vision technology can replace doctors to complete the identification technology in some specific environments and complete a series of medical work more effectively.

Thus, computer vision technology has made a significant contribution to security work, through face recognition, iris recognition, and fingerprint recognition technology to achieve effective control of security work, these technologies have been widely used in building security work and equipment protection work.

VI. CONCLUSION

In this paper, computer vision technology has been employed in the process of the development of the computer, such as image enhancement and restoration, image edge sharpening, image segmentation and recognition, and image transformation. Finally, we introduce some applications of computer vision technology, such as automatic production, national defense and so on. In future development work, computer vision technology is bound to be more intelligent.

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