Two-Dimensional Dendritic Growth Using Phase-Field Model Design Document

CS 294-73 Group H

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1 Discretization Methods and Numerical Schemes

Recall the governing equations:

$$\begin{cases} \frac{\partial u}{\partial t} = & D\nabla^2 u + \frac{1}{2}\frac{\partial \phi}{\partial t} \\ \tau\frac{\partial \phi}{\partial t} = & \phi(1-\phi)(\phi - \frac{1}{2} + \tilde{n}(u)) - \frac{\partial}{\partial x}(WW'\frac{\partial \phi}{\partial y}) \\ & +\frac{\partial}{\partial y}(WW'\frac{\partial \phi}{\partial x}) + \nabla(W^2)\cdot\nabla\phi + W^2\nabla^2\phi \\ W = & W_0(1+\mu cos(a_0(\theta-\theta_0))) \\ \theta = & tan^{-1}(\frac{\partial \phi}{\partial y}/\frac{\partial \phi}{\partial x}) + \pi(1 - sign(\frac{\partial \phi}{\partial x})) \end{cases} \tag{1}$$

A 2nd order central difference scheme will be used for spatial discretization while a 4th order Runge-Kutta scheme for time integration.

The final computational solution consists of time dependent phase field (ϕ) and dimensionless temperature field (u) in the form of vtk files.

2 Software Design

The following existing classes will be directly utilized:

Point

Box

RectMDarray

RK4

VisitWriter

2.1 Analysis

Output

Timer

3 Optimization

4 Parameter Study

5 Work Contribution