Contribution ID: **83** Type: **not specified**

Urban surveillance camera for urban extreme rainfall estimation

Monday 17 March 2025 11:30 (15 minutes)

In recent years, under the dual influence of global warming and urbanization, extreme precipitation events in cities have become more frequent. The randomness, suddenness, and spatiotemporal variability of urban precipitation have significantly increased, posing serious threats to the healthy development of society and the safety of people's lives and property. High spatiotemporal resolution surface precipitation observations are crucial for meteorological forecasting, climate analysis, and disaster warning. The widely distributed urban surveillance cameras can continuously record precipitation events and dynamically describe changes in rainfall intensity, offering advantages such as high density, rapid speed, and low cost. This provides a new opportunity for a high-resolution perception of urban precipitation.
To this end, this study analyzes the imaging patterns of heavy rainfall from the novel perspective of urban surveillance videos. It establishes a dynamic model for the relationship between precipitation intensity and video features. Based on this, a deep learning-based algorithm for quantitative estimation of precipitation from surveillance videos is proposed, and long-term precipitation observation experiments are conducted in various locations, including Nanjing, Wuxi, Changzhou, and Vienna. Comparison with synchronous measurements from devices like 2-DVD and Parsivel shows that in heavy rainfall scenarios with intensities ranging from 20 mm/h to 90 mm/h, the surveillance cameras achieve 75% accuracy in estimating rainfall intensity and 83% accuracy in measuring cumulative rainfall. In scenarios with rainfall intensities from 90 mm/h to 140 mm/h, the surveillance cameras can achieve 70% accuracy in measuring precipitation intensity and 78% accuracy in cumulative rainfall measurements.
This research aims to enhance the quantitative estimation accuracy of precipitation using surveillance cameras, thereby providing a beneficial supplement to improve the high-resolution perception capability of urban heavy rainfall and offering foundational data support for the forecasting and analysis of urban precipitation.

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Session

From Classical to Integrated Remote Sensing: New observation strategies for clouds and precipitation (multi-frequency, spectral polarimetry, multi-sensor)

Preferred Contribution Type

Oral Presentation

VAT

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