APPLICATION OF ARTIFICIAL INTELLIGENCE IN ASSESSING THE EARTHQUAKE RESISTANCE OF BUILDINGS

Author: Kushbakov Sanjarbek Mavlidinovich

Institution: Samarkand State University named after Sharof Rashidov,

Institute of Artificial Intelligence and Digital Technologies

Abstract

This thesis examines the possibilities of using artificial intelligence technologies to assess the earthquake resistance of buildings. Earthquakes can cause cracks, deformations, displacements, and other types of damage to building structures. Since traditional assessment methods often require considerable time and human resources, the use of modern machine learning and computer vision algorithms is becoming increasingly important. This study analyzes the possibilities of using photographs and video data of buildings to automatically detect structural damage, assess its severity, and provide a preliminary evaluation of the building's seismic performance.

Keywords

artificial intelligence, earthquake resistance, building structures, computer vision, machine learning, crack detection, deformation, technical diagnostics.

Introduction

Earthquakes can cause significant damage to the structural elements of buildings and other engineering structures. In particular, cracks and deformations occurring in reinforced concrete, masonry, and steel structures may create serious risks for further operation. Therefore, rapid assessment of the technical condition of buildings before and after an earthquake is an important engineering task.

Traditional methods of assessing the condition of buildings involve visual inspections, measurements, and the use of specialized equipment by engineers. Such procedures can require considerable time, especially when a large number of

buildings need to be inspected. The development of artificial intelligence technologies provides new opportunities for automating this process.

Main Part

The process of assessing the earthquake resistance of buildings using artificial intelligence can be divided into several stages.

At the first stage, photographs and video images of building structures are collected. These data can be obtained using conventional cameras, drones, or mobile devices.

At the second stage, computer vision algorithms are used to identify structural damage. For example, the system can detect:

• cracks in walls and columns;

• concrete deterioration;

• displacement of structural elements;

• deformation and bending;

• other defects on structural surfaces.

For this purpose, Convolutional Neural Networks (CNNs), YOLO, U-Net, and other deep learning algorithms can be applied.

For example, if a crack is present in a building column, a computer vision model can detect the crack in an image and determine its length and width. The relative crack size can be calculated using the following expression:

Equation 1

$$r = w_c / W$$

where:

w_c — detected crack width;

W — overall dimension of the structural element;

r — relative crack parameter.

Deformation Assessment

The deformation obtained from images is also an important parameter for assessing the technical condition of a structure. For example, the displacement between the initial and deformed positions of a structural point can be calculated as:

Equation 2

$$\Delta = \sqrt{[(x_1 - x_0)^2 + (y_1 - y_0)^2]}$$

where x_0, y_0 are the initial coordinates of the structural point, while x_1, y_1 are its coordinates after deformation.

Artificial Intelligence-Based Assessment Model

The proposed system can operate according to the following sequence:

Building → Photo/Video → Computer Vision → Crack and Deformation Detection → Machine Learning → Damage Assessment → Preliminary Seismic Resistance Evaluation

The machine learning model can be trained using previously collected data. The input data may include structural parameters of buildings, the number and dimensions of cracks, deformation values, building age, structural type, and earthquake intensity.

As a result, the artificial intelligence system can classify buildings into categories such as “good condition,” “moderately damaged,” and “severely damaged.”

Such a system should not completely replace a professional structural engineer. Instead, it can serve as a rapid preliminary diagnostic tool. The final technical assessment should be based on engineering calculations and relevant construction and seismic safety standards.

Conclusion

The use of artificial intelligence and computer vision technologies makes it possible to assess the earthquake resistance and technical condition of buildings more rapidly and automatically. In particular, image-based detection of cracks and deformations, measurement of their geometric parameters, and classification of structural damage represent promising research directions.

In the future, integration of these technologies with drones, IoT sensors, and Digital Twin technologies could enable continuous monitoring of the technical condition of buildings. Such systems can contribute to improving the safety of buildings and protecting human lives and property, particularly in earthquake-prone regions.

References

1. Spencer, B. F., Hoskere, V., & Narazaki, Y. Advances in Computer Vision-Based Civil Infrastructure Inspection and Monitoring.
2. Cha, Y. J., Choi, W., & Büyüköztürk, O. Deep Learning-Based Crack Damage Detection Using Convolutional Neural Networks.
3. Yeum, C. M., & Dyke, S. J. Vision-Based Automated Crack Detection for Bridge Inspection.
4. Dong, C. Z., & Catbas, F. N. A Review of Computer Vision-Based Structural Health Monitoring at Local and Global Levels.