# Response Letter

**Atmospheric Measurement Techniques**

AMT-2022-196

Title: Estimation of raindrop size distribution and rain rate with infrared surveillance camera in dark conditions

Author(s): Jinwook Lee et al.

MS type: Research article

Iteration: Revised submission

# Referee #1

***Overall Comments***

I appreciated the revision efforts of the authors and I still believe the article is relevant for AMT.

I have the following concerns that I would like to see addressed prior to publication.

**Answer:**

The authors appreciate the valuable comments. As suggested by the referee, all the comments were considered in the revision of the manuscript.

**Q1. I would like the limitations of this method to be better stated at the beginning of the paper, especially in terms of scalability and overall relevance of the approach for meteorological measurements. The methodology is technically correct and interesting, but still limited in terms of applicability (even foreseen potential applicability) for what can be seen in this manuscript. The limitation to night-time measurements should be further stressed.**

**Answer:**

The authors appreciate the valuable comment. As suggested by the referee, we have modified the manuscript to better state the limitations of the method at the beginning of the paper.

(Revised Manuscript (Track), Lines 58-71)

It is true that these previous studies confirmed the possibility of rainfall measurement using surveillance cameras. However, several limitations still prevent the actual expansion of the measurement systems using surveillance cameras. In general, most surveillance cameras are installed for monitoring purposes, and people's faces are inevitably captured. Therefore, it is not easy to disclose the data due to privacy concerns. Data storage and transmission are also limitations. Since most surveillance cameras use a hard disk, data must be taken out directly. In other words, rainfall estimation cannot be done in real-time unless a system is in place to transmit data over the Internet. In addition, the applicability to night-time is more limited. In the case of general surveillance cameras in the past, observation is possible only when sunlight exists. For the observation system to expand, these various limitations must be addressed, and it seems that a lot of time and effort are needed. Nevertheless, research to develop algorithms using surveillance cameras in various conditions and to

confirm applicability can have sufficient meaning. The case of dark conditions is one of the conditions worth studying. This is because the recently installed surveillance cameras are equipped with an Infrared recording function, so most cameras will be able to take videos at night soon. However, the final purpose of utilizing these devices and the method is not to replace existing devices. It could be a supplement to improve the spatiotemporal resolution and accuracy of existing observation instruments. In particular, a study on the drop size distribution of rainfall, rather than simple rainfall estimation, would have more potential application value.

**Q2. If there was a rain gauge on-site, even if not working 100% of the time, it is crucial in my view that it is used to show some evaluation with respect to rainfall rate estimation. Otherwise the reader will always have the legitimate doubt whether the PARSIVEL is actually a good reference for rainfall rate at the range of rainfall rates shown in the study. I suggest to reconsider the decision to remove the rain gauge from the analysis.**

**Answer:**

The authors agree with the referee's comment. As the referee mentioned, securing the quantitative reliability of observational data is very important. Therefore, the authors have added the contents of quantitative verification with rainfall data obtained from rain gauge site operated by KMA (Korea Meteorological Administration) located close to the PARSIVEL observation site to the manuscript.

(Revised Manuscript (Track), Lines 301-311)

In order to secure the quantitative reliability of the PARSIVEL observation data, rain gauge observation data were used to verify the rainfall calculated through the PARSIVEL observation. The rainfall data used for verification are rain gauge observation data operated by KMA (Korea Meteorological Administration) installed closer than 4 km from the PARSIVEL observation site (Table 3). The rainfall comparison period is from September 14, 2021, to October 4, 2022, including the period of the analysis case. Fig. 7 shows scatter plots comparing hourly rain rates from rain gauges and PARSIVEL. As a result of comparison with the observation data at three rain gauge sites, it had low MAE (Mean Absolute Error), RMSE (Root Mean Square Error), MAPE (Mean Absolute Percent Error) values of less than 0.11 mm $h^{-1}$, 0.6 mm h-1, and 8%. Also, correlation values were more than 0.9.

**Table 3. Location information of rain gauge observation sites.**

| Raingague site | Latitude (°) | Longitude (°) | Range from PARSIVEL site (km) |
|---|---|---|---|
| G1 | 37.4933 | 126.9175 | 3.73 |
| G2 | 37.5196 | 126.9763 | 2.42 |
| G3 | 37.5249 | 126.9390 | 2.87 |

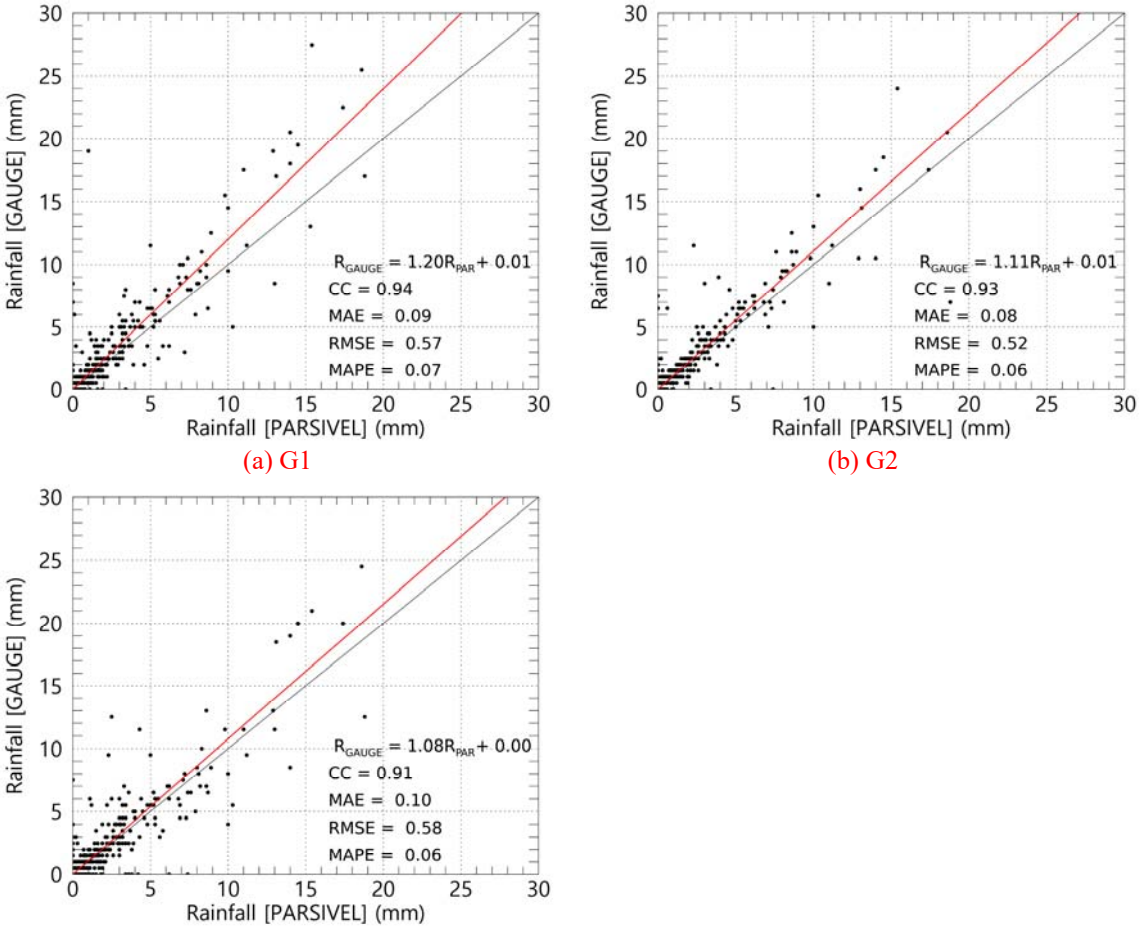


**Figure 7. Scatter plot of rainfall amount every 1 hour from the PARSIVEL observation and the rain gauge observation.**

**Q3. Data and code availability: I find it a little weak for this paper to propose the "available upon request" approach. It is not sustainable in the long term. I recommend to have data and code in an appropriate repositories, as previously suggested.**

**Answer:**

The authors agree with the referee's comment. Suggest by the referee, the authors uploaded the videos, data, and sample codes used in the study to 'figshare' and 'GitHub' to increase the availability of the code and data used in this study.

(Revised Manuscript (Track), Lines 519-521)

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| The raw videos and data used in the analysis can be downloaded from https://doi.org/10.6084/m9.figshare.c.6392430.v1, and the sample codes are available in a public GitHub repository from https://github.com/jinwook213/Rain_CCTV.git. |