FOSSEE Fellowship Report

on

DUST PARTICLES TRACKING INSIDE A MODEL ROOM

Submitted by

JISHNU HANDIQUE

Under the guidance of

Prof. Shivasubramanian Gopalakrishnan

Department of Mechanical Engineering

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

July, 2019

Acknowledgment

I would like to express my sincere gratitude to Prof. Shivasubramanian Gopalakrishnan for his guidance. I deeply thank Prof. Kannan M Moudgalya for starting the fellowship program and providing the project work opportunity at FOSSEE, IIT Bombay.

In addition, I am thankful to Sathish Kanniappan, research associate, FOSSEE and Deepa Vedartham, research assistant, FOSSEE for their mentorship and help during my fellowship.

Contents

Nomenclature

U	Velocity, m/s
g	Gravitational acceleration, m/s^2
F_{Drag}	Drag force, N
P	Pressure, Pa
V_p	Volume of the particle

Greek Symbols

α	Particle volume fraction
ρ	Particle density, kg/m^3
τ	stress tensor, Pa

Chapter1
Introduction and Problem Statement

Dust particle parcels driven by air inside a room was simulated using a Lagrangian solver DPMFoam [1]. The 2D geometry of the problem can be seen in the Figure 1.1. The other computational details are given in the following tables.

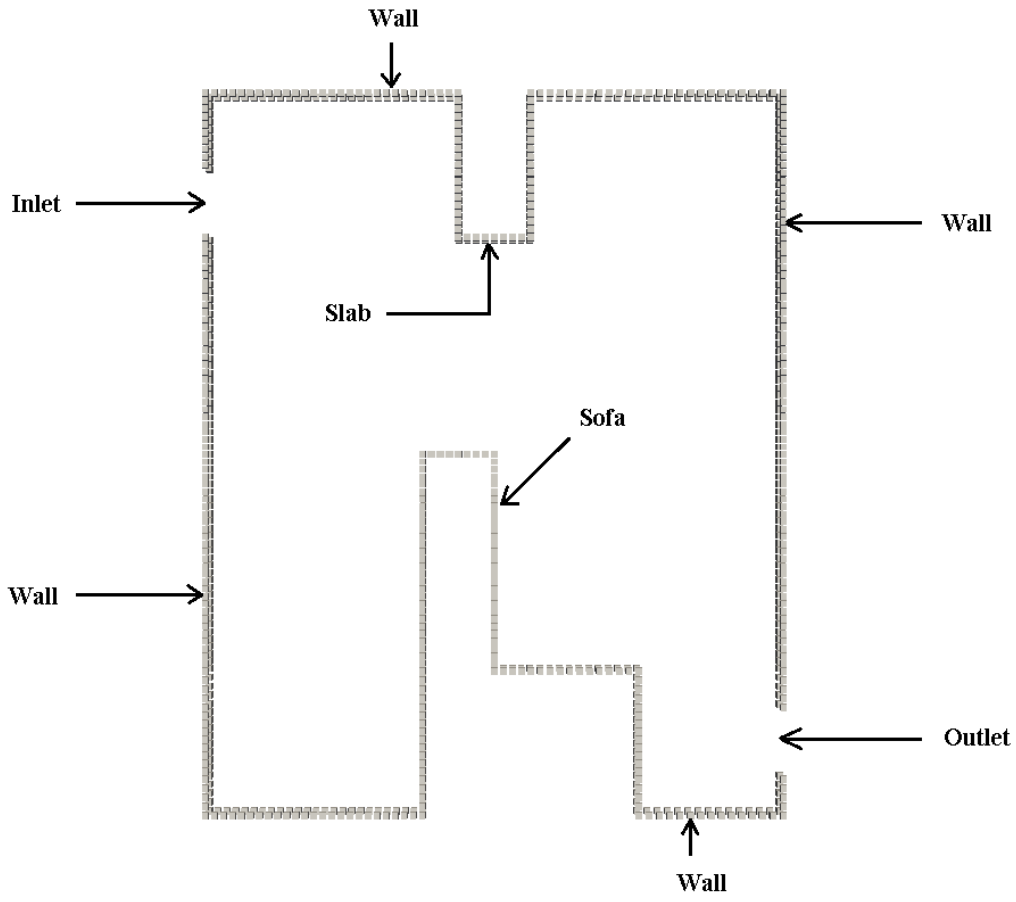


Figure 1.1. 2D Geometry

Table 1. Geometry and Computational Details

Parameter	***Detail***
Model	2 Dimensional
Geometry-Mesh creating software	ICEM CFD
Number of cells	4,906
Post-processing tool	Paraview, Sigma Plot
Solver	DPMFoam
Turbulence property	Laminar
Pressure-velocity coupling	PIMPLE algorithm [1]
Convective term solving scheme	Gauss linear upwind V unlimited [1]

Table 2. Fluid properties and initial conditions

Parameter	***Value/Condition***
Continuous phase	Air
υ_{air}	1e-05 m^2/sec
ρ_{air}	1.2 kg/m^3
$\rho_{particle}$	2600 kg/m^3
No. of particles in one parcel	1e6
Inlet injection	5000 parcels/sec
Initial parcel velocity	5 m/sec
U_{air}	10 m/sec
Inlet	Particles escape
Outlet	Particles escape
Wall	Particles rebound
Sofa	Particles rebound
Slab	Particles rebound

Chapter2

Equations

2.1. Continuity Equation [2]

$$\frac{\partial}{\partial t}(\alpha) + \nabla.(\alpha U) = 0$$

2.2. Momentum Transfer Equation [2]

$$\frac{\partial}{\partial t}(\alpha U) + \nabla.(\alpha UU) - \nabla.\alpha\tau = -\nabla P + g + \frac{F_{Drag}}{\alpha\rho} - \frac{1}{V}\sum_p V_p \left[\frac{DU}{Dt}\right]_p$$

Chapter3
Results and Discussion
3.1. Plots

The air velocity was calculated at different positions to have an idea about the flow.

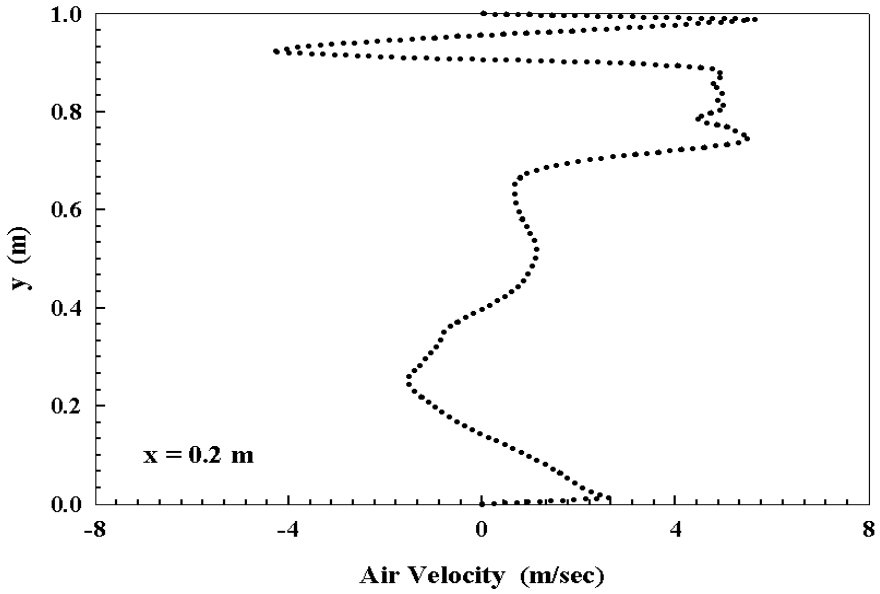


Figure 1.2. Air velocity along height at x = 0.2m

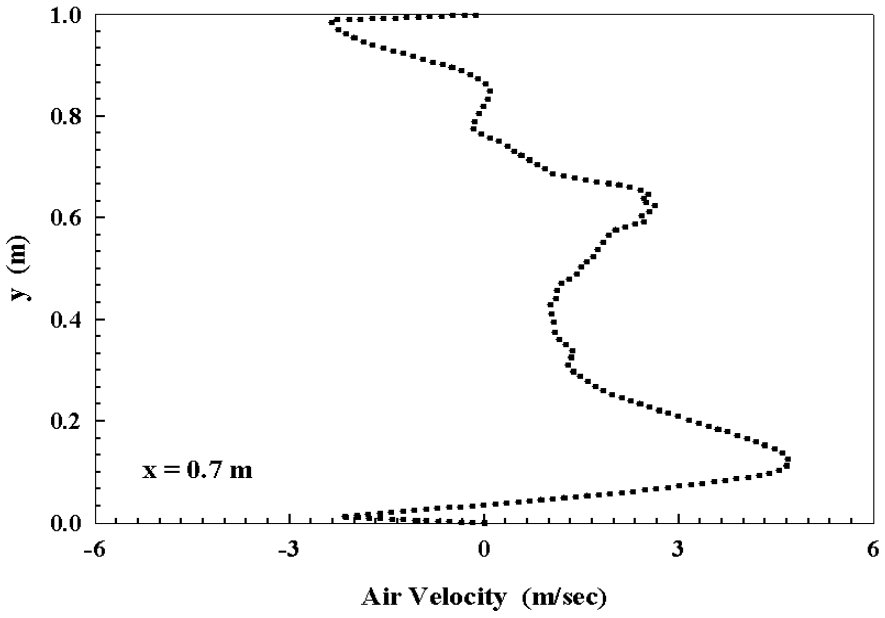
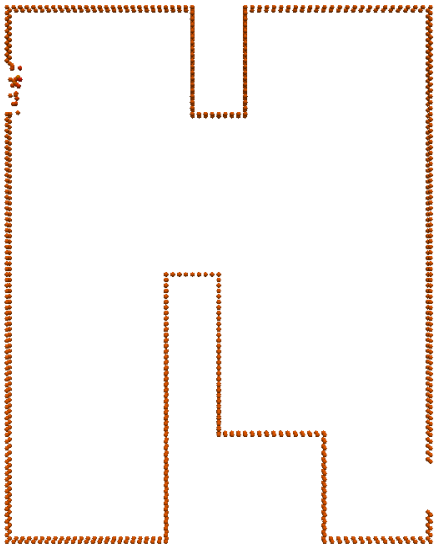
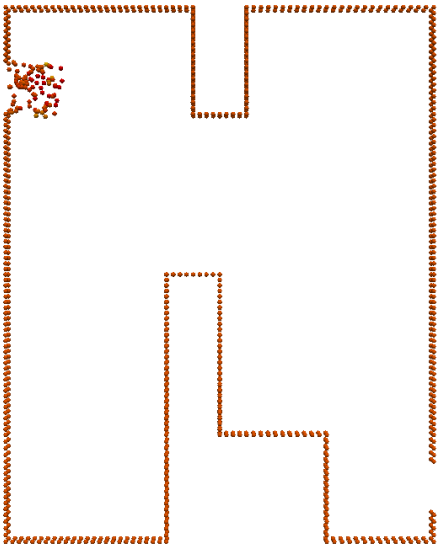


Figure 1.3. Air velocity along height at x = 0.7m

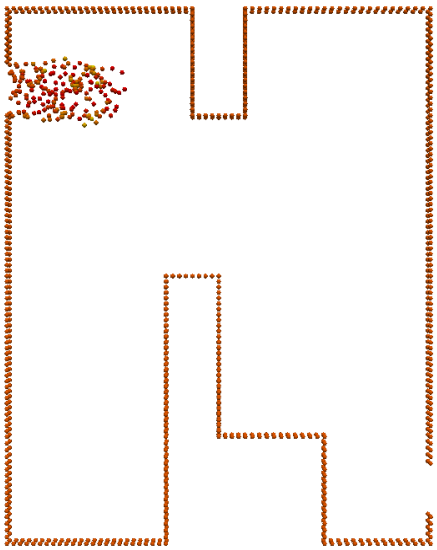
3.2. Contours



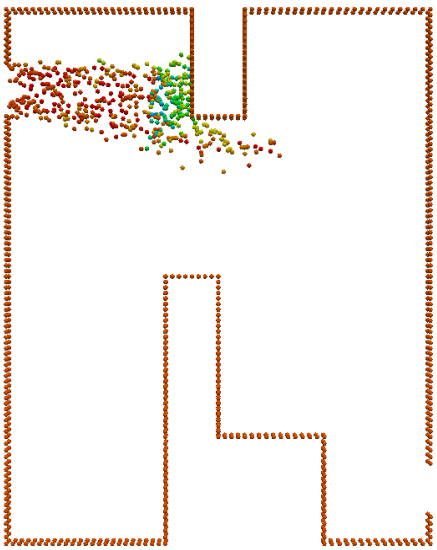
(a)



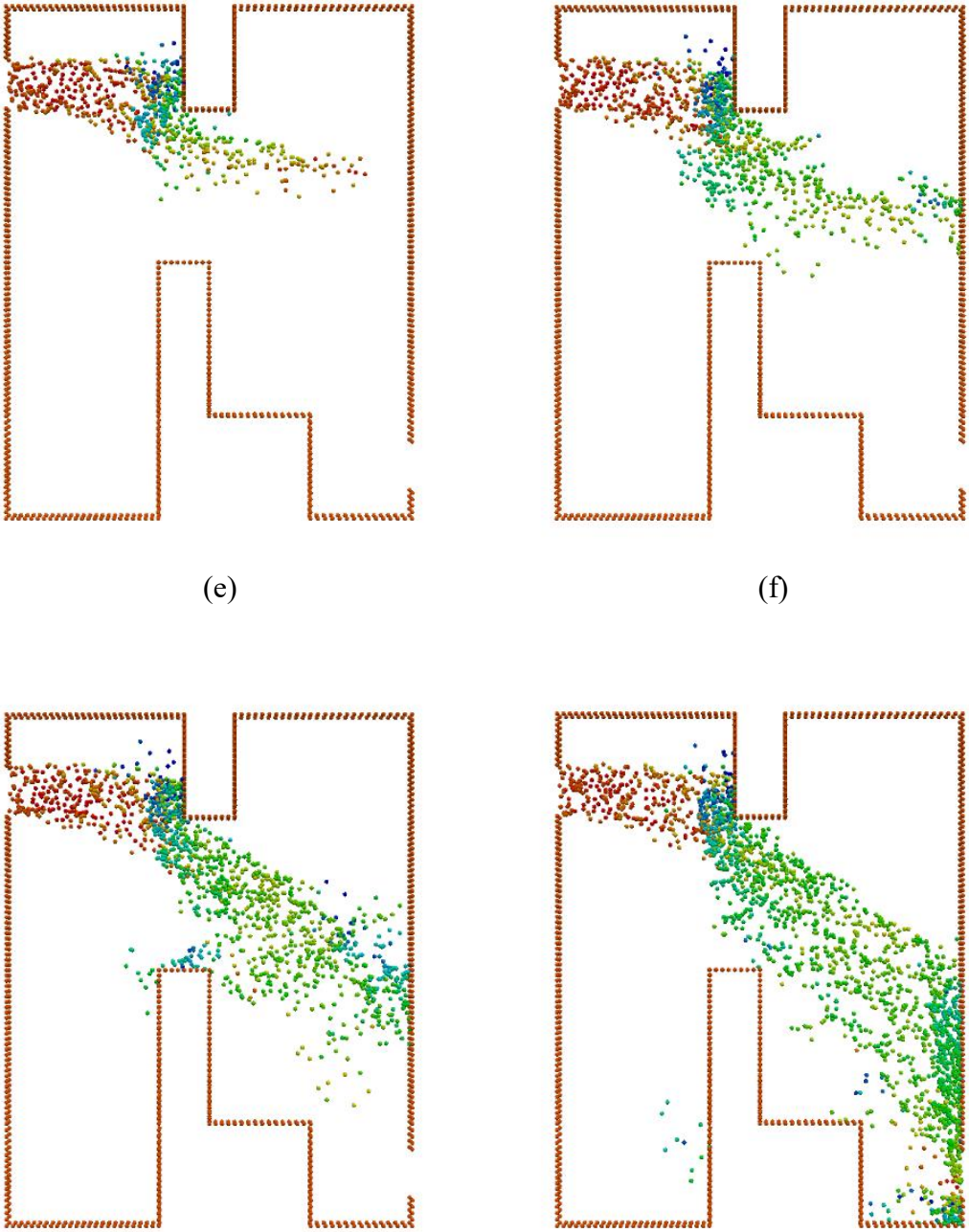
(b)



(c)



(d)



(e) (f)

(g) (h)

Figure 1.4. Particle tracked inside the room at (a) 0.0003, (b) 0.001, (c) 0.002, (d) 0.005, (e) 0.007, (f) 0.01, (g) 0.014 and (h) 0.021 sec

3.3. Conclusion

The locations of all the particle parcels can be tracked at different time with the DPMFoam solver.

Reference

[1] OpenFOAM User Guide version 6.0 (2018)

[2] Hofman J., Understanding DPMFoam/MPPICFoam (2015)