ABSTRACT

The authentication of gelatin halalness in the food and pharmaceutical industries requires rapid portable screening instruments such as the Electronic Nose (E-Nose). However, the use of Metal-Oxide Semiconductor (MOS) gas sensor arrays faces cross-sensitivity issues, causing extreme transient signal pattern overlaps between bovine and piscine gelatin. This study aims to compare the spatial feature extraction performance of a 1-Dimensional Convolutional Neural Network (1D-CNN) against the sequential temporal feature tracking of a Gated Recurrent Unit (GRU) in classifying gelatin classes (porcine, bovine, piscine). This comparison was conducted because 1D-CNN represents a static pattern recognition approach susceptible to temporal information loss, whereas GRU represents dynamic tracking capable of retaining the entire history of gas adsorption rates while suppressing parameter complexity as a lightweight algorithm. Data acquisition was performed on 24 pure physical samples for 120 seconds using eight MOS sensor channels. Pre-processing methods included fractional baseline correction, Z-Score standardization, an 80:20 test ratio split, and a sliding window augmentation of size 90 to multiply matrix data variations. The testing results demonstrated that the 1D-CNN architecture failed to distinguish between bovine and piscine classes, with a 50% misclassification rate and a final accuracy of only 0.60. This failure was triggered by the matrix Flattening operation, which destroyed the chronological memory of gas propagation. In contrast, the memory gate mechanism in GRU successfully extracted the gas adsorption rate deviation, penetrating the cross-sensitivity blind spot to achieve an absolute accuracy of 1.00 (100%). Quantitatively in terms of memory load, the GRU model was compressed to only 6,403 parameters, 14.5 times more efficient than the 1D-CNN, which experienced a computational surge up to 93,347 parameters. In conclusion, GRU is proven to be the most analytically superior lightweight model and is ready to be realized in the Static Random-Access Memory (SRAM) space of portable microcontrollers.

Keywords: *1-Dimensional Convolutional Neural Network, Cross-Sensitivity, Electronic Nose, Gated Recurrent Unit, Gelatin, Lightweight.*