



Sistemi e Tecnologie Industriali Intelligenti
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Consiglio Nazionale delle Ricerche

A system for detection of tampering on intermodal containers

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- Shipping containers provide a standard and ubiquitous way to move goods between different places and countries
- Improving transport security of the containers hosting those goods is hence paramount
- Tampering needs to be addressed

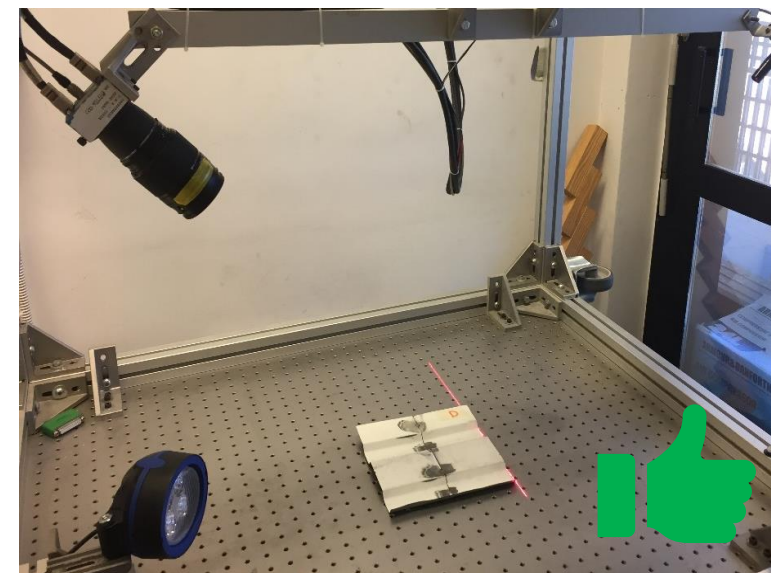
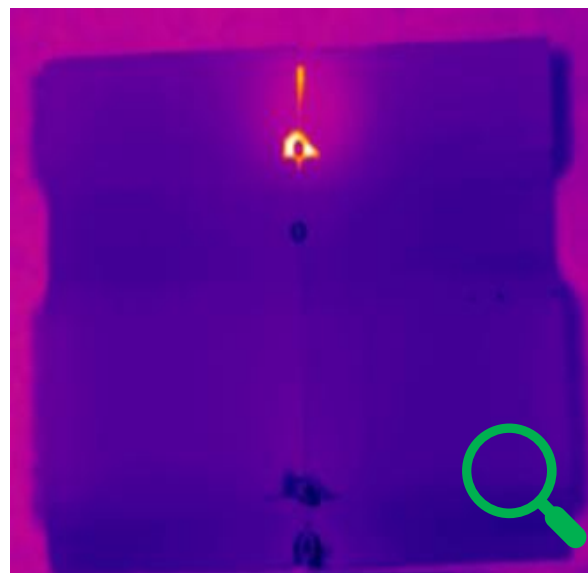
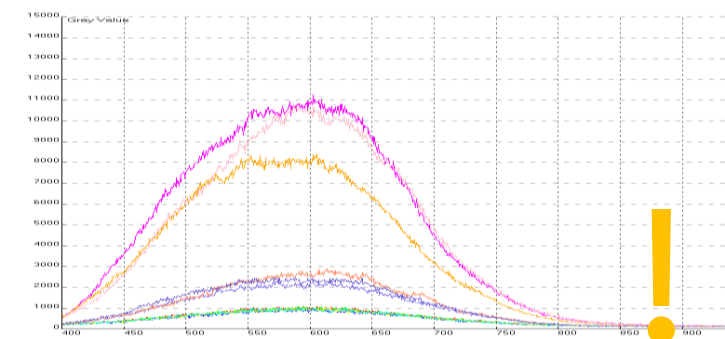
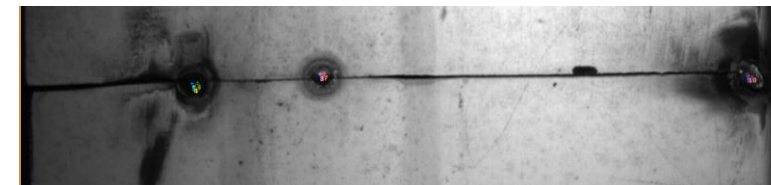


- Standard tampering and intrusion counter-measures “instruments” the container and include:
 - Locks
 - Hard walls
 - Tamper evident seals
- Just a few solutions approach the issue differently, but they are usually expensive or oriented toward similar (but not quite the same) problems:
 - Damage detection solutions: aiming to understand if a container is damaged – regardless of the particular reasons, just an accident or deliberate
 - Solutions using expensive and invasive technologies such as X-ray screening

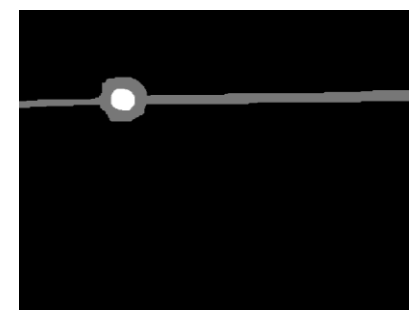
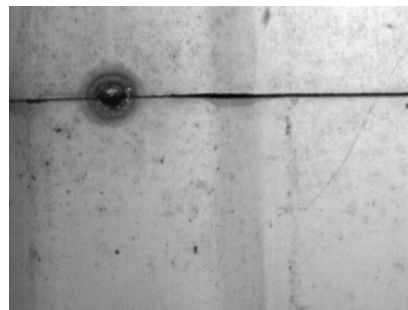
- What is tampering?
 - Tamper: «interfere with something» in order to cause damage or make unauthorized alterations
- How to detect tampering?
 - No easy answers here
 - If someone looks for an alteration, it means that a general idea of «normal» should be already known
 - An tamperer might:
 - Leave the damaged or altered part in plain sight
 - Try to hide it, with different degrees of success
- The followed approach (untested yet, due to current situation):
 - Understand container characteristics by looking to recurrent patterns (limited to dry van type)
 - Find anomalies
 - Classifying tampering related changes from accidental ones is a challenge on its own, regardless of the technologies

- Understanding container characteristics:
 - Corrugated plate sidewall structural design can be used as a reference model
- Finding anomalies:
 - A different color, altered shape or material can indicate a tampered area
 - Or maybe not:
 - Rust or corrosion are common and natural
 - Punctures or gouges can be clear signs of tampering
 - Or collateral damages caused by a fork lift, due to human error while moving the container
- No magic wand:
 - Detect anomalies
 - Assign a warning score to each one
 - Report to the officer for validation
 - In this investigation even welding spots could be an anomaly – if present in strange places

- A cost-effective prototype of a “transportable” system is being devised.
- Different sensing technologies are being tested, including:
 - Color
 - Hyperspectral
 - 3d Profilometry
 - Thermal imaging
- Color alone is unreliable

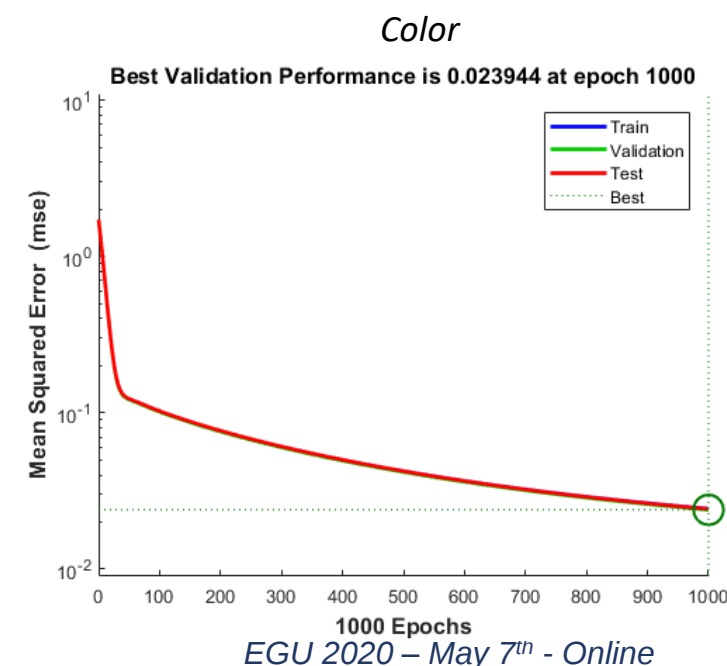
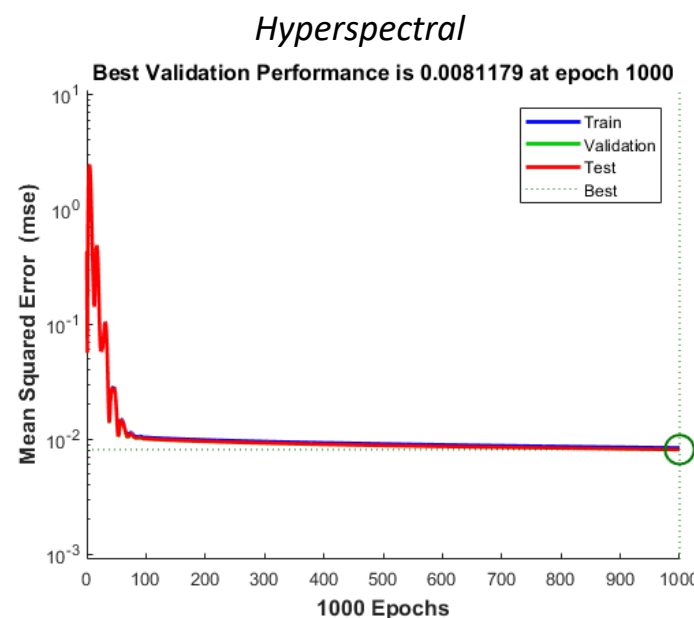


- Why hyperspectral?
 - A valid solution in other fields to classify different materials
 - There is potential there...
- Why not?
 - Slow
 - Expensive
 - Very noisy
- Express a wish (maybe two):
 - Find a bunch of discriminative wavelength ranges
 - Convert the analysis in multispectral to speed-up acquisition and processing

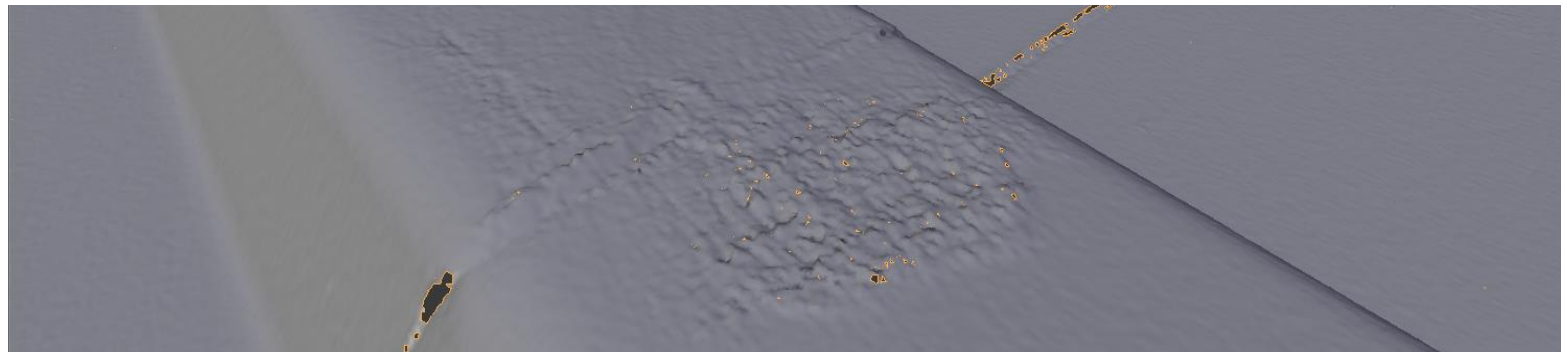


A toy problem for understanding Hyperspectral potential, in a classification problem
White: class 1; black: class 2;
grey: do not care

- 1) Panel acquired in VIS range of the spectrum (320-1000nm), about 900 bands
- 2) Hyperspectral image converted to RGB
- 3) Classification using NN with Hyperspectral show reduced error, despite noise

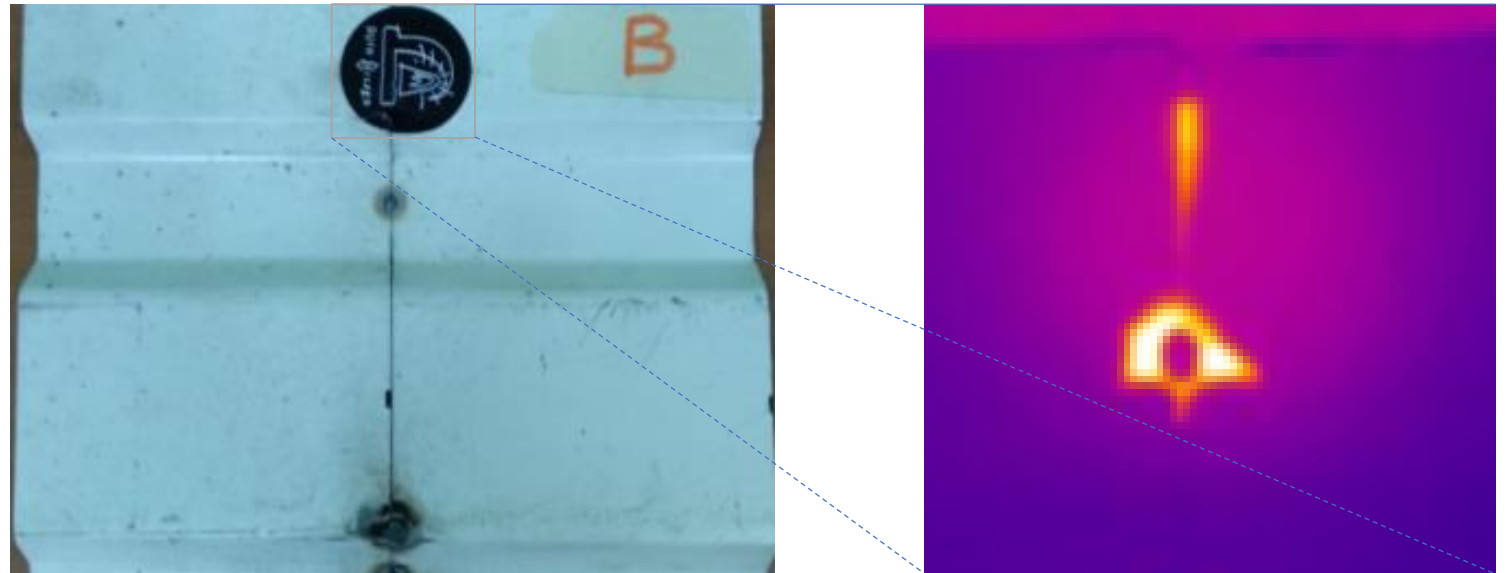


- Why 3d?
 - Most tampering, if cannot break/open a lock must create punctures/gouges in the wall
 - 3d is today accurate enough to detect anomalies
- Challenges:
 - Bumps and holes do are not caused by tampering alone
- Express a wish:
 - Avoid tampering misclassification

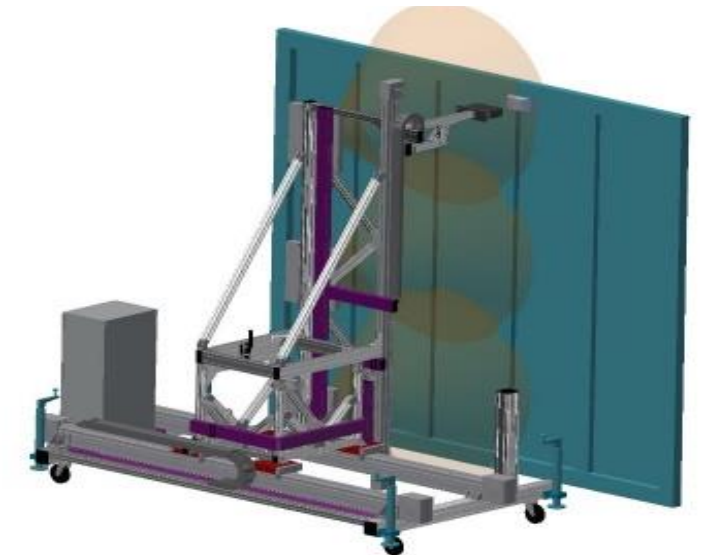
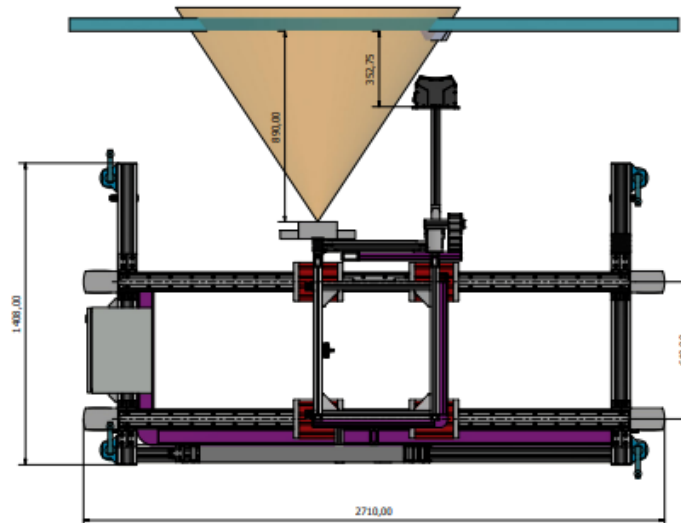
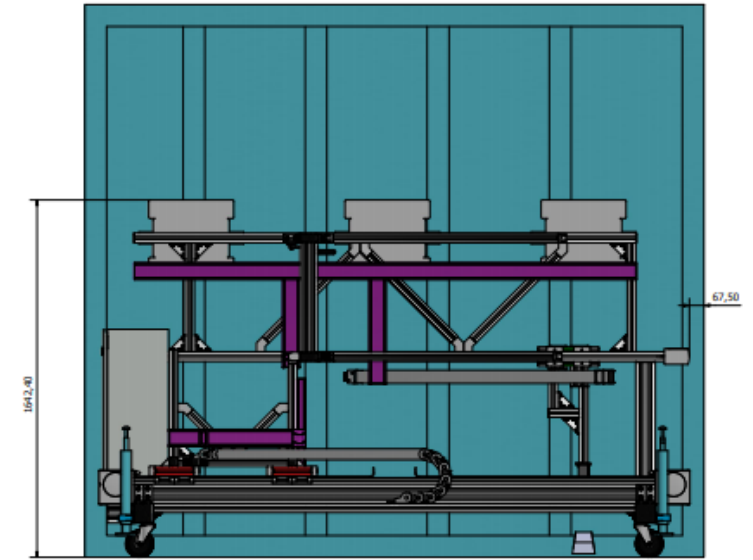
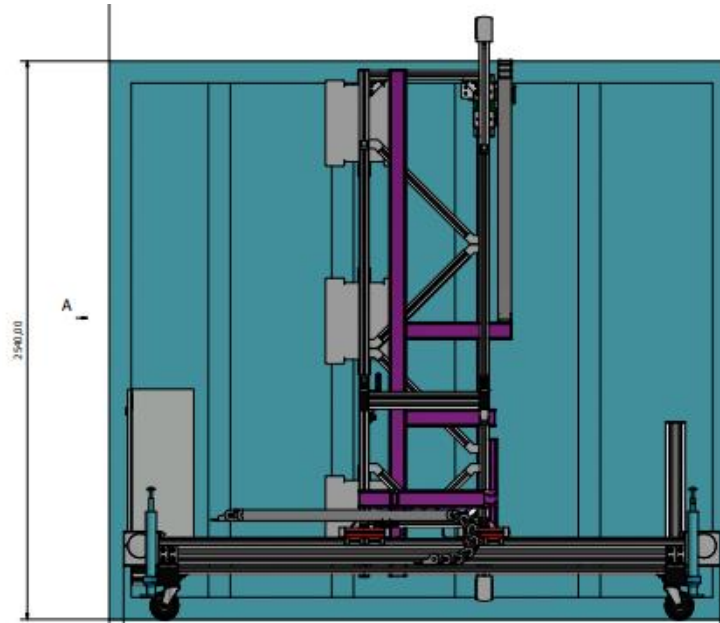


- Why Thermography?
 - One of few techniques able to see beyond the surface
 - Not quite X-ray effective but «cheaper» and less invasive as well
- Challenges:
 - Active thermography is more time consuming w.r.t. color & 3d
- Express a wish:
 - Cost reduction might help

A weld has been hidden under a sticker. Active thermography is able to detect it regardless



- The color cameras scan the whole surface and the 3d snapshot sensor is then used on selected areas
 - a separate *thermo camera setup* can be used to collect further data
- It is foldable to better fit logistic operations
 - the system is designed to inspect a container while trespassing the controlling gate in the terminal



- Technologies and algorithms are being tested on lab-friendly patches
- The assembled system is going to be tested on a full scale container





Programming will resume after the (out-) break