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Statistical Methods for Dimensional Control in Shipbuilding

The advent of Industry 5.0—characterized by its emphasis on resilient and sustainable technology integration—aims to reorient industrial production toward a more competitive model with a positive societal impact. Within this framework, the Joint Research Unit (CEMI) formed by the shipbuilding company Navantia and the Universidade da Coruña is focused on developing and validating advanced methodologies for highly accurate and precise dimensional analysis of ship components, leveraging large-scale 3D datasets captured via 2D/3D laser profile sensors.

Ship panels, which consist of welded steel plates reinforced with longitudinal stiffeners, are the fundamental building blocks in modern shipbuilding. It is critical to inspect these fabricated panels to detect any structural defects or dimensional inconsistencies that could lead to assembly issues in subsequent production stages. This work presents statistical procedures to develop a digital model of the manufactured panel and extract relevant features to assess whether it can be successfully assembled later.

Given the high precision required (0.5 mm), a 3D scanning process is employed using a set of 2D laser profile sensors, resulting in a high-resolution 3D point cloud. These point clouds often contain hundreds of millions of points, making it necessary to develop big data processing techniques. The proposed tools are being implemented in an R software package. They include dimensionality reduction methods, triangular mesh generation, and comparison against theoretical CAD models. Additionally, the tools allow for the identification of key structural components (plate surface, stiffeners, etc.) and the extraction of critical geometric measurements, primarily dimensions and positioning.

Special/ Invited session

Classification

Both methodology and application

Keywords

Metrology, Dimensional analysis, Set estimation, Nonparametric statistics, Shipbuilding.

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