5G Smart Park Project Report - Video networking technology

1 Background

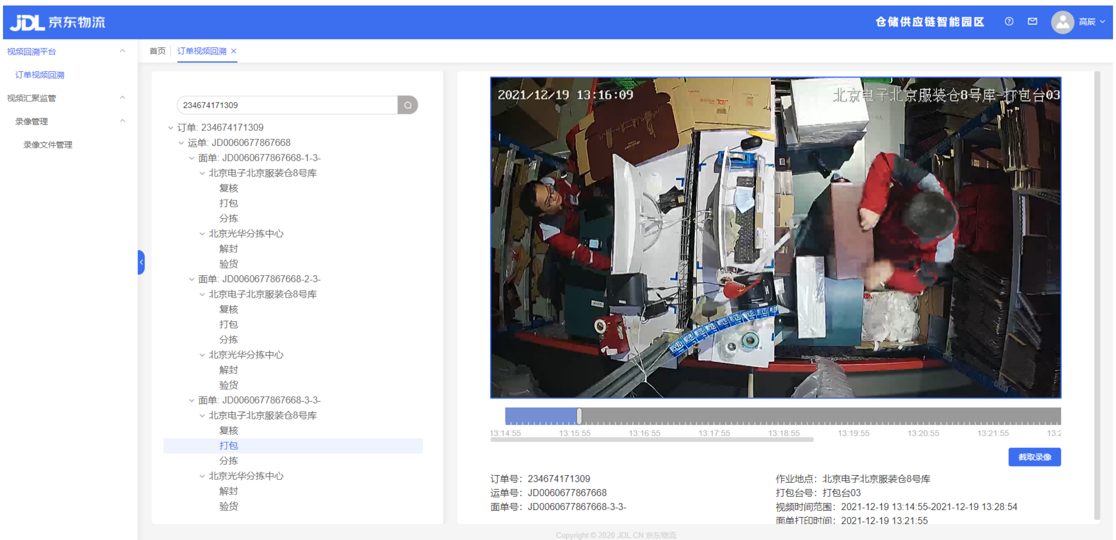
Relying on the ability accumulation of intelligent technology innovation and full scene application, JD Logistics has created a three-dimensional supply chain technology platform covering the underlying technology, software and hardware systems and intelligent supply chain, which can be exported in a modular way. With the fundamental purpose of technology-driven business, the visualization project in the warehouse is now carried out for the small and medium parts warehouse of JD Logistics nationwide. Video backtracking is conducted for the packing desk of the warehouse operation through video networking technology. Through edge computing technology and video networking combined with license plate recognition algorithm developed by JD Logistics, the throughput of the warehouse platform is monitored to control the flow of goods into the warehouse. Finally, through the combination of CAD drawings and basic business data in the warehouse, the visual map of JD logistics warehousing is created.

2 JD Logistics Packing Table Video Networking Retrospect

2.1 Background

Through the video network backtracking of the warehousing and packaging table, real-time identification and alarm of dangerous behaviors, monitoring of the situation on the job site, supervision of the presence of goods, and analysis of operation efficiency, establish the mapping relationship between key production events and monitoring videos, and quickly find the entire process based on information such as orders A video clip of the specified process (time and location). Support video cloud accelerated playback, which can be opened to customers or users for original playback; improve internal management efficiency and facilitate quality control and accident judgment. The main advantages are:

- Event templates can be flexibly defined according to business patterns
- Supports real-time recording and retrospective mapping operations
- Local storage + cloud storage integration to maximize cost optimization



2.2 Scheme Features

(1) Multi-regional networking

- Multi-vendor multi-protocol compatibility (GB/T28181, Onvif, proprietary protocol, etc.)
- Camera, video recorder networking, video platform cascade, multi-level compatible networking
- Fully benefit the old, low cost to achieve group networking

- Supports PC, mobile and large-screen multi-terminal distribution and playback
- Can simultaneously meet the enterprise internal management requirements and external regulatory requirements

(2) Rich signaling control and communication

- Full link device status monitoring
- Support PTZ
- Support voice shout, intercom, and broadcast

(3) Enterprise data security and authority management

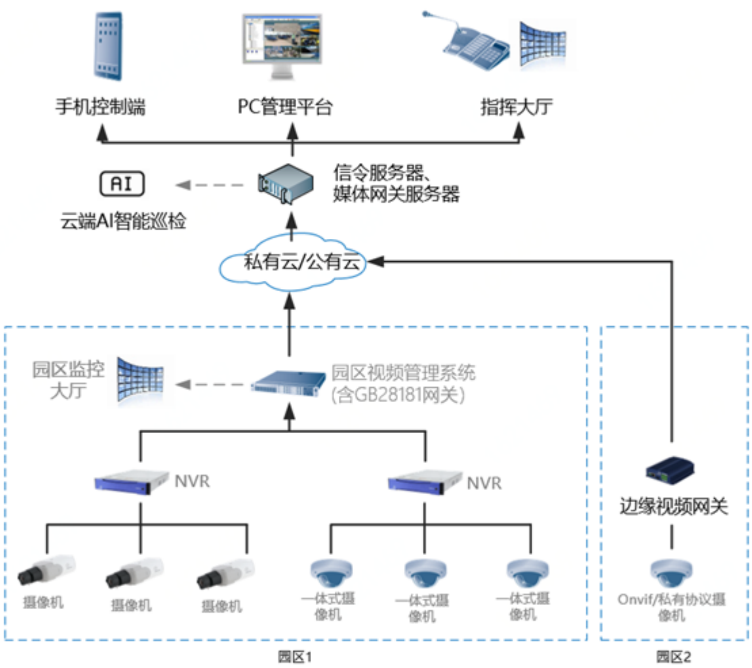
- 100% isolation of enterprise user data
- Flexible regional organization management, user, and permission group management
- Real-time video streaming and video data management
- Hierarchical and regional device control permission management

(4) Complete streaming media function support

- Instant pull stream, remote access to local storage video
- Multi-terminal streaming playback (computer client, web page, mobile APP)
- Multiple streaming media formats (RTMP, RTSP, HLS, FLV, etc.)
- Cloud video storage, cloud transcoding, cloud on-demand acceleration
- Frame snapshot, image quality AI monitoring

2.3 Storage test plan

(1) JD Logistics video surveillance networking case



(2) Two options are currently being evaluated

At present, about 161 warehouses are connected to LCV video networking; The camera is not complete, can be made in the local warehouse, the same as part of the local sorting scheme, the local warehouse is the equipment installed in the warehouse room, can directly monitor physical docking, but the actual use demand is far more than the expected demand, so it is relatively slow.

- Scheme 1 - USING LCV: the cost of cloud server is mainly shared by national resources, which is relatively reasonable. But the promotion of the national packaging network itself is a huge collaborative work, will also produce some old hardware update costs. And the promotion of LCV requires two requirements :(1) all the cameras in the warehouse should be connected, the bandwidth of the warehouse should be re-evaluated, and the viewing consumption should be controlled. Simple access only involves signaling transmission, which consumes less resources; (2) LCV may need to expand capacity and add servers, and the cost needs to be confirmed through communication.

- Scheme 2 - Local construction: The intelligent supply chain department has advantages over external suppliers, which can be reduced to tens of thousands of sites. Some services are still run in the cloud, but regional coordination and on-site deployment are also required.

(3) Short-term test plan

- Current short-term plan: Beijing Clothing Database 8 is used for testing, and data is connected through the packing time field of FDM_WMS5_Report_OB_PACKage_M_CHAIN. The order number/package number can be directly located to a certain range of the packing time, and the worker can check the video before and after dragging within the positioning video range.
- If the effect is good, a comprehensive promotion meeting will be held in the future to directly connect with the WMS production system (tentative), which is expected to realize the video range from the scanning time of the first product to the scanning time of the last product in the order, so as to make the video range more accurate

3 JD Logistics warehousing digital platform

3.1 Background

The warehousing process of small and medium-sized parts in JD Logistics is rather complicated, and most drivers cannot accurately arrive at the warehouse for unloading according to the scheduled time. Based on the above pain points, promote the storage digital platform video networking project, identify the license plate number of trucks through computer recognition technology, and accurately monitor the time of vehicles entering and leaving the warehouse, and synchronize the data recorded in video to the digital platform dashboard in real time, so that drivers can check the platform throughput in real time.

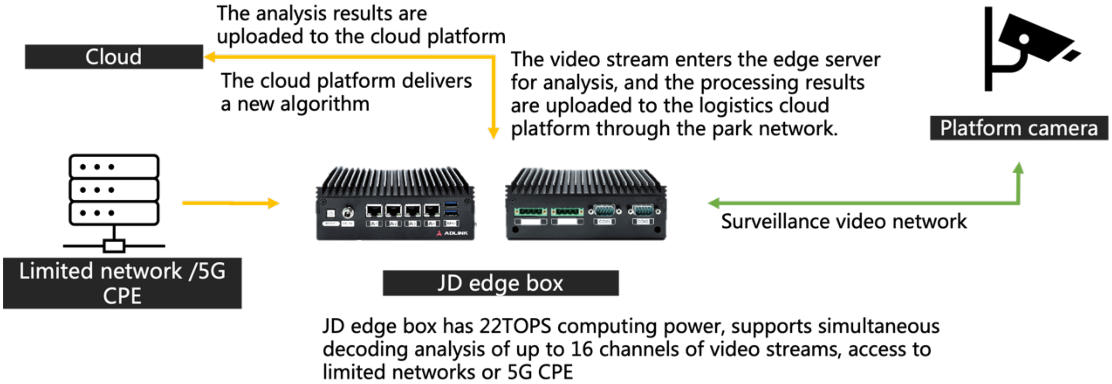
3.2 Plan

(1) At the same time, support PC and App digital platform dashboard upgrade, platform docking time check, timeout docking warning, platform real-time video check.

(2) Support for other algorithms

- Replace the HIKVISION license plate recognition algorithm with the license plate recognition algorithm developed by JD Logistics.
- Through edge computing technology, directly access to the existing monitoring network to enable AI for the existing monitoring equipment.

- Single-lane and dual-lane identification is supported. The number of lanes identified at the same time can be adjusted according to actual scene requirements.
- Support the identification of car body number, and still have the ability to recognize the vehicle license plate in the case of occlusion.
- Support linkage of intelligent station vehicle task information to improve license plate recognition rate.
- Support 7*24 hours of uninterrupted operation.
- Have the ability to deliver update algorithms from the cloud and dynamically improve the recognition ability.

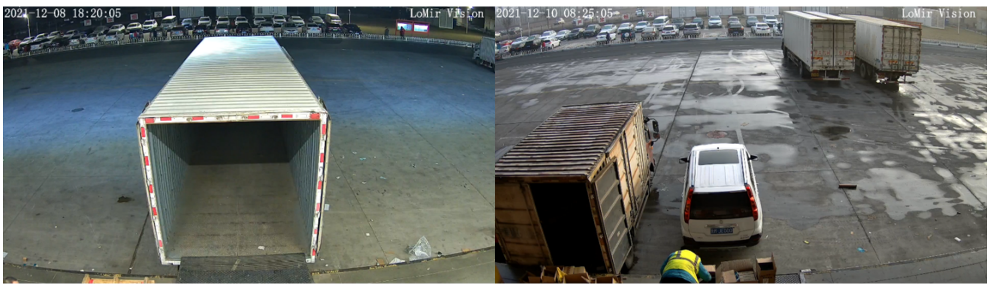


- Platform single lane identification

- Platform dual lane identification

3.3 Status quo

The current digital platform can recognize the arrival situation of the vehicle, the vehicle license plate number, and return the platform situation at that time. At present, the algorithm is further trained according to the field environment to reduce the occurrence of false positives and false returns.



Finding problems:

1. No lane line is drawn on the platform at the warehouse side, and the parking position of vehicles is uncertain every day, which brings great challenges to vehicle identification.

2. There are a large number of discarded cartons and other items in the warehouse side platform every day after warehousing, which has a great impact on the recognition rate.

Next stage plan:

1. Deploy the front-end display page to show the platform occupation.

2. Optimize the algorithm to improve the accuracy of vehicle identification.

3.4 Build k-NN model

3.4.1 Model Building

```python
import os

def read_data(path, max_num=-1):
    data, label = list(), list()
    for root, dirs, files in os.walk(path):
        if len(dirs) == 0:
            y = root.split(os.path.sep)[-1]
            file_lst = files[:max_num] if max_num > 0 else files
            for f in file_lst:
                img = Image.open(os.path.join(root, f))
                data.append(np.array(img).reshape(-1))
                label.append(y)
    return np.array(data), np.array(label)

PREFIX = '/Users/chan/Documents/5G/data/'
x_train, y_train = read_data(os.path.join(PREFIX, 'train'))
x_test, y_test = read_data(os.path.join(PREFIX, 'test'))
x_train.shape, y_train.shape, x_test.shape, y_test.shape

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score

clf = KNeighborsClassifier()
clf.fit(x_train, y_train)
```

```
p_test = clf.predict(x_test)
accuracy = accuracy_score(p_test, y_test)
print('accuracy: {:<.4f}'.format(accuracy))
```

Conclusion: accuracy = 0.6969

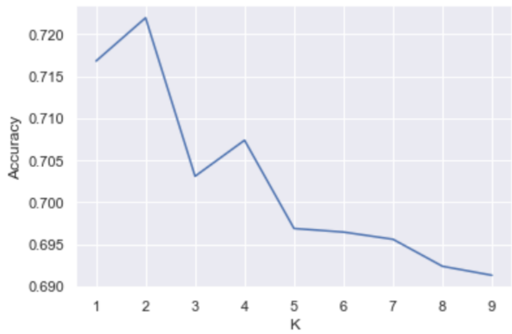
3.4.2 The influence of K

```
import matplotlib.pyplot as plt
import seaborn as sns
sns.set()

k_range = range(1, 10)
acc_lst = list()
for k in k_range:
    clf = KNeighborsClassifier(k)
    clf.fit(x_train, y_train)
    p_test = clf.predict(x_test)
    accuracy = accuracy_score(p_test, y_test)
    acc_lst.append(accuracy)
    print('K: {}, accuracy: {:<.4f}'.format(k, accuracy))

plt.plot(k_range, acc_lst)
plt.xlabel('K')
plt.ylabel('Accuracy')
plt.show()
```

```
K: 1, accuracy: 0.7168
K: 2, accuracy: 0.7220
K: 3, accuracy: 0.7031
K: 4, accuracy: 0.7074
K: 5, accuracy: 0.6969
K: 6, accuracy: 0.6965
K: 7, accuracy: 0.6956
K: 8, accuracy: 0.6924
K: 9, accuracy: 0.6913
```



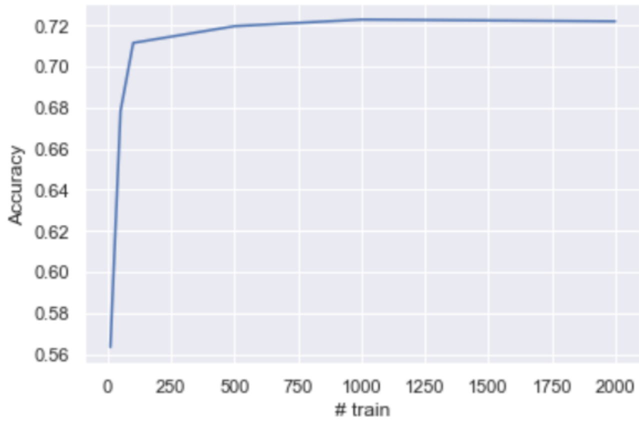
3.4.3 Training

```
train_range = [10, 50, 100, 500, 1000, 2000]
acc_lst = list()
for train_num in train_range:
    x_train, y_train = read_data(os.path.join(PREFIX, 'train'), max_num=train_num)
```

```
    clf = KNeighborsClassifier(2)
    clf.fit(x_train, y_train)
    p_test = clf.predict(x_test)
    accuracy = accuracy_score(p_test, y_test)
    acc_lst.append(accuracy)
    print('train: {}, accuracy: {:<.4f}'.format(train_num, accuracy))

plt.plot(train_range, acc_lst)
plt.xlabel('# train')
plt.ylabel('Accuracy')
plt.show()
```

```
train: 10, accuracy: 0.5633
train: 50, accuracy: 0.6782
train: 100, accuracy: 0.7115
train: 500, accuracy: 0.7196
train: 1000, accuracy: 0.7228
train: 2000, accuracy: 0.7220
```



4 Conclusion

The training set ranged from 10 to 2000, and the accuracy ranged from 0.5633 to 0.7220. The model was applied to the JD Logistics digital platform to monitor vehicle throughput.

Access to the video networking project can effectively reduce the working time for abnormal order handlers to retrieve monitoring from the system, and it is estimated that the query efficiency can be improved by about 70%. Abnormal orders account for 2/10,000 of the total, daily single orders are 6 million, and there are about 800 order processing staff, with a total profit of about 672,000 yuan/month.