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Effect of Different Data Structures When Applying CLLA to Accelerate Computational Processing of the State-of-the-art Meshfree Based Plant Cellular Models

K.G.P. Hansani[a], S. Baduge[b] and H.C.P. Karunasena[b]

[a]*Department of Mathematics, Faculty of Science, University of Ruhuna, Sri Lanka*
[b]*Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka*

Corresponding author: chaminda@mme.ruh.ac.lk

Compared to numerous theoretical and empirical models, in order to simulate a wide range of plant cellular models to predict complex microcellular behaviour, numerical models are increasingly being used by the researchers in recent times. In this regard, meshfree methods such as Smoothed Particle Hydrodynamics (SPH) which is a popular method to model fluid flows, are found to be more adaptable and capable, particularly when handling excessive deformation. This is mainly due to the method of interaction calculation where meshfree methods update the neighbour particles in real-time and do not rely on fixed grids like in grid-based methods. However, the neighbourhood finding and interaction calculation become extremely costly in meshfree methods and hence the simulation time extends more than grid-based numerical methods. As a solution, the study applied Cell Linked List Algorithm (CLLA) which is one of the Nearest Neighbour Particle Searching (NNPS) technique over conventional All Pair Searching (APS) using the state-of-the-art meshfree based plant cell numerical model. The novelty of this paper is to determine the effectiveness of different data structure usage towards computational efficiency of meshfree based plant cellular models. The study used same algorithm with different data structures to analyse the efficiency. Accordingly, the study compared the performance of two data structures: map and vector. Both qualitative and quantitative simulation outcomes of a fresh single cell and tissues composed four and seven cells, were simulated with APS and CLLA, incorporating both maps and vectors. CLLA with maps resulted in 10-17% computational time saving while CLLA with vectors gave 30-24% time saving compared to the original model using APS and vectors. Therefore, the study found that the vector data structure can be recommended for meshfree based plant cell models in order to minimise computational cost.

Keywords: Cell linked list algorithm (CLLA), Maps and vectors, Meshfree based plant cell model, Nearest neighbour particle searching (NNPS), Smoothed particle hydrodynamics (SPH)