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Modeling of the Behavior of a Robot in a Virtual Environment in 3D

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Abstract : ***A robot is a machine equipped with capacities of perception, decision and action which enable him to act in an autonomous way in its environment. The mobile robots are largely used in the industrial environments. The possible types of applications are innumerable. This work proposes to implement an architecture 3D and to define a general method of representation and modeling of the behavior of a robot in a virtual world in 3D. Various scopes of application, whose virtual library 3D which is an environment in three dimensions, designed to turn inside a classical web browser (provided that this one is provided with one plug-in vrml) are studied to show the founded good of the approach proposed.***

Keywords : virtual 3D, Architecture 3D, virtual Environments, virtual Reality, virtual Numeric library, Robot, graph, shorter way.

1. Introduction

A robot is a machine equipped with capacities of perception, decision and action which enable him to act in an autonomous way in its environment. The possible types of applications are innumerable [1].

Such a framework of use requires that the robotized system has a minimum level of autonomy and facilities of navigation. With this intention, the system must generally achieve three basic tasks which are the localization, planning and navigation [10].

The constraints relating to the robot relate to its geometry, its kinematics and its dynamics and their taking into account can be complex according to initial architecture considered. The criteria to be satisfied during the resolution of the problem of planning relate to the fact that a solution must optimize an index performance expressed in term of the distance covered by the robot between the two configurations ends, of the duration or energy necessary to the execution of its movement.

Vis-a-vis the also various nature of these aspects and to the difficulties which it can induce on a process of resolution, most work suggested in the field of the planning of movement concerned the consideration of certain authorities of the general problem. Thus to plan a trajectory for a solid body in Cartesian space amounts planning the trajectory of a point within the space of work [9]. If the obstacles of the environment now are considered, one realizes that the " plonger" within the space of system requirements is not an easy task, especially if the system comprises many variables of configuration and that consequently the dimension of space is high.

The objective of this work is to suggest a solution making it possible to find a way for a robot in a virtual environment in 3D. To present this solution, we start by introducing the notion of the shortest way. The second part of this document is devoted to the presentation of the general architecture of our solution. The design of the various modules is presented in third part. We finish by a conclusion and the prospects considered.

2. State of the art

A virtual world is a representation of a world, created with images in 3D, which one can handle using a mouse or of a keyboard [3]. These virtual worlds can take all the conceivable forms. It can be a question of a simple object (like a helicopter or a cube) or of a character that one can animate. In fact, any three-dimensional representation constitutes a virtual world paradigm of the remover of piano and his resolution was the object of several work. Most this work are based on the concept of space of the configurations of the robot [9]. The problem of planning is formulated in a space of dimension N, the space of the configurations, where the robot is compared to a point and obstacles with subsets also of dimension N. Thus, a movement solution is given by a curve corresponding to a continuous sequence of configurations without collision connecting the initial and final configurations considered. One will speak then about a mouvement within the space of free configurations or with the contact

3. The Optimal Way and Graph Theory

The problems of optimal ways are very frequent in the practical applications. One meets them as soon as it is a question of conveying an object between two points of a network, in order to minimize a cost, a distance or a duration. They also appear in combinative subproblems, in particular the floods in the graphs and schedulings. All this justified very early the search for effective algorithms. Most algorithms of search for shorter way calculate for each top X a label V [X], value of the shortest ways of the starting top at top X. This value represents at the beginning an estimate by excess (raising) value of the shortest ways. Certain algorithms definitively treat a top with each iteration: they select a top X and calculate the final value of V [X]. These algorithms are said to fixing of labels [7] and are represented by the algorithm of Dijkstra and its derivatives. Other algorithms can refine until the last iteration the label of each top.

They are called algorithms with correction of labels [7]. The algorithm of Bellman is a very known algorithm with correction of labels, of standard dynamic programming.

4. Modeling of the behavior of Robot in a virtual environment in 3D : A Virtual Library 3D

4.1 Presentation

The Virtual library 3D is an environment interactive mono-user, in three dimensions, designed to turn inside a web browser. This library was created for mission, enter others, to make it possible to visitors to view resources inside of an environment in three dimensions, more ludic and more attractive than the classical interfaces. The library represents a virtual world which one can handle using a mouse or of a keyboard. In this environment a robot is put at the disposal of visitors to satisfy their requests as shown in the figure 1

4.2 Modeling

Let us consider a graph valué G = (X; With; W). X indicates a set of NR tops (or nodes) and A a set of M edges. W (I, J) also noted Wi; J, is the evaluation (also called weight or cost) of the edge (I, J), for example a distance, a cost of transport, or run time. For the most spread economic function, the cost of a way between two tops is the sum of the costs of these edges. The associated problems consist in calculating ways of minimal cost (in summary minimal ways, or shorter ways). They have a direction if G does not have a negative circuit, if not one could infinitely reduce the cost of a way while turning in such a circuit, called for this reason absorbing circuit [14]. In our case, the library is represented in the form of a graph Figure 1, Figure 2, Figure 3 and Figure 4

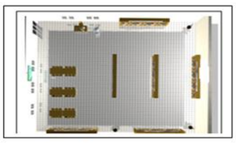

Figure 1 : The library

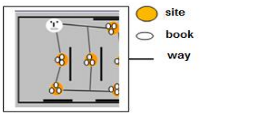

Figure 2: Simplified graph of the environment

Figure 3 : The library (internal sight)

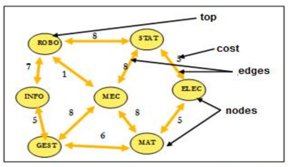

Figure 4 : Evaluated graph of the environment

4.3 Algorithm of construction of the trajectory of the ROBOT

4.3.1 Algorithm of creation of the shortest way

To create the shortest way to cross all the nodes (all requests) chosen by the user while basing itself on their costs. This lower part a description of the principle of operation of the first algorithm:

A: the whole of the nodes of the graph.
S: Summit of the graph.
Pi: initial position of the robot
B: the whole of the nodes chosen by the user with B A.B': the unit B treated by the algorithm
B': the unit B treated by the algorithm.
Entries: {B} (subset of nodes) {A}, S top)
Outputs: {B'}

Begin
1. $B' \leftarrow \phi$, $S \leftarrow PI$
2. To sort the nodes of B in the order ascending according to their distances by contribution S; [They will be noted B1, B2,…, Bm.]
3. $B' \leftarrow B' \cup \{B1\}$;
4. $B \leftarrow B \setminus \{B1\}$;
5. $S \leftarrow B1$
6. if $B \neq \phi$ **to return at stage 2.**
7. to turn over B'
End

With each time the user chooses positions belonging to the initial tree, the algorithm tries to build a new unit which contains these classified positions but so that they create the shortest way for the trajectory of the ROBOT.

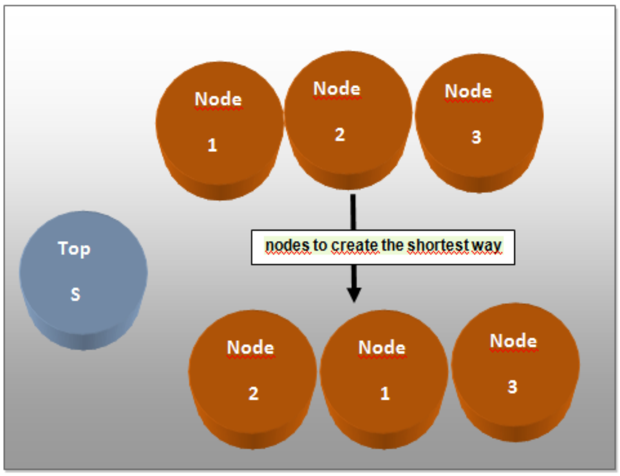

Figure 5: Algorithm 1

4.3.2 Algorithm which builds the trajectory of the ROBOT

Once the nodes chosen by the user are treated by the first algorithm, the positions destinations are classified in a table at end which they create the shortest way, the role of the second algorithm is to create a trajectory validate ROBOT, in other term; to create a trajectory which avoids the collisions with the other objects in the scene. The principle is to create an intermediate node between a node I and one node i+1 for each couple of nodes which makes a trip between them according to the x axis and the y axis in the Cartesian reference mark

S:Summit of the graph.
B': the whole of the nodes chooses by the user and treaty by

algorithm 1.
Traj: the B' unit treated by the algorithme2. (The trajectory of the robot).
Entries: {B'} One will note them [B' 1, B' 2,…, B' Mr.], S top
Outputs: {Traj}

```
Begin
1.Traj' ← φ
2. for I = 1 to  m do
If To check B'I and B'I+1=TRUE
Then
        To produce Intermediate node To add node Bi to Traj
         To add Intermediate node to Traj To add Bi+1 node to
Traj
End if
3. to turn over Traj
End
```

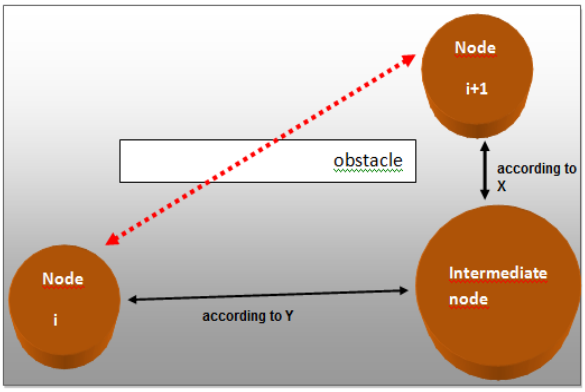

Figure 6: Algorithm 2

5. Conclusion

Most algorithms consist in sweeping a space of research (containing a noncountable infinity of points) with an aim of finding a solution optimal. A specific approach does not make it possible to analyze that a negligible portion of this space of research. This last can frequently be covered by a number finished of under - simple units, on which one can calculate, and who them, contain an infinity of points. Our strategy of modeling begins with the development from the virtual environment in 3D in one using language vrml increased. Then, one tests by using the two algorithms previously presented to find, according to the requests of the user the shortest way followed by the robot to satisfy these requests. This methodology led us to tackle new problems in the field of Man/machine interface and especially on the level amongst requests provided by a user.

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