CONffIDENCE: Contaminants in food and feed: Inexpensive detection for control of exposure

Detection of contaminants in cereals by near infrared hyperspectral imaging

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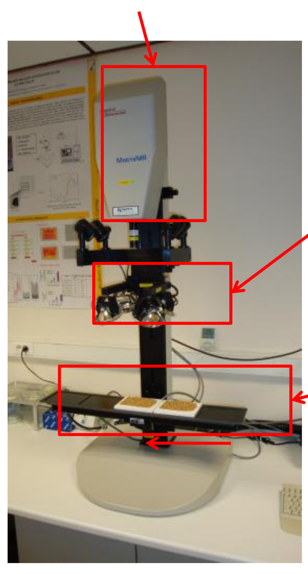
In the last years, hyperspectral imaging has proven its performance for quality and safety control in the cereal sector by allowing the collection of spectroscopic images at single kernel level, which is of great interest for cereal control laboratories. Contaminants in cereals concern, among others, impurities such as straw, grains coming from other cultures or insects but also undesirable substances such as ergot (*Claviceps purpurea)*. For the cereal sector, the presence of ergot involves high toxicity risk for animal and human due to its content in alkaloids. To reduce the risk of poisoning, the European directive 2002/32/EC on undesirable substances in animal feed fixed a limit of 0.1% for ergot in all feedingstuffs containing unground cereals. The regulation EEC No 689/92 restricted to 0.05% the concentration of ergot bodies in cereals for humans. The current work, performed in the framework of the CON*ff*IDENCE project (http://www.conffidence.eu), aims to detect and quantify the presence of ergot bodies in cereals using NIR hyperspectral imaging.
For this study, several hyperspectral instrumentation settings (plane and line scan) and chemometrics tools (SVM, PLSDA, SIMCA) have been tested at the laboratory level and further transfer to an industrial setting for testing and validation. The aim was to show the advantages of hyperspectral imaging system in order to try to integrate it in an automatic cereal control scheme.

NIR hyperspectral plane scan imaging system

NIR camera

Light source

Sample plate



NIR hyperspectral plane scan camera

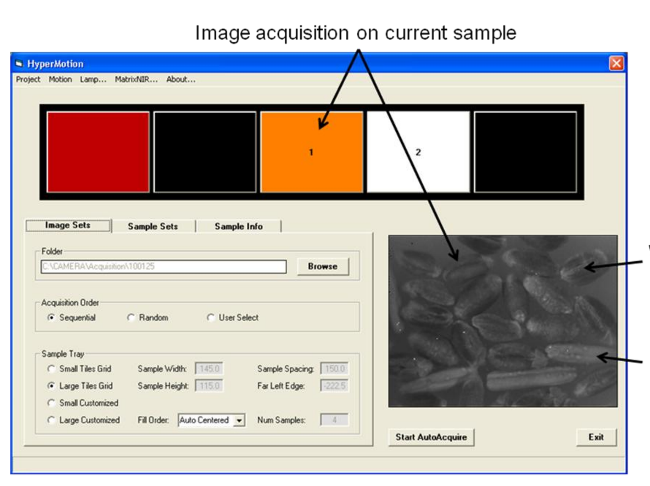
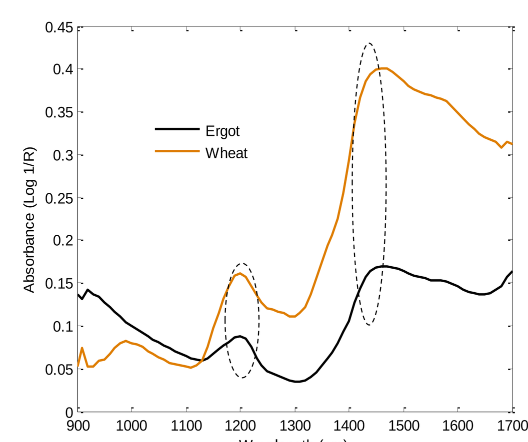
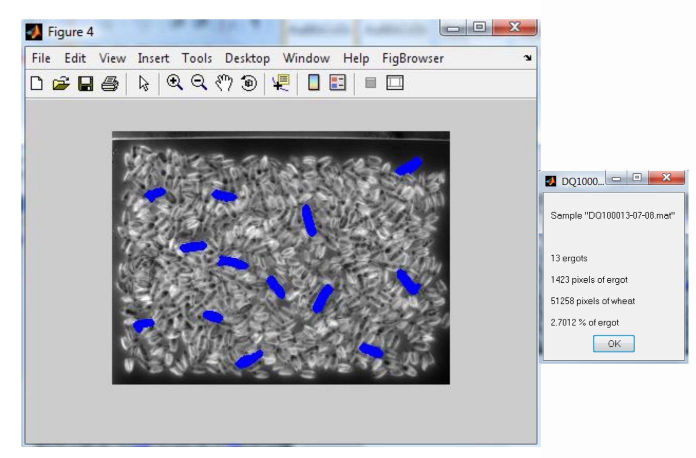


Image acquisition

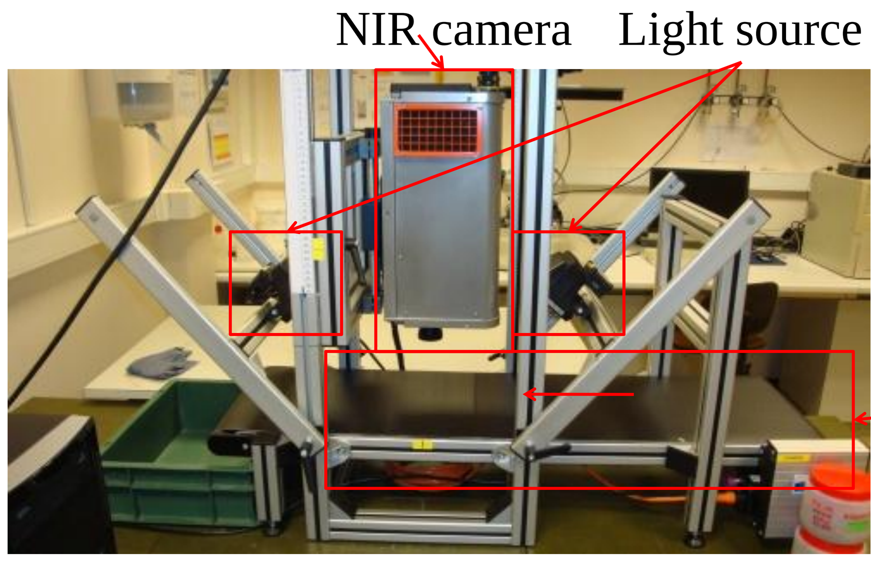




The first image shows the typical spectra for wheat kernels and ergot bodies. The second image shows the results of the prediction using a SVM (Support Vector Machine) discrimination model for a wheat sample adulterated with ergot. After applying the density-based clustering method (DBSCAN), wheat grains are in grey, ergot bodies in blue and background in black. The number of ergots and the number of pixels counted for each class of the model is also provided.

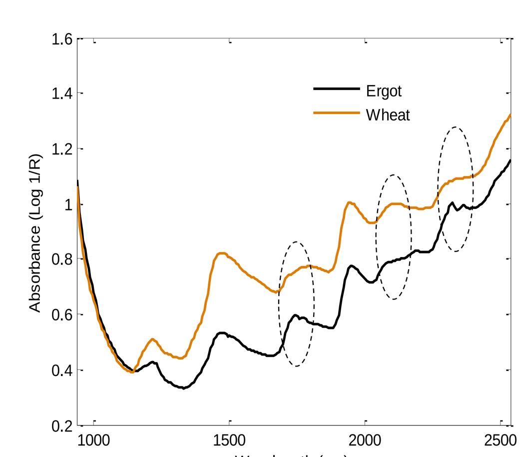
NIR hyperspectral line scan imaging system using a conveyor belt

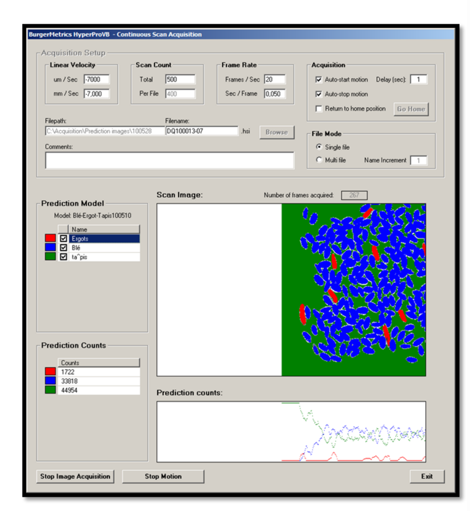
NIR camera   Light source



Conveyor belt

NIR hyperspectral line scan camera

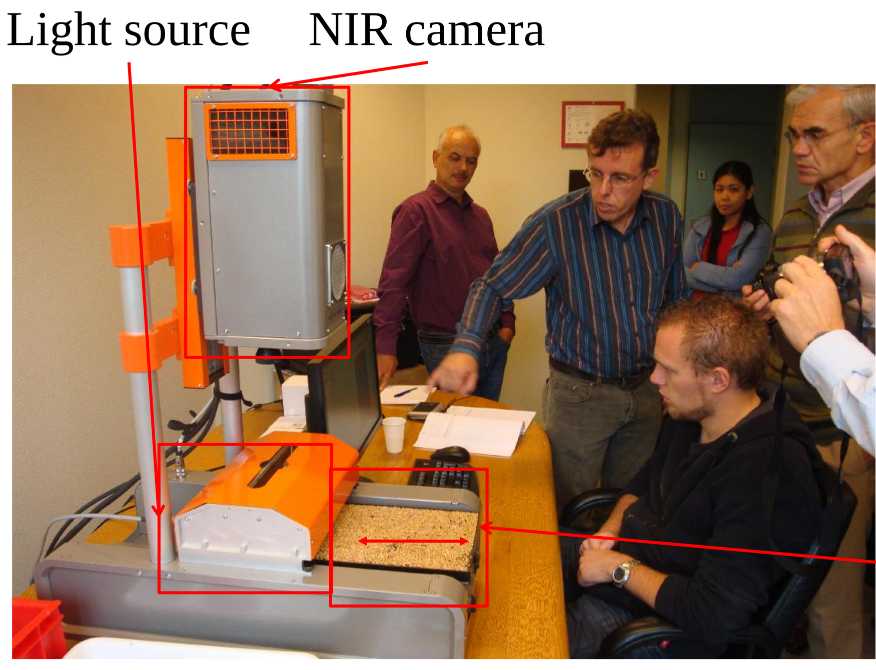




The first image shows the typical spectra for wheat kernels and ergot bodies. The second image shows the analytical parameters used and the on-line prediction results of the PLSDA (Partial Least Squares Discriminant Analysis) model for an adulterated wheat sample on the conveyor belt. Wheat grains are in blue, ergot bodies in red and background in green. The number of pixels counted for each class of the model is also provided.

NIR hyperspectral line scan imaging system using a moving tray

Light source   NIR camera



NIR hyperspectral line scan camera tested at NUTRECO

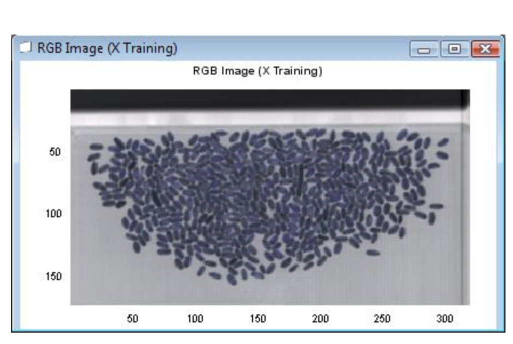
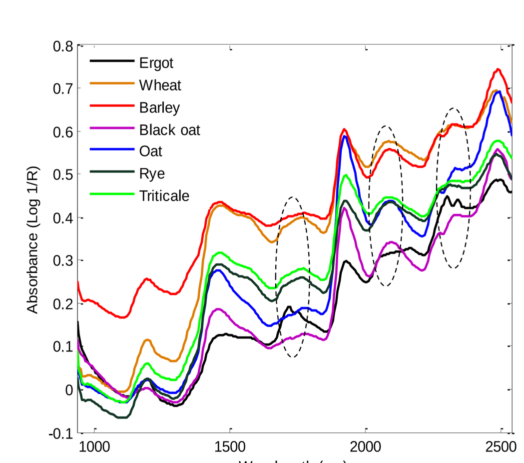
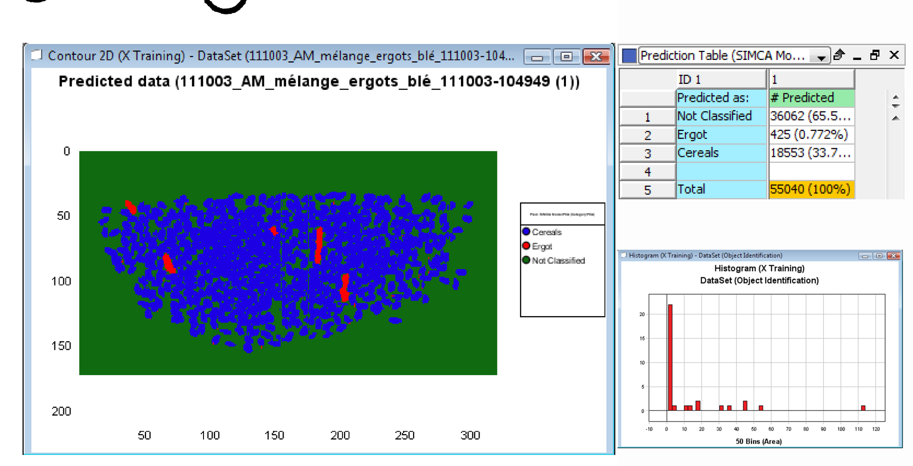


Image acquisition

Tray





The first image shows the typical spectra for several cereals kernels and ergot bodies. The second image shows the prediction results of the SIMCA (Soft Independent Method of Class Analogy) model for an adulterated wheat sample on the tray. Wheat grains are in blue, ergot bodies in red and background in green. The number of pixels counted for each class of the model and the distribution of groups of pixels detected as ergot are also provided.

Conclusion

The conclusions obtained from both at the laboratory level and at the industrial level have shown that NIR hyperspectral imaging and chemometric tools could be used as control method to assess and quantify the presence of contaminants such as ergot bodies in cereals. The 3 configurations using respectively SVM, PLS-DA and SIMCA gave good results.

References

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Vermeulen Ph., Fernández Pierna J.A., Van Egmond H., Dardenne P. and Baeten V. (2011). *On-line detection and quantification of ergot bodies in cereals using near infrared hyperspectral imaging*. Food Additives & Contaminants, in press.

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