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Intelligent Building Hoisting Operation Detection System Based on APC Algorithm Assisted Sensor Monitoring

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Abstract. With the development of intelligence in today's society, APC Algorithm technology has also emerged in the computer industry, playing a very accurate role in monitoring various aspects. Now, due to the progress of the times, we can use APC Algorithm assisted sensors to monitor our lifting operations. Intelligent buildings are leading a new direction in the construction industry. In modern building construction, more and more buildings are committed to creating intelligent functions, but currently, lifting operations, as an important component of buildings, still lack the creation of intelligent functions. By comparing the performance of three deep learning model algorithms, Fast RCNN, SSD, and YOLO, this paper identifies a monitoring algorithm suitable for intelligent building lifting operations using APC Algorithm sensors for auxiliary monitoring, which can be used to solve monitoring problems in lifting operations. In order to achieve the people-oriented work goal, it is very important to monitor the safety of lifting operators in complex building environments through APC Algorithm monitoring algorithms. Experiments have shown that through APC Algorithm assisted monitoring, we can better regulate intelligent lifting operations and ensure the safety of workers. However, due to the insufficient comprehensiveness and diversity of the algorithms we study, further research is needed on the combination of APC Algorithm and algorithms.

Keywords. AI-assisted sensor monitoring, sensor technology, APC Algorithm, Intelligent Building

1. Introduction

Sensor networks represent a new type of computer network that integrates wireless communication technology, network technology, sensor technology, computer technology, and embedded systems. They can organically integrate the logical information world with the objective physical world, inject fresh data into the logical world, solve data source problems, and also achieve human-computer interaction - achieving the computing concept of "ubiquitous, always present". With the development of automation technologies such as sensor technolo[2]gy and APC

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Algorithm, the development of intelligent buildings has laid the foundation. [1] At present, relying solely on traditional sensor sensing systems is no longer sufficient for the purpose of intelligent buildings, and a combination of multiple technologies is needed to ensure intelligent buildings."Design Standards for Intelligent Buildings" defines intelligent building technology as a building that integrates structure, systems, services, management, and optimization. [2]

Previous research on sensors has involved magnetic sensors, self-validating sensors, color sensitive sensors, and position free sensors. The Hall effect was discovered by Edwin Hall in 1879, and the Hall element is the most well-known and widely used magnetic field sensor. The advantages of Hall sensors are low cost, miniaturization, low power consumption, and high reliability. Currently, approximately 2 billion Hall elements are produced annually in the world (Popovic, 2003). Its application scenarios include various aspects, from automobiles to airplanes, mechanical equipment to medical instruments, industrial applications to scientific research, and the presence of Hall elements can often be seen. Professors M. P. Henry and D. W. Clarke from the University of Oxford have also proposed the concept of self-confirming sensors and established a functional model for self-confirming sensors.[3] They have long been committed to researching methods for monitoring the operational status and evaluating the measurement quality of sensors during use, in order to improve the reliability of sensors. A self-validating sensor is an intelligent sensor that not only outputs the measured values of the sensor, but also evaluates the uncertainty of the measured values online to indicate the accuracy range of the measured values and achieve measurement quality evaluation.

This article proposes a new solution for lifting operations by analyzing Faster RCNN algorithm and SSD algorithm, combined with APC Algorithm assisted sensors.This kind of intelligent buildings can provide users with a safe, convenient, efficient, healthy, energy-saving and environmental protection environment, and effectively improve the quality of building use.Intelligent building technology is a comprehensive form of a variety of technologies, in addition to building technology, but also the integration of information and communication technology.Intelligent buildings attach great importance to the optimal utilization of resources, upgrade construction methods, and achieve the goal of maximizing the value of resource utilization.Intelligent building technology runs through the beginning and end of the construction project, in the design, construction, management and other links are reflected.[4]The core of the APC Algorithm monitoring system derived from the APC algorithm includes communication systems, computer management systems, and building equipment automatic control systems. Multi sensor fusion enhances the safety and efficiency of intelligent building lifting operations through complementary advantages. At the same time, improving the accuracy of operations is also one of the issues we need to pay attention to. In recent years, APC Algorithm algorithms have achieved great success in both academia and industry. Therefore, it is natural to apply APC Algorithm technology to sensor fusion in intelligent building lifting operations. This article compares the performance of three deep learning model algorithms, including Fast RCNN, SSD, and YOLO, and combines them with APC Algorithm assisted monitoring to determine a suitable monitoring algorithm model for worker safety assurance in lifting work environments - the APC algorithm model. This algorithm greatly provides the accuracy and safety of intelligent lifting operations.

2. Methodology

Intelligent building technology combined with AI-assisted sensor monitoring technology effectively breaks through the constraints of traditional building development mode, and has the following multiple functions 1) The application of intelligent building technology in the design stage: for example, relying on BIM technology to establish the information model related to building hoisting and judge the problems existing in the design in a more intuitive way is conducive to the smooth progress of hoisting operations 2) Application in the construction operation stage: relying on the Internet of Things to promote data sharing and give play to the guiding role of data in construction projects [5]; AI dynamic monitoring, data retrieval and other methods are jointly adopted to clarify material supply, mechanical equipment running state and other specific conditions, and AI sensor technology is used to dynamically control resources according to engineering requirements to promote the completion of hoisting operations.

We compared the performance of Fast RCNN, SSD, and YOLO deep learning model algorithms using APC Algorithm assisted monitoring, and combined them with APC Algorithm assisted monitoring to obtain a new APC algorithm model, greatly improving the accuracy and safety of intelligent lifting operations.

2.1. Faster-RCNN algorithm

Fault tolerance. Mainly measures the impact of the failure of some sensor nodes in the region on the overall performance of the network. Fault tolerance emphasizes the ability of the network to maintain overall communication smoothness even after some sensor nodes fail. To represent the fault tolerance or reliability of a single node L. The mathematical model of this indicator satisfies the distribution. The fault tolerance of a single node during a time period can be represented by formula (1).

$$L = \{(i,j): 1 \leq i \leq N_1, 1 \leq j \leq N_2\} \tag{1}$$

The Faster-RCNN algorithm in 2015, which is based on the RPN candidate box generation algorithm. On this basis, the monitoring of target tasks is greatly accelerated. Under Faster-RCNN mode, the judgment process of hoisting operation is as follows: input the test picture of hoisting machine, input the whole picture into CNN, carry out feature extraction, and then edit through RPN to generate a group of Anchor boxes.And then it clipped and screened, and finally decided anchors is foreground or foundation, object, non-object, so it's a dichotomy.See figure 1. for the specific description of Faster-RCNN.

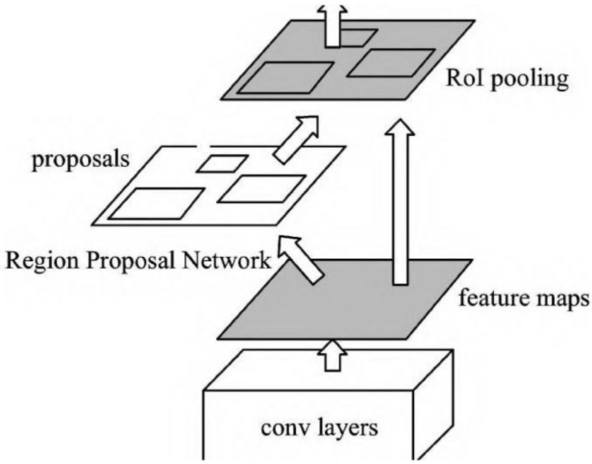

Figure 1. Faster-RCNN structural detail

2.2. YOLO algorithm

Scale based indicators. The number of nodes in a sensor network varies according to the actual application requirements. If the number of nodes reaches the maximum allowable value in the region, it will not only affect the normal communication between nodes in the region, but also increase the operating cost of the network. This indicator mainly calculates the number of sensor nodes per unit area. Please refer to formula (2) for details.

$$L = \{(i, j): 1 \leq i \leq M, 1 \leq j \leq N\} \tag{2}$$

2.3. SSD algorithm

Multi-scale feature mapping (maps) was used in SSD algorithm. The algorithm adopted conv4_3, conv_7, conv8_2, conv8_2,conv9_2, conv10_2, conv11_2 and other feature maps.Since the perception range of the underlying feature map is small while that of the upper layer is large, different feature maps can be used to achieve multi-scale goals.See formula (3) for details.

$$\delta = f(s, E, \rho, t, v, \alpha, g, w) \tag{3}$$

2.4. Comparison of experimental results

Aiming at the safety and accuracy monitoring of hoisting operation, we constructed a data set of 1 500 images through the images collected by the on-site real-time monitoring system, marked and trained 1 500 images, and finally conducted a safety monitoring experiment on 100 images.Based on the constructed image data set, we conducted experiments using the above three algorithms respectively to obtain the training model, and used 100 identical images to test the model. The specific experimental results are shown in table 1. As shown in the table, we finally innovated the APC algorithm and obtained a new intelligent lifting operation system. Combined with APC Algorithm sensor assisted monitoring, the model obtained can reach a rate of 21 frames per second, basically meeting the needs of real-time monitoring.

Table 1. Comparison of the performance of YOLOv5, SSD and Faster-RCNN algorithms

Method	Map	Precision	Recall	FPS	Batch size
YOLOv5	63.2	0.973	0.989	21	1
Faster-RCNN	67.9	0.947	0.976	6	1
SSD	70.3	0.966	0.964	17	1

2.5. The combination of AI and vision sensors

Conventional visual sensor refers to all able to capture at least similar to the human eye of two-dimensional image sensors, including RGB (Red - Green Blue) camera, black and white camera and infrared camera. Through the triangulation method can calculate the distance. In particular, the distance between the camera and the target based on triangulation is estimated to be D, the estimation error is, and the correlation among the three is shown in formula (4).

$$\Delta D = \frac{D^2}{fB}\Delta V \tag{4}$$

We need to fully analyze and combine the advantages and disadvantages of the three algorithms, and use the APC Algorithm monitoring system to obtain the optimal model. The APC algorithm improves the accuracy of intelligent building lifting operations, while also ensuring the safety of workers at 85% or above.

3. Experiment

Under the background of the rapid development of communication technology and the rapid rise of APC Algorithm, 5G technology and APC Algorithm will also change the existing sensors and sensor networks, making them more rapid, efficient and intelligent.Typical structure model diagram of standard networked AI sensor is composed of intelligent transmitter unit (STIM), signal conditioning unit, digital processing module, sensor spreadsheet, sensor independent interface, network control module (NCAP), network interface and other unit modules [6].In the monitoring of intelligent buildings, the sensing components of intelligent sensors are composed of a variety of sensor nodes, which can simultaneously monitor a variety of structures in hoisting operations under the action of AI technology. Each sensor is directly connected to the signal transmitting node of the communication module, and the collected data is transmitted to the processor module through the network.Signal perception is the analog signal collected by the sensor perception module in rapid response to the external factors.[7] AI auxiliary sensors are characterized by high hotspot capacity, low time delay, high reliability, low power consumption and large connection.The information data is collected and processed and then fed back to the sensor node to achieve self-adjustment and self-correction and reduce measurement errors.

The implementation of APC Algorithm Assisted Sensor Monitoring systems requires many devices. Mechanical and non mechanical machines can only be assembled together to improve their accuracy and safety. The main equipment of the system consists of a command center and multiple wiring terminals, and the main equipment of the wiring terminals is shown in table 2.

Table 2. Monitor the main equipment of the monitoring system

Serial number	Name of major equipment	Quantity/unit	Remarks
1	Camcorder	2	Infrared night vision range 26m
2	Pedestrian awareness radar	2	Limited monitoring distance 15m
3	Vehicle awareness radar	2	Limited monitoring distance 40m

In the previous text, we also mentioned many methods of using visual sensors. However, visual sensors have limitations. If there is movement or a lot of obstruction in the camera's field of view, the measurement results are likely to be unexpected and cannot compare to APC Algorithm assisted sensors. In order to overcome these external disturbances, many new methods have emerged that combine deep learning with visual sensors and APC Algorithm technology. We have conducted a performance comparison of various visual sensors at this stage, as shown in table 3.

Table 3. Comparison of various visual sensors

	BlackCam	RGB Bayer	INFRARED CAMERAS
Distinguishability	Excellent	Excellent	Inferior
Dark light property	Moderate	Inferior	Excellent
Object Classification	Inferior	Excellent	Moderate

Each type of camera has its own advantages and disadvantages, the choice depends on the actual situation. Combined with AI technology, all kinds of visual sensors can better give play to their performance, and increase the security and accuracy of hoisting operations.

4. Discussion

Through the implementation and promotion of the intelligent operation platform, the mission of scientific management of production safety is implemented, the sustainable development of production safety benefits is always put in the first place, and the production accident rate of personnel and equipment is effectively reduced. The integrated intelligent application of AI robot, multi-sensor fusion technology, robot vision technology and online monitoring system has greatly solved the problems of safety and accuracy in hoisting operation.[8]

In practical sensor network applications, the main nodes or aggregation points within the region have strong communication capabilities, long transmission distances, and high electrical energy, which can transmit information outside the sensor network. The other nodes act as sensor slave nodes, gathering and transmitting data from the nodes to the base station. Various sensor nodes collaborate to detect, perceive, and collect various environmental factors in real-time.[9] The typical structure of APC Algorithm sensor network is shown in figure 2.

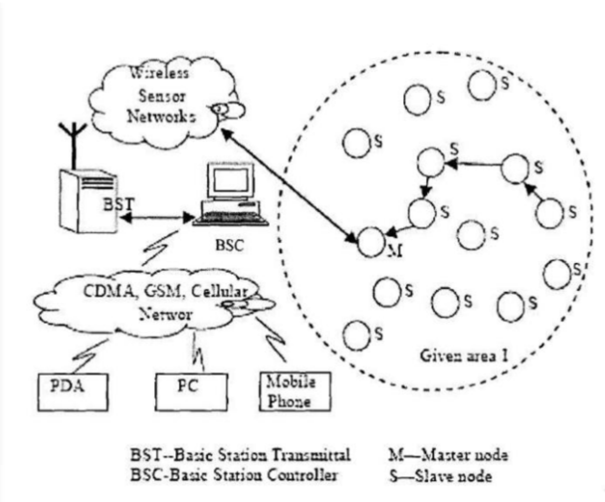

Figure 2. Schematic diagram of APC Algorithm sensor network structure

Through the implementation of AI auxiliary sensor monitoring, the accident rate in the hoisting operation area can be effectively reduced. However, in terms of the current degree of informatization, adequate training enables AI robots to have the ability of some professionals to some extent. [10] There is still a long way to go before AI robots can completely replace people, and the pace of promotion still needs to be gradual.

5. Conclusion

To sum up, combining AI assisted sensor technology and integrating intelligent building technology into traditional building development mode will greatly improve the construction quality and efficiency of hoisting operation and reduce resource consumption and cost input. The rapid development of APC Algorithm and the innovation of intelligent buildings are one of the important development directions in the future. We need to recognize the connotation of intelligent building technology, clarify the key points of artificial intelligence monitoring technology, apply intelligent building technology reasonably based on construction conditions, and demonstrate the economic, social, and ecological benefits created by the combination of intelligent building technology and artificial intelligence technology. Utilizing the APC algorithm to fully utilize artificial intelligence for intelligent monitoring of buildings can achieve more comprehensive and frequent monitoring of lifting operations, effectively carrying out preventive safety work.

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