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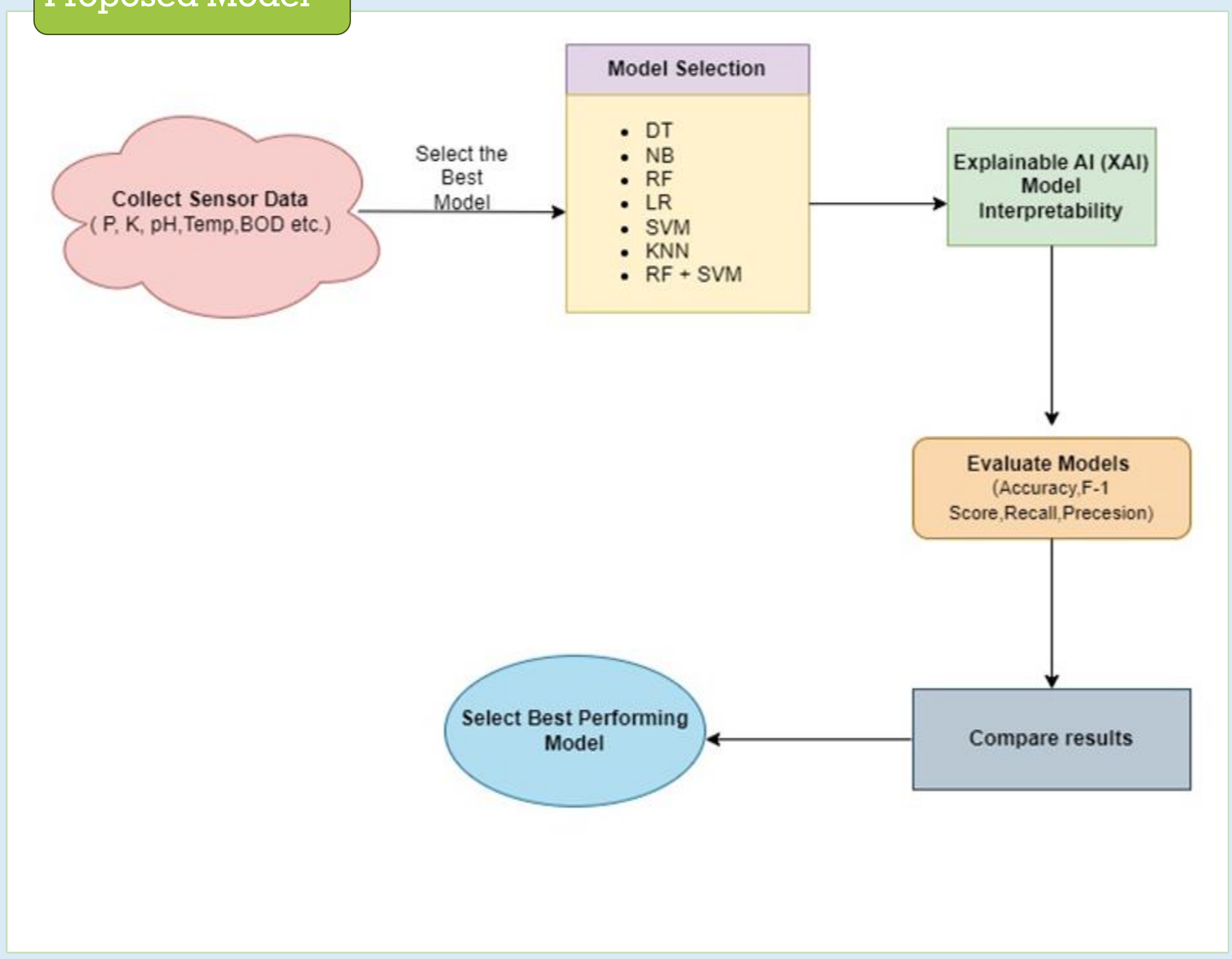
Integrated IoT and AI Systems for Real-Time Multi-Nutrient Water Quality Analysis in Agriculture

MDPI

Abstract

Drinking water that is clean and safe is important for everyone's health. 14 About 1.4 million deaths worldwide are noted to contaminated drinking water each 15 year. Because contaminated water sources are the primary cause of diarrheal infections, 16 they account for about 505,000 deaths every year. To overcome these challenges, this 17 work proposes an integrated IoT and AI-based solution for real-time, multi-nutrient 18 water quality analysis.

Proposed Model



Result

The performance metrics like accuracy, precision, recall, and F1-score are 33 calculated for predicting the water quality. Our experimental observation reveals that 34 the ensemble classifier RFS (Random Forest + SVM) classifier exhibits well and has an 35 accuracy of 90% in comparison to other models. The hybrid classifier is significantly 36 higher than the traditional approaches. As well as we used XAI techniques to increase 37 the interpretability of the classifiers to make effective decision-making for water 38 management. For data security, we used encryption and decryption algorithms to 39 ensure data integrity and protection against unauthorized access.

Experimental observation of different classifiers

Model Name	Accuracy in %	Precision in %	Recall in %	F1-Score
DT	87.30	88.00	87.00	87.00
RF	90.40	91.00	90.00	91.00
SVM	55.00	57.00	55.00	50.00
KNN	65.00	67.00	70.00	69.00
LR	70.00	64.00	70.00	65.00
NB	88.00	87.00	88.00	89.00
RF+SVM	90.99	90.00	91.00	92.00

Conclusion

we divided water quality into different classes based on their “WQI” values 13 where we divided the values obtained into four classes excellent(3), good(2), poor(1), and very poor(0). We 14 used different classification algorithms in this data set for predicting the quality of water from which the 15 ‘Random Forest’ outclasses every other algorithm in every field, it scored an accuracy of 90%, precision of 16 91%, recall of 90%, and F1-score of 91%. Our study introduces a unique framework for real-time 17 multi-nutrient water quality measurement in agriculture using an integrated IoT and AI system. The use of 18 an ensemble model (RF+SVM) significantly improves predicted accuracy and system robustness, 19 establishing a new standard for nutrient monitoring in precision agriculture.

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