Finanziato dall'Unione europea
NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA

ICSC
Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

HaMMon-EQ

F. Vitello
INAF - OACT

Spoke 3 II Technical Workshop, Bologna Dec 17 -19, 2024

Scientific Rationale

This project **extends** the **HaMMon** initiative by enhancing its system for **seismic risk assessment** and management, particularly focusing on populated areas. Additionally, it aims to assess the impact of the HaMMon initiative on the territory.

Expected results:

- Development of **high-resolution 2-D and 3-D dataset** regarding buildings affected and unaffected by **earthquake-induced damages**.
- Development of a proper **workflow to analyze the multisource dataset** and selection of the best type of data for the expert-based and automatic analysis.
- Development of an **expert-based dataset** of earthquake-induced damages for **training IA algorithms**.
- Development of **deep learning algorithms** for extracting damaged features.

Scientific Rationale

The work plan of HaMMon-EQ is organized in the following four tasks:

Task 1 – Creation of **datasets** regarding **building** and **infrastructures** affected and unaffected by **earthquake-induced damages**.

Task 2 - **Identification** and **classification** of the various type of **damages**

Task 3 - **Automatic Damages** Feature **recognition** and **extraction** from the selected dataset

Task 4 - Evaluation of the HaMMon-EQ initiative's **impact on the local territory**, focusing on both direct and indirect effects

Proponent: **Unipol Sai - Leitha**
Other ICSC partners involved in the project: **INAF, UniMIB**
Coordinating Spoke: **Spoke 3**
Other Spokes involved in the project: **Spoke 2**

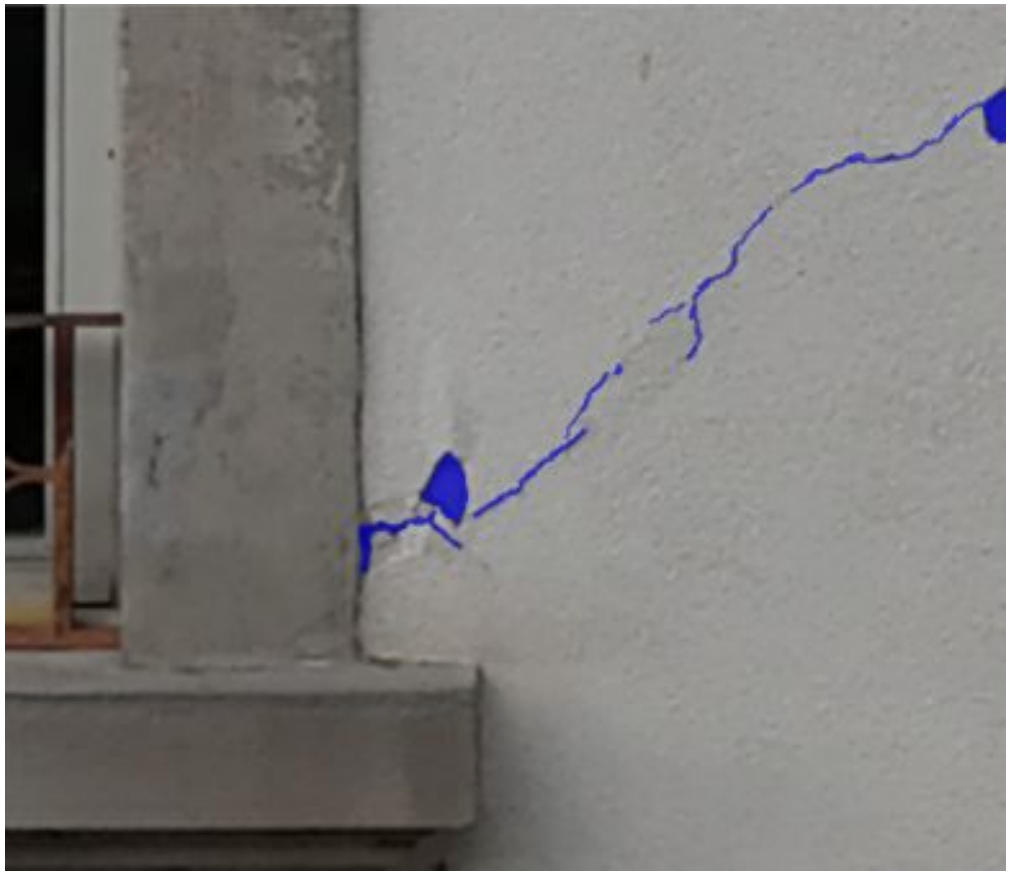
Technical Objectives, Methodologies and Solutions

Automatic Damages Feature recognition Proof of Concept Pipeline Development

Development of a **proof of concept (PoC)** pipeline for the **automatic extraction of damage-related features** on buildings (vertical and horizontal surfaces) and roads.

We are focusing primarily on the detection of wall and roof **cracks**, as these are key indicators of structural damage.

This task serves as a straightforward validation step for the pipeline's effectiveness before expanding to more complex damage features.



Technical Objectives, Methodologies and Solutions

Key Steps:

- Selection of a robust Machine Learning (ML) **algorithm for crack detection** and segmentation
- Survey of **public datasets to pretrain the algorithm**
- Preparation of an **original crack dataset** based on **UAV-collected images**.
- Fine tuning and test of the ML model on the original dataset;
- Adaptation of the **ML** inference to be **applied** to the **texture of the 3D models**.
- Damage features **visualized** directly on **3D models.**

Main Results

Earthquake-Induced Damage Data Collection Overview

1. Initial Data Collection

- **2D and 3D Datasets**: Focused on earthquake-induced damages to single buildings and/or infrastructures.
  - **792 2D UAV-Collected Images**: Captured at two sites in Southern Italy (Sicily, Italy), where earthquake-induced damages are clearly detectable.
  - **4288 2D UAV-Collected Images**: Acquired at Tredozio (Emilia Romagna, Italy), documenting damages to four individual buildings.
- **Photogrammetry Processing**:
  - **2 3D Models and 2 Dense Clouds**: Generated from 2D UAV-collected images at two key sites (from point 1).
  - **4 3D Models and 4 Dense Clouds**: Derived from 2D UAV-collected images at two additional key sites (from point 2).

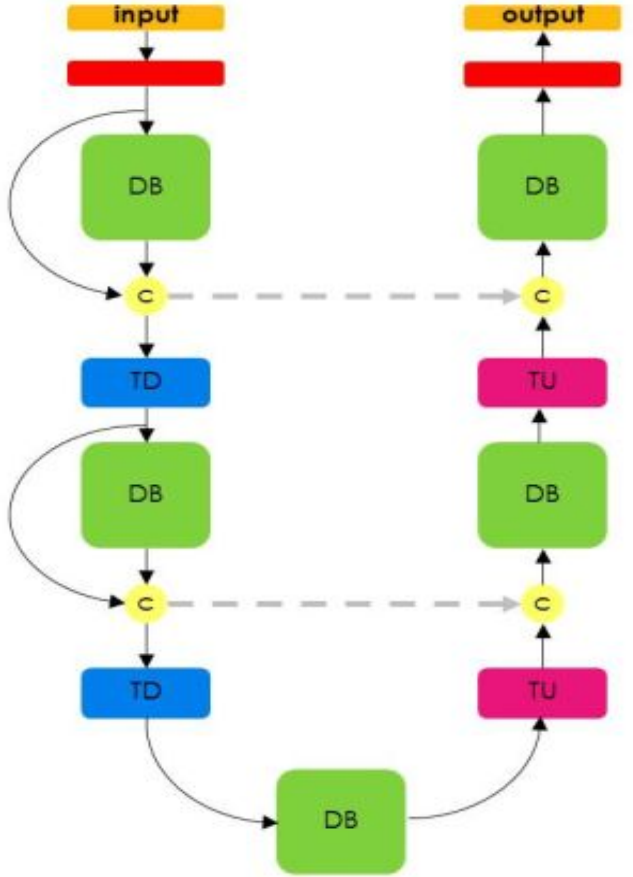
2. Extended Data Collection

- **Additional 2D and 3D Datasets**: Expanded focus on earthquake-induced damages across a district.
  - **10 360° VR Images (Street View)**: Captured in Fleri village (Sicily), highlighting earthquake-induced damages at a village level.
  - **2099 2D UAV-Collected Images**: Documenting a district in Tredozio village (Emilia Romagna), including multiple buildings.
  - **2 Large 3D Models and 2 Dense Clouds**

Main Results

Automatic Damages Feature recognition

- **Algorithm Selection**: We selected the "Tiramisu" model due to the expertise developed with its training within the HaMMon project. The model is easy to train and effective in recognizing complex shapes that do not require much contextual information.
- **Survey of Public Datasets**: A survey identified multiple public datasets for crack segmentation, which will be merged into a comprehensive one to improve training and enhance the model's ability to generalize.



Main Results

Semantic Segmentation Dataset Development

A new team member has been hired (UniMiB - Spoke 2) to create a specialized dataset.

His role is to select images containing cracks from those collected by drones and annotate them at the pixel level using the Label Studio software.

This process generates segmentation masks that will be used to train and test the neural network.

Next Steps

- Finalization of the multi source datasets
- Expand datasets to include features beyond cracks, broadening its applications.
- Training and test of deep learning algorithms for extracting damages features from the entire dataset.
- Cost-effective strategies for maintaining and updating the HaMMon platform.
- Evaluation of the scalability of the project and its potential expansion or adaptation for future needs.