# AUGMENTED REALITY SANDPIT SIMULATING ANT COLONIES

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**ABSTRACT**

The way ants navigate their environment and forage for food is an intricate process. A common way ant species navigate is by using pheromone chemical trails leading to and from food sources. This paper summarizes an augmented reality sandpit project that aims to show the creation and evolution of these pheromone trails within a colony in an interactive way. A complex yet accessible simulation was built to allow users to move sand in a real sandpit while seeing virtually projected images on top of the sandpit change accordingly to showcase emergent ant colony behavior. A demo video of the project is available at https://www.youtube.com/watch?v=63Kx_xVEZkk.

**Summary**

It is complicated to describe how ants move and forage for food and how ant colonies respond to danger. However, watching ant trails form in a visualization on a novel tool such as an augmented reality (AR) sandpit makes the concepts easy to digest and fun to learn. The concept of an AR sandpit was originally made popular by researchers at the UC Davis in 2014. The initial sandbox software underlying the ant simulation was built at Monash University's Sensilab in 2016. Based on the UC Davis implementation, our software was written from scratch in Unity3D using C# to easily edit and create new applications (e.g., *ant colony simulations* in our project).

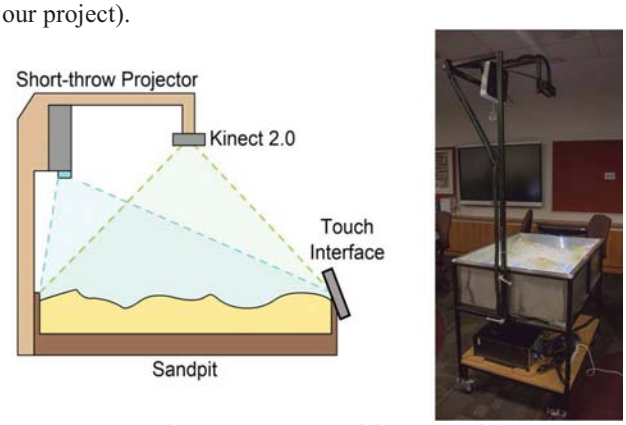


Fig. 1. Components of the AR sandpit.

Our aim is to implement an empirically realistic ant colony foraging simulation on an actual sandpit. The resulting AR sandpit, shown in Fig. 1, is enjoyable to use and educational. It has the following five major components: *Microsoft Kinect 2.0 depth sensor, short-throw projector, touch screen interface, the sandpit, and computer to power the set up.*

In our simulation, ants will constantly search for food and attempt to return it to the nest. The sand can be readily moved and deformed to reveal an impassable water layer and the ant colony will react in turn. Trails can be disrupted and ants will find a new way to their goal if possible. Other agents such as spiders can also be added to the simulation. If a forager ant runs into a spider, it will run back to the nest to alert the soldier ants for the protection of the colony.

On the side of the sandpit is a touchscreen which displays many useful statistics about the colony and houses different settings which can affect how the colony functions. Options such as the water level and the ant metabolism rate greatly change how ants navigate the environment and how far they can venture to find food.

Finally, the software also includes hand detection which is used to create food for the ants to eat. When a user places their hand over the top of the sandpit and holds it still, their hand is detected and food is placed directly below it.

Fig. 2. Final sandpit build featuring touchscreen.

The final sandpit is shown in Fig. 2. The features that enabled successful AR sandpit simulation of ant colony are

- A fully realized pheromone navigational model for the ant colony,
- A generalized agent model which allowed for the easy creation of many different agents,
- An efficient 2D collision system,
- A touchscreen UI used to control the simulation,
- Simulation of surface deformation using the AR sandpit.

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