Journal Paper Presentation

Alshejari, A., Kodogiannis, V. S. (2017): An Intelligent Decision Support System for the Detection of Meat Spoilage Using Multispectral Images. *Neural Computing & Applications,* 28(12): 3903-3920.

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Problem statement, goals, scope and data sources

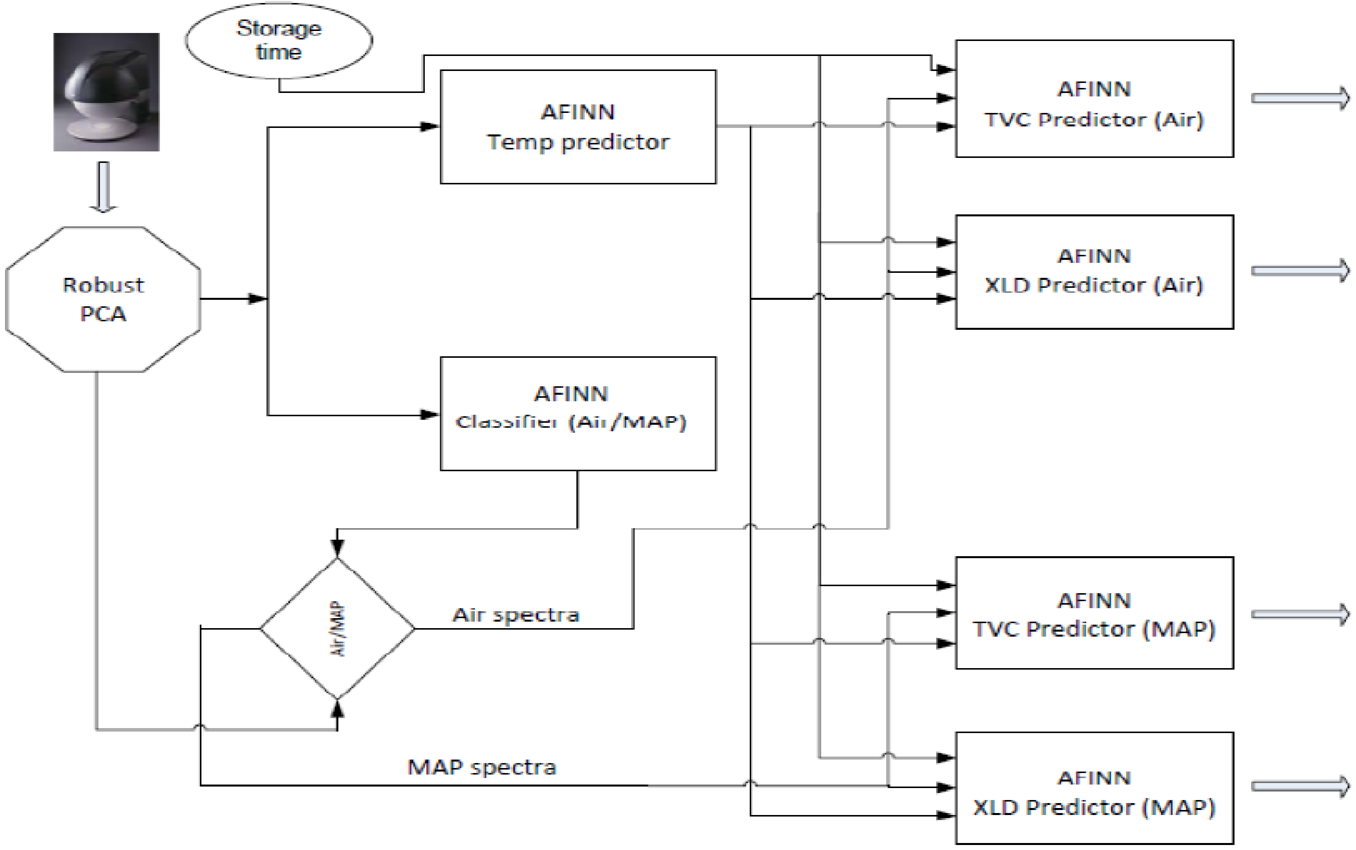
Problem: Meat is a nutritious and expensive food product in human diet worldwide. The challenge is to maintain and assure food quality and safety. Low-cost and non-invasive quality and safety inspections are needed to enable food companies to satisfy different market needs.

Goals: To associate spectral data acquired by multispectral imaging techniques with meat spoilage by using neuro-fuzzy stems, for the first time according to literature

Scope: Methods based on multispectral imaging. This technique attempts to attain simultaneously both spatial and spectral information from the target product. Neural network (NN) algorithms already showed promising results, but to overcome the NN's limitations, neuro-fuzzy approaches are investigated. The Adaptive Fuzzy Inference Neural Network (AFINN) has been considered as the classifier model for the proposed decision support system.

Data sources: Data received from the Agricultural University of Athens, Greece. A microbiological analysis was performed, and resulting growth data from plate counts were log10 transformed and fitted to the Baranyi & Roberts' model of in order to show the parameters of
microbial growth for the total viable count (TVC) and salmonella (XLD)

Graphical scheme of the IDSS' architecture



AIR: packaged aerobically
MAP: packaged under modified atmosphere
TVC: total viable counts of bacteria
XLD: growth of salmonella

Predictions made for different circumstances:

- Packaged individually either aerobically or under modified atmosphere:
  - ($40\%\ CO_2$, $30\%\ O_2$, $30N_2$)
- Kept in different temperatures:
  - 0, 5, 10, 15 °C

Intelligent methods for end user's decision making

Pre-processing data analysis:

- The robust Principal Component Analysis (RPCS) scheme is utilized to obtain the five first principal components (accounted for 99%), as input components that are not influenced much by outliers.

AFINN architecture (consists of 6 layers):

- Layers L1 and L2: IF part of fuzzy rules
- Layers L4 and L5: THEN part of the fuzzy rules
- Layer L3: Mapping between the rules layer and output layer, performed trough a competitive learning process

Support for decision making:

- Classification rules induction
  - Predictions are classified by being packed either in the AIR or MAP condition
- Artificial Neural Networks
  - Start of the ANFINN system is based on neural network systems, which came first.
  - Predictions are also compared to neural network-based models
- Time Series Analysis
  - Predictions are made after different moments in time and at different temperatures.

Data analysis in Matlab:

- (Root) Mean squared error (RMSE/MSE), Bias factor (Bf), Accuracy factor (Af), Standard error of prediction (SEP%)

Evaluation description

Comparisons:

- Results of the AFINN scheme are compared against models based on:
  - Adaptive neuro fuzzy inference systems (ANFIS)
  - Multilayer neural networks (MLP)
  - PLS-schemes

- MLP and PLS schemes have already been applied to similar multispectral studies
- The exploitation of neurofuzzy models for this specific imaging relation is completely novel

Conclusions:

- Compared to MLP and PLS-schemes, the ANFIS models' predictions for TVC and XLD has been considered very satisfactory, although lower performance was observed especially for the MAP cases.
- ANFIS's prediction performance appeared to be comparable to AFINN's case, however such results were achieved with huge expensive computational costs.