



Autonomous systems and Hangar of the Future

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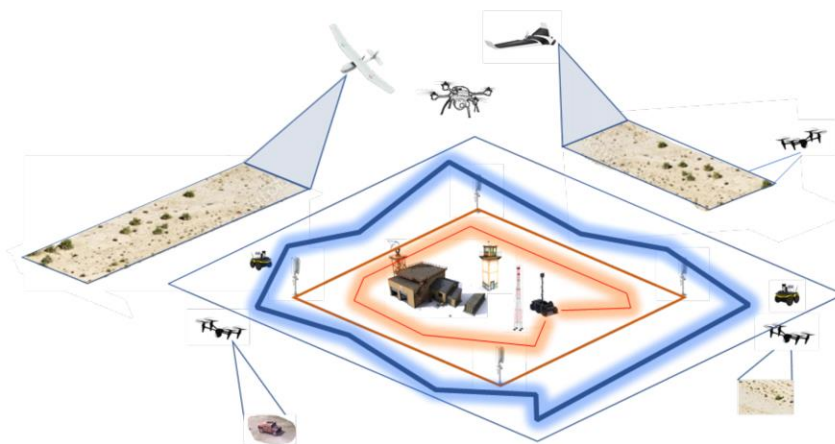
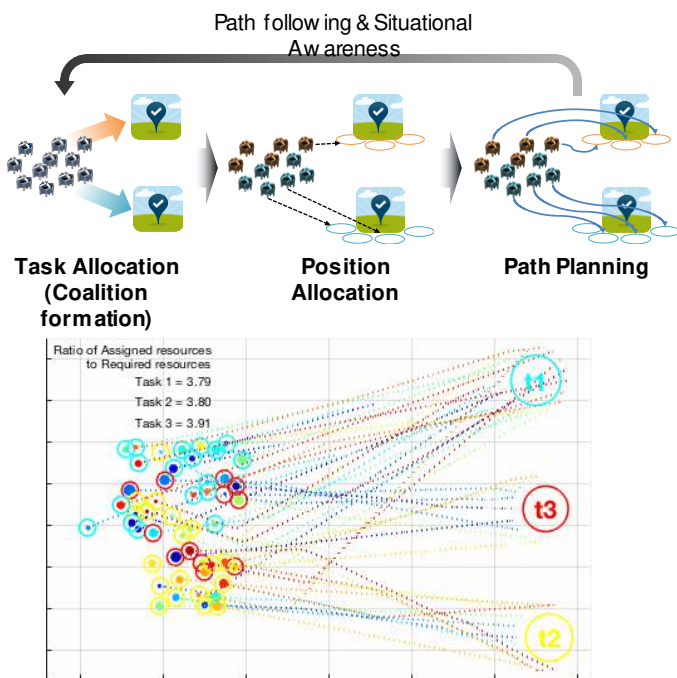
Centre for Autonomous and Cyberphysical Systems

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Autonomous Systems

- Perception: detection with deep learning models, multi-target tracking and data association.
- Sensor Fusion architectures (distributed architectures).
- Task allocation.



ShufflePointNet

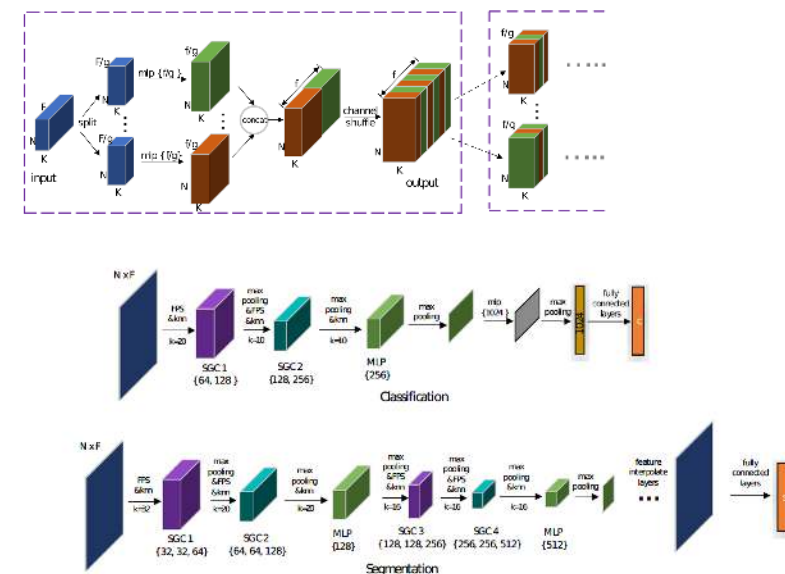


Fig. 3. ShufflePointNet architecture: The architecture use PointNet++ as backbone, and it contains classification structure (top branch) and semantic segmentation structure (bottom branch) for point cloud. In detail, N , F indicates the number of input points, and corresponding feature channels respectively. k is the number of the neighbors. Besides, the number in the brace $\{\}$ indicates the MLP filters.

ShufflePointNet: An Efficient Neural Network for Point Cloud Analysis via Group Convolutions

- ShufflePointNet is an efficient way to process point-cloud data
- Uses the concept of channel shuffle and shuffle layer
- A state-of-the-art deep neural network capable of reaching high-level accuracy for segmentation and classification
- Efficient computational performance

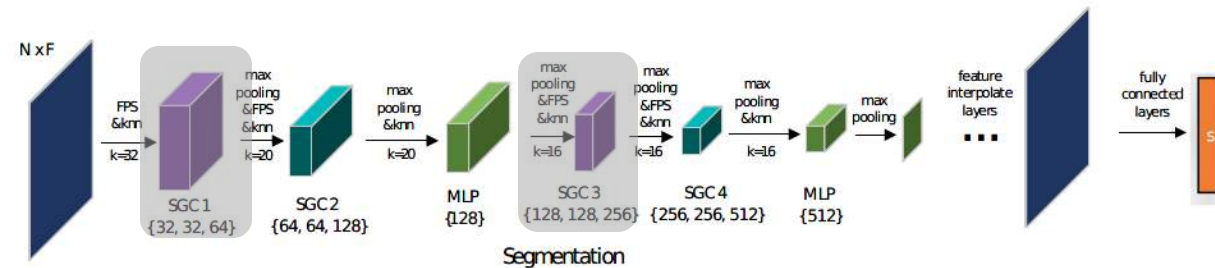
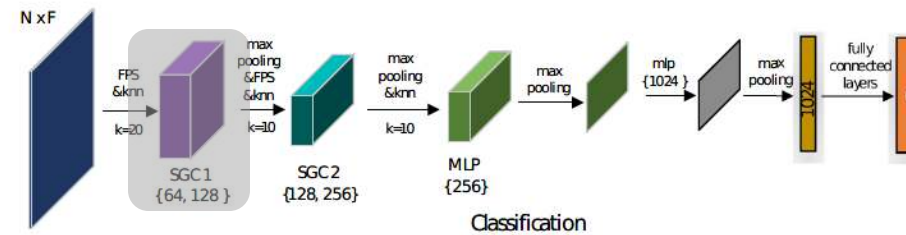
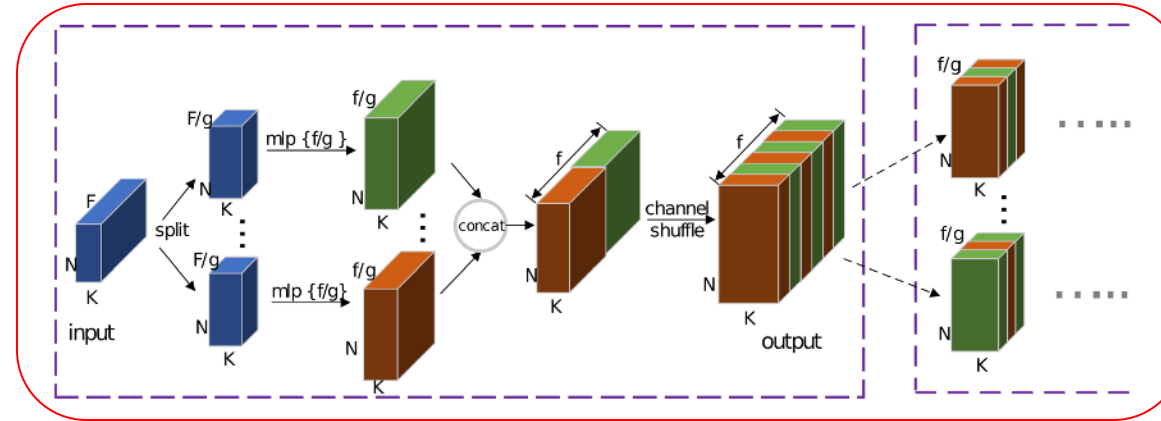
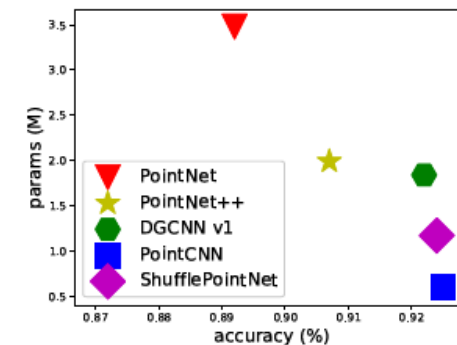
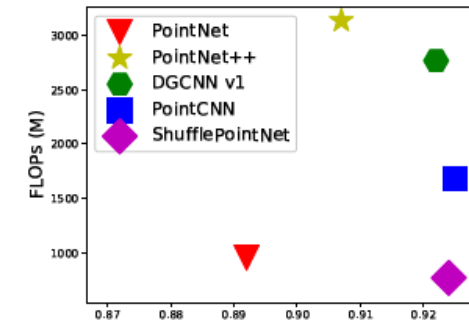
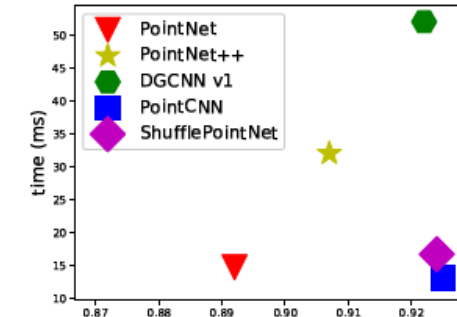


Fig. 3. **ShufflePointNet architecture:** The architecture use *PointNet++* as backbone, and it contains classification structure (top branch) and semantic segmentation structure (bottom branch) for point cloud. In detail, N, F indicates the number of input points, and corresponding feature channels respectively. k is the number of the neighbors. Besides, the number in the brace $\{\}$ indicates the MLP filters.





Hangar of the future

- Automated inspections
- Sensor fusion
- Data analytics
- Predictive maintenance

HANGAR OF THE FUTURE DEMONSTRATOR

Less time in the hangar, more time in the air

Automatic inspection and data collection

Upon entering the hangar, cameras perform a complete scan of the aircraft to inspect it for damage.

Data storage and predictive maintenance

The aircraft is released and maintenance data is digitally archived and stored where it's needed: inside the aircraft, hangar, or at the airline or manufacturer's premises.

Using advanced data analytics, the data generated can be used to perform predictive maintenance, allowing airlines to boost maintenance efficiency and keep costs to a minimum.

Intelligent robots and drones carry out more detailed inspections.

All aircraft-related data is transferred to the data management system.

Automated task planning and real-time supervision

Data is automatically analysed and broken down into tasks. Tasks are assigned to workers, who receive real-time notifications on their mobile devices.

A state-of-the-art interactive control room displays the status of maintenance tasks as they are performed, allowing task planning to be continuously optimised. Customers can also track the progress of the maintenance being performed.

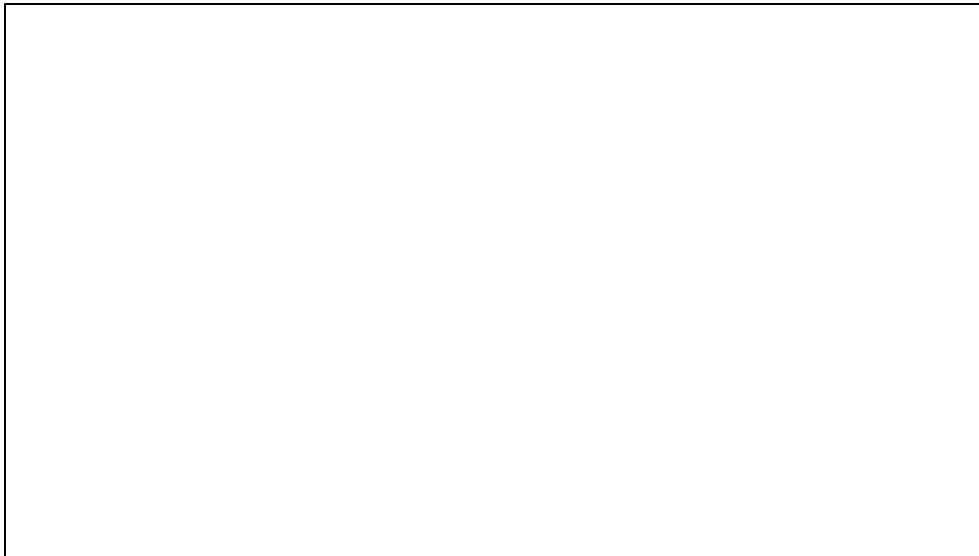
Streamlined maintenance

Workers' wearable devices provide access to all necessary information to perform tasks including technical and training documentation. Devices are equipped with augmented reality capabilities that help them perform and report on tasks, thus eliminating the need for paper.

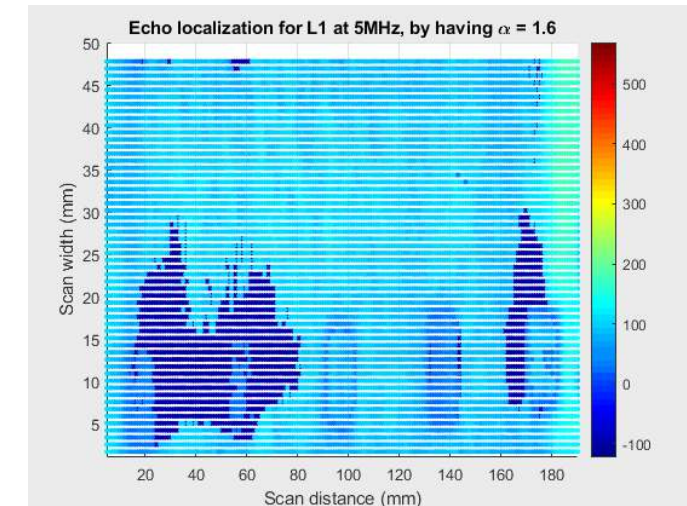
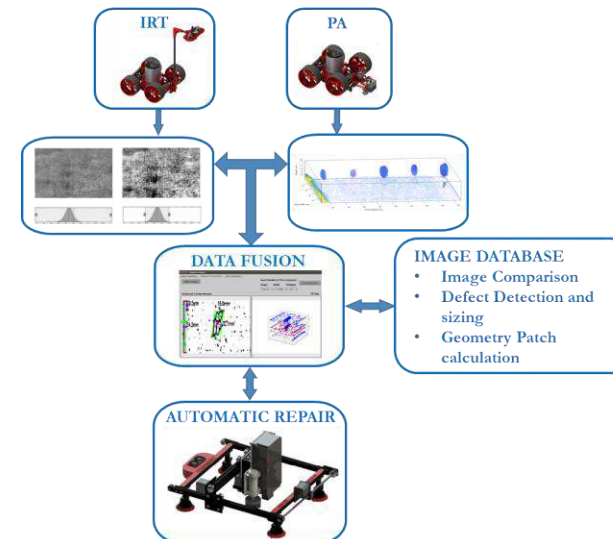
The mobile devices connect to other smart tools to perform specific tasks. The results are integrated seamlessly into the overall maintenance plan.

3D printers are used to print special maintenance tools or spare parts on the spot as needed.

UAV inspection (using RGB or IRT cameras)



Robo-inspections (Ultrasonic + IRT)



Using data analyse patterns



PROGNOSTICS

- ▲ Replacement of unscheduled maintenance by systematic scheduled maintenance
- ▲ Replacement of scheduled maintenance by condition based maintenance



MOBILE TOOLS

- ▲ Contextualised Documentation
- ▲ Dispatch assessment
- ▲ Augmented/Virtual Reality
- ▲ Defects Reporting
- ▲ Elapsed time control



COLLABORATIVE ENVIRONMENT

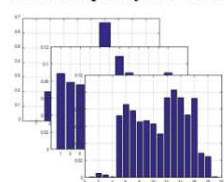
- ▲ Configuration management
- ▲ Maintenance Planning Optimisation
- ▲ Data Analytics
- ▲ Knowledge Database



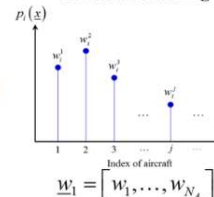
Pattern Analysis

Identify unusual patterns of fault frequency across the fleet aircraft → Early warning for potential issue

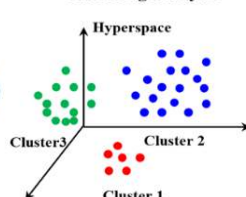
Fault Frequency of Aircraft



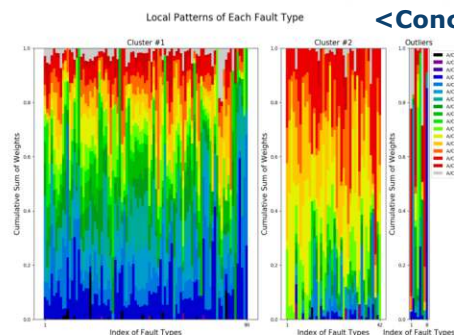
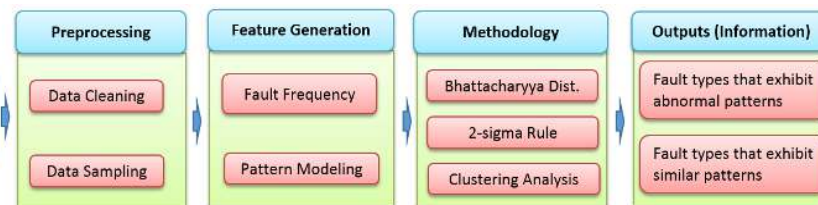
Pattern modelling



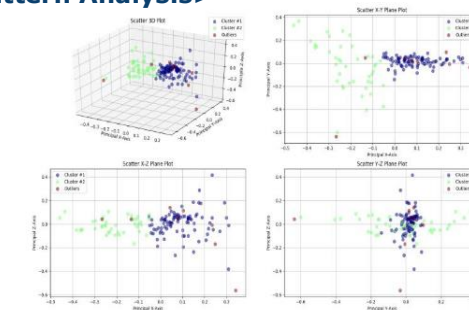
Clustering Analysis



Raw Data (Fault Record Data)



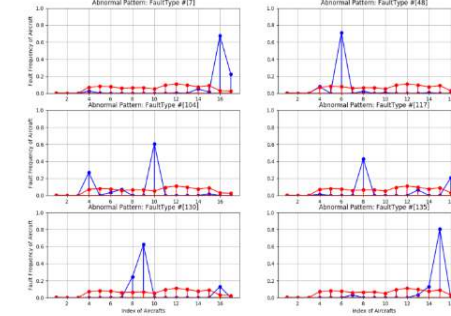
<Concept of Pattern Analysis>



<Analysis Results>

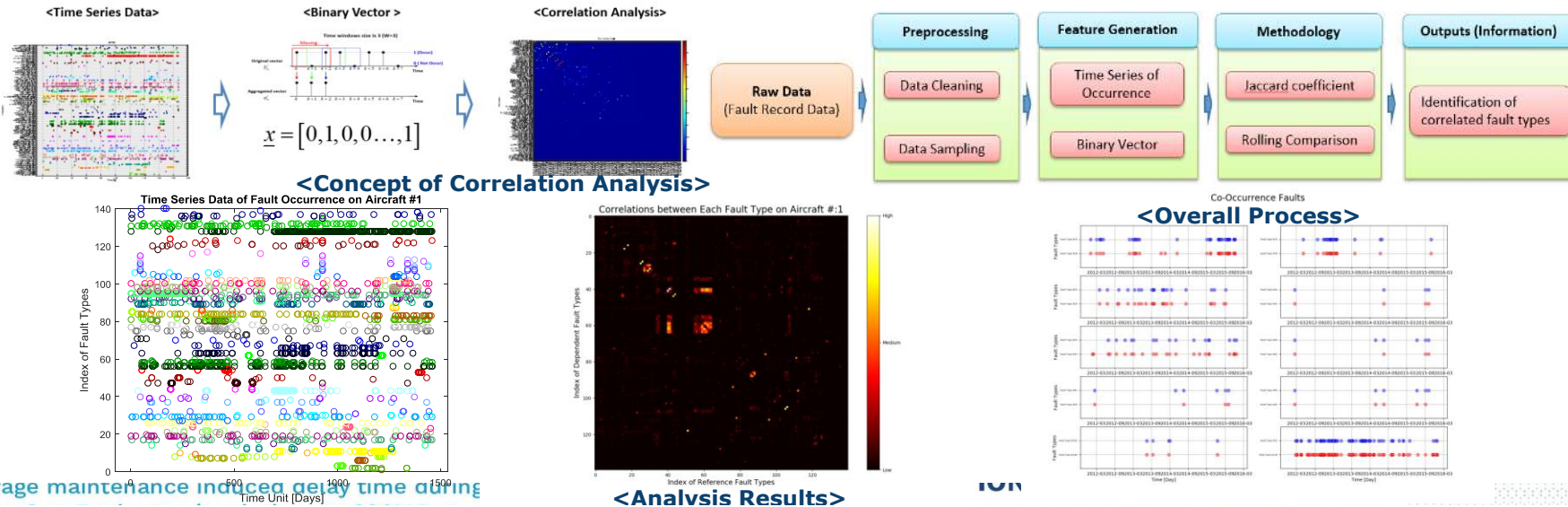
Results of Global Pattern Analysis

<Overall Process>



Correlation Analysis

Identify correlated fault types in term of occurrence pattern → High-level fault prognosis



Data Mining

Knowledge Based System

K-means algorithm

Machine Learning

Decision Trees

Support Vector Machine

Density-Based Clustering

Self-Organizing Map

Hill Climbing Algorithm