LEVEL 0 SUMMARY TEMPLATE

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Paper title: AI Based Self Learning System in Distributed Structural Health Monitoring and Control

Keywords specific to the paper: Artifical Intelligence, Structural Control System, Distributed fiber optic, Abnormality recognition, Pattern matching method

Summary of the main contributions:

The article discusses the use of artificial intelligence in combination with fiber optic sensors for monitoring and supervising the integrity of civil infrastructures. The intelligent system, Brillouin Optical Time-Domain Analysis (BOTDA), enables reliable, full-scale perception of the infrastructure's condition, as well as the gathering of data from the entire optical fiber network in near real-time, regardless of the distance or density of the fiber optic network. The use of this new technology offers the possibility to be efficient because it allows for a global as well as localized understanding of the condition, unlike traditional sensors. Therefore, maintenance can be both active and proactive. In the supervision systems of large current structures, it is clearly more difficult to analyze and interpret data from BOTDA compared to smaller structures. It is thus necessary to develop customized safety decision systems that are based on specific criteria and correlate with the tool's interpretations.

In the second part of the document, it is explained how and why a dense network of optical fiber provides more information than the point-measurement method. The basis of the measurements of this system is the use of stimulated Brillouin scattering. This can be define as a light scattering phenomenon that occurs when light interacts with acoustic waves or vibrations, such as in an optical fiber. The goal is to measure temperature and strain variations along the optical fiber, thereby enabling large-scale monitoring of structures such as bridges, buildings, or railway infrastructures. Artificial intelligence allows for the analysis of points both as a whole and individually. To determine if a data point is an anomaly, the use of a data model allows for matching to a known state; the more comprehensive the data model, the more precise the degree of anomaly detection will be. The data models are created based on the procedures and various standards of civil infrastructures.

The third part of the document explains the method for monitoring the condition of the structure. Thanks to the different measurements and the definition of constraints for each element, always by defining the data model with the load that the structure can bear, the tension, and the temperature, the BOTDA system can indicate areas of the surface that are impacted by anomalies.

The fourth part explains the advantages of this system by taking as an example a train station with a very large steel roof covered in optical sensors, detailing the installation process that includes the use of adhesive to maintain contact between the structure and the fibers (which is crucial for the BOTDA system), as well as the various technical challenges that were overcome to ensure data reliability.

The document concludes by detailing the analysis and validation of different simulations offered by the tool, such as load tests on the entire roof. The tool is thus effective in real-time supervision and in the identification of anomalies in a reliable, flexible, and rapid manner for the safety of civil infrastructures.