



Multimodal Approach for Marine Food Quality Prediction Toward Sustainable Food Security

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Ensuring marine food quality and food security has become increasingly challenging due to rising food waste, environmental concerns, and public health risks. Conventional methods used to assess marine food freshness, such as manual sensory inspections and laboratory based testing, are often time consuming and unsuitable for rapid real-time decision making. This study proposes a data-driven artificial intelligence approach for marine food quality prediction by integrating machine learning and deep learning techniques. The proposed system combines visual features extracted from marine food images with environmental parameters, including temperature and humidity, to improve prediction accuracy. A multimodal fusion approach is utilized to integrate complementary data sources, enabling more reliable predictions compared to single modality approaches. Lightweight models, including convolutional neural networks and efficient machine learning algorithms, are employed to maintain computational efficiency, making the system suitable for portable devices and low resource environments. In addition, an interactive user interface was developed to support clear and user-friendly interpretation of prediction outcomes. The findings of this study demonstrate the potential of multimodal learning to support marine food preservation, quality management practices, and sustainable food security initiatives. The proposed approach also aligns with the growing demands of Industry 4.0 by promoting intelligent, efficient, and scalable food quality monitoring solutions.

Keywords: *Marine food quality prediction, Multimodal systems, Sustainable food security, Data-driven decision making, Industry 4.0*