LIDAR-Based Real-Time Rainfall Prediction Utilizing Deep Learning Techniques on RTI Signal Maps

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**Abstract.** Accurate weather forecasting is essential for various sectors, including agriculture, disaster management, and daily planning. With advancements in remote sensing technology and data analytics, it is now possible to utilize high-resolution environmental data for improved weather prediction. This paper proposes a comprehensive methodology for rainfall prediction using Range-Time Intensity (RTI) signal maps derived from data collected by the Light Detection and Ranging (LIDAR) instrument positioned at the National Atmospheric Research Laboratory (NARL), Tirupati. The RTI signal maps, representing spatio-temporal variations in LIDAR signal intensity, are labelled with specific weather conditions such as rainfall duration, likely to rain, and no rainfall duration, based on prior knowledge data. The methodology involves employing deep learning techniques to extract detailed features from these signal maps by treating them as high-dimensional images and decomposing them into individual pixels to capture intricate intensity patterns and trends. The feature extraction process involves preprocessing the signal map data, applying Convolutional Neural Networks (CNNs) to detect spatio-temporal features, and using the Adam optimizer for optimizing the proposed model. These extracted features were used to train the proposed predictive model, utilizing the labelled dataset that associates specific signal map patterns with known weather conditions. Following the training process, the model was validated using test data consisting of untrained RTI signal maps. The observed performance of the model was noteworthy, achieving a high accuracy of 97% in predicting the correct weather conditions. Additionally, qualitative analysis was performed to compare predicted weather conditions with actual conditions, examining the similarity between test and trained signal maps. This approach aims to provide a robust framework for rainfall prediction, leveraging detailed RTI signal map analysis to capture complex weather patterns, thus enhancing the accuracy and reliability of weather forecasting models and contributing to the field of atmospheric science by offering a novel method for interpreting LIDAR data and improving predictive capabilities.

**Keywords:** LIDAR, RTI signal maps, Deep Learning, Feature Extraction, Weather Forecasting