CERN has more than 50km of tunnels which need to be regularly inspected for defects. These include cracks, spalls, water ingress and other structural defects that might occur over time. CERN’s tunnels are most of the time inaccessible to humans due to ongoing operation. When access is possible it is limited to certain periods of time, such as during technical stops or shutdowns.

**MANUAL INSPECTIONS**

- require personnel in underground areas (possible, dust, lack of space, radioactivity, lack of oxygen)
- may result in subjective survey reports
- are time consuming

**ROBOTIC SOLUTION**

- multi-sensor set up
- makes use of a Remotely Operated Vehicle (ROV)
- enables data capture automation
- allows easier comparison of survey images to the reference dataset to monitor for changes
- detects cracks and other structure defects using computer vision

**AUTOMATIC CRACK DETECTION**

- As civil infrastructure (e.g., bridges, tunnels and dams) ages due to weathering, corrosion, carbonation and thermal cycles, it becomes susceptible to structural deterioration which may lead to deviations from their original design functions.
- Cracks are one of the earliest indications of degradation, hence, their detection allows preventive measures to be taken to avoid further damage.
- The acclaimed traditional method used to inspect cracks in CERN’s tunnels is through manual, visual surveys.
- We use deep learning to detect and localize cracks on concrete surfaces such as in tunnels.

**3D MODEL OF TUNNEL WALL SECTIONS**

- Using the image data captured on site, we generate 3D models of the tunnel walls.
- A 3D model of an infrastructure provides a comprehensive visual and geometric image of its environment to help with better documentation and reporting.
- Using 3D models, structural health examiners can better contextualise the location of damages found during observations and evaluate the defects relative to the neighbouring areas.
- Using the resulting images from the crack detection module, texture replacement is carried out on the reference model such that the detected cracks can be displayed on the 3D model.

**VIRTUAL REALITY (VR)**

Our system uses Unity3D, a cross-platform game engine to generate the virtual model and refine it by changing the scale, adding lights and other modifications through a user interface.

Viewing 3D models using VR technology:

- allows personnel to familiarise themselves to the environment before going on a mission
- tele-presence comes into play, where a user is able to view and perform preliminary wall inspection remotely without visiting the actual site
- provides a better context when viewing inspection results such as the localisation of detected cracks with respect to their neighbourhood