# Bees in action: Avoiding the collision of robotic bees as an alternative for pollination!

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## ABSTRACT

During the last years, the world has come across the problem of the disappearance and extermination of bees that achieve pollination and give multiple advantages to crops and therefore the human being, for which reason they have taken remedial measures by means of robotics and programming, however, the problem of the collision of these robotic animals has been worrying in this field because their possible impacts would cause significant damage.

## 1.INTRODUCTION

Almost two thirds of the cultivated plants that are predestined for human consumption depend on the pollination of bees. For 15 years these beings have diminished considerably their number, due to the use of pesticides and attack of parasites; for this reason, different universities around the world have put in the work of creating small mechanical bees that make the work of these living beings, combining innovative technologies such as miniature robotics and processing algorithms.

## 2. PROBLEM

Treating the problematic spoken in "Motivation" we concentrate mainly on the processing algorithm; here we will focus on identifying which robotic bees are 100 or less meters away from any other bee, taking as a priority the algorithm's runtime efficiency.

## 3. RELATED WORK

For the current report, an investigation was conducted of different data structures that promoted to give an effective solution to the problem posed.

### 3.1 Octree

An octree or octal tree is a "tree" structure of data in which each internal node has exactly 8 "children". The octree structures are based on the recursive division of the Envelope box of the figure to be represented in eight octants that completely cover the volume. If an octant is completely occupied by the solid is labeled as black, if it is not as white and if on the other hand it is partially occupied as gray, in which case it is necessary again divide it into 8 children that correspond to the subdivision. The complexity of this algorithm is O (log (n)) and for obtain a complete and correct solution must be had in account:

- Ensure that the entire geometry contained in the node is used when calculating its envelope

- Ensure that the envelope at level n this completely contained at level n-1
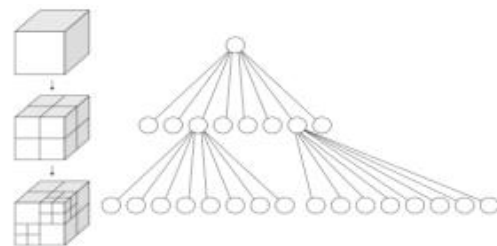
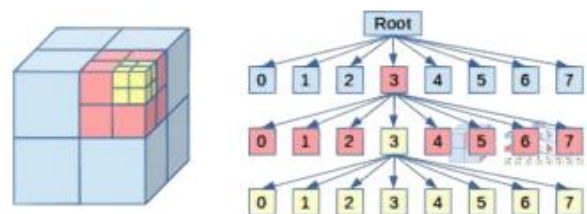- Avoid gaps between adjacent nodes.



Figura 1



Figura 2

## 3.2 BSP

Binary space partitioning or Binary Space Partition (BSP) is a method or algorithm used to subdivide recursively a space in convex elements using hyperplanes. This subdivision gives rise to a representation of the scene by means of a structure of data from the tree known as the BSP tree. These two Semi-spaces are usually referred to as positive and negative, the positive half-space being in the part of the plane towards which your normal points.
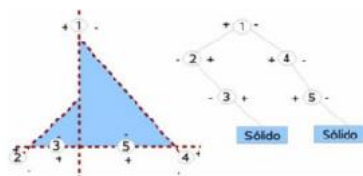


Figura 3



Figura 4

## 3.3 Quadtree

The term Quadtree, or quaternary tree, is a algortimo which is used to describe classes of data structures hierarchical whose common property is that they are based on the principle of recursive decomposition of space. In a QuadTree of points, the center of a subdivision is always at one point. When inserting a new element, the space is divided into four quadrants. By repeating the process, the quadrant is divided again into four quadrants, and so on.
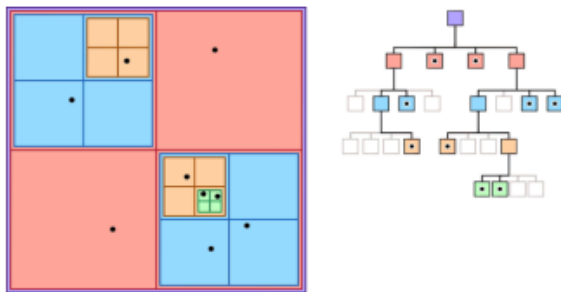


Figura 5

This type of algorithms are used for different problems related to the space of objects and in this case, avoid collisions of figures, since their different levels provide different resolutions of details being useful in many ways. For example, if has a two-dimensional data point, x, and then they will be immersed in exactly one node at each level of the tree, so it can be used to perform a search fast of a data set.

## 3.4 Arbol kd

U Tree kd (abbreviation of k-dimensional tree) is a Partitioning data structure of the space that organizes the points in a Euclidean space of k dimensions. Since there are many possible ways to choose blueprints aligned to the axes, there are many ways to generate trees kd. The usual system is: As it descends on the tree, cycles are used through the axes to select the planes. (For example, the root can have a plane aligned with the x axis, its descendants would have planes aligned with him and the grandchildren of the root aligned with the z, and so on) In each step, the selected point to create the plane of cut will be the median of the points placed on the kd tree, what respects their coordinates in the axis that is being used.

- Construct a static kd tree from n points is from O (nlogn).

- Insert a new point in a balanced kd tree it's O (logn).
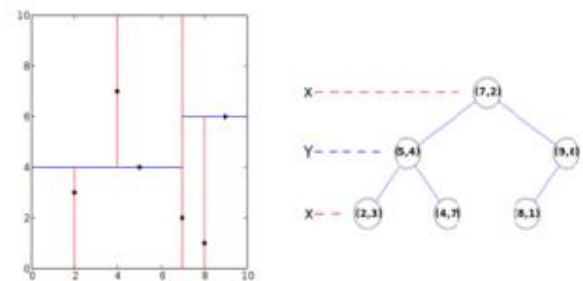
- Remove a point from a balanced kd tree is from O (logn).



Figura 6



Figura 7
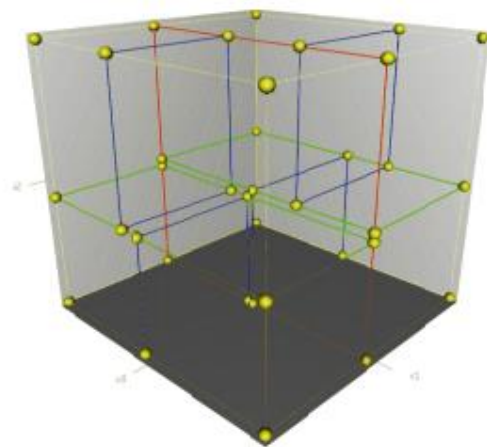
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