The Virtual Sandbox

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Abstract

The overall goal of the Virtual Sand Box project is to increase the general public perception of research in the area of wet granular materials. This is realized by means of a physical sandbox, which is integrated with the particle simulation environment LIGGGHTS®. Specifically, the surface of the sand is recorded using a 3D camera, and the geometry is then fed into LIGGGHTS®. Finally, a virtual model of the real-word sand surface can be reconstructed, and the benefits of such a virtual sand model can be explored by the user.

Introduction

Wet granular materials, or cohesive powder (i.e., "sticky sand") – are essential for many products and processes, such as in the pharmaceutical and food industries, geophysics or mining technology. Cohesive effects in collections of particles are also essential in astrophysics: these effects contribute to the formation of planets [1,2], they are important to explain the cohesion of comets and asteroids [3]. The key to this understanding lies in the description of tiny liquid bridges [4–6] connecting particles. However, the particle and liquid bridge scale generally can be rather small, so that experimental techniques to look inside into these particle systems are often not available. Therefore, using computers to model and virtualize granular material is of great importance for a variety of engineering applications. That is the reason we use computer simulation and virtualization for this science communication project.

The main goal of this work is to attract the curiosity of young people for scientific or technical issues, to strengthen intuitive learning abilities of young people, and to let students understand why simulations are important in scientific research. In a more general context, this project will finally give the target groups (i.e., students from elementary school, secondary school and the general public) a more concrete understanding in the thematic areas of (i) physics and fluid mechanics, (ii) particle and process engineering, (iii) geology and hydrology, (iv) software development and electronic data processing, (v) 3D surface measurement technologies, and (vi) new communication media.

Methodology

The installation and operation of AR Sandbox has been performed several times before [7]. The installation requires the purchase of a powerful simulation computer, a high performance graphics cards, a 3D camera, as well as the mechanical design of the sandbox.

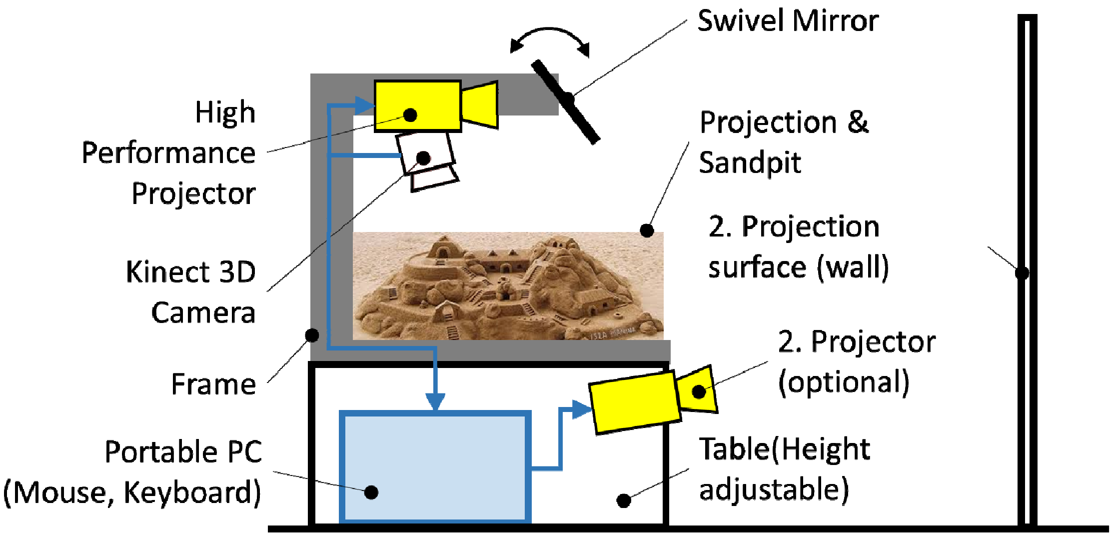

Figure 1: Planned virtual sand box (front view).

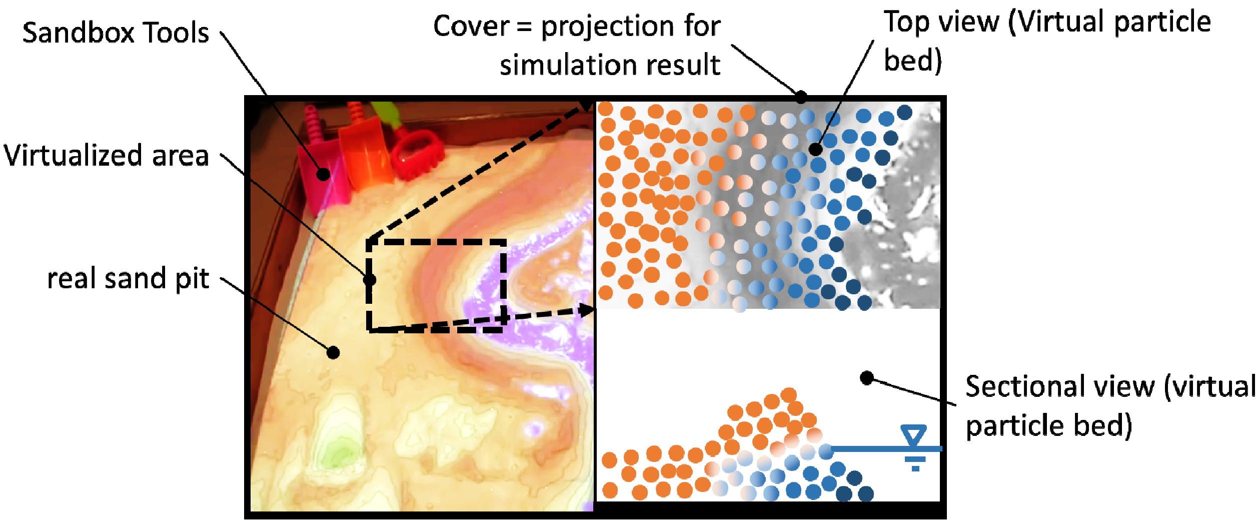

Figure 2: Planned virtual sandbox (point of view from the top, on the left half of the sandbox is to see the projection surface to the visualization of simulation results is shown on the right half of the already established version with extended reality).

Results

The sandbox results are presented in two stages, in the first stage, we use the AR sandbox software to virtualize the sand surface based on different altitude of the surfaces, and inject liquid in the lower altitude region (i.e. a lake), that is what we call the virtual sandbox (see figure 3).

The second stage, we use a Kinect sensor to capture the sand surface, and then convert this spatial information (i.e., data points on the sand surface) to stl-formatted files that can be read into LIGGGHTS®. Here we test this procedure by using the Kinect camera to record the surface of a person. Then, we convert the wall surface to a stl file, and load it into LIGGGHTS® for simulation (an example is show in Figure 4).

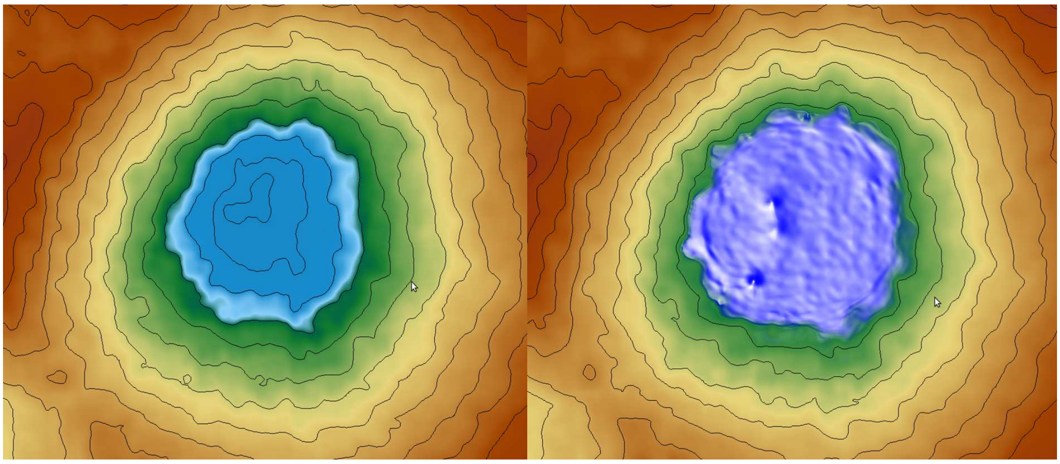

Figure 3: Sand surface based on different altitude without liquid (the left panel), liquid injection in the region of lower altitude (the right panel).

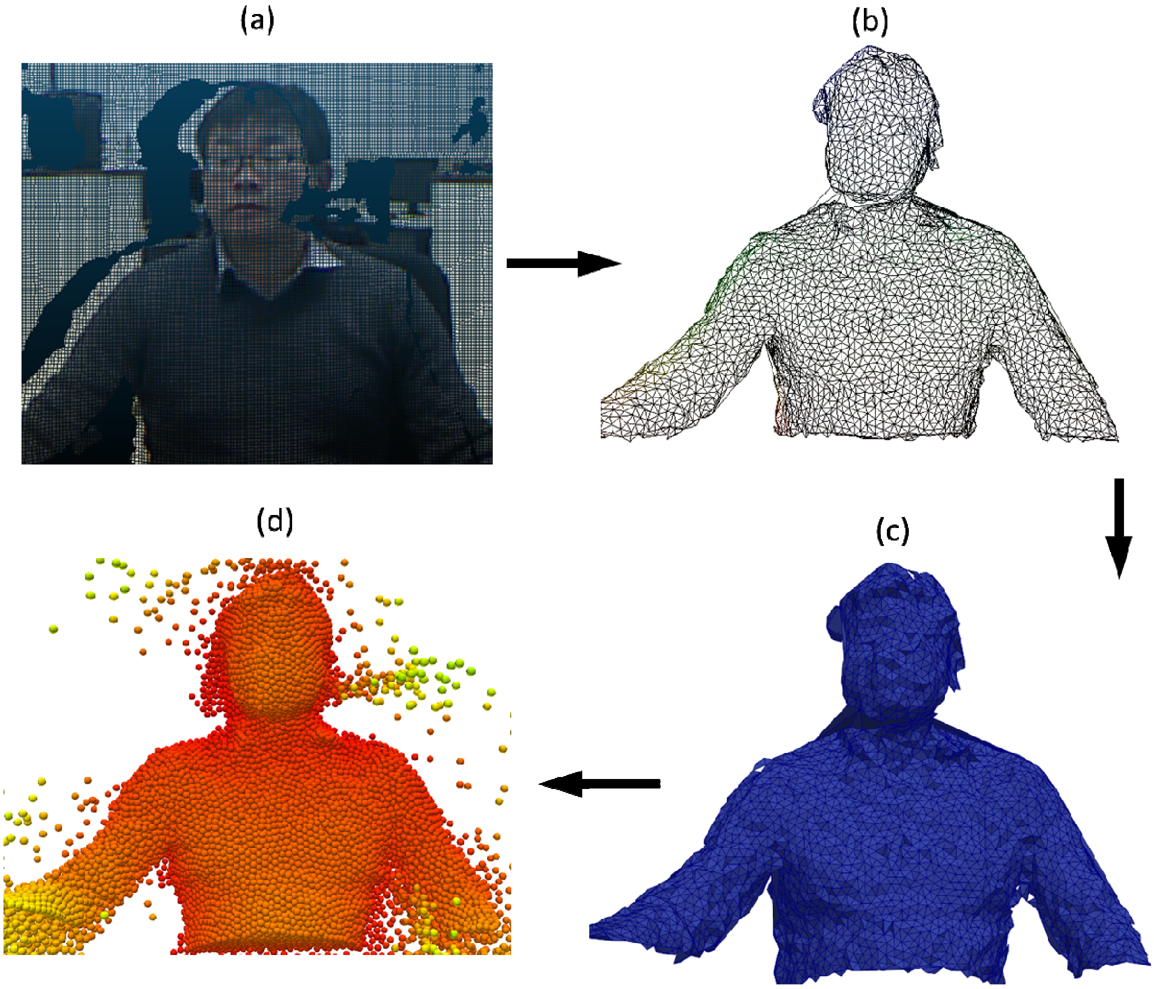

Figure 4: Conversion of the output of the Kinect camera to be fed into the particle simulator LIGGGHT® (i.e., a: camera output, b,c: conversion of the geometry to vtk and stl format, d: filling of the geometry with particles).

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