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Development and Application of Machine Vision in COVID-19 Era

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Abstract

Machine vision is an important branch of artificial intelligence technology. With the development of computer technology, the machine vision technology, which has a great development prospect, has been widely used in many fields. In the era of COVID-19, machine vision has solved many tasks that were difficult for artificial vision. It made great contributions to the manufacturing industry and the medical industry and provided a new idea for the development of intelligent manufacturing in the future. This paper integrates relevant data, discusses the application of machine vision technology in the COVID-19 era, analyzes its advantages and disadvantages, and makes a prospect for the future development of machine vision technology.

Keywords

Machine vision; Intelligent manufacturing; Industry development; COVID-19 era.

1. Introduction

Machine vision is an important research topic in the field of artificial intelligence. Its core includes software and hardware technologies such as image acquisition equipment, corresponding algorithms, and lens control equipment. With the development of the times, humans need to deal with more dangerous researching and working conditions. In some dangerous work environments that are not suitable for manual operations or scenes where artificial vision is difficult to meet the requirements, machine vision is often used instead of artificial vision to obtain information. Until now, machine vision has been widely used in various fields, including industry, agriculture, medicine, military, aerospace, meteorology, astronomy, public security, transportation, safety, scientific research and many other industries, and it has been obtained good feedback in the process of continuous practice development,

In 2020, COVID-19 broke out. The high infection rate and mortality rate of the virus made the first-line treatment and prevention and control of the epidemic very difficult. Thus, such rates promote the development and application of machine vision technology. In the era of COVID-19 situations, machine vision is widely used to protect human beings, control and prevent the spread of the virus. The assistance it brings not only contributes to the manufacturing process of pharmaceutical and medical equipment, but also helps to check, identify, diagnose and even treat COVID-19 patients. For example, Orbbec of the United States has cooperated with robot manufacturers in China to deploy food delivery robots, disinfection robots, and guidance robots in hospitals to reduce the unnecessary human to human contact. For another example, Guangzhou Gaoxinxing Robot Co., Ltd. has developed a 5G patrol robot, which can simultaneously scan the body temperature of 10 people within a radius of 5 meters. Any potential risks observed, such as the absence of a mask or high temperature, will cause the robot to alert the relevant authorities and initiate a real-time response. The extensive application of machine vision technology in the COVID-19 era has proved its development potential and necessity, although there are still many problems in machine vision due to the limitations of

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technology. For example, in visual tracking, there is the problem of tracking loss caused by the rapid movement or sudden change of the target. In image analysis, machine vision will be interfered with by some modified images, and the modified parts of these images can be easily found by artificial vision. Despite of such problems, machine vision technology will still become one of the most critical solutions for the manufacturing industry to mitigate the impact of current and future potential epidemic challenges.

This paper mainly integrates some existing relevant data, analyzes the development process of machine vision, illustrates the application of machine vision technology in the epidemic era, and focuses on the recognition of mask matching by machine vision, puts forward several practical application models, analyzes and discusses the advantages and disadvantages of each model and its future development. Finally, the paper expresses a bright vision for the future development of machine vision technology and looks forward to the development of machine vision technology in the next decade.

2. The Development of Machine Vision and Its Application in the COVID-19 Era

2.1 The development of machine vision

Machine vision technology as an important branch of the development of artificial intelligence technology, its development and course are inseparable from the development of artificial intelligence technology and computer technology. Since its birth and development, machine vision technology has a history of nearly 30 years, and its functions and applications are gradually improved and promoted with the development of industrial automation. Its technological exploration began in the mid-1960s when American scholar L.R. Roberts studied the "building block world" composed of polyhedrons. After that, the emergence of Professor David Marr's vision theory further promoted the research on new theories and methods of machine vision technology, and then promoted the development of emerging industries, and started a global research boom. After that, thanks to the wide application of CCD, COMS image sensor and digital interface technology, a large number of miniaturized, lightweight and low-power industrial vision devices appeared in the market, more and more electronic and semiconductor factories appeared, and a complete business chain began to be established, which also marks the beginning of the real market demand for machine vision. At the beginning of the 21st century, the popularity of computers makes machine vision technology to a higher level. More and more companies realize that in the process of mass repetitive industrial production, using machine vision detection methods can greatly improve the efficiency of production. These industries and companies have begun to take the initiative to introduce machine vision equipment. Investors also began to realize the market potential of machine vision technology, more and more capital began to flow in, machine vision began to develop rapidly, and got more and more applications. Up to now, machine vision technology has been put into many fields on a large scale. Furthermore, according to the characteristics of its application fields and subdivision technology, it can be further divided into industrial vision and computer vision. Correspondingly, its application fields can be divided into intelligent manufacturing and intelligent life, such as industrial flaw detection, automatic welding, medical diagnosis, tracking alarm, mobile robot, fingerprint identification, simulated battlefield, intelligent transportation, unmanned driving, smart home and so on.

2.2 Application of machine vision in COVID-19 Era

2.2.1 Intelligent multi camera system for vaccine bottle quality control

Fighting against COVID-19 is the top priority of all nations in the world. In COVID-19 Era, countries all over the world are trying to provide vaccines to the public as soon as possible. However, it is not easy to provide 8 billion doses of vaccine (at least one dose per person). A key factor in the successful delivery of these billions of doses of vaccine is the glass bottle. However, medical grade vaccine bottles are not ordinary standard glass tubes. Whether they are curling bottles, screw bottles, or

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ampoule bottles, they are all made of borosilicate glass, which needs a customized production line to produce. As any chemical interference will affect the effect of the vaccine, it is necessary to prevent the container from reacting with the internal liquid. Even the smallest scratch or crack may cause the whole batch to be unusable, contaminate the production line in the filling process, and even cause the production line to stop.

In such conditions, Isotronic GmbH has developed the tubular glass automatic detection system "VialChecker". This system uses IDS industrial camera of uEye CP camera series as the image processing component of size and surface detection. These components enable the system to detect whether the size of vaccine bottles meets the requirements and whether there are defects on the surface. Its IDS camera can detect defects such as cracks, scratches, notches, inclusions or stains with an accuracy of 0.1 square millimeters, and intelligent software can realize accurate description, analysis and classification of faults. Under the background of global epidemic prevention, the global demand for vaccine bottles is expected to increase by another 1-2 billion in the next two years. The "VialChecker" tubular glass automatic detection system will greatly improve the production efficiency of vaccine bottles and help the global anti epidemic.

2.2.2 Intelligent vision human body automatic temperature measurement system

COVID-19 epidemic prevention and control should not be lax. Temperature detection, as the most basic medical examination, can effectively screen new crown patients effectively and avoid re-transmission. However, in airports, stations, subways, hospitals, shopping malls, schools, parks, communities, and other crowded public places, the hand-held temperature measurement method requires a lot of manpower and material resources , also increases the risk of infection caused by close contact. Therefore, the simple hand-held thermometer cannot meet the needs of a large flow scene.

In this case, Shanghai Betterway Automation Technology Co., LTD has developed the "Betterway Bi-Guard series intelligent vision human body automatic temperature measurement system", which solves the temperature measurement problem in the crowded public places with the innovative solution of "dual light camera plus AI face tracking plus intelligent calibration". The dual light camera provides visible video and infrared video at the same time, and the two images are calibrated accurately through the independent algorithm. In the visible light vision system, AI deep learning algorithm is used to detect and track the face position in the field of vision in real time, and the accurate temperature data of the measured person is obtained adaptively through the infrared temperature data. In addition, in order to ensure the long-term stable temperature measurement of the system, the system supports the full-automatic calibration function. With the simple configuration of the blackbody, the system can automatically realize the long-term stable and accurate operation, greatly improving the temperature measurement efficiency in public places and providing a guarantee for epidemic prevention and control.

3. Application and Model of Machine Vision in Mask Recognition

3.1 Problems in machine vision application

The working process of machine vision is inseparable from deep learning. Deep learning is a new field in machine learning research. Its motivation is to establish and simulate the neural network of the human brain for analytical learning. It imitates the mechanism of the human brain to interpret data, such as images, sounds and texts, The concept of deep learning comes from the research of artificial intelligence neural networks. The workflow of deep learning can be summarized as tagging, training and reasoning.

There are many crucial problems in the practical application of machine vision, such as too few defect samples. When building a good model, the number of samples often leads to the imprecision of the model. For example, when labeling a data set, it is difficult to label what because there are too many data sets; for the problem of mixing unknown images, in a large data set, there are often some data sets with fuzzy description, or there are differences with the content of the data set we need, which

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leads to our model misjudge our data set. These problems are practical problems in the application of machine vision, we need to improve and perfect them more precisely.

An ideal deep learning model should be able to deal with many aspects, such as in dealing with irregular images, deep learning machine vision solutions, even if the image is complex, through the deep learning algorithm, the software can automatically learn the characteristics of defects, analyzing irregular images possible; In terms of accuracy, deep learning machine vision solution can improve the accuracy of detection through deep learning algorithm and manufacturing specific data.

3.2 Ideal application of machine vision -- mask recognition

3.2.1 Background

In early 2020, novel coronavirus pneumonia was very infectious. Wearing masks became a necessary measure to prevent and control the disease. In order to control the spread of COVID-19, masks are needed when entering or leaving public housing, schools, factories and other public places, or by means of buses, trains and other means of transport. However, during the epidemic period, some people were less alert to COVID-19. Wearing masks in public places or wearing masks wrongly brought troubles and inconvenience to epidemic prevention and control. Therefore, it is necessary to design a mask recognition system, which can well classify whether a person is wearing a mask and whether he is wearing a mask wrongly so that it can remind the relevant personnel and strengthen the work of epidemic prevention and control.

3.2.2 Dataset introduction

The system is designed to identify the masks of the crowd,.it can be divided into three situations: wearing masks correctly, wearing masks wrongly and not wearing masks. Therefore, we collected the relevant data of these three behaviors from Kaggle the training set of our system. Figure 1 from left to right shows the situation of not wearing masks, wearing masks, and wearing masks wrongly.

Figure1. Three kinds of data set display (Pictures are collected from the web)

3.2.3 System model and its effect

This system uses RESNET residual neural network as the model to train the data set. The advantage of this neural network is that when the depth increases, the training error of residual networks is lower than that of ordinary networks, and it is easier to obtain higher accuracy than ordinary network. However, there are several kinds of RESNET residual neural networks, such as resnet-18, resnet-50 and resnet-101. At the same time, there are many details in the process of model training, such as the selection of optimizer, the selection of loss function and the size of model parameters. In order to get a better result of the mask recognition system, we choose different RESNET networks with different optimizers for training, in order to find a group of better choices.

Table 1. Effect presentation of RESNET model under different choices

Model	Optimizer	Validation Loss	Accuracy
Resnet-18	Adam	0.0378	99.7872%
Resnet-18	SDG	0.2102	95.6410%

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Resnet-50	Adam	0.0241	99.7436%
Resnet-50	SDG	0.2044	96.6667%
Resnet-101	Adam	0.0393	99.2308%
Resnet-101	SDG	0.2551	96.1538%

Through the experimental comparison, it is obvious that the effect of using Adam optimizer in the mask recognition system is better than that of using SDG optimizer. The accuracy of resnet-18 is 99.7872%, followed by 99.7436% of resnet-50 and 99.2308% of resnet-101. Therefore, this mask system uses resnet-18 network and Adam optimizer to complete the construction of the system model and uses the model to train our data set.

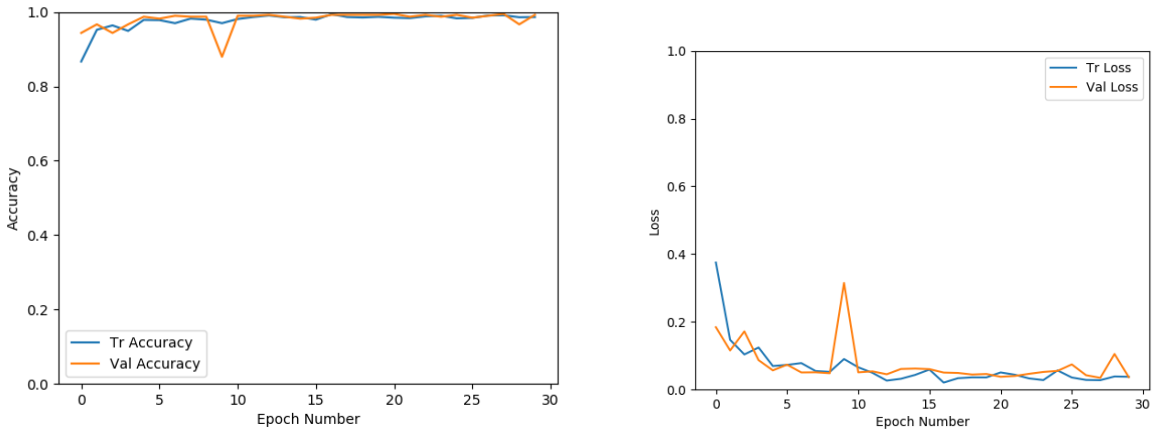

Figure2. Visualization of training effect of resnet-18 network with Adam optimizer

3.2.4 Application of the system in reality

At the end of the experiment, we apply the system to real-life to test the feasibility and accuracy of the system. We use Pytorch to load the trained mask recognition model into the system, and then use OpenCV to obtain videos and pictures, and realize face recognition and target tracking on the data source, so that the system can track the face in the pictures or videos, and use the model to judge whether the current face data is wearing masks and whether it is wearing masks correctly.

The result of the system application is shown in the figure below.

Figure3. Mask recognition of the system in real life (Pictures are collected from the web)

3.2.5 The system in the future

This system can accurately classify three cases of wearing masks, no wearing masks and wrongly wearing masks, but there is still an unsolved problem that once the face wearing objects are not masks, such as water bottles, water cups and other shielding objects, such objects will be classified as masks. In order to improve the above problems, the number of data sets will be increased in the future, and

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the target recognition module will be more refined. The wearing items or occlusion on the face will be classified into masks and non masks, and then the masks will be classified and recognized.

4. Bottleneck and urgency of machine vision development

In the nearly 30 years of the development of machine vision technology, many key technologies have made great progress and breakthroughs. The successful application of machine vision in some industries has proved the importance and necessity of its development. From the current situation, there are many bottlenecks restricting the development of machine vision, the most important of which can be attributed to three aspects: lack of computing power, unclear cognitive theory and the contradiction between accurate recognition and fuzzy features.

1. The research object of machine vision is mainly image and video. Machine learning is characterized by a large amount of data, redundant information and high dimension of feature space. Considering the diversity of objects and problems faced by real machine vision, a single simple feature extraction algorithm (such as color, spatial orientation and frequency, boundary shape, etc.) is difficult to meet the requirements of universality so that in the design of universal feature extraction algorithm, the demand for computing power and storage speed is very huge, which leads to a substantial increase in the development cost.

2. How does the machine accurately perceive? It is difficult to answer this question technically, even though the development of artificial intelligence theory has gone through a series of development schools such as symbolism, behaviorism and connectionism, it cannot get a definite answer.At present, relatively new ideas state that we should build an intelligent machine vision system by analyzing, understanding and simulating the information processing function of the human brain, but the development of neuroscience has limited the development of computer system. As a result, the problem of how people perceive a target or scene by science and technology is still limited to qualitative description rather than quantitative description.

3. One of the biggest bottlenecks in machine vision systems is accuracy. Take the face recognition algorithm as an example. Although a series of seemingly excellent algorithms have been published continuously, the accuracy of face recognition under a non-specified large-scale sample base still cannot meet the needs of practical applications, so it cannot replace the biometric recognition methods of close contact such as fingerprint or iris. This problem also shows that when the target is more detailed and complex, and the information is larger, the vagueness and uncertainty will be stronger. Faced with a large amount of information, even artificial vision, there is also the problem of accuracy decline.Therefore, how to simultaneously improve the ability of machine vision to process a large amount of information and recognition accuracy is also a big problem.

According to the above three points, the development of machine vision will still focus on the development of recognition algorithms for specific tasks or specific targets in the short term. There is still a long way to go to achieve the ideal degree of application.

5. Summary and Prospect

With the continuous development of the times, the environment that human beings are facing is becoming increasingly complex. From industrial manufacturing to home life, more and more information needs to be processed, and the requirements for work efficiency also increase. Artificial vision has been unable to meet the demand of production capacity, so the development of machine vision technology is inevitable and necessary. In industrial production, machine vision technology is a necessary means to realize industrial automation and intelligence, and it is one of the key technologies of intelligent manufacturing. It makes the original human-oriented production form gradually change to the industrial robot-oriented production form, makes the production line realize the real automation, and greatly improves the manufacturing capacity and efficiency of the factory. Similarly, in home life, machine vision technology is integrated into intelligent robots, makes robot more intelligent, anthropomorphic and better serve people's life needs. In terms of technology

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development, with the vigorous development of computer technology and artificial intelligence technology, machine vision has become an indispensable part of their technological breakthrough. In order to develop robot technology, we must overcome the difficulties of machine vision. It can be said that machine vision technology has been thoroughly integrated into the science and technology and life of human society, and gradually undertakes many tasks that are difficult to be completed by human beings, which is of great significance to the entire automation industry and robot industry. Moreover, with the advent of 5g era and the mutual penetration of the Internet of things, cloud computing and other technologies, machine vision technology will get a more long-term development in this era of mutual integration, especially the organic combination of machine vision and artificial intelligence, which will further tap the development potential of an intelligent society. Perhaps in the near future, we will see the application of mature machine vision technology. Those intelligent cars and robots that only exist in science fiction films will really appear in our lives, making human life more convenient and society more developed. Generally speaking, modern machine vision technology still has a long way to go. Many defects and bottlenecks in the development process need to be solved. We should always maintain a positive and encouraging attitude to support the continuous development and progress of machine vision technology.

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