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# *Research on Water Online Monitoring and Identification*

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***Keywords:*** Multi sensor cooperation; Road water accumulation; Online monitoring

***Abstract:*** Aiming at the monitoring of urban road water depth, based on narrow-band Internet of things, with the help of multi-sensor collaborative calibration, accurate real-time measurement of road water depth under complex outdoor conditions is realized. Combined with semi real-time image, it can realize the intuitive grasp of road water regime dynamic. The system is suitable for urban road water monitoring, risk warning and dispatching decision support under heavy rainfall. The real-time online water quality monitoring based on multi-sensor collaborative calibration collects semi real-time image data, real-time monitoring data of ultrasonic and capacitive liquid level meter, and the measurement is more accurate through multi-sensor collaborative calibration of camera, ultrasonic and capacitive liquid level meter; the online monitoring method based on convolution neural network model reasoning analysis is used for ponding image recognition to improve the urban intelligent drainage monitoring efficiency Test ability.

## 1. Current Situation of Pavement Ponding Monitoring

At present, the problem of Urban Road Waterlogging tends to be frequent and serious, which is mainly caused by the following two factors: one is the frequent occurrence of short delay heavy rainfall events caused by global climate change, and the other is the significant change of urban hydrological characteristics caused by rapid urbanization. Serious urban road waterlogging problem will bring great impact on urban production, life and personal property safety, which has attracted great attention of local governments. Various measures have been taken to improve the ability to deal with rainwater waterlogging disaster prevention. Real time online monitoring of Road area water is the most important part.

The road area water monitoring instruments on the market can be divided into ultrasonic water level meter, capacitive water level meter, observation trace type water level recorder and manual report according to the principle.

The principle of ultrasonic water level gauge is that the propagation speed of ultrasonic wave in water and air is different, which can be divided into upward type and downward type according to the installation position[1]. Among them, the downward ultrasonic water level meter emits ultrasonic wave from high to road, and the accumulated water depth is obtained by subtracting the distance obtained each time from the installation height of the instrument. The upward type ultrasonic water level meter is installed on the road surface, emits ultrasonic waves from the road surface to the air, and returns to the water depth.

The principle of capacitive water level gauge is that the conductivity of water and air is different. At present, electronic water gauge is widely used in the market.

There is also a way to report the ponding situation manually. There are many specific forms: hiring patrol teams to patrol the whole city, opening citizen drainage hotline, providing Internet platform for citizens to upload data, and obtaining flood information based on crawler. The advantages and disadvantages of water level monitor on the market are analyzed in Table 1.

Table 1: Analysis of advantages and disadvantages of water level monitors on the market

| Name of monitoring instrument | Advantage | Shortcoming |
|---|---|---|
| Ultrasonic water level monitor | Real time, high precision, anti-jamming | High cost |
| Capacitive water level monitor | Real time, high precision, | Exposed, easy to be damaged, high cost |
| Observation trace water level monitor | Low cost | Non real time, only the deepest water can be observed |
| Report manually | Wide coverage | Non real time, low precision, high demand for the enthusiasm of the masses |

It can be seen that the monitoring methods that can meet the requirements of urban waterlogging monitoring accuracy and time have the disadvantages of high cost, while the low-cost monitoring methods have poor effect. Therefore, it is urgent to develop a flood monitoring method with wide coverage, low cost and real-time. In order to solve the above problems, a real-time road area water online monitoring device and method based on multi-sensor collaborative calibration is designed, which collects semi real-time image data, real-time monitoring data of ultrasonic and capacitive liquid level meter, and makes the measurement more accurate through multi-sensor collaborative calibration of camera, ultrasonic and capacitive liquid level meter; based on reasoning analysis, when a monitoring device fails, it can be timely discharged In order to improve the ability of intelligent drainage construction.

## 2. The Instrument and Device of Road Ponding

The real-time online water monitoring device with multi-sensor collaborative calibration includes seven parts: solar photovoltaic panel, charging controller, battery pack, central processing and data storage module, communication module, contact sensor and non-contact sensor; the solar photovoltaic panel is directly connected with charging controller and battery pack, and the battery pack is connected with central processing and data storage module The central processing and data storage module is directly connected with the communication module, contact sensor and non-contact sensor and controls them, as shown in Figure 1.

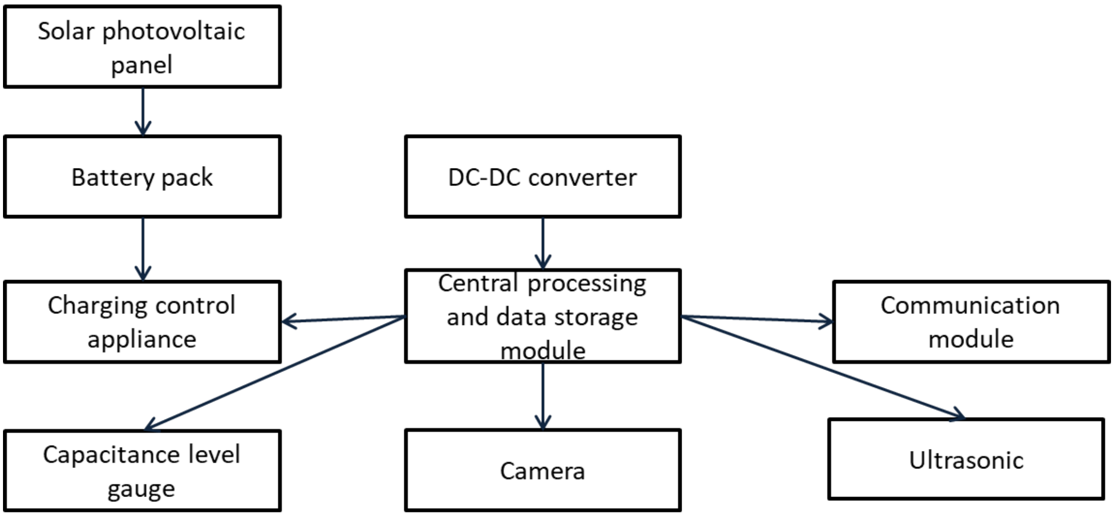


Figure 1: structure diagram of online water monitoring device

## 3. Online Monitoring and Analysis Method

### 3.1. Recognition Method of Ponding Image Based on Convolution Neural Network

At present, some relevant departments monitor the road water accumulation in their respective areas by means of "global eye", as shown in Figure 2. This method relies on manual identification, and gives flood emergency instructions by observing the severity of road ponding in the video.

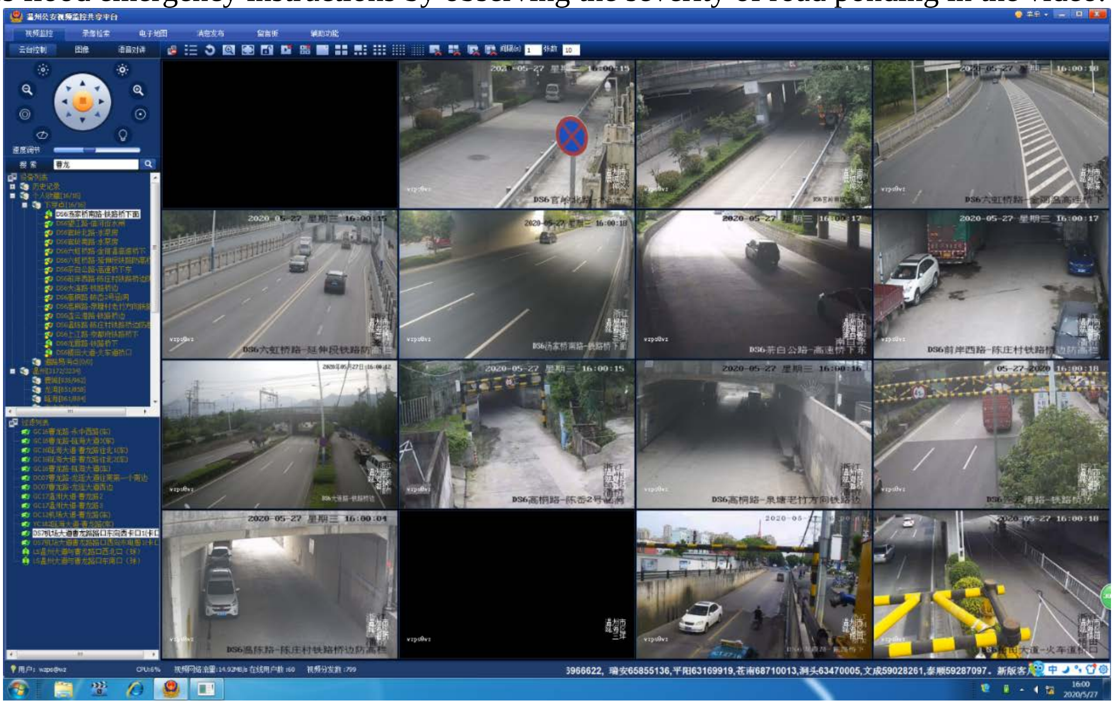

Figure 2: Example of electronic eye road monitoring system

However, this kind of manual "global eye" road monitoring method is effective but inefficient. Aiming at the disadvantages of slow speed, leakage, fatigue and low efficiency of manual identification of water logging video, this paper proposes a method of road water logging identification based on computer vision.

Deep learning is an important part of artificial intelligence. Compared with shallow model, deep learning has obvious advantages in feature extraction and modeling. As a branch of deep learning, convolutional neural network effectively reduces the number of parameters in the neural network, reduces the complexity of the network, is easy to train and optimize, and has certain robustness and good normalization ability[2]..

In this study, a neural network based on DenseNet40 architecture was built to train the severity of road water logging. DenseNet model, as a convolutional neural network, is an improved version of deep residual neural network[3]. Different from the deep residual neural network, DenseNet establishes dense connection between the front layer and the back layer. Another feature of DenseNet is to realize feature reuse by connecting features on the channel These characteristics make DenseNet achieve better performance than convolutional neural network with less parameters and computational cost. In short, DenseNet algorithm directly connects all the neural layers on the premise of ensuring the maximum information transmission between the middle layer and the layer.

Compared with ResNet, DenseNet does not combine features by summation, but by connecting them before passing them to the layer. Therefore, layer X (excluding input layer) will have X inputs, which are the feature information extracted from all previous layers. If the convolutional network contains shorter connections between the layers close to the input and close to the output, the network can be significantly deepened and become more accurate.

In short, DenseNet alleviates the problem of vanishing gradient, enhances feature propagation, and greatly reduces the number of parameters, which is more suitable for the purpose of this study.

It is a difficult and fuzzy process to identify the depth of ponding from the image. Even if the ponding is identified manually, it can only roughly judge its range, but can not accurately determine the specific depth of ponding. In view of this situation, this study proposes to take the severity as the training target, and divide the ponding image into five categories: dry without ponding (0cm), wet without ponding (0-5cm) Slight (5-10cm), moderate (10-20cm) and severe (> 20cm). The classification of ponding according to its severity can achieve higher accuracy without losing more practicability.

### 3.2. Acquisition Method of Training Data Set

The training set used in this study marks the severity of ponding, which is used to fit the model and train the classification model by setting the parameters of the classifier[4]. Later, when combined with the verification set, different values of the same parameter will be selected to fit multiple classifiers.

The original water logging data and images collected by this research institute come from the " global eye" road monitoring system in the study area. For the collected water logging image data, this research classifies them by manual identification. 3000 road monitoring devices can provide about 10000 pieces of data for the training set in a 3-hour heavy rainfall. A total of 500000 images were collected during the study, which can meet the basic data requirements of neural network training, as shown in Figure 3.

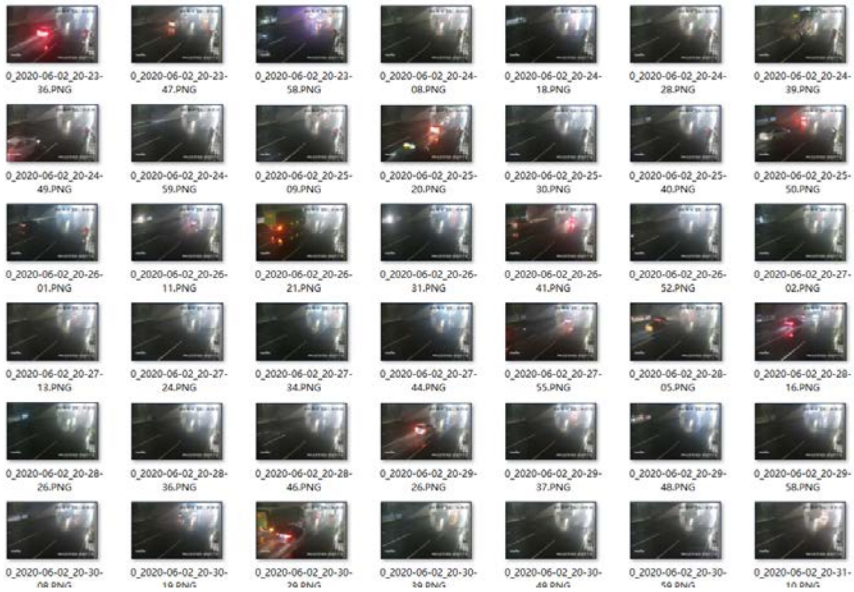

Figure 3: Example of manual annotation

### 3.3. Analysis and Summary of Model Effect

The research group cut 10% data from the original training set as the test set to verify the accuracy of the model. It is verified that the average recognition accuracy of the trained neural network for the monitoring data of ponding can reach more than 97%, and the recognition accuracy of serious ponding can reach more than 98%.

Using the key layer of neural network proposed by the research group for training technology, it is found that the train loss and valid loss at the end of training are significantly reduced, which indicates that this scheme can improve the generalization ability of the model.

## 4 Summary

In recent years, due to the increase of the number of vehicles in the city, the incidents of vehicle water related flameout, unnecessary casualties and property losses caused by road water often occur[5]. The occurrence of urban flood disaster is not only a natural phenomenon, but also a social phenomenon. In the 20th century, the global population and property concentrated in high-risk areas of natural disasters, which accelerated the change of natural environment on the one hand, and increased the vulnerability of society and property on the other hand, resulting in frequent disasters and serious losses. Therefore, it is necessary to monitor the road surface water in real time.

This paper studies the real-time water area online monitoring device and method based on multi-sensor collaborative calibration. The narrow-band Internet of things is used for data transmission, which can provide the interface with cloud big data. After data analysis and verification, the online monitoring method can ensure high accuracy under the premise of meeting the generalization ability, and can get good monitoring effect in different scenes, which can meet the real scene According to the precision and application requirements of the system, the real-time monitoring of the road area water condition improves the intelligent application of urban drainage.

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