Route Map Generation

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Abstract— In this paper we present a route map generation of an autonomous mobile robot. The work in path planning has led into issues of map representation for a real world. Therefore, this problem is considered as one challenge in the field of mobile robots because of its direct effect for having a simple computationally efficient path planning strategy. For the real application in a real environment, it is necessary for the mobile robot to have a real time section while executing the planned path connected the start point and the goal point**.** The robot must then be able to understand the structure of the environment to find a way towards its target without collisions. To perform well this task several requirements must be satisfied and intelligent components become a necessity. More, world understanding and data interpreting is very solicited in any way of navigation When the target position is detected, the path planner will generate the proper path between the start and the goal position. This is called path planning step. The next step is to generate the geometric information of the generated path by searching the ways around the robot along the paths. This is called route map generation. When a route map generation is done, the next work is to control the robot itself to execute the route map, in order to achieve the goal planned by path planner and it is named as route runner. This is will be more clarified by the proposed work while answering to some interesting questions. The software implementation is very interesting to see the main factors are realized.

Keywords— Intelligent Autonomous Systems (IAS), Intelligence, Obstacle avoidance, Route Map Generation.

I. INTRODUCTION

For real application in real environment, it is necessary for the mobile robot to have a real time mission, while executing the planned path connected the start position and the target position . For this purpose the planned path and the environment information are required to be presented in a correct format.

To achieve that, the route map will be the appropriate representation in which the rout map generation will generate the geometric information for each block by searching the ways in which the system moves without collisions.

It is useful to take into consideration that the constitution of an autonomous mobile system in which the definition of the world map is just the relation of the object within its structure. This will represent the external parameters of the given world map. These parameters will be translated to generate the internal parameters of the world map which will be used by the path planner during the generation of the optimal path between the start and the goal point.

The step of translating the external parameters of the world map is done off-time and represents a prior knowledge about the environment where the mobile robot moves.

When the target position is detected, the path planner will generate the proper path between the start and the goal position. This is called path planning step. The next step is to generate the geometric information of the generated path by searching the ways around the robot along the paths. This is called route map generation.

When a route map generation is done, the next step is to control the robot itself to execute the route map, in order to achieve the goal planned by path planner and named as route runner.

The route runner is a real time which performs adjustment actions while confirming the real position of the robot according to the information in the route map.

To address this problem, two (02) questions are asked here

1) How the world external (environment) is described?
2) How the robot position is described in this world?

The question of architecture is of paramount importance when one chooses to address the higher-level competences of a mobile robot: how does a mobile robot navigate robustly from place to place, interpreting data, localizing and controlling its motion all the while? For this highest level of robot competence, which we term *navigation competence*, there are numerous mobile robots that showcase particular architectural strategies.

In the artificial intelligence community planning and reacting are often viewed as contrary approaches or even opposites. In fact, when applied to physical systems such as mobile robots, planning and reacting have a strong complementarily, each being critical to the other's success.

The navigation challenge for a robot involves executing a course of action (or plan) to reach its goal position. During execution, the robot must react to unforeseen events (e.g., obstacles) in such a way as to still reach the goal. Without reacting, the planning effort will not pay off because the robot will never physically reach its goal. Without planning, the reacting effort cannot guide the overall robot behavior to reach a distant goal again; the robot will never reach its goal.

In order to reach its goal nonetheless, the robot must incorporate new information gained during plan execution. As time marches forward, the environment changes and the robot's sensors gather new information. This is precisely where reacting becomes relevant.

In the best of cases, reacting will modulate robot behavior locally in order to correct the planned upon trajectory so that the robot still reaches the goal. At times, unanticipated new information will require changes to the robot's strategic plans, and so ideally the planner also incorporates new information as that new information is received.

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.

Robot programming is the mean by which a robot is instructed to perform it task .The guiding for example, is the process of moving a robot trough a sequence of motion to "*show it*" what it must do. One guidance method is to physically drag around the end effectors of the robot, while it records joint position at frequent intervals along the trajectory. The robot then plays back the motion just as it was recorded. An alternative is a master-slave or teleoperation configuration. Early systems of this type were first used or manipulate radioactive material remotely.

Robot programs must command robots to move: thus, the way in which motion is specified is important. Also, the program use information obtained from sensors. One way of using sensory information is to monitor sensor until prescribed condition occur and then perform or terminate a specified action is to use feedback from sensors to modify the robots behaviour continuously. A different approach is used to describe the behaviour of the system in terms of relationships that are to be maintained with respect to force, velocity, position, and another measured and controlled quantities.

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. Automated reasoning systems are typically built on a transaction-oriented model of computation .knowledge of the world is stored in a database of assertion in some logical language, indexed perhaps by predicate name.

This paper presents a novel approach based on intelligent computing which offers to the autonomous mobile system the ability to realize these factors: recognition, learning, decision-making, and action (the principle obstacle avoidance problems). The main details of concept are clarified. The results are promising for nest development.

II. WORLD MAP DATA

We can divide the task of moving of a mobile robot into two step process:

1) Planning paths which are better to be optimal according to some criteria.
2) controlling the robot to execute the planned path.

A self sufficient robotic system is the overall objective of an autonomous mobile robot.

The robot must then be able to understand the structure of the environment to find a way towards its target without collisions. The main ask question in design of any mobility of an autonomous system is to how well it finds the target position? In fact recognition, learning, decision-making, and action constitute principal factors to be endowed with robot to answer this question.

To perform well this question several requirements must be satisfied and intelligent components become a necessity. More, world understanding and data interpreting is very solicited in any way of navigation.

An interesting problem is how a mobile robot should understand the environment where to be moved. This problem involves:

- How the environment described?
- How is the position of the robot in its environment described?

Furthermore, the work in path planning has led into issues of map representation for a real world. Therefore, this problem is considered as one challenge in the field of mobile robots because of its direct effect for having a simple computationally efficient path planning strategy.

For the real application in a real environment, it is necessary for the mobile robot to have a real time section while executing he planned path connected the start point and the goal point .

For this purpose, the planned path and the environment information are required to be presented in a suitable form. To achieve that, the route map will be the appropriate representation, in which the route map generation will generate the geometric information for each block searching the paths in the front, right, left direction of the robot. A block will be considered as a combination of going straight and turning. Turning means: the turning angle to go from one block to another.

Navigation is the ability to move and on being self-sufficient. 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 [9,10,11].

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. Therefore, the space and how it is presented is an important role in the domain of moving an intelligent system. We can clarify this importance by the following reasons :

-It provides the necessary information to do path panning.

-It gives information for monitoring the position of the robot during the execution of the planned path.

-It is essential that the mobile robot have the ability to build and use models of its environment that enable it to understand the environment's structure. This is necessary to understand orders, plan and execute paths [12,13,14]

Therefore, the autonomous mobile robots 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 [4,5]

One of the specific characteristics 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 [1, 2, 3]

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 [6,7,8]

However, 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 obstacle, and finding data from many sources. Today, robotic occupies special place in the area interactive technologies.

It combines sophisticated computation with rich sensory input in a physical embodiment that can exhibit tangible and expressive behaviour in the physical world. In this regard, a central question that occupies some research group pertains to the social niche of robotic artefacts in the company of the robotically uninitiated public - at –large: "what is an appropriate first role for intelligent human-robot interaction in the daily human environment? The time is ripe to address this question. Robotic technologies are now sufficiency mature to enable interactive, competetent robot artefacts to be created .

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 deign can help prime such interaction experiment by providing immediately comprehensible social cues for the human subjects [6]. Technology has made this feasible by using advanced computer control systems. Also, the automotive industry has put much effort in developing perception and control systems to make the vehicle safer and easier to operate.

To perform all tasks in different environments, the vehicle must be characterized by more sever limits regarding mass volume, power consumption, autonomous reactions capabilities and design complexity. Particularly, for planetary operations sever constraints arise from available energy and data transmission capacities, e.g., the vehicles are usually designed as autonomous units with: data transfer via radio modems to rely stations (satellite in orbit or fixed surface stations) and power from solar arrays, batteries or radio-isotope thermo electric generators (for larger vehicles). A common application of mobile robot is the object manipulation. Examples include pick and place operation on the factory floor, package sorting and distribution.

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.

III. THE PROPOSED APPROACH

The implementation of a collision avoidance scheme on-board the robot can cause conflict between the users actions and the movement of the robot. For example, consider a situation where the operator directly controls the movement of a mobile robot with a joystick and the robot is supposed to move forward when the user pushes the stick forward. Imagine that he robot is also programmed with a simple collision avoidance algorithm to avoid obstacle.

If an obstacle exists in front of the robot, the robot may stop or turn in order to avoid collision, although he operator is clearly commanding it to, move ahead. In this example, the conflict may be not a problem if the user can easily see the obstacles. If however, the obstacles are invisible due a restricted viewing angle, the user might be confused since the robot does not move nor act according to the teleoperation commands. We hypothesize that the conflict can be naturally resolved by exploiting hap tic information, that is, by providing the operator with force feedback. Force-feedback has been used for precise remote control in teleoperation of manipulator.

The conflict between the operator command and the actual movement of the robot was difficult to perform precise navigation in a cultured environment with their method since the turn rate was not considered for force rendering and collision avoidance was automatically performed compelling the robot to stop at the distance desired from obstacles.

Force rendering is the force of computing the force that the operator in contact with the haptic device feels. in direct control, the users action (i.e. designating the logical position of the haptic probe) is used to determine the speeds and turning rate of the robot. When the user determines the logical position, the force that the user should feel at that position is computed from the position information of the obstacle represented as a list of distance value between the robot and the obstacles.

In the figure 1 we present one example of navigation approach using a square cellule grid for the movement. Another example is presented in the figure 2 to find an optimal path to navigate intelligibly avoiding the obstacles. This example shows the way on which the scene of navigation is decomposed. The figure 3 illustrates one model of navigation where the polygonal model is used for the navigation.

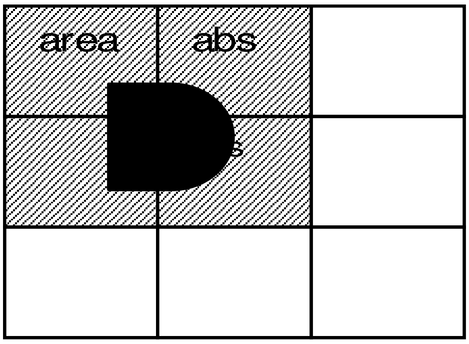

Fig. 1 an example of a square cellule grid navigation

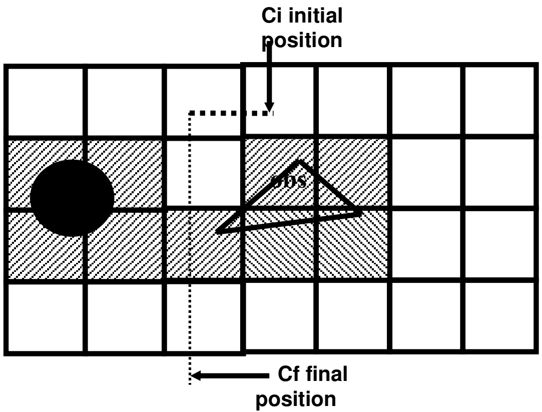

Fig. 2 example of the navigation finding an optimal path

Between these tasks we can divide the mission of moving a mobile robot within its environment in a two step process:

- Planning paths which are optimal by certain criteria.
- Controlling the robot to execute the planned path.

An example of the constitution of an autonomous navigation system is shown below in figure 3.

We assume that the constitution of an autonomous navigation system in which the definition of the world map, which expresses the relation of the object within its structure will represent the external expression of the given world map. This expression will be translated to generate the internal expression of the world map; this later will be used by the path planner during the generation of the optimal path between the start and the goal point. The step of translating the external expression of the world map is done off-line and represents a prior knowledge about the environment where the mobile robot moves.

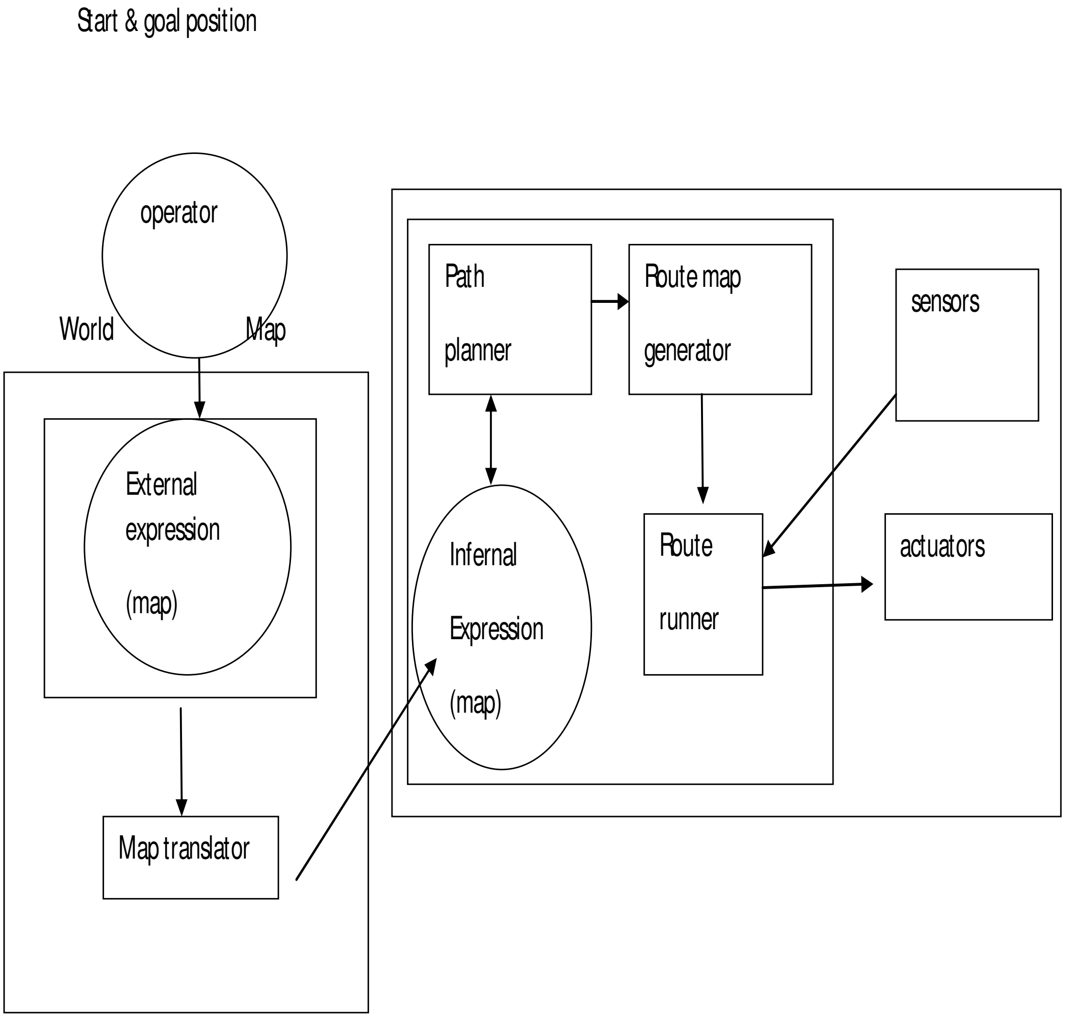

Fig. 3 an example of an autonomous navigation system structure for mobile robot

For any starting point within the environment representing the initial position of the mobile robot, the shortest path to the goal is traced. 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.

The use of autonomous robots can provide significant benefits in the surveillance field. Robots can be used to reduce the risk involved with human physical intervention, especially in hazardous environments. They can approach the locations of interest to report sensory data and to show more detailed views of a suspicious area. Moreover they can perform long-time tedious tasks that require reliable execution, without lowering their level of efficiency. In recent years there has been a number of projects dealing with the problems involved in the use of autonomous robot to enhance a surveillance system.

Some works focus on surveillance algorithms and path planning during the patrolling task. Others deal with navigation and localization problems. An important challenge in robotics is path planning in dynamic environments. That is, planning a path for a robot from a start location to a goal location that avoids collisions with the moving obstacles. In many cases the motions of the moving obstacles are not known beforehand, so often their future trajectories are estimated by extrapolating current velocities (acquired by sensors) in order to plan a path

Often, a path is planned off-line for the robot to follow, which can lead the robot to its destination assuming that the environment is perfectly known and stationary and the robot cant rack perfectly. Early path planners were such off-line planners or were only suitable for such off-line planning.

However, the limitations of off-line planning led researchers to study on-line planning, which relies on knowledge acquired from sensing the local environment to handle unknown obstacles as the robot traverses the environment.

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 the mobile robots because it is essential that the ;mobile robots have 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.

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

The environment set up is shown in the figure 4. When The path is found by figuring all possible positions. Once the path is found, the robot moves from one sub_position to the next until the target is reached. We do this by starting at point A, checking the adjacent sub_positions, and generally searching outward until we find our target position.

We start the search by the following steps: we have fixed the starting position, it moves forward reacting and acting to eventually events are surrounded. Learning from hazardous situations, turning if the obstacle is detected, changing position to exit from hazardous area, reacting if another event is encountered and controlling the movements are the main considered factors here realized with execution of missions.

An interesting problem is how a mobile robot should understand the environment where to be moved. This problem involves:

- How the environment described?
- How is the position of the robot in its environment described?

For the first question we have interpreted the structure of the environment to our autonomous mobile robot that means that, the robot has a general view data of the external world while a separation between the hazardous area and the safety area is done in parallel. This general view can offer to the robot the ability to trace a reasonable and feasible path inside the scene of navigation.

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.

The robot meets an obstacle, it moves a step down then back until it meets another obstacle. The robot keeps navigation in this manner until the target is found.

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.

In this present work, an efficient collision free-path planning 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 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 and 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 the 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.

We denote that the configuration walking is a representation of the configuration space. In the configuration space starting from any location to attend another one, sub_positions are thus belonging to reachable or unreachable path.

Note that the set of reachable sub_positions is a subset of the set of free configuration space, the set of unreachable area is the set which is belonging to the hazardous area. By selecting a goal that lies within reachable space, we ensure that it will not be in collision and it exists some "feasible fuzzy path" such that the goal is reached in the environment.

Having determined the reachability space, the algorithm works and operates on the reachability sub_positions .This one specifies at the end the target position area.

To maintain the idea ; we have created several environments which contain many obstacles. The search area (environment) is divided into NXM matrix. Each item in the array is represented by its status which is recorded as walkable (free area) or unwalkable area (obstacle).

The robot starts from any position while interpreting data map. The robot must move and attends its target. The trajectory is designed in form of a set of free sub_positions, when it moves it must verify the adjacent sub_position by avoiding the obstacle that can meet to reach the targett at the same line.

As an example: the environment set up is shown in the figure 4. The path is found by figuring all the free sub positions. We start the search by the following steps: we have selected the starting position, it moves forward as shown above in the figure . The robot keeps navigation in this manner until the target is found, as shown in figure 5.

For unwalkable space, we compute the total size of free sub_positions around danger (obstacle) area. This total may be at least greater 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±SE (S is size of security)

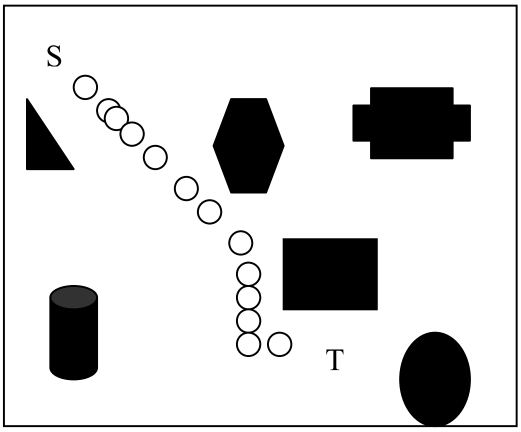

Fig. 4 an example of a set-up navigation environment 1

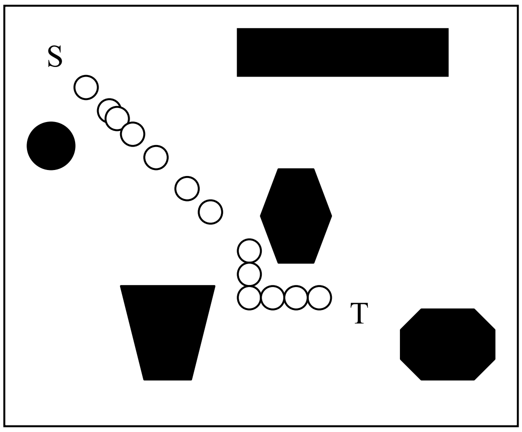

Fig. 5 an example of a set-up navigation environment 2

IV. CONCLUSION

the theory and practice of Intelligent systems 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 software implementation of collision avoidance of an autonomous mobile robot. 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 .We have run our simulation in several environments where the robot succeeds to reach its target in each situation and avoids the obstacles capturing the behaviour of intelligent expert system. The proposed approach can deal a wide number of environments.

The route runner is here a real time which performs adjustment actions while confirming the real position of the robot according to the information in the route map. This is done in order to interpret the world external (environment) and to describe the robot position. For this purpose, the planned path and the environment information are required to be presented in a suitable form.

To achieve that, the route map will be the appropriate representation, in which the route map generation will generate the geometric information for each block searching. This way of working is efficacy to see the main principals factors of the navigation are realized. Besides, the robot reacts perfectly and finds its target safely without collisions. The principal is useful to be more developed to interpret and translate the world external of the scene of navigation of an autonomous mobile robot. This way helps the navigator system to achieve its task perfectly.

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