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Flight Accident Risk Prediction Using Machine Learning

[1] Nashita Gazi, [2] Suma Rani P, [3] Srushti, [4] Sneha, [5] Sara Tahniyath
[1]Student, [2]Student, [3]Student, [4]Student, [5]Assistant Professor
[1]Department of Computer Science and Engineering,
Navodaya Institute Of Technology,
Visvesvaraya Technological University (VTU),
Raichur, Karnataka, India

Abstract- Aviation safety is a critical concern due to the complex and high-risk nature of flight operations. Although aviation technology has advanced significantly, accident prevention systems are still largely reactive, relying on post-incident investigations. With the availability of large volumes of aviation and environmental data, artificial intelligence techniques can be utilized to predict potential risks before flight operations. This paper presents an AI-based flight accident risk prediction system using a One-Dimensional Convolutional Neural Network (1D-CNN). The proposed system analyzes multiple factors such as weather conditions, aircraft characteristics, flight duration, and pilot experience to estimate accident risk levels. Data preprocessing techniques including normalization and categorical encoding are applied to improve model performance. The trained CNN model effectively captures complex non-linear relationships among features and classifies flights into high-risk and low-risk categories with associated probability scores. The system is deployed through a Flask-based web application that allows real-time and manual risk prediction. Experimental results indicate that the proposed approach provides reliable predictive performance and supports proactive aviation safety management.

Index Terms **-** Aviation Safety, Deep Learning, 1D Convolutional Neural Network, Risk Prediction, Artificial Intelligence

I. INTRODUCTION

Aviation is widely recognized as one of the safest modes of transportation; however, flight accidents, though rare, can lead to severe human and economic losses. Traditional safety management systems primarily focus on investigating accidents after they occur, which limits their effectiveness in preventing future incidents. With increasing air traffic and operational complexity, there is a growing need for intelligent systems capable of predicting potential accident risks in advance. Recent advancements in artificial intelligence and deep learning have enabled the analysis of large-scale aviation data to uncover hidden patterns related to safety risks. This paper proposes a deep learning-based approach for predicting flight accident risk using a 1D Convolutional Neural Network.

II. LITERATURE REVIEW

Previous research in aviation safety has explored various machine learning techniques such as Decision Trees, Support Vector Machines, Random Forests, and Logistic Regression for accident analysis and risk prediction. These approaches have demonstrated moderate success in identifying safety trends and risk factors. However, traditional machine learning models often face limitations in capturing complex non-linear relationships among multiple variables. Recent studies indicate that deep learning models, particularly convolutional neural networks, are more effective in feature extraction and pattern recognition from structured datasets. This motivates the adoption of a 1D-CNN model for accurate and efficient flight accident risk prediction.

III. PROPOSED SYSTEM

The proposed system introduces an AI-driven framework for predicting flight accident risk prior to flight operations. The system considers multiple input parameters including environmental conditions, aircraft specifications, operational details, and pilot experience. Data preprocessing is performed to handle missing values, normalize numerical features, and encode categorical variables. The processed data is then fed into a 1D Convolutional Neural Network that learns complex feature interactions and classifies the flight risk level. The system outputs both a categorical risk label and a probability score to assist in decision-making.

IV. SYSTEM ARCHITECTURE AND IMPLEMENTATION

The proposed flight accident risk prediction system follows a modular architecture designed to support efficient data processing, risk analysis, and result visualization. The overall system integrates data preprocessing, deep learning-based risk prediction, and user interaction through a web interface.

The use case diagram illustrates the functional interactions between the user and the system. The primary actor, the user, provides flight-related input parameters such as aircraft details, environmental conditions, and operational factors. The system processes these inputs and performs risk prediction using the trained deep learning model. The use case representation highlights the core functionalities of data input, risk evaluation, and result display, ensuring clarity in system behavior.

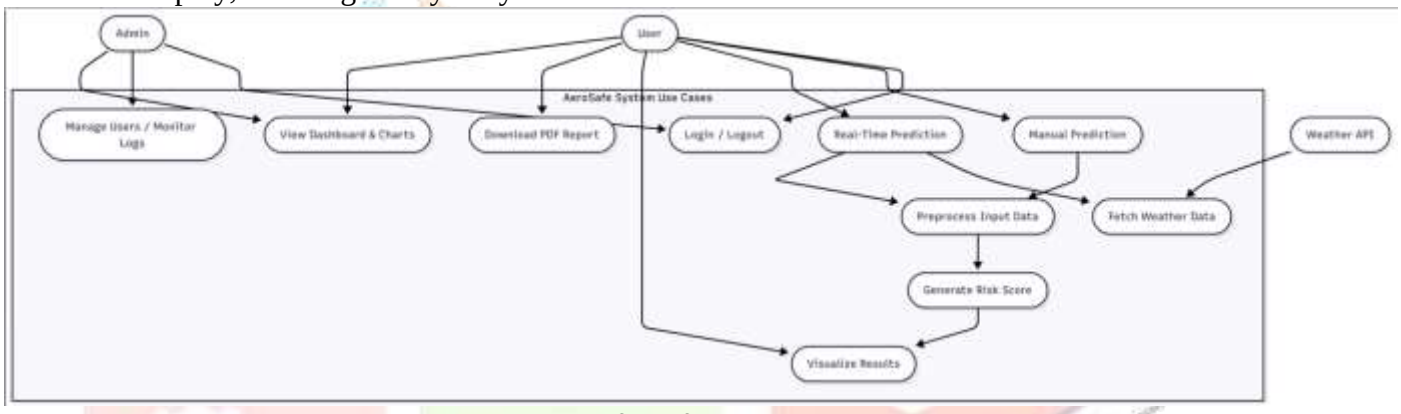

Figure 1. Use case diagram of the flight accident risk prediction system.

The entity relationship (ER) diagram represents the logical data structure of the system. It defines key entities such as flight details, aircraft information, pilot data, and weather conditions, along with their relationships. The ER model ensures structured data storage and efficient retrieval, which is essential for accurate risk analysis and system scalability.

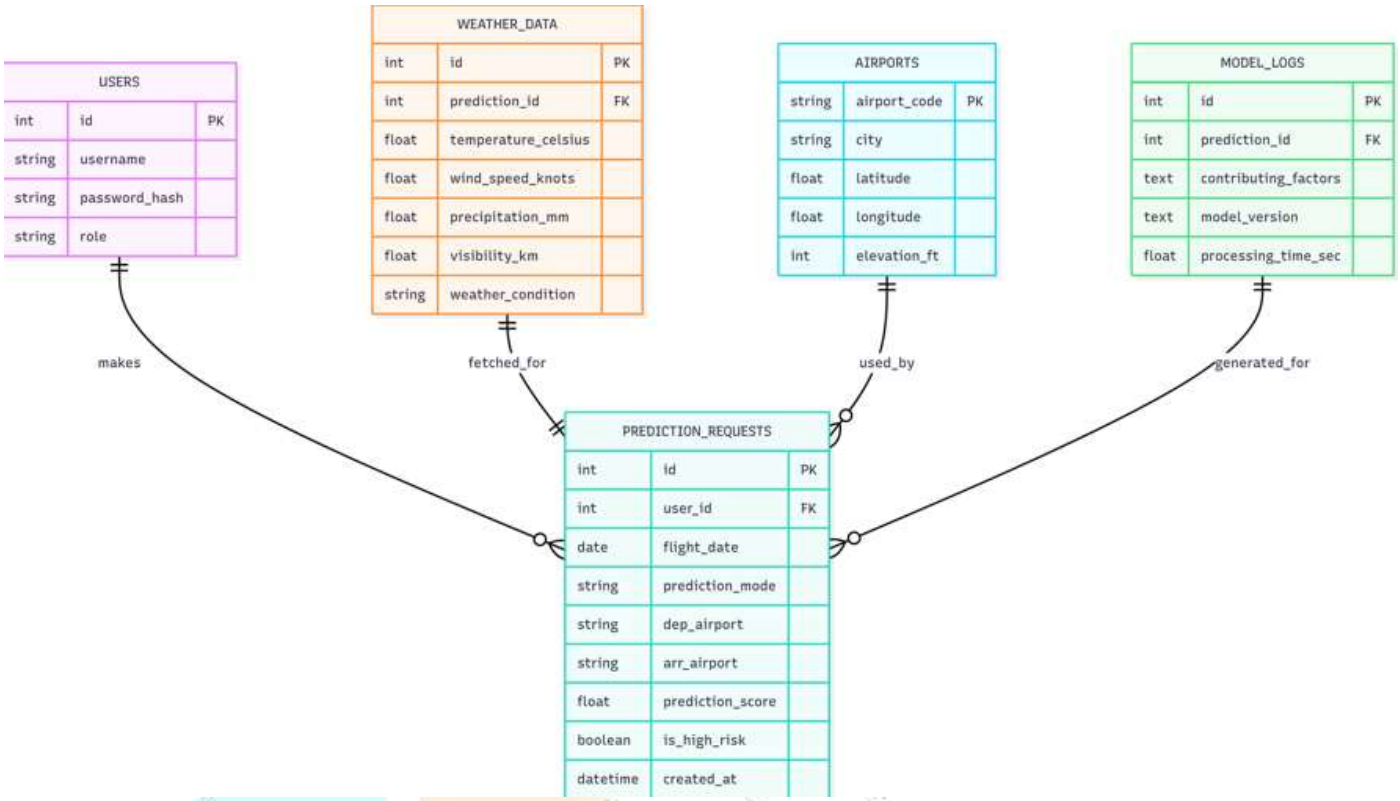

Figure 2. Entity relationship diagram of the proposed system.

The implementation of the system is carried out using Python with TensorFlow and Keras libraries for developing the 1D Convolutional Neural Network model. Data preprocessing techniques such as normalization and encoding are applied before model training. The trained model is integrated into a Flask-based web application that enables real-time interaction and prediction. This architectural design ensures modularity, scalability, and effective integration of analytical and user-interface components.

V. RESULT AND OUTPUT ANALYSIS

The performance of the proposed flight accident risk prediction system was evaluated using simulated test data. The 1D-CNN model achieved an overall prediction accuracy of approximately 92% on the experimental dataset, demonstrating its effectiveness in distinguishing between high-risk and low-risk flight scenarios. The system generates output in the form of a risk category along with a probability score, providing clear and interpretable results. Experimental observations indicate that adverse weather conditions, increased aircraft age, and lower pilot experience contribute to higher predicted risk values. These results confirm the suitability of deep learning techniques for proactive aviation safety assessment.

VI. CONCLUSION AND FUTURE SCOPE

This paper presented an AI-based flight accident risk prediction system using a One-Dimensional Convolutional Neural Network. The proposed approach effectively analyzes aviation-related data and provides early risk assessment to support safety decision-making. The integration of deep learning with a web-based application enhances system usability and accessibility. Future work may involve training the model on real-world aviation datasets, incorporating explainable AI techniques to improve model transparency, and extending the system to predict accident severity and causal factors.

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