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EXPERIMENTS OF POTENTIAL FIELDS' METHOD APPLIED TO A MINI CATERPILLAR ROBOT

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Abstract: *In this paper is analyzed the potential fields algorithm. The study shows how we have implemented the theoretical method and how we have simulated the results of navigation with obstacles and one target. Also, we tested this method practically by creating an autonomous caterpillar robot and programmed it with this algorithm. We compared the results and we analyzed the areas where the robot presents most of the errors and those where it goes off the simulation normal path.*
Key words: *robotics, algorithm, autonomous, vehicle, caterpillar*

1. INTRODUCTION

The movement of a virtual robot in a virtual space has been examined in order for it to obtain the capacity to adapt to peculiar conditions without man's interference. When talking about a real robot, one can use several strategies to achieve this aim, such as the space mapping strategy, the surface scanning strategy, the strategy of iterative methods and others. For iterative methods, the motion trajectory planning algorithm builds the trajectory standing on a set of spatial positions and the intelligent control system transposes this trajectory in the spatial positions taken by the robot.

With the use of iterative methods, the performances of the robot system can be adjusted to a level that will allow him to adapt to new situations. The adjustment process continues in accordance to the established protocol until the wanted accuracy is obtained.

2. THE POTENTIAL FIELDS METHOD

In Potential fields method, we use vectors to represent behavior (in particular, for the motor diagram of the behavior) and the vector summing operation for combining the vectors that correspond to different behaviors in order to obtain the emergent behavior.

A potential field is a picture (field) of vectors, characterized by an amplitude and a direction (a, d). Generally, vectors are used to represent forces of a certain nature. They are drawn as an arrow, whose length represents the amplitude (size) of the force, while the angle represents the direction.

A picture of vectors represents a region of space. The objects that can be perceived in a certain region of the space exert a force field (attraction, rejection, etc,) to the surrounding regions. A force field can be considered analogous to a magnetic field or to a gravitational field. The robot can be seen as a particle entering the field that is generated by an object or by the environment.

That region can be divided into small squares; a network of points characterized by the coordinates (x,y) is being created. Thereby, each element of the picture represents a vector (force) associated with each such point. Such a vector is defined by the movement direction and by the amplitude (or velocity) of the movement in that direction; these are some components a robot would perceive if he were in that position. Since each and every point in space has a corresponding vector, potential fields are continuous.

3. PROGRAMMING POTENTIAL FIELDS

The potential fields methodology entails that all behaviors should be implemented as potential fields. The main characteristic states that the mixing up of the behaviors will be possible through vector sum. Generally, upon the robot will operate „forces" generated by multiple behaviors that act in concurrent mode (Lalonde & Bartley, 2006).

In order to navigate in a simple way towards a target, we will consider a robot heading a target (for example, he moves 10 meters in the x direction and then he meets an obstacle).

For representing the movement, we will use: a travel behavior towards the target, whose motor diagram move2goal is represented as an attraction potential field. To detect the proximity to the target, odometer measurements can be used for a obstacle avoidance behavior, whose motor diagram Avoid is represented as a rejection potential field that uses a distance sensor to detect the proximity to the obstacle.

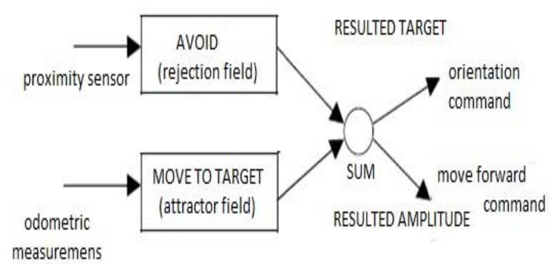

Fig. 1. Diagram representing potential fields implementation

4. THE CHOOSING AND THE IMPLEMENTATION OF THE ROBOT FOR TESTS

In order to build the robot, I chose the development board and the microcontroller from Parallax, due to the simplicity of use, the low cost and the simple interaction with the computer, which was made in Pbasic.

For detecting obstacles, I chose the use of ultrasonic sensors because they are some of the most useful and effective sensors of mobile robots. They allow a sufficiently accurate measurement, without any contact, of the distances from other objects in the environment, providing the premises for some of the most important activities self configurable robots can develop:

For the mechanical construction of the tank, the drawing was made in SolidWorks; the use of only one board was chosen in favor of separate parts because of the high level of stiffness that was obtained, while for casing, I chose the slide joints to the bearings, due to their simplicity and gauge.

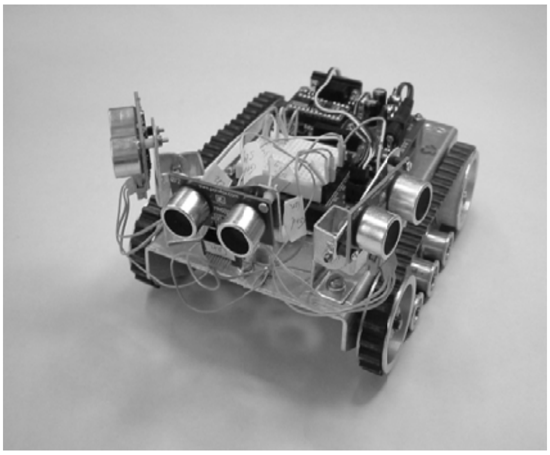

Fig. 2. The robot used for the implementation of algorithms

5. EXPERIMENTAL RESULTS

The potential fields' method was firstly simulated and afterwards implemented on the robot. The target of the robot was positioned at 5 meters from it; three other obstacles were placed along its trajectory. The simulation of the trajectory is similar to the real track of the robot; possible displacements from the ideal trajectory are due to the reduced accuracy of the main board and of the microprocessor that has been used to program the kinematics and the potential fields' method. Other slightly errors possibilities are the known problems of potential fields method

1. Trap situations due to local minima (cyclic behavior).
2. No passage between closely spaced obstacles.
3. Oscillations in the presence of obstacles.
4. Oscillations in narrow passages.

In this case if the intesity of a sum in any point of the path is 0 our robot remains blocked (local minima problem)

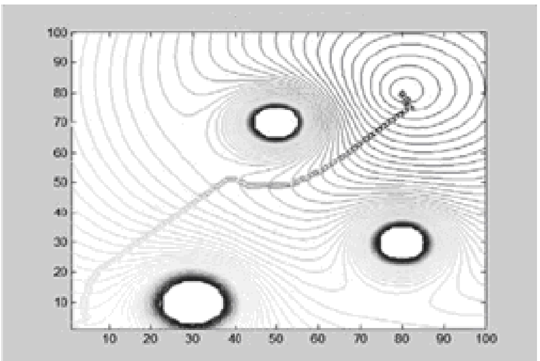

Fig. 3. The ideal trajectory of the robot

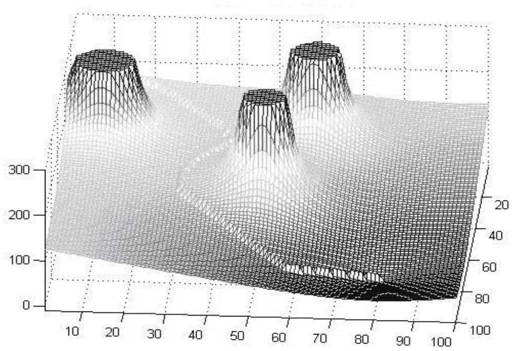

Fig. 4. 3D representations of the mathematical model with 3 obstacles

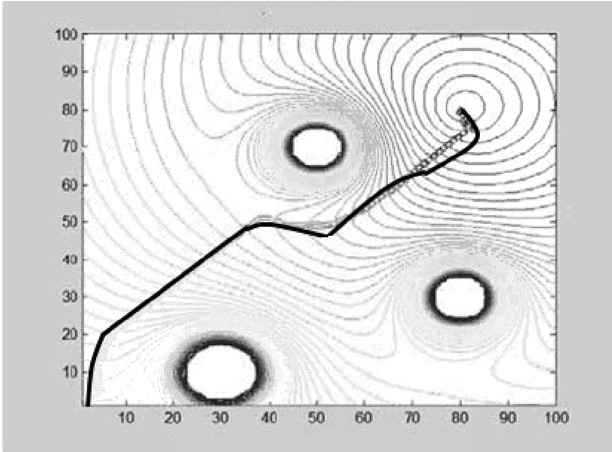

Fig. 5. Real trajectory overlapped the ideal trajectory

The way the robot navigates in the same condition like in the mathematical model (3 obstacles and one target) is represented with black.

6. CONCLUSION

It can be easily observed that the area where the robot comes near the target and also the area where are influences by the two near obstacle represents the biggest difference.

Most researchers concentrate their efforts on simulation programs of potential fields; they don't seem to be aware of the substantial possibly irresolvable problems that are bound to surface once actual implementation in an experimental system is attempted. Other researchers work with actual mobile robots, but at slow speeds which conceal the disadvantages of the Potential Fields Method. Because of the results of this study ,the errors and disadvantages who made the path of the robot off it's theoretical planned steps we currently test the method called the vector field histogram created by Johann Borenstein and Yoram Koren, a method who theoretically produces less errors ,a smooth and non-oscillatory motion.

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