Intelligent Autonomous Path Planning Systems

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Abstract— The theory and practice of Intelligent Autonomous Robot IAR are currently among the most intensively studied and promising areas in computer science and engineering which will certainly play a primary goal role in future. These theories and applications provide a source linking all fields in which intelligent control plays a dominant role. Cognition, perception, action, and learning are essential components of such-systems and their use is tending extensively towards challenging applications (service robots, micro-robots, bio-robots, guard robots, warehousing robots). The present paper studies the problem of motion of a mobile robot that moves inside an unknown environment with stationary unknown obstacles. This paper deals with the main principles of Intelligent Autonomous Systems IAS Path Planning and illustrates some criteria to be taken into account in any intelligent navigation control of IAS. For any starting point within the environment representing the initial position of the mobile robot,

Keywords— Motion Planning, Autonomy requirements, Intelligent Autonomous Systems (IAS), Intelligence Obstacle avoidance .

I. Introduction

Autonomous mobile robots which work without human operators are required in robotic fields. In order to achieve tasks, autonomous robots have to be intelligent and should decide their own action. When the autonomous robot decides its action, it is necessary to plan optimally depending on their tasks. More, it is necessary to plan a collision free path minimizing a cost such as time, energy and distance.

When an autonomous robot moves from a source position to a target position, it must find a feasible connection between the source and the target. In other word: It is necessary to plan an optimal or feasible path avoiding obstacles in its way and answer to some criterion of autonomy requirements such as: thermal, energy, time, and safety for example. Therefore, the major main work for path planning for autonomous mobile robot is to search a collision free path. Many works on this topic have been carried out for the path planning of autonomous mobile robot [1,2,3,,4,5].

To operate independently in unknown or partially known environments is the basic feature of an autonomous mobile robot. The autonomy implies that the robot is capable of reacting to static obstacles and unpredictable dynamic events that may impede the successful execution of a task. To achieve this level of robustness, methods need to be developed to provide solutions to localization, map building, planning and control. The development of such techniques for autonomous robot navigation is one of the major trends incurrent robotics research.

Hostile environments such as Mars trigger even more unusual locomotion mechanisms. In dangerous and inhospitable environments, even on Earth, such *teleoperated* systems have gained popularity. In these cases, the low-level complexities of the robot often make it impossible for a human operator to directly control its motions..

The human performs localization and cognition activities, but relies on the robot’s control scheme to provide motion control. For example, Plustech’s walking robot provides automatic leg coordination while the human operator chooses an overall direction of travel. As an example an underwater vehicle that controls six propellers to autonomously stabilize the robot submarine in spite of underwater turbulence and water currents while the operator chooses position goals for the submarine to achieve.

Other commercial robots operate not where humans *cannot* go but rather share space with humans in human environments . These robots are compelling not for reasons of mobility but because of their *autonomy*, and so their ability to maintain a sense of position and to navigate without human intervention is paramount.

Another more accurate example, AGV (autonomous guided vehicle) robots autonomously deliver parts between various assembly stations by following special electrical guidewires using a custom sensor. The Helpmate service robot transports food and medication throughout hospitals by tracking the position of ceiling lights, which are manually specified to the robot beforehand.

Several companies have developed autonomous cleaning robots, mainly for large buildings. One such cleaning robot is in use at the Paris Metro. Other specialized cleaning robots take advantage of the regular geometric pattern of aisles in supermarkets to facilitate the localization and navigation tasks. Research into high-level questions of cognition, localization, and navigation can be performed using standard research robot platforms that are tuned to the laboratory environment.

This is one of the largest current markets for mobile robots. Various mobile robot platforms are available for programming, ranging in terms of size and terrain capability. There is one fact that is true of virtually every successful mobile robot: its design involves the integration of many different bodies of knowledge. No mean feat, this makes mobile robotics as interdisciplinary a field as there can be. To solve locomotion problems, the mobile roboticist must understand mechanism and kinematics; dynamics and control theory.

To create robust perceptual systems, the mobile roboticist must leverage the fields of signal analysis and specialized bodies of knowledge such as computer vision to properly employ a multitude of sensor technologies. Localization and navigation demand knowledge of computer algorithms, information theory, artificial intelligence, and probability theory.

Although mobile robots have a broad set of applications and markets as summarized above, there is one fact that is true of virtually every successful mobile robot: its design involves the integration of many different bodies of knowledge. No mean feat, this makes mobile robotics as interdisciplinary a field as there can be.

Deriving a model for the whole robot's motion is a bottom-up process. Each individual wheel contributes to the robot's motion and, at the same time, imposes constraints on robot motion. Wheels are tied together based on robot chassis geometry, and therefore their constraints combine to form constraints on the overall motion of the robot chassis. But the forces and constraints of each wheel must be expressed with respect to a clear and consistent reference frame. This is particularly important in mobile robotics because of its self contained and mobile nature; a clear mapping between global and local frames of reference is required [6,7].

The study of human-robot interaction, while fruitful in recent year, show great variation both in the duration of interaction and the roles played by human and robot participants. In care where human caregiver provides short-term, nurturing interaction to a robot, research has demonstrated the development of effective social relationships. Anthropomorphic robot design can help prime such interaction experiment by providing immediately comprehensible social cues for the human subjects [8,9].

Some researchers are interesting in the simplest kind of object manipulation i.e. pushing. Pushing is the problem of changing the pose of an object by imparting a point contact force to it. For the simplicity, they constrain their self to the problem of changing the pose (in a horizontal plane). An early approach to robot pushing was implemented with two wheeled, cylindrical robots equipped with tactile sensors which implemented object reorientation and object translation. The strategy was to use two robots to push the object at its diagonally opposite corner. As a result of this off-center pushing a torque is applied to the box, rotating it roughly in place.

This problem is addressed to detect and push stationary objects in a planar environment by using an environment-embedded sensor network and a simple mobile robot. The stationary sensors are used to detect push able objects. This way illustrates how he robot box-pushing with environment embedded Sensors. On the other direction, the teleoperation is very important and it is the way which is always studied to propose a good navigation. Teleoperation is often employed in controlling mobile robots navigating in unknown environment and unstructured environment. This is largely because teleoperation makes use of the sophisticated cognitive capabilities of the human operator [9,10,11]

In all research developments, the robot has to find a collision-free trajectory between the starting configuration and the goal configuration in a static or dynamic environment containing some obstacles. To this end, the robot needs the capability to build a map of the environment, which is essentially a repetitive process of moving to a new position, sensing the environment, updating the map, and planning subsequent motion.

The planner's approximation of the configuration space is a direct function of the configuration space samples that the planner observes. Consequently, sampling is the search for the set of samples that provide enough information to construct a sufficient approximation of configuration space connectivity. For every configuration space, there are an optimal number of samples that must be selected to construct a sufficient approximation of configuration space connectivity.

Local planners impose an artificial potential field function on top of the configuration space. This potential field function is sloped so that its minimum is at the goal configuration. The artificial potential field is also influenced by configuration space obstacles.

Configuration space obstacles have high artificial potentials that decline gradually with distance from the obstacle. At any instance, the robot calculates the derivative of the potential function and descends the maximal downward gradient in an effort to reach the minimum at the goal position. This calculation quickly determines the motion to take next.

Several others guided sampling strategies use information obtained from previous experience to guide their behaviour. Entropy-guided sampling adapts sampling to find configurations that offer maximal information gain given the current state of the planner. The measure of information gain can be mathematically proven to converge (in the limit) on the desired state. Reinforcement learning achieves a similar outcome at a higher level.

Reinforcement learners develop a policy for action given the state of the agent. Because this policy applies to many different agent states, an agent using such a policy is partially robust to stochastic execution of its actions. Regardless of the state in which the planner finds itself after taking some action, the policy provides a subsequent action to take. Many reinforcement learning algorithms also converges on the optimal policy (given some reward function) after enough experience.

Motion planning algorithms have also been applied to an array of problems beyond traditional robotics. The two main areas of application are computational biology and computer games and animation. Though not the main focus of this thesis, these non traditional applications of planning may benefit from many of the improvements in performance and reliability offered by the utility-guided framework [12,13,14].

Motion planning algorithms find collision-free paths for robots in obstructed configuration spaces. Because the size of configuration space is often quite large, and in many cases the task of planning constrained by time, the efficiency of this search is a significant concern, especially in real-world motion planning. To be useful for real world robotics, a motion planner must be able to compute a path quickly. The actual time required depends on the robots task and how quickly the environment changes.

To plan efficiently despite the proven computational intractability of motion planning, sampling-based methods compute an approximate implicit representation of configuration space connectivity. This representation is constructed by sampling and observing a subset of all points in a particular configuration space.

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For every configuration space, there is an optimal number of samples that must be selected to construct a sufficient approximation of configuration space connectivity.

Path planning in spatial representation often requires the integration of several approaches. This can provide efficient, accurate, and consist navigation of a mobile robot. It is sufficient for the robot to use a topological map that represents only the areas of navigation (free areas , occupied areas of obstacles). It is essential the robot has the ability to build and uses models of its environment that enable it to understand the environment's structure. This is necessary to understand orders, plan and execute paths [4].

Path planning is one of the key issues in mobile robot navigation. Path planning is traditionally divided into two categories: global path planning and local path planning. In global path planning, prior knowledge of the workspace is available. Local path planning methods use ultrasonic sensors, laser range finders, and on-board vision systems to perceive the environment to perform on-line planning.

Motion planning is one of the important tasks in intelligent control of an autonomous mobile robot. It is often decomposed into path planning and trajectory planning. Path planning is to generate a collision free path in an environment with obstacles and optimize it with respect to some criterion. Trajectory planning is to schedule the movement of a mobile robot along the planned path. A wide variety of approaches have been considered, but these can broadly be categorized into on-line and off-line techniques.

However, few algorithms have been developed for on-line motion planning in a time-varying or unknown terrain. The problem of the path planning has been studied extensively over the last decades . Most great research application efforts have been spent on path planning in *static* environments. That is, a path has to be found between two configurations for a movable object in an environment containing stationary obstacles whose geometry and coordinates are given.

Whereas less attention has been given for *dynamic* environments. Besides stationary obstacles, dynamic environments contain moving obstacles with which collisions must be avoided as well. As an example, a mobile robot operating at a factory floor will have to navigate among humans or other robots, which can be considered as moving obstacles. In general, we can clarify the path planning problem is in its most general form a geometric problem which is based on the following steps:

A description of the geometry of the robot.

. A description of the geometry of the environment or *workspace* in which the robot moves or operates.

. A description of the degrees of freedom of the robot's motion.

. An initial and a target configuration in the environment, between which a path is to be planned for the robot

Using these informations, we can construct the *configuration space* of the robot, in terms of which the path planning problem is formulated generally. Previous research on the path planning can be classified as following one of two approaches: model-based and sensor –based. In general, the model-base approach considers obstacle avoidance globally it uses prior models to describe known obstacles completely in order to generate a collision free path. In contrast, the sensor-based approach aims to detect and avoid unknown obstacles.

To detect and to avoid known, partially known or unknown obstacles, we need the theory and practice of intelligence and robotic systems are currently the most strongly studied and promising areas in computer science and engineering which will certainly play a primary role in future. These theories and applications provide a source linking all fields in which intelligent control plays a dominant goal. Cognition, perception, action, and learning are essential components of such systems and their integration into real systems of different level of complexity (from micro-robots to robot societies) will help to clarify the true nature of robotic intelligence

Intelligent Autonomous systems IAS designers search to create dynamic systems to navigate and perform purposeful behaviours like human in real environments where conditions are laborious. However, the environment complexity is a specific problem to solve since the environments can be imprecise, vast, dynamical, and partially or not structured.

Then, IAS must then be able to understand the structure of these environments. To reach the target without collisions, IAS must be endowed with recognition, learning, decision-making, and actions capabilities. IAS have many possible applications in a large variety of domains, from spatial exploration to handling material, and from industrial tasks to the handicapped helps. In fact, recognition, learning, decision-making, and action constitute principle problems of the obstacles avoidance of IAS.

Three levels are required to recognition namely: inaccurate data processing (issued from sensors), construction of knowledge base, and establishments of an environment map. To solve these problems and remedy in sufficiency of classical approaches related to real-time, autonomy, and intelligence, current approaches are based on hybrid intelligent systems.

Path planning plays an important role in various fields of application and research, among which are CAD-design, computer games and virtual environments, molecular biology, and robotics. In its most general form, we can say that the main work of this level is to plan a feasible path for some moving mass between a start position and a goal position in some environment.

A more challenging path planning problem occurs when the set of all possible states is not discrete as in the case of a grid, but continuous. To clarify more the idea, an industrial manipulator robot that has to move in a three-dimensional environment while avoiding collisions with itself and obstacles in the environment. The challenge in these cases is to discretize the problem in a sensible way, such that it becomes tractable.

Motion planning will frequently refer to motions of a robot in a 2D or 3D world that contains obstacles. The robot could model an actual robot, or any other collection of moving bodies, such as humans or flexible molecules. A motion plan involves determining what motions are appropriate for the robot so that it reaches a goal state without colliding into obstacles. When the autonomous robot decides its action, it is necessary to plan optimally depending on their tasks especially if it is a 3D environments complexity.

To plan 3D collision free path is to find the capability to operate independently in unknown or partially known 3D environments complexity. The autonomy implies that the robot is capable of reacting to static 3D obstacles and unpredictable dynamic 3D events that may impede the successful execution of a task. To achieve this level of robustness, methods need to be developed to provide solutions to localization, map building, planning and control. The development of such techniques for autonomous robot navigation is one of the major trends in current robotics research.

Many works on this topic have been carried out for the path planning of autonomous mobile robot. Because perfect information concerning the moving obstacles in the environment may not be available, it is important that partial information is adequately coped with. There are a number of existing methods for dealing with this scenario. In particular, we can estimate future trajectories of the obstacles based on current behaviour, or we can assume worst-case trajectories. Whichever of these we choose; we end up with some trajectory or set of trajectories that we can represent as 3D objects in the configuration-time space.

This paper deals with the intelligent path planning of autonomous mobile robots AMR in an unknown environment, by applying the principles of the genetic algorithms. The aim of this paper is to develop an AMR for the AMR stationary obstacle. Recently, applications of genetic algorithms to path planning or trajectory planning have been recognized.

II. Motion Planning

A. Necessity of intelligent autonomous Robot

A robot is a "device" that responds to sensory input by running a program automatically without human intervention. Typically, a robot is endowed with some artificial intelligence so that it can react to different situations it may encounter. The robot is referred to be all bodies that are modeled geometrically and are controllable via a motion plan.

A robotic vehicle is an intelligent mobile machine capable of autonomous operations in structured and unstructured environment. It must be capable of sensing thinking and acting. The mobile robot is an appropriate tool for investigating optional artificial intelligence problems relating to world understanding and taking a suitable action, such as , planning missions, avoiding obstacles, and fusing data from many sources.

Industrial robots used for manipulations of goods; typically consist of one or two arms and a controller. The term controller is used in at least two different ways. In this context, we mean the computer system used to control the robot, often called a *robot work-station* controller. The controller may be programmed to operate the robot in a number of way; thus distinguishing it from hard automation. The controller is also responsible for the monitoring of auxiliary sensor that detect the presence, distance, velocity, shape, weight, or other properties of objects.

Robots may be equipped with vision systems, depending on the application for which they are used. Most often, industrial robot are stationary, and work is transported to them by conveyer or robot carts, which are often called autonomous guided vehicles (AGV). Autonomous guided vehicles are becoming increasingly used in industry for materials transport. Most frequently, these vehicles use a sensor to follow a wire in the factory floor. Some systems employ an arm mounted on an AGV.

Robot programmability provides major advantages over hard automation. If there are to be many models or options on a product, programmability allows the variations to be handled easily. If product models change frequently; as in the automotive industry, it is generally far less costly to reprogram a robot than to rework hard automation. A robot workstation may be programmed to perform several tasks in succession rather than just a single step on a line. This makes it easy to accommodate fluctuations in product volume by adding or removing workstations.

Also; because robots may be reprogrammed to do different tasks; it is often possible to amortize their first cost over several products. Robots can also perform many applications that are poorly suited to human abilities. These include manipulation of small and a large object like electronic parts and turbine blades, respectively. Another of these applications is work in unusual environments like clean rooms, furnaces, high-radiation areas, and space. Japan has led the world in the use of robots in manufacturing. The two sectors making heaviest use of robots are the automotive and electronics industries. Interest in legged locomotion has been stimulated by application in traversing rough terrain and in unmanned exploration of unknown environment. Aside from electronic motivation, there are many unanswered scientific.

Several autonomy requirements must be satisfied to well perform the tasks of AMR such as: Thermal, Energy, Communication Management, Mechanical design, etc. The development of such techniques for autonomous robot navigation is one of the major trends in current robotics research. Though there are many skills that are necessary for a robot to achieve in general.

The autonomy is one of the most significant problems that a remains largely unsolved is the dexterous physical manipulation of objects in the world. Without the ability to interact with physical objects in a variety of sophisticated ways, robots can never be truly autonomous. Additionally, there are many practical robotic tasks, from elder care to building construction that require physical manipulation of the world. Human beings manipulate their world in a myriad of sophisticated ways on a daily basis. On any given day, entering the computer science building and attending to tasks at my desk requires a large number of sophisticated manipulations of physical objects.

It is important to understand that a given object or concept might be represented in several of these pools simultaneously, with each pool representing different aspect of the object. This is supported in part by allowing element of different pool to share a sing tag register. For example, the lexicon pool entry of the word “show” , the behaviour SHOW, and the semantic net node representing information about the behaviour all share a common tag register.

Therefore, when the parser bind “show” to a role, the behaviour that can implement the verb is automatically bound to the same role at the same time. A several works were demonstrated in this domain, many researchers have attended this problem to give a successful reasoning system. They have discussed a lot of an alternate class of architectures-tagged behaviour-based systems- that support a large subset of the capabilities of classical artificial intelligence architecture, including limited quantified inference, forward and backward-chaining, simple natural language question answering and command following, reification, and computational reflection, while allowing object representation, to remain distributed across multiple sensory and representational modalities.

Classical artificial intelligence systems presuppose that all knowledge is stored in a central database of logical assertions or other symbolic representation and that reasoning consist largely of searching and sequentially updating that database. While this model has been successful for disembodied reasoning system, it is problematic for robots. Robots are distributed systems; multiple sensory, reasoning, and motor control processes run in parallel, often on separate processor hate rate only loosely coupled with one another. Each of these procure necessarily maintains its own separate, limited representation of the world and task; requiring them to constantly synchronize with the central knowledge base is probably unrealistic.

B. Navigation

Navigation is the ability to move and on being self-sufficient. The AMR must be able to achieve these tasks: to avoid obstacles, and to make one way towards their target. In fact, recognition, learning, decision-making, and action constitute principal problem of the navigation. One of the specific characteristic of mobile robot is the complexity of their environment. Therefore, one of the critical problems for the mobile robots is path planning, which is still an open one to be studying extensively. Accordingly, one of the key issues in the design of an autonomous robot is navigation, for which, the navigation planning is one of the most vital aspect of an autonomous robot.

Navigation is the science (or art) of directing the course of a mobile robot as the robot traverses the environment. Inherent in any navigation scheme is the desire to reach a destination without getting lost or crashing into any objects. The goal of the navigation system of mobile robots is to move the robot to a named place in a known, unknown, or partially known environment.

The goal of the navigation process of mobile robots is to move the robot to a named place in a known, unknown or partially known environment. In most practical situations, the mobile robot can not take the most direct path from the start to the goal point. So , path planning techniques must be used in this situation, and the simplified kinds of planning mission involve going from the start point to the goal point while minimizing some cost such as time spent, chance of detection, or fuel consumption.

Several models have been applied for environment where the principle of navigation is applied to do path planning. For example, a grid model has been adopted by many researchers, where the robot environment is dividing into many line squares and indicated to the presence of an object or not in each square. On line encountered unknown obstacle are modelled by piece of “wall”, where each piece of “wall” is a straight-line and represented by the list of its two end points. This representation is consistent with the representation of known objects, while it also accommodates the fact the only partial information about an unknown obstacle can be obtained from sensing at a particular location.

The navigation planning is one of the most vital aspect of an autonomous robot. In most practical situations, the mobile robot can not take the most direct path from start to the goal point.

So, path finding techniques must be used in these situations, and the simplest kinds of planning mission involve going from the start point to the goal point while minimizing some cost such as time spent, chance of detection, etc. When the robot actually starts to travel along a planned path, it may find that there are obstacles along the path, hence the robot must avoid these obstacles and plans a new path to achieve the task of navigation.

Systems that control the navigation of a mobile robot are based on several paradigms. Biologically motivated applications, for example, adopt the assumed behavior of animals. Geometric representations use geometrical elements like rectangles, polygons, and cylinders for the modeling of an environment. Also, systems for mobile robot exist that do not use a representation of their environment. The behavior of the robot is determined by the sensor data actually taken. Further approaches were introduced which use icons to represent the environment.

One of the specific characteristics of mobile robots is the complexity of their environment, therefore, one of the critical problem for the mobile robots is path planning. Several approaches for path planning exist for mobile robots, whose suitability depends on a particular problem in an application. For example, behavior-based reactive methods are good choice for robust collision avoidance.

Path planning in spatial representation often requires the integration of several approaches. This can provide efficient, accurate, and consist navigation of a mobile robot. It is sufficient for the robot to use a topological map that represents only the areas of navigation (free areas, occupied areas of obstacles). It is essential the robot has the ability to build and uses models of its environment that enable it to understand the environment's structure. This is necessary to understand orders, plan and execute paths.

Many researches which have been done within this field, some of them used a "visibility graph" to set up a configuration space that can be mapped into a graph of vertices between which travel is possible in a straight line. The disadvantage of this method is time consuming. At the opposite, some researches have been based on dividing the world map into a grid and assign a cost to each square. Path cost is the sum of the cost of the grid squares through which the path passes. A grid model has been adopted by many authors, where the robot environment is divided into many squares and indicated to the presence of an object or not in each square [6, 9].

A cellular model, in other hand, has been developed by many researchers where the world of navigation is decomposed into cellular areas, some of which include obstacles. More, the skeleton models for map representation in buildings have been used to understand the environment's structure, avoid obstacles and to find a suitable path of navigation.

These researches have been developed in order to find an efficient automated path strategy for mobile robots to work within the described environment where the robot moves.

In this paper, a simple and efficient navigation approach for autonomous mobile robot is proposed in which the robot navigates, avoids obstacles and attends its target.

Note that, the algorithm described here is just to find a feasible and flexible path from initial area source to destination target area, flexible because the user can change the position of obstacles it has no effect since the environment is unknown. This robust method can deal a wide number of environments and gives to our robot the autonomous decision of how to avoid obstacles and how to attend the target. More, the path planning procedure covers the environments structure and the propagate distances through free space from the source position.

For any starting point within the environment representing the initial position of the mobile robot, the shortest path to the goal is traced. The algorithm described here therefore is to develop a method for path planning by using simple and computationally efficient-way to solve path planning problem in an unknown environment without consuming time, lose energy, un-safety of the robot architecture.

To determine the nature of space of navigation, and as we have illustrated before, cells are marked as free or occupied; otherwise unknown. We can therefore divide our search area into free and occupied area. Note that all free space cells represent the walkable space and unwalkable in occupied space.

Each free cell is able of laying all the neighbor free cell within a certain distance "d". This distance "d" is usually set to a value greater than or equal to the size of cell. Note that the set of free cells is a subset of the of free cells, which is in turn a subset of the set of free occupancy cells. Thus, by selecting a goal that lies within free space, we ensure that the free sub-path will not be in collision with the environment, and that there exists some sub-paths to get the target. Note that, we determine the free resultant cells within free space to get a feasible path during navigation. For unwalkable space (occupied space) we just develop a procedure of avoiding danger. The figure 1 shows an example of walkable or unwalkable space.

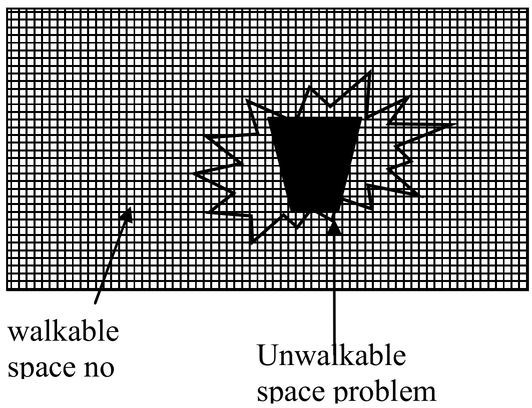

Fig. 1 an example of walkable space and walkable space

For unwalkable space, we compute the total size of free cells around danger (obstacle) area. This total may be at least or equal than to the length of architecture of robot. This is ensure the safety to our robot to not be in collision with the obstacle, and that the path P has enough security SE to attend it target where it is given by P$\pm$SE (S is size of security). In principle, we generate a plan for reaching safety area for every neighboring danger area. The safety distance is generated to construct the safety area building to the navigation process, to be near without collision within this one.

The goal of the navigation process of mobile robots is to move the robot to a named place in a known, unknown or partially known environment. In most practical situations, the mobile robot can not take the most direct path from the start to the goal point. So, path planning techniques must be used in this situation, and the simplified kinds of planning mission involve going from the start point to the goal point while minimizing some cost such as time spent, chance of detection, or fuel consumption.

One of the key issues in the design of an autonomous robot is navigation, for which, the navigation planning is one of the most vital aspect of an autonomous robot. Therefore, the space and how it is represented play a primary role in any problem solution in the domain of mobile robots because it is essential that the mobile robot has the ability to build and use models of its environment that enable it to understand the scene navigation's structure. This is necessary to understand orders, plan and execute paths.

For path planning areas, it is sufficient for the robot to use a topological map that represents only the different areas without details such as office rooms. The possibility to use topological maps with different abstraction levels helps to save processing time. The static aspect of topological maps enables rather the creation of paths without information that is relevant at runtime. The created schedule, which is based on a topological map, holds nothing about objects which occupy the path. In that case it is not possible to perform the schedule. To get further actual information, the schedule should be enriched by the use of more up-to date plans like egocentric maps.

III. Simulation results

The algorithms are implemented in Borland C++, afterwards tested with visual basic and DELPHI programming language; whereby the environment is studied in a two dimensional coordinate system. The simulation part is an approach to the real expected result; this part is done using C++ to recognize all objects within the environment and since it is suitable for graphic problems. Taking the segmented environment issued from C++ development, the algorithm permit the robot to move from the initial position to the desired position following an estimated trajectory using visual basic and Delphi language.

A. General Flowchart

Our general flowchart is presented in the figure 2, where the main work is described in order to get the target. To reflect the vehicle behaviors acquired by learning and to demonstrate generalization and adaptation abilities of our approach, the robot is simulated in different static environments. In this context, we have created N unknown environments containing static obstacles; (complexity order of theses creations is limited at the last environment one, until now we have tested 56 environments), we start with no obstacle until the complexity order is done.

As there is no information at advance, this creation can give another configurations of environments, that means that, the user of this concept can change the positions of all objects as he want in the scene and can change the shapes of obstacle(big, small, different sizes,…), this have no effect since the environment is unknown, the robot success, in satisfactory manner, to avoid suitably the static obstacles while it makes one's way toward its target, we can give different infinite environment complexity, in order to achieve the desired task.

Tested in different unknown environments with static obstacles, we present simulation results which provide the most preferable path between another one treated. As it is illustrated In Figure 4, 5 ,6.a where S: Robot and B: Target, the vehicle succeeds to avoid obstacles and reaches its target. In this case, we present virtually the best optimum path, e.g. the robot doesn't endanger itself or other objects in the environment.

The input parameters Map contain the ground information In order to evaluate, the performance of navigation algorithm of autonomous mobile robots over various environments, we observed simulation of the navigation in different environments.

We can change the position of obstacles so we get other different environments. These environments were randomly generated. To find a new path after insertion of deletion of an obstacle. Hence, a mobile robot detects unknown hazardous obstacle on the path and find its free path without collision.

More, after the generation of several paths given by the process of navigation, the robot reaches its target intelligibly by deciding itself how to navigate, how to avoid obstacle, and how to reach carefully his goal. This navigation approach has an advantage of adaptivity such that the mobile robot algorithm works perfectly even if an environment is unknown. This proposed approach has made the robot able to achieve these tasks: avoid obstacles, deciding, perception, and recognition and to attend the target which are the main factors to be realized of autonomy requirements

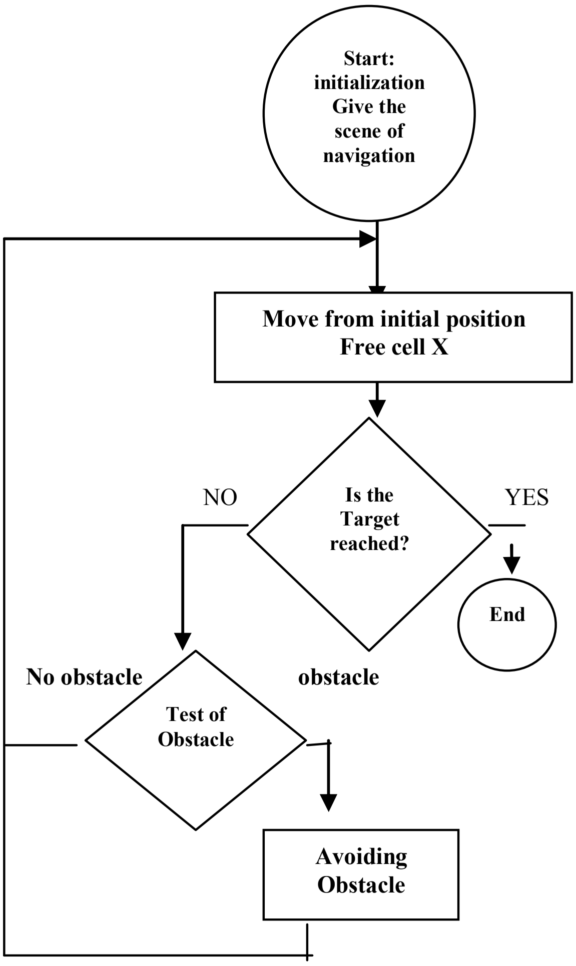

Fig.2 the general flowchart of the process of navigation of IAS

advance, the robot navigates virtually to structure the environment, and one or more camera are used for the perception which can guarantee to deliver acceptably accurate information all of the time. Also, the redundancy is useful (sensor data fusion), the robot receives a good deal of attention and recognizes all elements of the scene of navigation and learned where are situated the safety section to evolve and where the danger sections to avoid. After learning, the final decision is given as guide of steering vector. In this case, the robot is supposed not as square, it is replaced by point material and the path is a set of positions of all points of navigation.
The user can change the shape (body) of robot to execute the final path by gravity center (but the size of the vehicle is taken into account).

We replace the body of vehicle by gravity center (material point) to execute the path truly. Before, the optimum path has been calculated and the accurate avoidance direction is known , so now the robot knows at advance how to evolve and where is situated from the target, see the figure 3. The final decision is taken and the best path to execute is selected, the robot can evolve without risk. This sample of navigation is very easy and no problem is encountered because there is no obstacle during the navigation and the mission is achieved clearly without complexity.

These results display the approach ability making IAS able to intelligently avoid obstacles with different architectures. In the figure 4 we present another environment where the navigation is done in complex environment. The robot knows at advance how to evolve and where is situated from the target .The final decision is taken and the best path to execute is selected, the robot can evolve without risk (one obstacle avoidance) .the same principle is repeated if there is more than on obstacle during the navigation, so we repeat n times for n obstacles encountered during the mission.

In the figure 5 we present the case where the obstacle is for circular shape. We trace a square for the fourth points belonging the perimeter of this circle and we take into consideration the format of this square instead the circle and the circle is inside this square. So avoiding the circle means avoiding the square and this is the most problem of navigation problem where it is solved by this way.

The shortest /optimal path is essential for the efficient operation of mobile robot. For any starting point within the environment representing the initial position of the mobile robot, the shortest path to the goal is traced by walking, avoiding obstacles, taking a correct decision, recognizing and the best reasoning

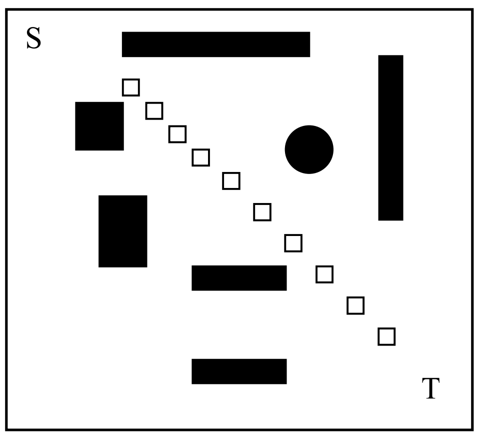

Fig.3 the reached best path environment set-up 1

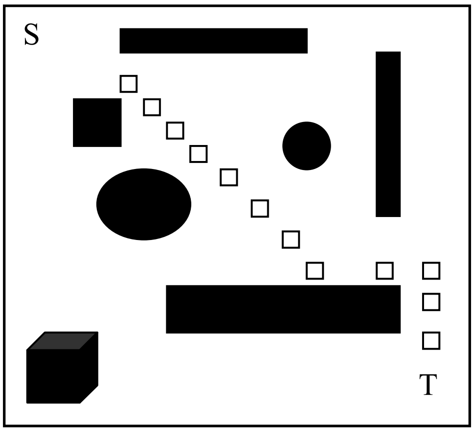

Fig.4 the reached best path environment set-up 2

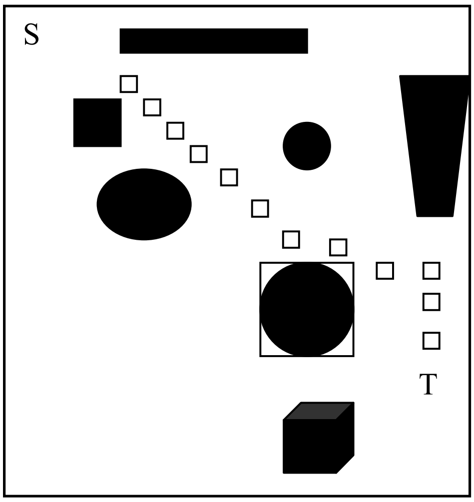

Fig.5 the reached best path environment set-up 3

V. CONCLUSION

The theory and practice of IAS are currently among the most intensively studied and promising areas in computer science and engineering which will certainly play a primary goal role in future.

These theories and applications provide a source linking all fields in which intelligent control plays a dominant role. Cognition, perception, action, and learning are essential components of such-systems and their use is tending extensively towards challenging applications (service robots, micro-robots, bio-robots, guard robots, warehousing robots).In this paper, we have presented a hardware implementation of navigation approach of an autonomous mobile robot in an unknown environment using hybrid intelligent. Indeed, the main feature of is the use of the best path of biological genetic principle combined with networks in the task fuzzy reasoning and inference capturing human expert knowledge to decide about the best avoidance direction getting a big safety of obstacle danger**.** Besides, the proposed approach can deal a wide number of environments.

This system constitutes the knowledge bases of our *approach* allowing recognizing situation of the target localization and obstacle avoidance, respectively. Also, the aim work has demonstrated the basic features of navigation of an autonomous mobile robot simulation using visual Basic and DELPHI programming languages. We have run our simulation using the two programming languages: in the basic programming language the robot reaches the target by avoiding obstacles regardless of the number of squares that it takes but in Delphi the robot takes the shortest path to reach the target.

The proposed approach can deal a wide number of environments. This navigation approach has an advantage of adaptivity such that the AMR approach works perfectly even if an environment is unknown. This proposed approach has made the robot able to achieve these tasks : avoid obstacles, deciding, perception, recognition and to attend the target which are the main factors to be realized of autonomy requirements. Hence; the results are promising for next future work of this domain

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