Research on Intelligent Perception Technology of Dynamic Flood Conditions Based on Video Images

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SUMMARY

1. Research Objectives

During catastrophic rainstorm and flood scenarios, monitoring equipment often fails due to power outages and data transmission interruptions, leading to an inability to obtain timely data on flood conditions, which hinders disaster assessment. Furthermore, the inadequate integration of software, hardware, and algorithmic models results in low resolution and accuracy in flood risk assessment and early warnings. This research utilizes easily accessible, weather-resistant, and information-rich surveillance and online video data as sources. By employing deep learning-based optical flow technology, an intelligent perception model for estimating river surface flow velocity from video images was developed. This model aims to significantly enhance the decision-support capabilities for flood emergency response.

2. Research Results

A deep learning optical flow model based on RAFT was employed to achieve global velocity measurement of water flow in video sequences. Optical Flow Visualization is a common velocity detection algorithm in the field of computer vision, and RAFT (Recurrent All-Pairs Field Transforms) is a deep learning implementation method for optical flow. The RAFT model analyzes the pixel intensity changes between two consecutive video frames, calculating the motion of corresponding pixels to obtain a dense optical flow field, thereby detecting the movement information of the water flow. This method does not rely on surface tracers such as leaves or debris; instead, it identifies surface velocity information by comparing water surface textures.

An indoor site was set up to simulate river flow, where water surface videos were captured, and a

portable velocimeter was used to measure the actual surface velocities for model testing. Additionally, the model was applied to surveillance video from the Shaziying Gate on the Qinghe River in Beijing, and the results were compared with measurements from a radar velocimeter. Both sets of results indicate that the model's frame-by-frame velocity recognition is stable, with an average velocity estimation error of less than 0.1 m/s, enabling tracer-free, pixel-level velocity measurement.

3. Research Conclusions and Significance

This study proposes an intelligent perception technology for river surface flow velocity based on video images, incorporating the RAFT model. Tests conducted on both indoor simulated channels and outdoor natural river channels demonstrate that the average velocity recognition error is less than 0.1 m/s, achieving non-tracer-based surface flow velocity estimation. The model results can effectively address the issue of acquiring hydrological data when conventional monitoring equipment fails, thereby enhancing the pervasive sensing capability of flood information.