Compact NIR system and Custom calculation Algorithms

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1. About DUNAMIST

DUNAMIST provides technical solutions for compact sp ectroscopic measurement systems.

We began in 2008 as an internal venture within HPK. Fur thermore, we are a company that has inherited the NIR te chnology of FANTEC, which was a research institute und er the Ministry of Agriculture, Forestry and Fisheries.

We build effective spectroscopic measurement systems b y leveraging practical technologies derived from industria l NIR measurement applications. We offer cost-effective, custom-tailored measurement systems optimized to meet the specific requirements of research and development pr ojects or small-scale quality control operations.

2-1. Compact NIR systems

Our measurement system is built around an existing spectroscopic module, incorporating a light source, power supply, illumination-synchronization mechanism, measurement probe, and a PC for data processing. By utilizing an existing spectroscopic module, the system keeps costs low; furthermore, the choice of module allows for the flexible configuration of measurement specifications—such as wavelength range and response sensitivity—to suit specific requirements. Figure 1 illustrates an example of a compact NIR system.

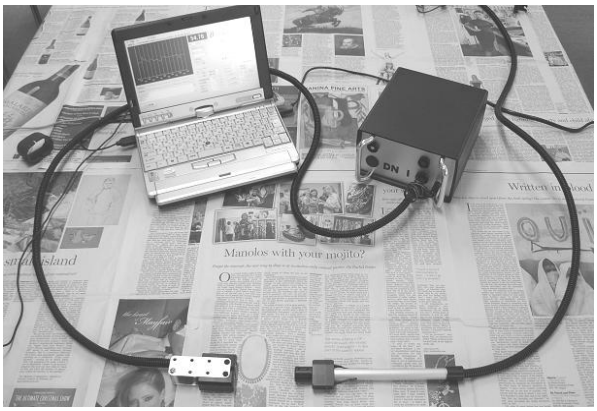


Figure 1. Compact NIR systems

The system minimizes power consumption by activating its light source only during measurements, which allows it to be powered by a rechargeable battery. Equipped with a rechargeable power source, the measurement system is compact and lightweight, making it suitable for outdoor use and enabling more extensive, proactive monitoring and observation.

By deploying observation equipment at a work site, users can monitor the state and conditions of objects in real time, thereby obtaining valuable information related to production, storage, and shipping.

The system incorporates a full suite of functions—from performing spectroscopic measurements to extracting (calculating) and outputting meaningful data—and can also serve as an applied tool for implementing in the field the results (such as calibration equations) originally developed using laboratory research equipment.

2-2. Custom probes

DUNAMIST offers a variety of measurement probe designs tailored to different types of samples. The standard-probes are engineered to allow for flexible light-projection and light-collection configurations, supporting transmission, reflection, and localized transmission (interact collection).

Furthermore, when conducting spectral measurements at industrial work sites, it is often impossible to ensure a completely dark environment. Consequently, it becomes crucial to employ light projection and collection methods that are optimized for both the ambient lighting conditions and the shape of the target object. At DUNAMIST, we optimize the design of our measurement probes to suit the specific shape of the sample and the operational conditions, thereby enhancing measurement accuracy and stability. Figure 2 illustrates an example of a custom probe designed for measuring small stems.

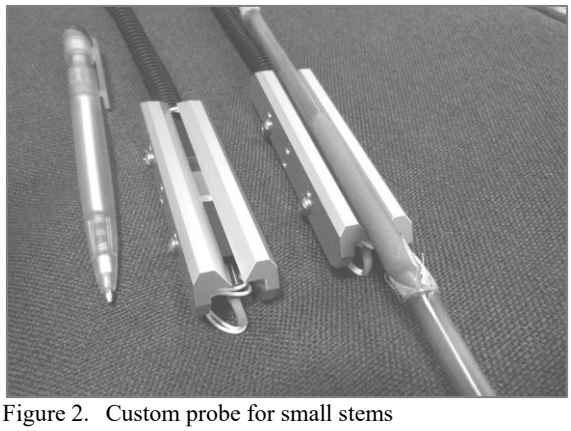


Figure 2. Custom probe for small stems

DUNAMIST has been developing a probe in the form of a work glove, designed to streamline the monitoring of agricultural produce growth—an example of customizing measurement probes. This glove-style probe incorporates a compact measurement sensor; the operator wears the glove and grasps the target object, allowing for the measurement of its spectral signature. Figure 3 illustrates shows glove probe at field operation.



Figure 3. Glove collection style

2-3. Example of system configuration

DUNAMIST's spectral system allows for the configuration of diverse measurement setups, depending on the specifications of the integrated spectral module. Several implementation examples are presented below.

Table 1 outlines the specifications for configurations that incorporate the mini-spectrometer series from Hamamatsu Photonics.

Case 1	**VIS – NIR Collection**
Core	HPK C11008MA
Wave Range	640 to 1050 nm
Detector	CMOS (256 Ch)
Power Supply	Battery
Propose for	plantation control
Case 2	**VIS – NIR Collection**
Core	HPK C10083CA
Wave Range	320 to 1000 nm
Detector	CCD (2048 Ch)
Power Supply	AC 100V
Propose for	Mold detection

Table 1. Configuration of our systems

3. About calculation Algorithms

DUNAMIST provides various computational algorithms for extracting target variables from spectral data. For standard multiple linear regression (MLR), the software utilizes a "combination search" method, which can be supplemented with a "step-up search" (forward selection) approach depending on the specific requirements. This is particularly effective in scenarios such as using a "combination search" to identify the principal components that capture the variations in the target variable, while subsequently employing a "step-up search" to incorporate additional terms that account for In addition to these least-squares algorithms, we also offer estimation algorithms based on network-based learning systems. In many cases, these multilayer learning algorithms yield superior results compared to least-squares-based algorithms, particularly regarding classification (qualitative) functions.

While learning-based algorithms are prone to the drawback of "overfitting," our system mitigates this through a realtime validation mechanism. Furthermore, by incorporating "pre-weighting"—achieved through a hybrid approach with MLR —it is possible to prioritize the maintenance of linearity.

Figure 4 illustrates a comparison of the configurations for MLR, PLS, and our learning-based system.

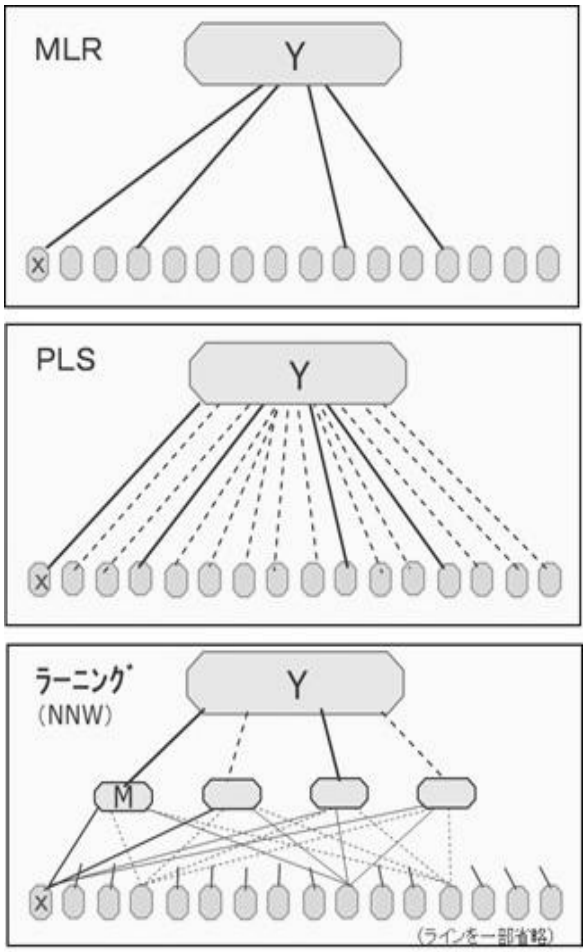


Figure 4. Overview of algorithm
TOP : MLR calculation operation
MID : PLS calculation operation
LOW : Learning calculation operation

We build these algorithms into software by developing them from the source code ourselves; this allows us to accommodate any customization requested by our clients. In addition to creating customized executable files (EXEs), we can also provide libraries of computational algorithms or the source code itself.

4. Memo

We aim to expand the scope of spectroscopic measurement applications by offering the necessary functions for various types of spectroscopic analysis in a compact, low-cost package.

As the configuration of measurement systems evolves—driven by the ongoing trend toward the extreme miniaturization of measurement devices—we intend to propose new modes of usage that are well-suited to these developments.