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Laboratory Dangerous Operation Behavior Detection System Based on Deep Learning Algorithm

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ABSTRACT

Aiming at the problem that dangerous operation behaviors in the laboratory is difficult to identify by monitoring the video. An algorithm of dangerous operation behavior detection in multi-task laboratory based on improved YOLOv5 structure is proposed. Firstly, the algorithm enhances, adaptively scales, and adaptively anchors box computing on the input of YOLO network. Then convolution operation is carried out to strengthen the ability of network feature fusion. Finally, the GIoU_Loss function is used at the output to optimize the network parameters and accelerate the convergence of the model. The experimental results show that the algorithm performs well in real-time head localization, head segmentation, and population regression, with significant innovation and superiority. Compared with traditional methods, this algorithm has better accuracy and real-time performance and can more effectively achieve human operation behaviors detection in laboratory application environments.

KEYWORDS

Behavior Detection, Deep Learning, Laboratory, YOLOv5

INTRODUCTION

Human behavior is an important part of human life. There are many kinds of hazardous chemicals in university laboratories, which are scattered in storage locations and densely used (Dewi, 2021) and they are flammable, explosive, toxic, infectious and corrosive, and some high-risk chemicals even have highly toxic characteristics. If we can quickly identify dangerous behaviors by monitoring the video taken by the camera in the laboratory, we can find potential accident risks in time and deal with them immediately, which can effectively reduce or eliminate laboratory safety problems and ensure personal and property safety. Behavior detection and recognition has attracted more and more attention from relevant researchers because of its great application potential in monitoring system, video analysis and other fields (Ophoff et al., 2020; Li et al., 2021), and how to solve various problems in video behavior detection and recognition by using DL (Deep learning) technology is the hottest topic (Chen et al., 2021; Xu et al., 2020).

At present, the target detection methods based on DL algorithm can be divided into two categories according to whether the regional candidate network is adopted or not. The first stage is the two-

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stage target detection algorithm, the first stage is to generate candidate regions through the regional candidate network, and the second stage is to classify and regress the candidate regions (Xing et al., 2020). Literature (Zheng et al., 2021) put forward the histogram feature of gradient direction, combined with simple linear support vector machine as classifier, and achieved the best effect in the human detection algorithm at that time. Literature (Dao et al., 2022) proposes to use multi-camera pictures to detect the position, gesture and finger bending of hands, and stable detection can be realized through bone pictures, instead of data gloves, a contact device. The slow fusion model proposed in reference (Zimoch & Markowska-Kaczmar, 2021) uses 3D convolution and average pooling in its first three convolution layers, and achieved the best behavior detection effect at that time. Literature (Kohiyama & Yamashita, 2020) proposes a feature pyramid network for small target detection on the basis of Faster RCNN. Before using the feature pyramid structure, most DL-based detectors only detect at the top of the network.

Over the years, China has carried out a lot of research work in sensor network and monitoring, but the research combined with laboratory site safety monitoring is still in its infancy and exploration stage. Therefore, in order to manage hazardous chemicals in university laboratories scientifically, normatively and efficiently, it is particularly important to build an information management platform covering the whole process of purchase, use, storage and abandonment. In this paper, a multi-sensor integrated, flexible combination of functions, compact appearance, high precision and low cost laboratory dangerous operation behavior detection system is designed to improve the efficiency of laboratory safety management.Traditional methods for detecting hazardous work behaviors often rely on manually designed feature extraction methods, which often struggle to achieve ideal results in complex and dynamic environments. However, the emergence of deep learning algorithms provides new solutions to this problem. By constructing deep neural networks, we can automatically learn and extract high-level features from images, thereby achieving more accurate behavior detection.

In this article, we adopt a network structure of deep learning neural networks. This network structure can effectively capture spatial and temporal information in images. Firstly, deep learning is used to extract spatial features from raw images to identify the actions and postures of personnel in the laboratory. Then, deep learning is used to process temporal information to identify patterns of continuous actions and predict possible future behaviors. This network structure not only improves the accuracy of detection, but also enhances the real-time performance of the system.

RESEARCH METHOD

Detection Algorithm of Dangerous Operation Behavior in Laboratory

In recent years, the state has paid more and more attention to education and scientific research, continuously increased investment in university laboratory construction projects, and the laboratory has developed rapidly. With the growth of experimental demand, the types and quantities of hazardous chemicals used in laboratories are increasing. Each laboratory should formulate rules and regulations and operating procedures for the safety management of hazardous chemicals, record and monitor the whole process from purchase, collection, storage, use, recovery and disposal, strengthen the hardware conditions for the safety management of hazardous chemicals, and improve the technical ability and professional quality of safety officers. Because the management mode is limited by time and the number of managers, there is still room for further improvement in the current laboratory safety management.

The management of hazardous chemicals in universities is a complex and challenging task. Many laboratory experimenters in universities, especially scientific research experimenters, do not systematically record the detailed information of the purchasers, quantities, channels and varieties of hazardous chemicals in detail, resulting in missing or distorted purchase data. Universities should constantly explore the methods and modes of hazardous chemicals management, strengthen and

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