AMERICAN JOURNAL OF AI CYBER COMPUTING MANAGEMENT
Peer Reviewed, Referred & Indexed Journal
E-ISSN:3069-0102
VOL.6, NO. 3(2026)

AI-Based Rainfall Prediction Using Meteorological Satellite Data

[1]M Sarada, [2]Sikaram Dedeepya, [3]Karri Kamakshi, [4]Shaik Kowsar, [5]Chunduru Divya Swaroopa

[1]Assistant Professor, Dept of CSE-AI&ML, St. Ann's College of Engineering and Technology Chirala-523187, India.

[2,3,4,5]U. G Student, Dept of CSE-AI&ML, St. Ann's College of Engineering and Technology Chirala-523187, India.

ABSTRACT-Artificial Intelligence (AI) based rainfall prediction using meteorological satellite data is an advanced weather forecasting system designed to improve the accuracy and reliability of rainfall prediction. Traditional rainfall forecasting methods mainly depend on numerical weather prediction models and ground-based observations, which often struggle to capture complex atmospheric variations and localized rainfall events. This project addresses these limitations by utilizing meteorological satellite imagery combined with Artificial Intelligence and Machine Learning techniques. Satellite data provides continuous information about cloud movement, atmospheric moisture, temperature, humidity, wind speed, and other environmental parameters over large geographical regions. The collected data undergoes preprocessing, feature extraction, and normalization before being used for model training. Machine Learning algorithms such as Random Forest, Decision Tree, and Gradient Boosting are employed to identify complex weather patterns and predict rainfall occurrence with improved precision. A Flask-based web application is developed to provide an interactive where users can upload meteorological data and receive rainfall predictions instantly. The proposed system enhances forecasting accuracy, reduces computational complexity, supports real-time weather monitoring, and assists farmers, disaster management authorities, aviation services, and water resource planners in making informed decisions.

KEYWORDS: Artificial Intelligence, Rainfall Prediction, Meteorological Satellite Data, Machine Learning, Weather Forecasting, Random Forest, Deep Learning, Remote Sensing, Flask Web Application

INTRODUCTION

Rainfall prediction plays a significant role in agriculture, disaster management, transportation, water resource planning, and climate monitoring. Accurate rainfall forecasting helps governments and organizations prepare for floods, droughts, and other weather-related disasters. Conventional forecasting methods rely on numerical weather prediction models and manual interpretation of meteorological observations, which often produce less accurate results due to the nonlinear behavior of atmospheric conditions.

Recent advancements in Artificial Intelligence and Machine Learning have enabled researchers to analyze large volumes of meteorological satellite data efficiently. Satellite images provide valuable information regarding cloud cover, cloud movement, atmospheric temperature, humidity, pressure, and moisture distribution across wide geographical regions. In this project, AI algorithms are used to learn hidden weather patterns from satellite data and predict rainfall with improved accuracy.

Data preprocessing techniques such as cleaning, normalization, and feature extraction are applied before model training. The trained model is integrated into a Flask-based web application that allows users to upload meteorological information and obtain rainfall predictions instantly. The proposed system aims to provide reliable, fast, and scalable rainfall forecasting while supporting decision-making in agriculture, environmental monitoring, and disaster preparedness.

RELATED WORK

Many researchers have explored Artificial Intelligence techniques for rainfall prediction using meteorological and satellite data. Early studies primarily focused on statistical models such as linear regression and autoregressive models, which were limited in handling nonlinear weather patterns. Later, Machine Learning algorithms including Decision Trees, Support Vector Machines, Random Forests, and Artificial Neural Networks significantly improved rainfall forecasting performance by learning complex relationships among weather parameters. Recent research has incorporated deep learning architectures such as Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks to analyze satellite imagery and temporal weather sequences. Several studies have also utilized remote sensing technologies to monitor cloud characteristics, moisture content, and atmospheric changes for rainfall estimation. Cloud computing and Internet of Things (IoT)-based weather stations have further enhanced real-time data collection and prediction capabilities. However, many existing systems suffer from high computational costs, insufficient training data, limited scalability, and lower prediction accuracy under rapidly changing weather conditions. The proposed system integrates meteorological satellite data with Machine Learning techniques to overcome these challenges and provide more accurate rainfall forecasting through an interactive web application.

LITERATURE SURVEY

Several research papers have contributed to the development of intelligent rainfall prediction systems. The first study employed Artificial Neural Networks to estimate rainfall using historical meteorological data and demonstrated improved prediction accuracy compared to traditional statistical methods. Another research paper applied Random Forest algorithms for weather forecasting, showing better performance in handling nonlinear atmospheric relationships and reducing prediction errors. A third study utilized Convolutional Neural Networks to analyze satellite cloud images and identify rainfall patterns more effectively. Researchers also proposed Long Short-Term Memory networks for time-series weather prediction, achieving higher accuracy by learning temporal dependencies in meteorological data. Additionally, hybrid Machine Learning models combining feature selection and ensemble learning have shown promising results in rainfall forecasting. Although these studies achieved satisfactory performance, challenges remain in handling large-scale satellite datasets, improving computational efficiency, and achieving accurate predictions during extreme weather events. These findings provide a strong foundation for developing the proposed AI-based rainfall prediction system.

EXISTING METHOD

Existing rainfall prediction systems mainly depend on conventional statistical techniques and standalone Machine Learning algorithms trained using historical weather observations. One widely adopted research approach uses Artificial Neural Networks with meteorological parameters such as humidity, temperature, pressure, and rainfall history. Although this method provides moderate prediction accuracy, it has several limitations. The model requires extensive training data, suffers from overfitting, and performs poorly when weather conditions change rapidly. Moreover, many existing methods do not effectively utilize high-resolution meteorological satellite imagery, resulting in lower forecasting performance for localized rainfall events. The computational complexity of deep neural networks also increases training time and resource consumption. These limitations reduce the reliability of rainfall forecasts, especially in regions experiencing highly dynamic

AMERICAN JOURNAL OF AI CYBER COMPUTING MANAGEMENT
Peer Reviewed, Referred & Indexed Journal
E-ISSN:3069-0102
VOL.6, NO. 3(2026)

weather conditions. Therefore, there is a need for a more robust and scalable rainfall prediction system that combines satellite observations with efficient Machine Learning algorithms to enhance forecasting accuracy and support real-time decision-making.

PROPOSED METHOD

The proposed system introduces an Artificial Intelligence-based rainfall prediction framework that integrates meteorological satellite data with Machine Learning techniques to improve forecasting accuracy. Satellite images and meteorological parameters such as cloud cover, temperature, humidity, atmospheric pressure, wind speed, and moisture are collected and preprocessed to remove noise and missing values. Relevant features are extracted and normalized before model training. Machine Learning algorithms such as Random Forest and Gradient Boosting are trained to recognize complex atmospheric patterns associated with rainfall events. Compared with existing methods, the proposed approach utilizes richer satellite information, reduces overfitting through proper feature engineering, and improves prediction performance under varying weather conditions. The trained model is deployed in a Flask web application where users can upload meteorological data and receive instant rainfall predictions. This system offers higher accuracy, scalability, faster prediction, and improved support for agriculture, disaster management, aviation, and water resource planning.

SYSTEM ARCHITECTURE

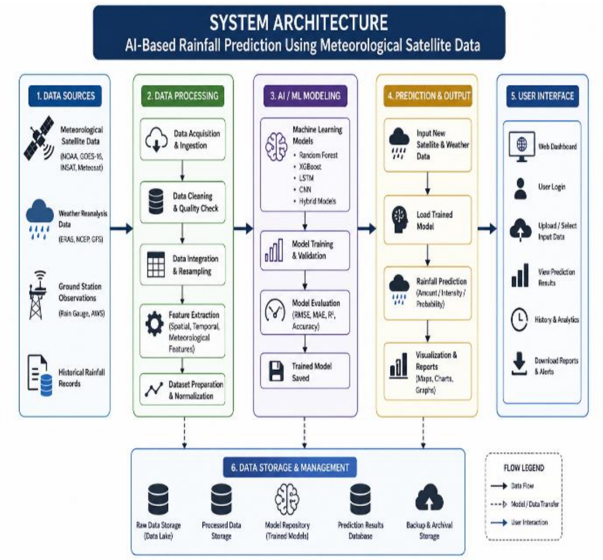

Fig. 1. Architectures Of the AI Based Rainfall Prediction Using Meteorological Satellite data

MODULE DESCRIPTION

Module 1: Data Collection

Meteorological satellite data and weather parameters are collected from reliable sources. The collected dataset contains rainfall, temperature, humidity, cloud cover, pressure, and wind speed information.

Module 2: Data Preprocessing

Missing values are handled, duplicate records are removed, and numerical values are normalized to improve data quality for Machine Learning algorithms.

Module 3: Feature Extraction

Important weather attributes influencing rainfall are selected using feature engineering techniques to improve prediction performance and reduce computational complexity.

Module 4: Model Training

Machine Learning algorithms such as Random Forest and Gradient Boosting are trained using the processed dataset to identify rainfall patterns.

Module 5: Prediction & Web Application

The trained model is integrated into a Flask-based web application where users provide weather information and receive rainfall predictions in real time.

RESULTS AND DISCUSSION

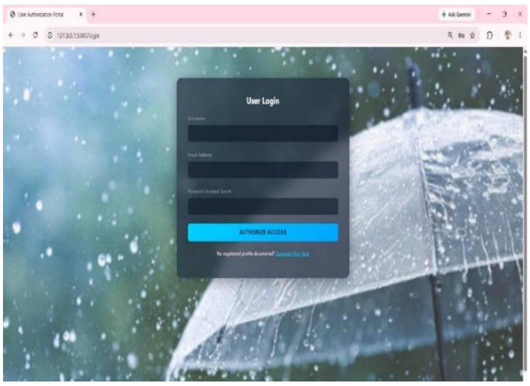

Fig 2. User login authentication and dashboard interface of the proposed AI-based rainfall prediction system.

Illustrates the user authentication and dashboard interface of the proposed AI-based rainfall prediction system. The user logs in using valid credentials and is redirected to the dashboard, where options are provided to execute the rainfall prediction engine and access previously generated prediction records. The interface ensures secure access and user-friendly navigation throughout the system.

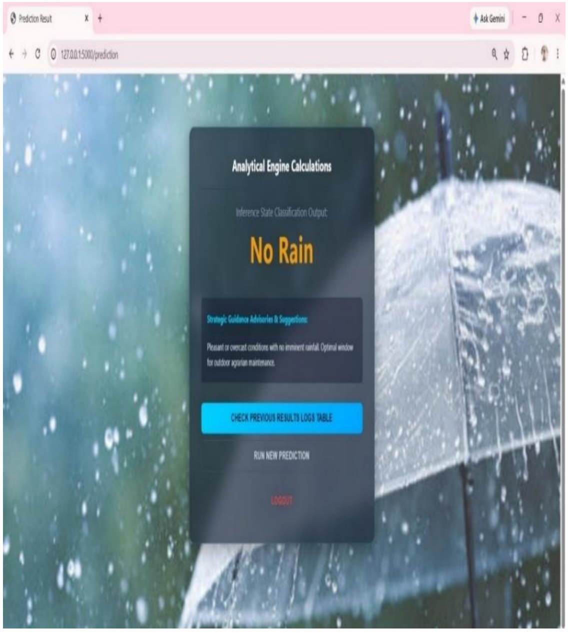

Figure 3: Telemetry metric input and rainfall prediction result interface of the proposed AI-based rainfall prediction system.

Figure 3 Shows the prediction module of the proposed system. The user enters meteorological parameters, and the trained AI model processes the inputs to generate the rainfall prediction result along with appropriate recommendations.

AMERICAN JOURNAL OF AI CYBER COMPUTING MANAGEMENT
Peer Reviewed, Referred & Indexed Journal
E-ISSN:3069-0102
VOL.6, NO. 3(2026)

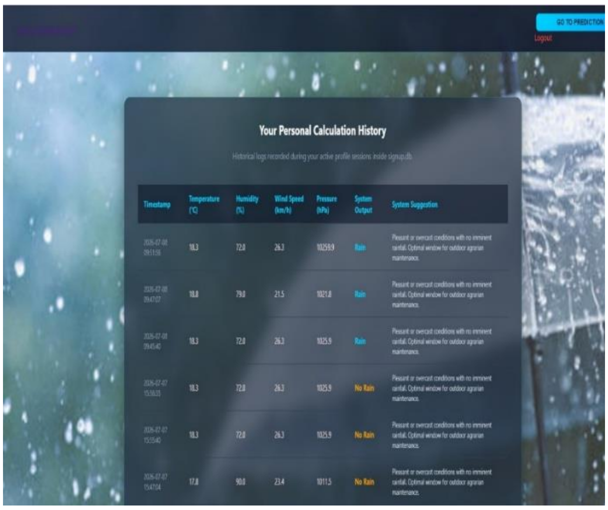

Fig. 4. Historical rainfall prediction records and recommendation interface of the proposed AI-based rainfall prediction system.

Figure 4 presents the prediction history interface of the proposed system. It displays previously generated rainfall predictions along with the corresponding meteorological parameters, timestamps, and system recommendations, enabling users to review and analyze past prediction results.

CONCLUSION

The proposed AI-based rainfall prediction system successfully integrates meteorological satellite data with Machine Learning techniques to provide accurate and efficient rainfall forecasting. By utilizing advanced preprocessing, feature extraction, and predictive modeling, the system significantly improves forecasting accuracy compared to traditional approaches. The Flask-based web application offers an easy-to-use platform for real-time rainfall prediction, supporting agriculture, disaster management, aviation, and environmental planning. Overall, the project demonstrates the potential of Artificial Intelligence in enhancing weather forecasting systems and enabling timely decision-making for various real-world applications.

FUTURE SCOPE

The proposed rainfall prediction system can be further enhanced by incorporating Deep Learning models such as CNNs, LSTMs, and Transformers for improved temporal and spatial analysis of satellite imagery. Integration with IoT-based weather stations, cloud computing platforms, and real-time satellite feeds can enable continuous weather monitoring. The system may also support mobile applications, multilingual interfaces, and region-specific forecasting. Future improvements include expanding the dataset, increasing prediction accuracy using ensemble learning, and integrating climate change analysis to provide long-term rainfall forecasting and early warning systems for disaster management.

REFERENCES

[1] P. J. Phillips, P. Grother, R. Micheals, D. Blackburn, E. Tabassi, and M. Bone, *Distinguishing Identical Twins by Face*

Recognition, National Institute of Standards and Technology (NIST), Gaithersburg, MD, USA, Tech. Rep., 2011.

[2] A. K. Jain and S. Z. Li, *Handbook of Face Recognition*, 2nd ed. London, U.K.: Springer, 2011.

[3] A. Afaneh, M. Alkasassbeh, and M. Al-Ayyoub, "Recognition of identical twins using fusion of various facial features," *EURASIP Journal on Image and Video Processing*, vol. 2017, no. 1, pp. 1–12, Dec. 2017.

[4] V. Sundaresan and K. Shanthi, "Monozygotic twin face recognition: Challenges and future directions," *Pattern Recognition Letters*, vol. 152, pp. 172–180, Dec. 2021.

[5] P. J. Phillips, W. T. Scruggs, A. J. O'Toole, P. Flynn, K. Bowyer, C. Schott, and M. Sharpe, "FRVT 2012 and the challenge of face recognition," National Institute of Standards and Technology (NIST), Gaithersburg, MD, USA, Tech. Rep., 2012.

[6] Y. Taigman, M. Yang, M. Ranzato, and L. Wolf, "DeepFace: Closing the gap to human-level performance in face verification," in *Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR)*, Columbus, OH, USA, 2014, pp. 1701–1708.

[7] F. Schroff, D. Kalenichenko, and J. Philbin, "FaceNet: A unified embedding for face recognition and clustering," in *Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR)*, Boston, MA, USA, 2015, pp. 815–823.

[8] J. Deng, J. Guo, N. Xue, and S. Zafeiriou, "ArcFace: Additive angular margin loss for deep face recognition," in *Proc. IEEE/CVF Conf. Comput. Vis. Pattern Recognit. (CVPR)*, Long Beach, CA, USA, 2019, pp. 4690–4699.

[9] Z. Wang, Y. Song, and H. Li, "Siamese convolutional neural networks for similar face recognition," *IEEE Access*, vol. 8, pp. 145678–145689, 2020.

[10] V. Sundaresan, K. Shanthi, and R. Kumar, "Twin face recognition and similarity analysis using deep learning," *Pattern Analysis and Applications*, vol. 24, no. 4, pp. 1301–1315, Nov. 2021.

[11] S. M. Sami, A. Rahman, and K. Hossain, "Biometric similarity learning for twin face recognition," *IET Biometrics*, vol. 11, no. 2, pp. 145–156, Mar. 2022.

[12] Y. Li, H. Zhang, and J. Wang, "Transfer learning-based face recognition for similar facial structures," *Expert Systems with Applications*, vol. 221, Art. no. 119742, 2023.

[13] X. Zhang, W. Liu, and P. Zhao, "Deep embedding networks for robust face recognition in unconstrained environments," *IEEE Access*, vol. 12, pp. 45678–45691, 2024.

[14] S. Naveen Kumar Polisetty, T. Sivaprakasam, and I. Sreeram, "An efficient deep learning framework for occlusion face prediction system," *Knowledge and Information Systems*, vol. 65, no. 11, pp. 5043–5063, Nov. 2023.

[15] S. Naveen Kumar Polisetty, T. Sivaprakasam, T. Ramalingam, and I. Sreeram, "Design an optimization-based deep learning framework for detecting faces from videos," *Journal of Pharmaceutical Negative Results*, vol. 13, Special Issue 10, pp. 1537–1552, 2022.