

Benefits of AI in Optical Equipment Development and Optimization



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MEMBRE DU  RÉSEAU DES CCTT

Bilal Khomri, Phd. Researcher & Coordinator of the AI Program

Optech is a **non-profit company** specializing in **optics-photonics**



In operation since 2002

In 2023



Team 30+ Scientists, engineers, technicians



140+ Projects



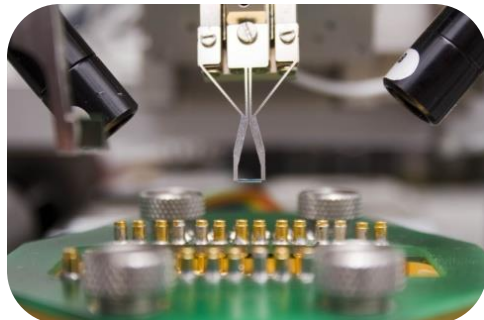
60+ Companies supported



10M\$+ in equipment, 600 m2 of laboratories



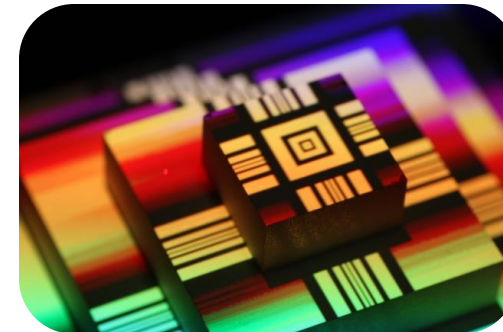
Fiber Optics



Microsystems



**Illumination
and Imaging**



Metrology




OPTICAL & AI

- **Helps develop your optical prototype :**
 - We are adopting a physics data driven approach, we combine our expertise in optics with simultaneous measurement-oriented processing (physics-driven), which gives us a cleaner data.
- **Allows to create and develop a model adapted to the physical nature of the newly created data**
 - To obtain value-added information to optimize your operations, processes or products.

Projects developed combining AI and optics in multiple fields :

Case study




Biomedical

Metabolic Imaging to Prevent Retinal Disease



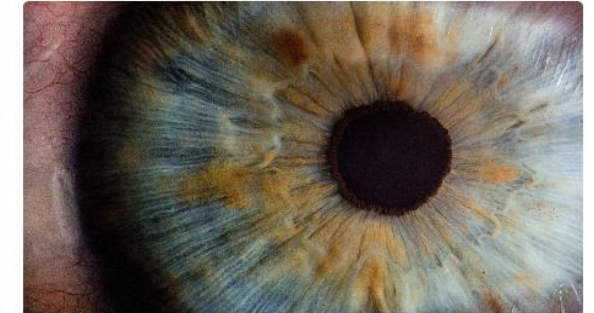
Environment

Feasibility study of an integrated strategy for the management of steel mill residual materials



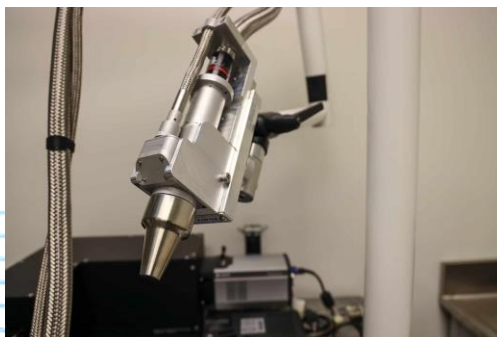
Environment

Technical feasibility study of an instrument for optical sorting of textiles



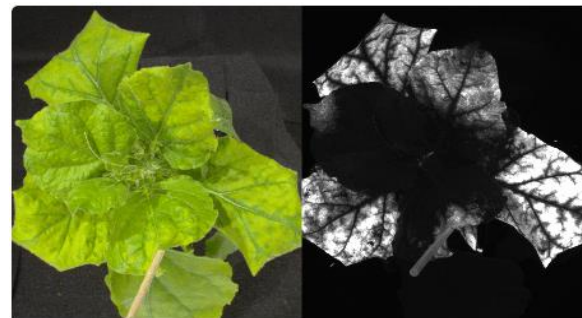
Biomedical

Experimental feasibility study of a molecular fundus imaging system




Biomedical

Development of a Raman and fluorescence spectroscopy imaging system for endoscopic probes



Agrophotonics

Improved multi-mode macroscopic imaging technology for phenotyping stress markers (defense proteins)



Agrophotonics

Development of non-destructive optical tools and methods for characterizing plant metabolism



Performing arts

Interactive system for large surfaces

OPTICAL-AI APPROACH (1): OPTECH STRATEGY TO BENEFIT FROM AI IN THE OPTICAL PHOTONICS FIELD

Optimize and develop simultaneously AI and the optical system using Optech's **Optical-AI platform** :

Our platform allows the operator and our multidisciplinary team to quickly validate/analyze data (2D, 3D), retrain models and even quickly compare the effectiveness of different AI approaches on data sets without knowledge of algorithmic programming !

Plateforme IA & Optique :

Cette plateforme permet l'Exploration de données optiques
et le Développement d un modèle d IA sans connaissance en
programmation algorithmique !

Home

- Data Header
- Data Summary
- All spectra
- Scatter Plot
- PCA
- AI Framework

Upload a optical data

Upload file

Drag and drop file here
Limit 200MB per file

Browse files

MLOPS & Optical Data Explorer

This platform web-application allows the exploration of optical data and the development of an AI model without knowledge of algorithmic programming.

Artificial Intelligence

Optical AI

DevOps

Optical

MLOPS

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OPTICAL-AI APPROACH (2): SPECTROSCOPY PLATFORM

Our spectroscopy platform help us to develop an optical prototype and extract tangible results using AI and the physical principles behind the data obtained.

Optech's approach is to inject a physical interpretation of the AI models obtained to make a direct link with the prototype being developed and optimize it.



Raman Spectrometer
Optech custom development

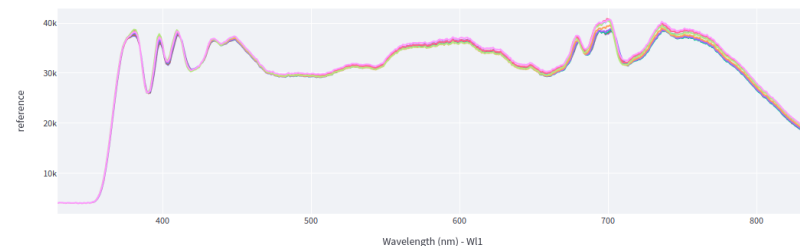
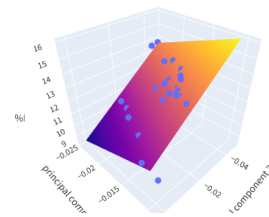
- Home
- Charger les données
- Données disponibles
- Analyse de répétabilité
- Analyse des mesures
- Analyse de température
- Modèles d'IA déployés
- Analyse de PCA
- Surface de prédiction & PCA**
- AI Framework-Régression
- Sélectionner & analyser un modèle d'IA
- À propos

Surface de prédiction VS PCAs

Note 📌: les points dans la visualisation représentent les mesures du Labo

et la surface de prédiction est tracée en fonction du modèle d'IA et des composants principales

Select Target: %
Select the X-axis principal component: principal component 3
Select the Y-axis principal component: principal component 4



variable
11.665871-ID-K000019-Tred1-23.4-2022/11/24 09:13:45
11.154721-ID-K000020-Tred1-21.5-2022/11/24 09:45:59
11.727610-ID-K000021-Tred1-19.6-2022/11/24 10:24:20
11.492173-ID-K000022-Tred1-19.0-2022/11/24 10:52:47
11.539242-ID-K000023-Tred1-15.7-2022/11/24 11:31:45
11.603644-ID-K000025-Tred1-13.7-2022/11/24 13:52:59
11.075541-ID-K000028-Tred1-15.5-2022/11/24 15:22:47
11.470558-ID-K000026-Tred1-13.3-2022/11/24 14:22:41
11.231721-ID-K000029-Tred1-17.9-2022/11/24 15:50:34



Cary-spectrometer



CCM-200plus

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OPTICAL-AI APPROACH (2): DEMOCRATIZING THE ACCESS HYPERSPECTRAL IMAGING TECHNOLOGY USING AI

Based on our **Optical-AI platform** and **fleet of Hyperspectral cameras**, we can develop a personalized and low-cost multispectral system that is specific for an application.

Our approach is to extend the ease of access to hyperspectral imaging technology to a wider audience of professionals. This affordability not only democratizes access to hyperspectral data, but also fosters innovation and exploration in various scientific fields where budget constraints have traditionally been a significant barrier.



SPECIM FX17
NIR (900 – 1700 nm)

Clustering d'images hyperspectrales

Maintenant que tu as le fichier npy, tu peux l'importer.

Drag and drop file here
Limit 1GB per file • NPY

Smile_nuts.npy 253.1MB

Importer l'image hyperspectrale, enlever le background and générer un graphique d'une bande

Choisir une bande spectral à visualiser (entre 0 et 224):

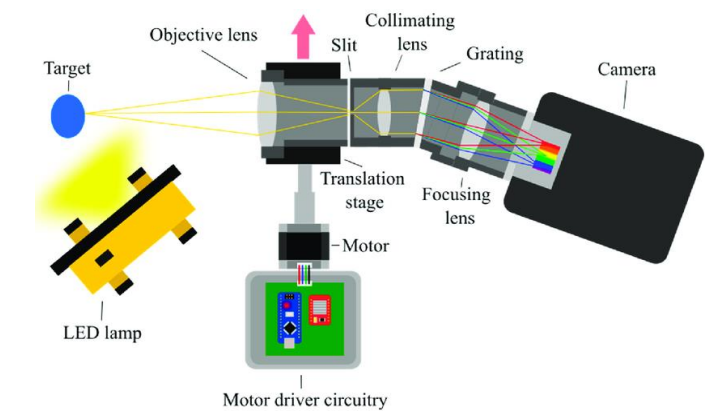
À sélectionner

Veux-tu rogner (crop) l'image hyperspectrale?

À sélectionner

Choisir une méthode parmi les différentes méthodes de détection d'anomalies pertinentes à votre classification_methode d'application?

À sélectionner



Schematic diagram of the Low-Cost High-Resolution hyperspectral imager

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OPTICAL-AI APPROACH (3): COMPUTER VISION PLATFORM (2D)

We use our vision platform to **select the best AI model** and **the right optical components** (lighting, lens, camera, etc.) **according to the application** (object classification, anomaly detection, segmentation).



LED lighting



Variety of lenses



Industrial Cameras

Accueil

- 1. Collecte de données
- 2. Entraînement du modèle IA**
- 3. Exécution d'un modèle IA (live)
- 4. Détection d'objets & Classificati...
- 5. Détection d'objets (live)

Contrôle de la caméra

1) Sélectionner une base de données / application

Sélectionner un modèle

vgg16

Note : Un prétraitement est appliqué sur les données brut

Voici les classes disponibles :

{ '1': 'Vis', '2': 'Cheville', '3': 'Background' }

2) Entraîner le modèle IA

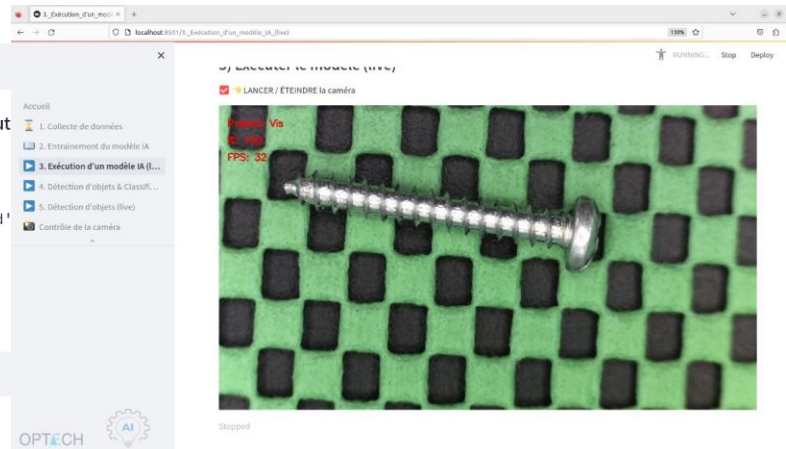
Définir le nombre d'itérations (époques)

3

Appuyez 🖱️ pour entraîner le modèle

Training in progress. Please wait.

Epoch: 2	Training Loss: 2.213..	Validation Loss: 0.107..	Validation Accuracy: 0.990..
Epoch: 3	Training Loss: 1.150..	Validation Loss: 1.399..	Validation Accuracy: 0.906..



OPTICAL-AI APPROACH (4): DEVELOPMENT OF AN AI SOLUTION USING DIFFERENT DATA SOURCES

Example of used data sources hardware:

If one source of optical information is not sufficient to develop a robust optical prototype. What do we do then?

- We design prototypes integrating custom AI, capable of processing various data sources such as photodiodes, temperature and pressure sensors, ..,etc.
- **Project Example:** Soil Irrigation Management
 - Compact probe design for a chemical substrate detection in soils
 - Integration into a real-time measurement system



LED



Fiber optic pressure sensor



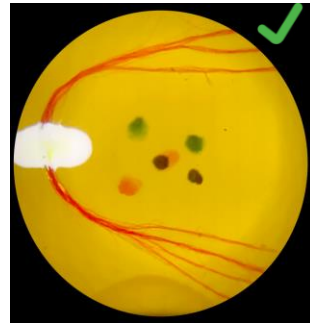
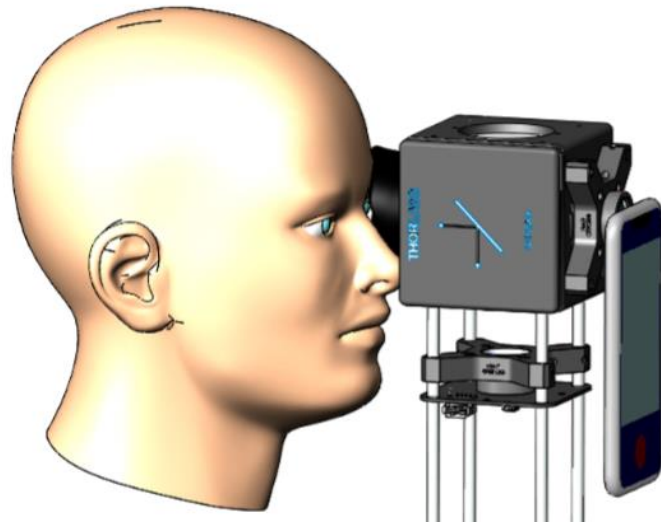
Humidity Sensor

Input data for AI solution

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OPTICAL-AI APPROACH (5): DEVELOPMENT OF RETINAL CAMERA WITH LED RING AND SMARTPHONE

Optical design and optimization by AI evaluation image quality system



Good	Usable	Reject
74%	80%	12%

Good: High probability of clinical interpretation
Usable: Medium probability of clinical interpretation
Reject: Low probability of clinical interpretation

Retinal camera prototype



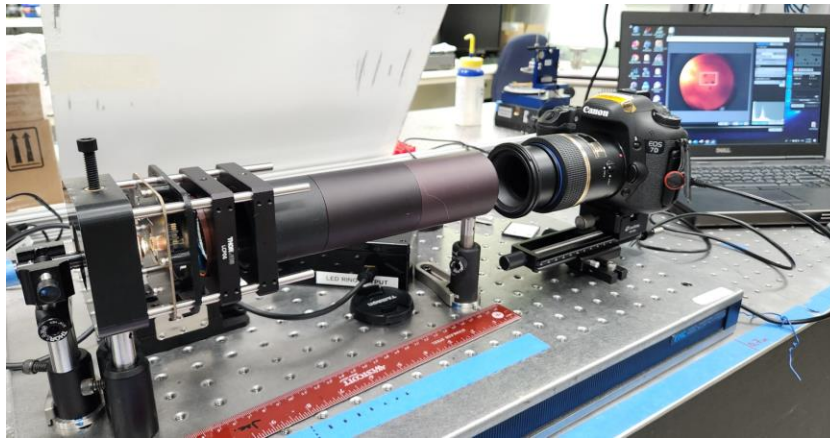
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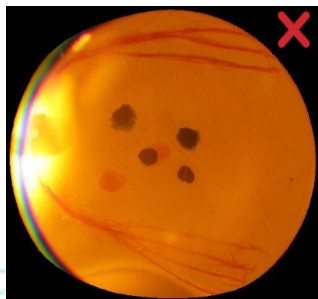
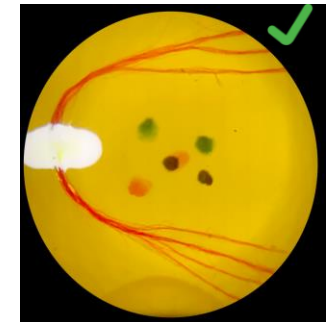
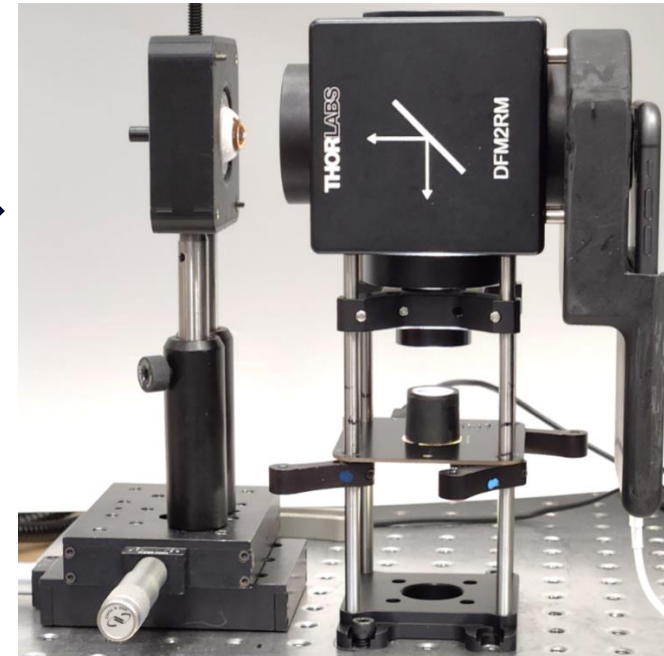
OPTICAL-AI APPROACH (5): DEVELOPMENT OF RETINAL CAMERA WITH LED RING AND SMARTPHONE

Before: First prototype



Optimized by AI

After: several optimizations



Good	Usable	Reject
8%	12%	74%

Good	Usable	Reject
74%	80%	12%

Good: High probability of clinical interpretation
Usable: Medium probability of clinical interpretation
Reject: Low probability of clinical interpretation

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