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Case-Based Reasoning for Modelling Random Variables in the Reliability Assessment of Existing Structures

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Abstract : The reliability assessment of existing structures with probabilistic methods is becoming an increasingly important and frequent engineering task. However probabilistic reliability methods are based on an exhaustive knowledge of the stochastic modeling of the variables involved in the assessment; at the moment standards for the modeling of variables are absent, representing an obstacle to the dissemination of probabilistic methods. The framework according to probability distribution functions (PDFs) are established is represented by the Bayesian statistics, which uses Bayes Theorem: a prior PDF for the considered parameter is established based on information derived from the design stage and qualitative judgments based on the engineer past experience; then, the prior model is updated with the results of investigation carried out on the considered structure, such as material testing, determination of action and structural properties. The application of Bayesian statistics arises two different kind of problems: 1. The results of the updating depend on the engineer previous experience; 2. The updating of the prior PDF can be performed only if the structure has been tested, and quantitative data that can be statistically manipulated have been collected; performing tests is always an expensive and time consuming operation; furthermore, if the considered structure is an ancient building, destructive tests could compromise its cultural value and therefore should be avoided. In order to solve those problems, an interesting research path is represented by investigating Artificial Intelligence (AI) techniques that can be useful for the automation of the modeling of variables and for the updating of material parameters without performing destructive tests. Among the others, one that raises particular attention in relation to the object of this study is constituted by Case-Based Reasoning (CBR). In this application, cases will be represented by existing buildings where material tests have already been carried out and an updated PDFs for the material mechanical parameters has been computed through a Bayesian analysis. Then each case will be composed by a qualitative description of the material under assessment and the posterior PDFs that describe its material properties. The problem that will be solved is the definition of PDFs for material parameters involved in the reliability assessment of the considered structure. A CBR system represent a good candi¬date in automating the modelling of variables because: 1. Engineers already draw an estimation of the material properties based on the experience collected during the assessment of similar structures, or based on similar cases collected in literature or in data-bases; 2. Material tests carried out on structure can be easily collected from laboratory database or from literature; 3. The system will provide the user of a reliable probabilistic description of the variables involved in the assessment that will also serve as a tool in support of the engineer’s qualitative judgments. Automated modeling of variables can help in spreading probabilistic reliability assessment of existing buildings in the common engineering practice, and target at the best intervention and further tests on the structure; CBR represents a technique which may help to achieve this.

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