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Geometric Deep Learning for rapid prototyping of satellites

A Satellite layout optimization design (SLOD) approach is here proposed to automatically generate effective and efficient layout configurations and guide engineers in choosing the most performing satellites designs.
In this approach the optimization of satellites layouts is addressed as a three-dimensional packing problem with layout constraints such as:

- behavioural constraints – e.g. no overlap amongst components
- technical constraints – e.g. Sun sensor placed on a specific surface of the satellite.

Main objective of the optimization problem here analysed is the determination of the optimal position of the Centre of Gravity of satellites components and their orientation. This can be solved in two sequential optimization steps:

- layers optimization - it determines the optimal distribution of individual components amongst satellite layers,
- position optimization - it determines the optimal position of components in each layer.

SLOD has been typically addressed as a single-objective optimization problem, aiming at minimizing the moment of inertia of the entire satellite.
Thus, we propose here to conduct a full analysis combining both steps described above, approaching the problem as a multi-objective optimization, accounting also for conditions such as uniformity of thermal and magnetic fields.
For this purpose, thermal and magnetic models will be built, ranging from low to high-fidelity (e.g. finite element modelling, computational electromagnetics), trying to strike a balance between accuracy and computational cost.
Finally, the high-fidelity models will be used to train surrogate models, with the aim of rapidly prototyping satellites designs, maintaining a reasonable level of predictions accuracy. A particular focus will be given to Geometric Deep Learning techniques, which allow to train AI algorithms using the 'real' shape of components.
We believe our proposed approach will bring advantages to satellites rapid prototyping, allowing to tackle the complexity associated with the optimization of such systems.

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