Emerging collective behavior in many particles systems

Umair Rehman Raffi[1], Martin Maza-Cuello[1], and Diego Maza[1]
[1]Granular Media Lab.
University of Navarra, Pamplona, Spain

The flow of grains through an orifice has always been of interest due to their numerous industrial applications as hoppers and silos. The previous works have been done with only solid particles exiting the silo in a dry state [1].

This project is a natural extension of the ”dry” problem to study the particles dispersion within a fluid matrix. Therefore, the starting point will be the study of the flow of particles in orifices and sizes of particles already studied in the ”dry” case, but now with the existence of an interstitial fluid. In this study we are analyzing and monitoring a newer system, for clogging and jamming frequencies, in which the particles exit the silo against the flow of a liquid. This interaction of solid particles and fluids creates a complex system with their own macroscopic and microscopic behavior [2].

It has been decided to work with water as an interstitial medium due to its easy obtaining and handling. The particles used will be 1 mm aluminum balls, which will allow us to compare the results achieved with previous studies in the absence of liquid. In subsequent stages, however, it is expected to explore the role of the material using PVC balls.

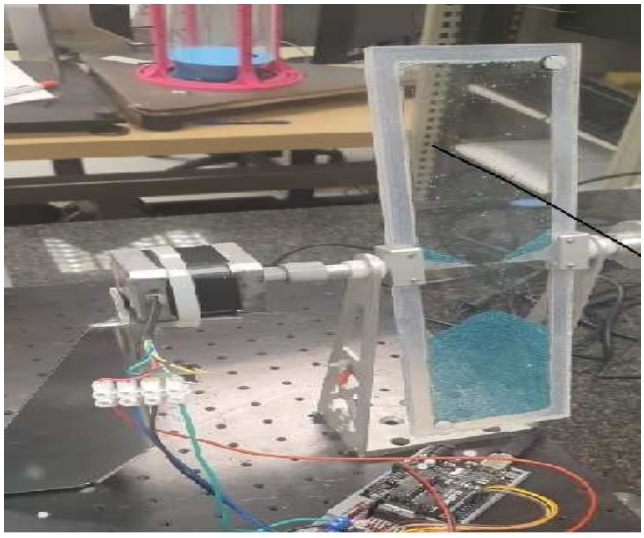

Fig. 1. Experimental setup.

Currently, in this study an automated lab scale silo has been set up with a stepping motor which is controlled by an Arduino board through MATLAB, as shown in Fig 1, and a camera is being used to capture and analyze videos of the exiting behaviors of the solid particles against the fluid. Image processing will be used to analyze the video frames and then track particles and measure velocities of the particles in this system. Also, the sedimentation rates and avalanches will be studied and measured. The major problem that currently needs solving is the elimination of bubbles as the bubbles choke the system.

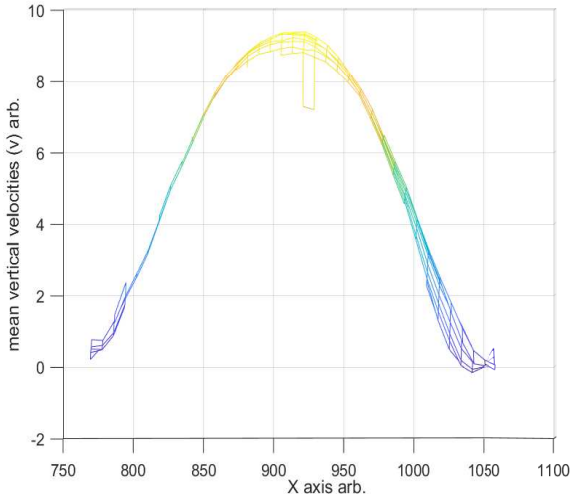

Fig. 2. Mean vertical velocity calculated using PIVLab.

In this work PIVLab (Particle Image Velocimetry) is being used to analyze the mean flow velocities at the orifice, as shown in Fig 2. The graph represents the average velocities of the particles, at the orifice, as the fluid interacts with the particles. Fig 2 shows that the system displays higher mean velocities at the center of the orifice and the lower values as we move away from the center.

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