Assemblability analysis of assemblages of interlocking blocks

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ABSTRACT

This paper proposes a method to check if a set of interlocking blocks can be stacked over each other and interlocked properly. Interlocking blocks are rigid units with a number of locks on their faces keeping the units together. In this work an interlocking interface has corrugated shape with locks having the rectangular cross section. The proper geometry for the interlocking interfaces including the number and orientation of the locks can be found so that the assemblage of interlocking blocks becomes structurally feasible. In addition, the structurally feasible model should also be assemblable.

In this work an assemblage is constructed unit by unit, and each unit is stacked on the model through a single step translation (no rotation). Given an assembling sequence, the proposed method checks if there is at least one direction in which the block is free-to-translate to be assembled or disassembled to a set of pre-assembled blocks. When such a direction does not exist, the block is always immobilized (deadlocked) and can never be assembled/disassembled.

There are studies developing the same concept to evaluate whether the interlocking pieces of furniture [1] and puzzles [2] can be interlocked successfully, while the pieces are only allowed to translate along x, y, z-axes during the assembling. In this research, units are free-to-translate in any direction in the 3D space.

Through presenting a single-step translation by a 3D vector, it is observed that a corrugated face can only be assembled after translation by a vector laying on a half-plane parallel to the lateral faces of its locks (valid vector). When a block is going to be connected to n pre-assembled blocks, the translating vector must lay on the half-planes along the locks of all n faces of the block. In other words, this vector must lay on the intersection of all these half-planes passing through a so-called initial point. When the intersection is only this point, no vector exists to translate the block successfully. In this case, the chosen geometries of the locks and the assembling sequence do not construct an assemblable block.

REFERENCES

[1] Fu, C.W., Song, P., Yan, X., Yang, L.W., Jayaraman, P.K., Cohen-Or, D., "Computational interlocking furniture assembly", *ACM Transactions on Graphics (TOG)*, Vol. **34**(4) p. 91 (2015).

[2] Song, Peng, Chi-Wing Fu, and Daniel Cohen-Or, "Recursive interlocking puzzles", *ACM Transactions on Graphics (TOG)*, Vol. **31**(6), p.128, (2012).