Robot bees as new pollination bees

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ABSTRACT

The decreasing number of pollinators is a major concern to the world. Significant crops, including cotton, potatoes and avocado are pollinator-dependant, which means that there is no way, other than pollination, to produce seeds to said crops. Additionally, this problem doesn't only affect the agriculture industry but the food industry and the clothing industry as well. What will fast food chain restaurants do without potatoes? What will clothing brands do without cotton?. If we don't address this problem soon, we may be facing a major crop deficiency that could drive many industries into bankruptcy.

1. INTRODUCTION

Pollination is one of the most important processes carried out by arthropods in nature, more specifically bees. It consists of transferring pollen from the male anthern of a flower to the female stigma, which results in the production of a seed. However, given that bees are the main participants in this process, and they are unfortunately becoming extinct because of numerous reasons, we must find a way to fill the void in pollination which directly affects the agriculture industry. There have been many potential solutions for this problem, including ecological farming, providing bee habitat, supporting beekeepers and robot bees.

2. PROBLEM

The decreasing bee population is directly affecting the seed production of significant crops in the agricultural industry. This means that there could be a serious shortage of certain foods and supplies in the market, which will not only directly affect the food and clothing industry, but us customers too. In order to keep crops from disappearing, we must use technology to come up with a solution that will not only keep pollination going but will also be environmentally friendly.

3. RELATED WORK

3.1 Quadtrees

A quadtree is a data structure made up by nodes, each node has exactly four children that act as nodes themselves. Each node works like a bucket in which, when it surpases a k amount of elements, it divides into four new nodes. Said process will be done every time a node reaches that k amount.

The purpose of this process is to keep the program from comparing each object to all the other objects to see if they will run into each other. This way, the program will only compare objects to the ones close by,

saving memory and unnecessary processes.

3.2 AABB (Axis-aligned bounding boxes)

This method is one of the easiest and fastest ones to check if two objects are near each other. It consists of wrapping the entities in a box, if the box of an object overlaps an other box, then there is a collision between the two objects.

The issue with this method is that it is not very accurate since the box cannot rotate with the object. It also consumes a lot of resources if there are many objects, since each object has at least a position (x,y,z) and a box with eight vertices, and the system has to keep track and change each parameter since the objects are always moving.

3.3 Bounding Volume Hierarchy

This method consists of a set of geometric objects in a tree-like structure. Each object is wrapped in bounding volumes that form the nodes of the tree. If the volumes of two nodes do not overlap, neither will the objects.

There are two ways for the tree to be built: top-down and bottom-up. In the top-down method we divide input set into two (or more) subsets. Bounding them in a defined volume and then keep on dividing them recursively until each subset consist of a leaf node (simplest form). On the other hand, in the bottom-up method, we begin with the input set as the leaves of the tree and bind them together to form a new node. We proceed in the same way until everything has been binded to a single group of objects, that is considered the root of the tree.

3.4 Sweep and prune

This method is based on the arrangement of objects along every axis. From each object we take its minimum and maximum value in the x axis. Then we arrange them according to their minimum x value and select the objects that might overlap in the x axis. From the selected pairs we repeat the process but with the (y) axis, then the (z) axis. If a pair of objects is true to the three tests, they collided.

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