

Automatic Tolerance Inspection via Reverse Engineering and PDM Feedback

FACOLTÀ DI INGEGNERIA
CIVILE E INDUSTRIALE



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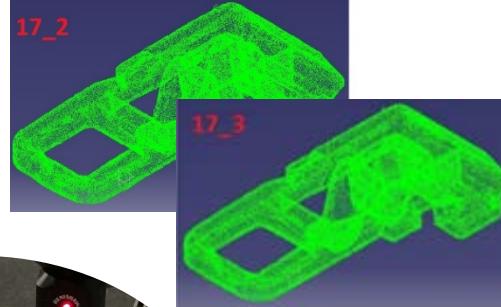
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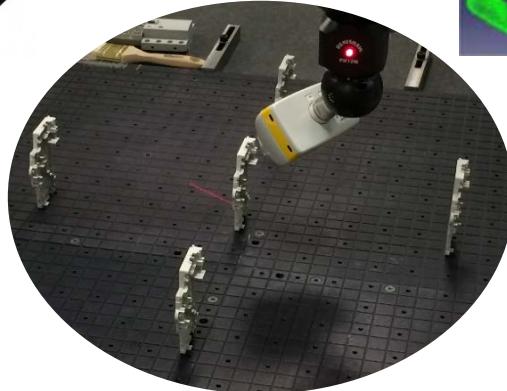
Introduzione e target



TARGET: Valutazione degli stampi in termini di rispetto delle tolleranze per componenti realizzati in Injection Molding



Portale CMM 3
COORD Hera
12.9.7 + Laser
scanner Nikon
LC15Dx



OUTPUT:
File PDM ed elaborazioni statistiche

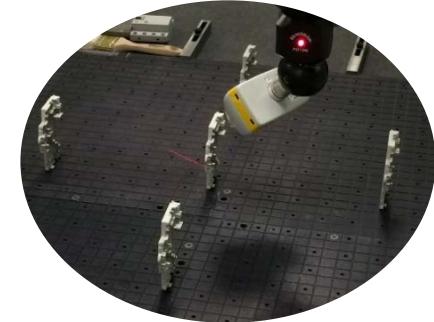
*Ogni campagna
di misura
richiede 20-30
ore di lavoro!!!*

Schema delle attività e obiettivi

L'intera procedura è suddivisibile in 3 macro-aree:

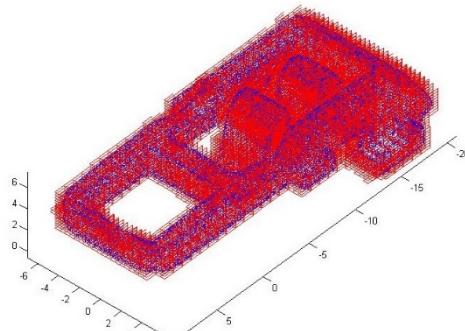
1. Ottimizzazione delle procedure di scansione

Orientamento dei componenti, viste e posizionamento scanner, percorsi e ingombri



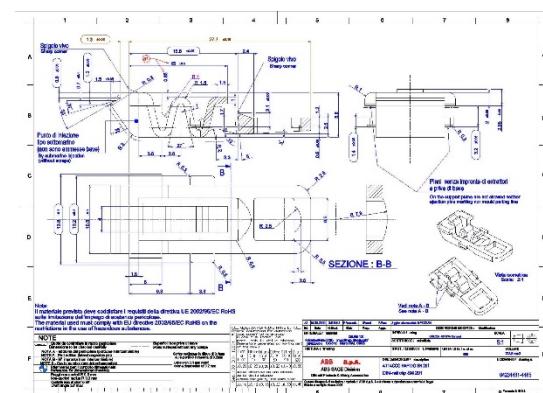
2. Sviluppo di routine automatiche di misura

Suddivisione in voxel (Octree), Hierarchical Clustering, Region Growing, best fit, CAT&I



3. Creazione automatica di report PDM e di uno «smart» draft

Desiderata e protocolli R&D, Gestione «storica», PDM report, Intelligent Draft

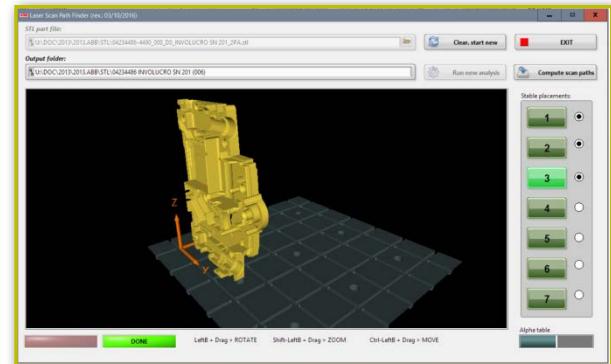


1- Ottimizzazione della scansione

GUI per orientamenti ottimizzati

- Stabilità del pezzo (controlli sul baricentro STL)
- % superficie esposta (acquisibile)
- Orientamenti facilmente perseguitibili (posizionamento manuale, successive rototraslazioni e assembly)

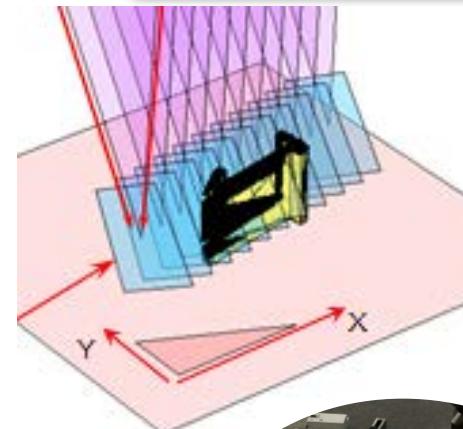
DEBUG



Macro per parametri posizionamento Scanning Head

- Angoli caratteristici
- Altezza, ingombri e safety positions

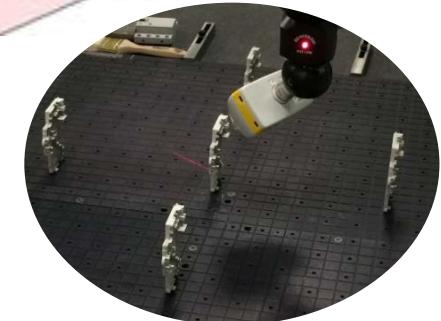
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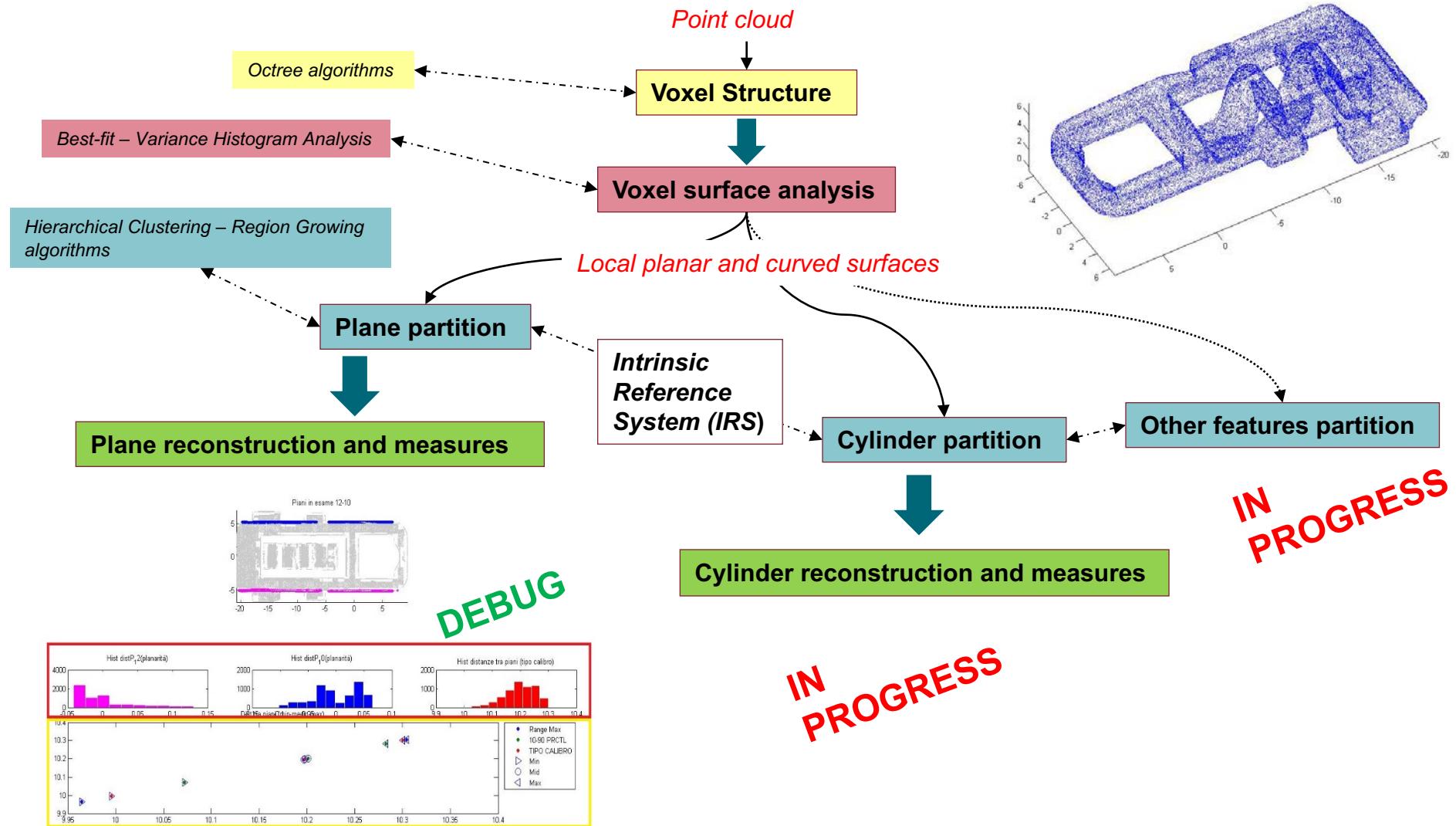
Macro per ottimizzazione Path

- Passate di scansione
- Gestione acquisizione multicomponente

IN PROGRESS



2- Sviluppo di routine automatiche di misura



Proposed Approach

Through a grid method (octree grid) derived from hierarchical space partitioning the point cloud is associated to a 3D voxel structure (\mathbf{V}).

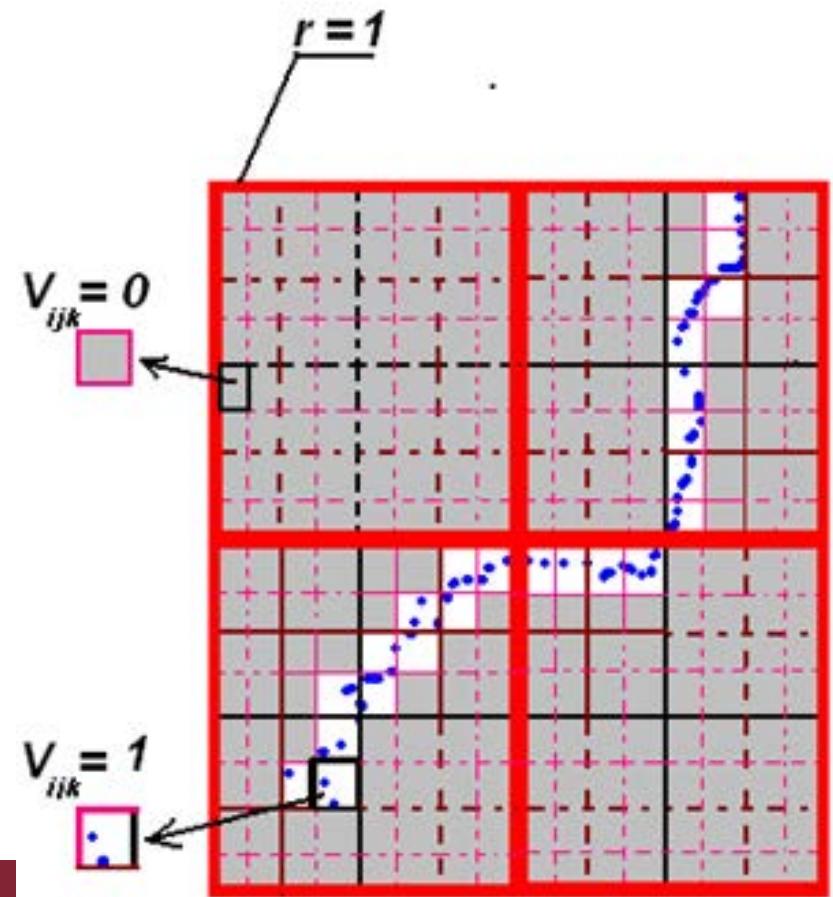
$V_{ijk} = 1$ if points are inside

$V_{ijk} = 0$ if not

$$step_i = \frac{\max(P_i) - \min(P_i)}{k_i} \quad i = x, y, z$$

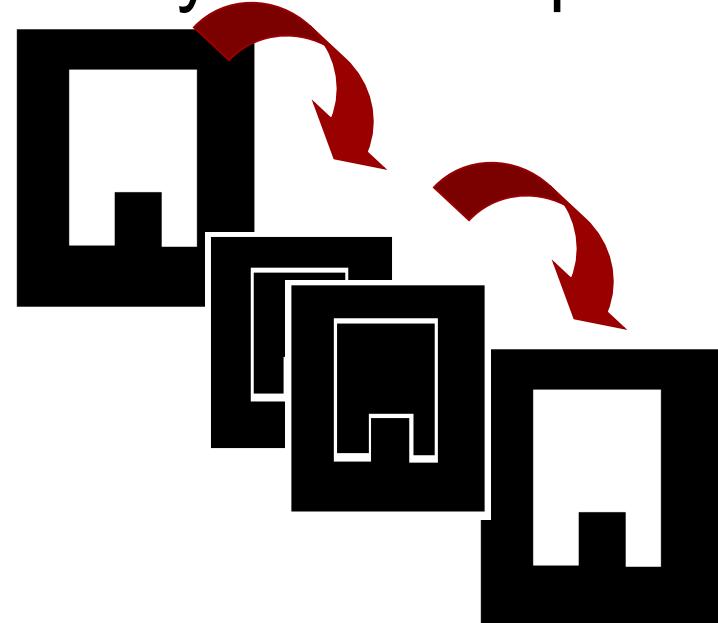
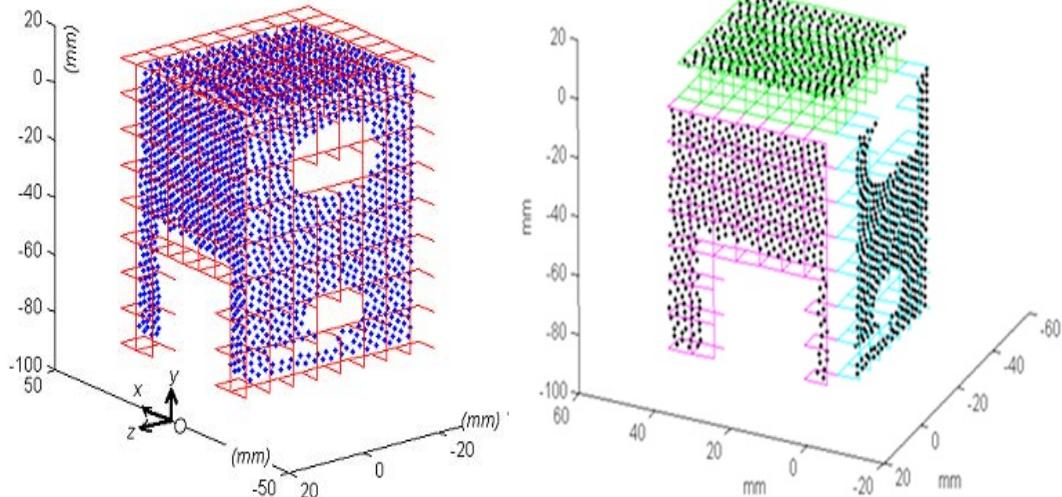
k_i represents a zoom factor:

$$k_i = 2^r \quad r = 0, \dots, \log_2 N$$



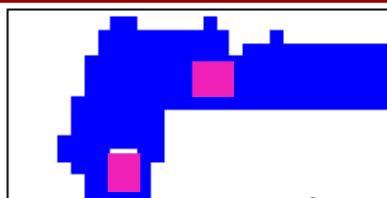
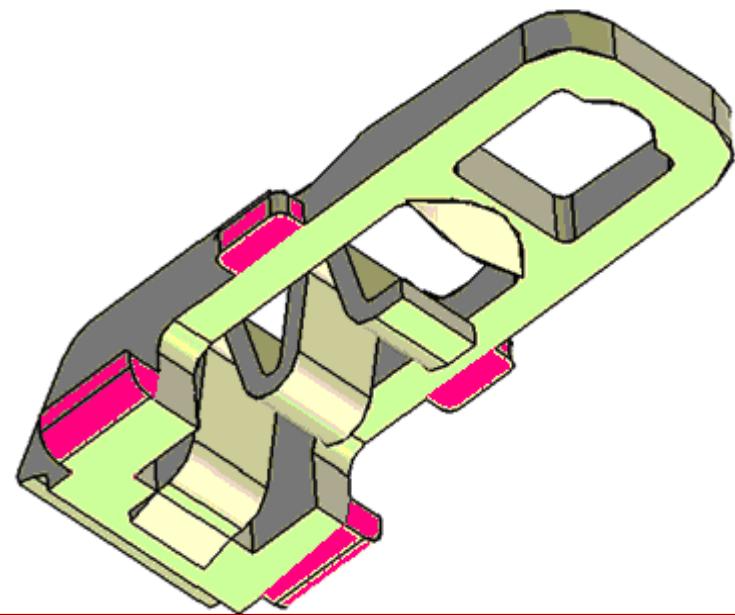
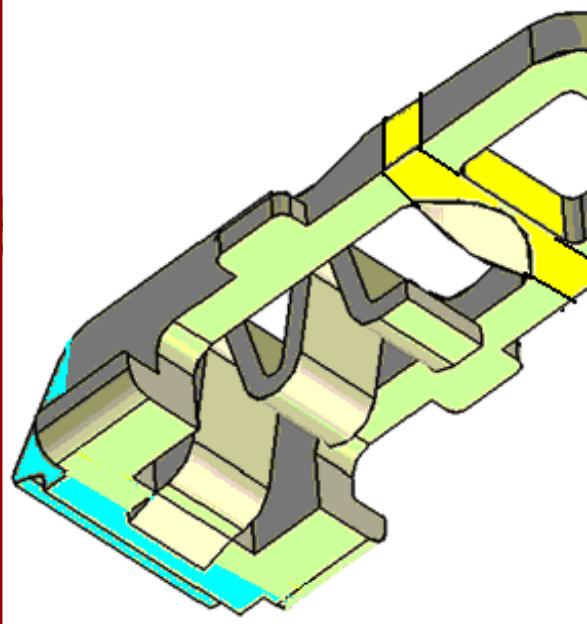
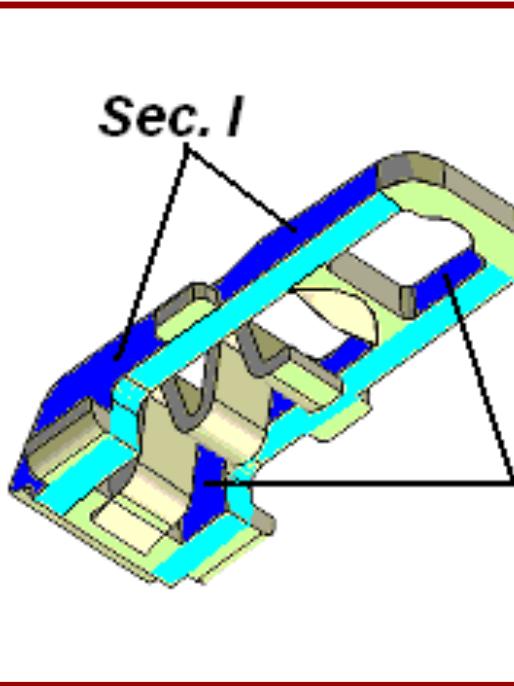
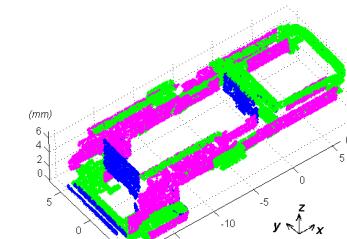
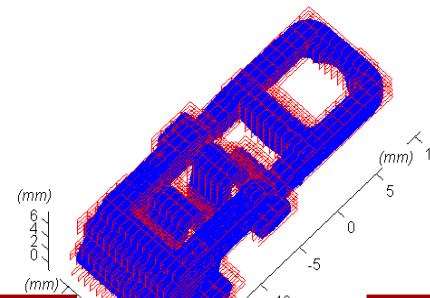
Proposed Approach

V is analysed according to the results of a surface partition of the cloud deducing the link between surfaces and volumes via image analysis techniques.

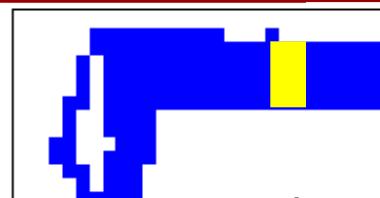


Voxel adjacency allows to understand features associated to the volume

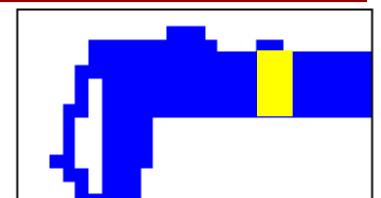
Case Study



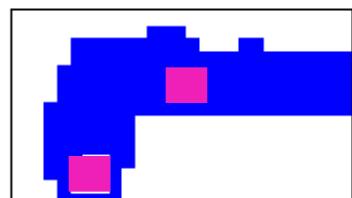
Sec. I



Sec. II



Sec. III



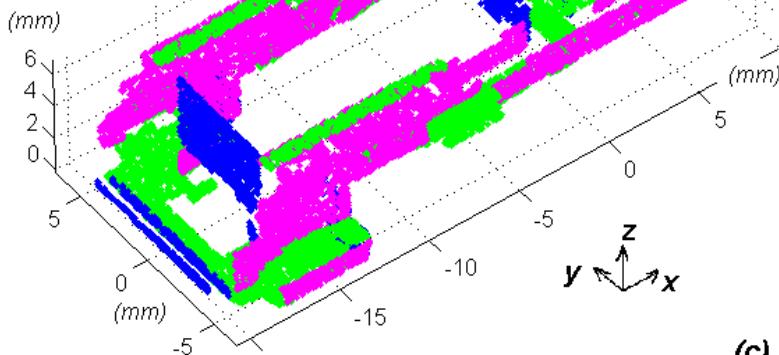
Sec. IV



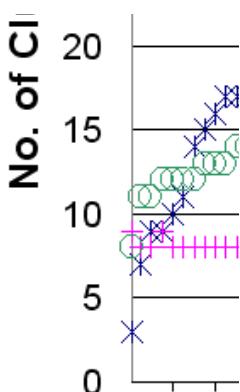
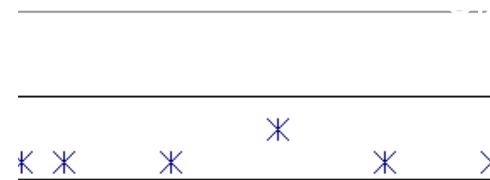
Discussion

Hold sensitivity

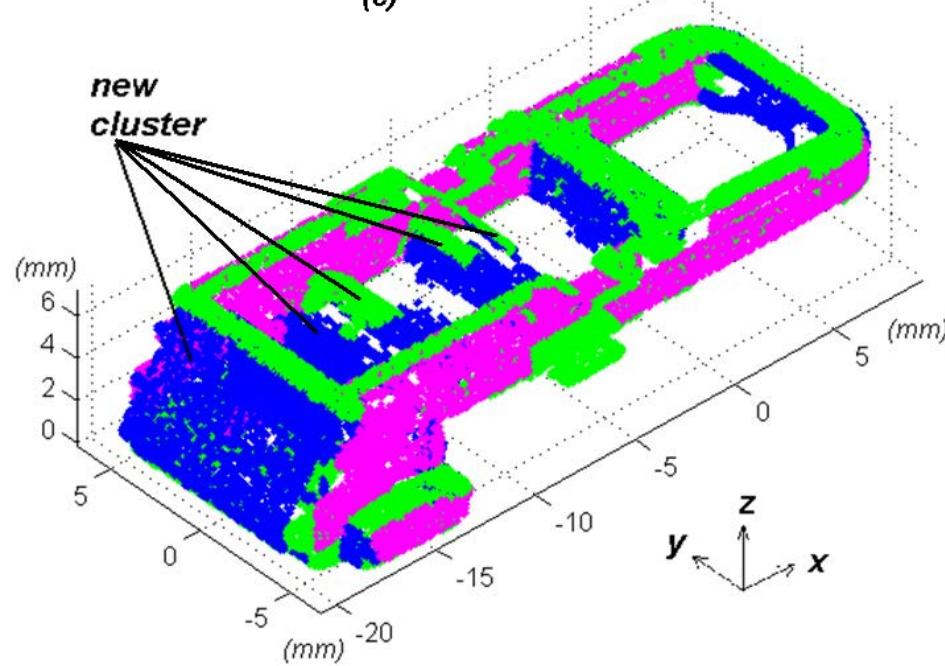
$$\left[b - c \right]^T \leq \varepsilon$$



(c)



new cluster



- normal to X
- normal to Y
- normal to Z

3- Creazione automatica di report PDM e di uno «smart» draft

Creazione Path con «storico» dei componenti:

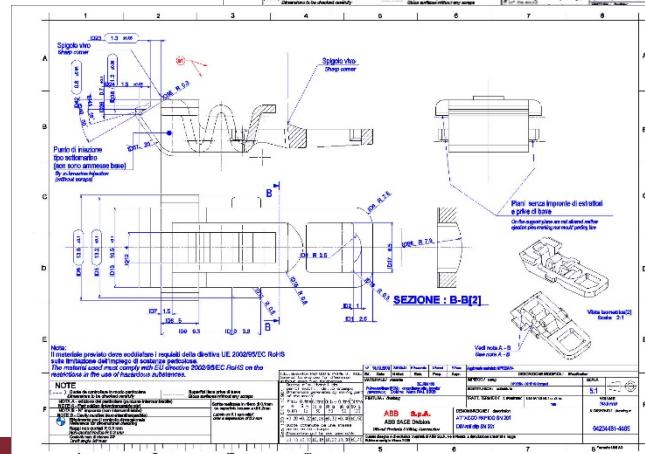
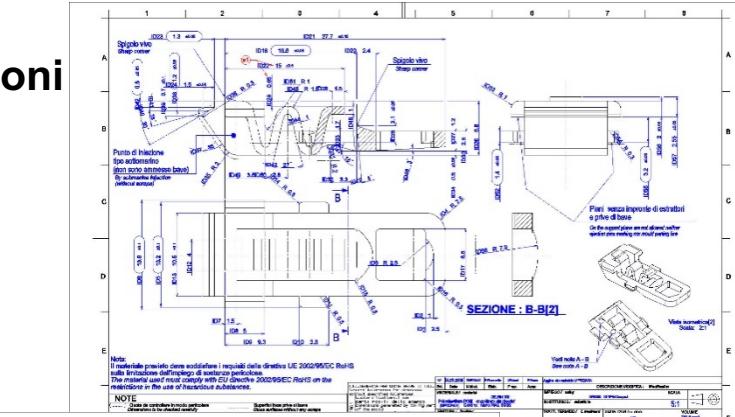
- Per fornitore, stampi ed edizioni successive (adattamento ai protocolli aziendali)

DEBUG

Creazione File PDM con risultati misure ad elaborazioni statistiche

Creazione Draft connesso con il file PDM:

- Reportistica integrata nelle quotature, con possibilità di selezione, indagine ed elaborazione simultanea.



Reference

- Bici, M., Campana, F., Trifirò, A., "Automatic post-processing for tolerance inspection of digitized parts made by injection moulding", (2016) Computer-Aided Design and Applications Volume 13, 2016 - Issue 6, Page 835-844. <http://dx.doi.org/10.1080/16864360.2016.1168231>
- M. Bici, F. Campana, S. Petriaggi, L. Tito, "Study of a Point Cloud Segmentation with Part Type Recognition for Tolerance Inspection of Plastic Components via Reverse Engineering", (2014) Computer-Aided Design and Applications, Vol. 11, Issue 6, pp. 640-648, DOI:10.1080/16864360.2014.914375
- M. Bici, F. Campana, A. Trifirò, C. Testani, "Development of automatic tolerance inspection through Reverse Engineering", Proceeding of Metrology for Aerospace (MetroAeroSpace), 2014 IEEE, 29-30 May 2014, Benevento - Italy. DOI: 10.1109/MetroAeroSpace.2014.6865903