A Neural Network Based Navigation for Intelligent Autonomous Mobile Robots

Hachour Ouarda

Abstract**—**in this present work we propose a neural network based navigation for intelligent autonomous mobile robots. Indeed, Neural Networks deal with cognitive tasks such as learning, adaptation generalization and they are well appropriate when knowledge based systems are involved. The adaptation is largely related to the learning capacity since the network is able to take into account and respond to new constraints and data related to the external environments. Just as human being, a neural network relies on previously solved examples to build a system of "neurons" that makes new decisions, classification and forecasts. Networks of neurons can achieve complex classification based on the elementary capability of each neuron to distinguish classes its activation function. In designing a Neural Networks navigation approach, the ability of learning must provide robots with capacities to successfully navigate in the environments like our proposed maze environment. Also, robots must learn during the navigation process, build a map representing the knowledge from sensors, update this one and use it for intelligently planning and controlling the navigation. The simulation results display the ability of the neural networks based approach providing autonomous mobile robots with capability to intelligently navigate in several environments.

Keywords**—**Intelligent Autonomous Mobile Robots, navigation, learning, neural networks, behavior.

I. Introduction

A robotic vehicle is an intelligent mobile machine capable of autonomous operations in structured and unstructured environment, it must be capable of sensing (perceiving its environment), thinking (planning and reasoning), and acting (moving and manipulating. 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 point to a target point in its given environment, 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.

The 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. For example, AGV (autonomous guided vehicle) robots autonomously deliver parts between various assembly stations by following special electrical guide wires 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. The most popular research robots are those of ActivMedia Robotics[4].

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. 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.

It is important that algorithms for navigation control in cluttered environments not be too computationally expensive as this would result in a sluggish response. It has been acknowledged that the traditional Plan-Sense-Model-Act approaches are not effective in such environments; instead, local navigation strategies that tightly couple the sensor information to the control actions must be used for the robot to successfully achieve its mission.

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. However, the environment complexity is a specific problem to solve since this environment can be imprecise, vast, dynamical and partially or not structured.

Robots must then be able to understand the structure of this environment. To reach the goal without collisions, these robots must be endowed with perception, data processing, recognition, learning, reasoning, interpreting, decision-making, and actions capacities.

To take the best decision and to react intelligibly, neural networks are the wishes to understand principles leading in some manner to the comprehension of the human brain functions and to build machines that are able to perform complex tasks requiring massively parallel computation.

Neural Networks deal with cognitive tasks such as learning, adaptation generalization and they are well appropriate when knowledge based systems are involved. In general Neural Networks deal with cognitive tasks such as learning, adaptation generalization and they are well appropriate when knowledge based systems are involved.

To solve navigation problems, neural networks prove interesting to deal with the behaviour of autonomous mobile robots near the human being in reasoning. This paper deals with an algorithm for two dimensional (2D) path planning to a target for mobile robot in unknown environment. The objective is to find a collision free path from an unknown initial position to an unknown target point. A complete path planning algorithm should guarantee that the robot can reach the target if possible, or prove that the target can not be reached. A few path planning algorithms are described here followed by the aim work of research in detail.

Our autonomous mobile robot is able to achieve these tasks: avoiding obstacles, taking a suitable decision, and attending the target which are the main factors to be realized of autonomy requirements. The algorithm returns the best response of any entering map parameters.

The simulation results illustrate the generalization and adaptation capabilities of neural networks. An interesting alternative for future work is the generalization of this approach by increasing the number of possible robot directions. In this paper we discuss clearly the proposed neural networks navigation for autonomous mobile robots.

II. Sensor classification

There are a wide variety of sensors used in mobile robots. Some sensors are used to measure simple values like the internal temperature of a robot's electronics or the rotational speed of the motors. Other, more sophisticated sensors can be used to acquire information about the robot's environment or even to directly measure a robot's global position. Here we focus primarily on sensors used to extract information about the robot's environment. Because a mobile robot moves around, it will frequently encounter unforeseen environmental characteristics, and therefore such sensing is particularly critical. We classify sensors using two important functional axes: proprioceptive/ exteroceptive and passive/active .

A. Proprioceptive

Proprioceptive sensors measure values internal to the system (robot); for example, motor speed, wheel load, robot arm joint angles, battery voltage.

B. Exteroceptive

Sensors acquire information from the robot's environment; for example, distance measurements, light intensity, sound amplitude. Hence exteroceptive sensor measurements are interpreted by the robot in order to extract meaningful environmental features.

C. Passive and Active category

Passive sensors measure ambient environmental energy entering the sensor. Examples of passive sensors include temperature probes, microphones, and CCD or CMOS cameras.

Active sensors emit energy into the environment, and then measure the environmental reaction. Because active sensors can manage more controlled interactions with the environment, they often achieve superior performance. However, active sensing introduces several risks: the outbound energy may affect the very characteristics that the sensor is attempting to measure. Furthermore, an active sensor may suffer from interference between its signal and those beyond its control. For example, signals emitted by other nearby robots, or similar sensors on the same robot, may influence the resulting measurements. Examples of active sensors include wheel quadrature encoders, ultrasonic sensors, and laser rangefinders. A number of sensor characteristics can be rated quantitatively in a laboratory setting. Such performance ratings will necessarily be best-case scenarios when the sensor is placed on a real-world robot, but are nevertheless useful.

III. Sensitivity

Sensitivity itself is a desirable trait. This is a measure of the degree to which an incremental change in the target input signal changes the output signal. Formally, sensitivity is the ratio of output change to input change. Unfortunately, however, the sensitivity of exteroceptive sensors is often confounded by undesirable sensitivity and performance coupling to other environmental parameters.

Cross-sensitivity is the technical term for sensitivity to environmental parameters that are orthogonal to the target parameters for the sensor. For example, a flux-gate compass can demonstrate high sensitivity to magnetic north and is therefore of use for mobile robot navigation.

However, the compass will also demonstrate high sensitivity to ferrous building materials, so much so that its cross-sensitivity often makes the sensor useless in some indoor environments. High cross-sensitivity of a sensor is generally undesirable, especially when it cannot be modelled.

Error of a sensor is defined as the difference between the sensor's output measurements and the true values being measured, within some specific operating context. Given a true value v and a measured value m, we can define *error* as .

Accuracy is defined as the degree of conformity between the sensor's measurement and the true value, and is often expressed as a proportion of the true value (e.g., 97.5% accuracy).

Thus small error corresponds to high accuracy and vice versa: Obviously, the specific sensors and sensor uncertainty of the robot impacts the appropriateness of various features. Armed with a laser rangefinder, a robot is well qualified to use geometrically detailed features such as corner features owing to the high-quality angular and depth resolution of the laser scanner. In contrast, a sonar-equipped robot may not have the appropriate tools for corner feature extraction.

IV. THE PROPOSED NAVIGATION BASED ON THE NEURAL NETWORKS

A .The principle of navigation

Navigation is one of the most challenging competences required of a mobile robot. Success in navigation requires success at the four building blocks of navigation: *perception,* the robot must interpret its sensors to extract meaningful data; *localization,* the robot must determine its position in the environment ; *cognition,* the robot must decide how to act to achieve its goals; and *motion control*(see the figure 1), the robot must modulate its motor outputs to achieve the desired trajectory. Of these four components, localization has received the greatest research attention in the past decade and, as a result, significant advances have been made on this front (see the figure 2).

If one could attach an accurate GPS (global positioning system) sensor to a mobile robot, much of the localization problem would be obviated. The GPS would inform the robot of its exact position, indoors and outdoors, so that the answer to the question, "Where am I?" would always be immediately available. Unfortunately, such a sensor is not currently practical.

The existing GPS network provides accuracy to within several meters, which is unacceptable for localizing human-scale mobile robots as well as miniature mobile robots such as desk robots and the body-navigating nanorobots of the future. Furthermore, GPS technologies cannot function indoors or in obstructed areas and are thus limited in their workspace.

But, looking beyond the limitations of GPS, localization implies more than knowing one's absolute position in the Earth's reference frame. Consider a robot that is interacting with humans. This robot may need to identify its absolute position, but its relative position. with respect to target humans is equally important. Its localization task can include identifying humans using its sensor array, then computing its relative position to the humans.

Furthermore, during the *cognition* step a robot will select a strategy for achieving its goals. If it intends to reach a particular location, then localization may not be enough. The robot may need to acquire or build an environmental model, a *map* that aids it in planning a path to the goal. Once again, localization means more than simply determining an absolute pose in space; it means building a map, then identifying the robot's position relative to that map.

Clearly, the robot's sensors and effectors play an integral role in all the above forms of localization. It is because of the inaccuracy and incompleteness of these sensors and effectors that localization poses difficult challenges.

The problem of representing the environment in which the robot moves is a dual of the problem of representing of the robot's possible positions. Decisions made regarding the environmental representation can have impact on the choices available for robot position representation. Often the fidelity of the position representation is posed by the fidelity of map.

Three relationships are posed here to understand how to choose particular map:

1. The precision of the map must appropriately match the precision with which the robot needs to achieve its goal.
2. The precision of the map and the types of features represented must match the precision and data types returned by robot's sensors.
3. The complexity of the map representation has direct impact on the computational complexity of reasoning about mapping, localisation, and navigation.

A continuous –valued map is one method for exact decomposition of the environment .the position of environmental features can be annotated precisely in continuous space. Mobile robots implementations to date use continuous map only in 2D representations, as further dimensionality can result in computational explosion.

A common approach is to combine the exactness of a continuous representation with the compactness of the closed-world assumption. This means that one assumes that the representation will specify all environmental objects in the map, and that any area in the map that is devoid of objects in the corresponding portion of the environment. Thus, the total storage needed in the map is proportional to the density of objects in the environment , and a sparse environment can be represented by a low- memory map.

Recent research on IAS has pointed out a promising direction for future research in mobile robotics where real-time, autonomy and intelligence have received considerably more weight than, for instance, optimality and completeness.

Many navigation approaches have dropped the explicit knowledge representation for an implicit one based on acquisitions of intelligent behaviours with its environments, they have to orient themselves, explore their environments autonomously, recover from failure, and perform whole families of tasks in real-time. However, the mobile robot is 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 [6,7,8].

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 [13,14,15,16,17,18].

Using these informations, we can construct the *configuration space* of the robot, in terms of which the path planning problem is formulated generally.

A configuration *or the workspace o*f the robot is described using a number of parameters. a configuration of a robot Translating in a two-dimensional workspace can be described using two parameters, which are often denoted *x* and *y*. or In 3D x, y, z or the angle ϴ can also viewed.

The simplest instance of the path planning problem is finding a path for a *point* robot in a two-dimensional static environment. In most cases, it is assumed that the geometry of the workspace obstacles is given using a polygonal representation. As the robot is considered as material point, the configuration space exactly resembles the workspace. Hence, the obstacles in configuration space are *explicitly* represented. This can be used to efficiently solve the planning problem.

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.

One of the specific characteristics of mobile robots 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 on an autonomous robot is navigation [9,10].

The 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.

Moreover, when a robot moves in a specific space, it is necessary to select a most reasonable path so as to avoid collisions with obstacles. 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 consistent navigation of a mobile robot.

The major task for path-planning for single mobile robot is to search a collision –free path. The work in path planning has led into issues of map representation for a real world. Therefore, this problem considered as one of challenges in the field of mobile robots because of its direct effect for having a simple and computationally efficient path planning strategy.

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 [1,2,3].

Topological path planning is useful for the creation of long – distance paths, which support the navigation for solving a task. Therefore, those nodes representing for example, free region space are extracted from a topological map, which connect a start point with a target point. The start point is mostly the actual position of the robot.

To generate the path, several sophisticated and classical algorithms exist that are based on graph theory like the algorithm; of the shortest path. To give best support for the path planning it could be helpful to use different abstraction levels for topological maps. For example, if the robot enters a particular room; of an employee for postal delivery, the robot must use a topological map that contains the doors of an office building and the room numbers.

Topological maps can be used to solve abstract tasks, for example, to go and retrieve objects whose positions are not exactly known because the locations of the objects are often changed. Topological maps are graphs whose nodes represent static objects like rooms, and doors for example. The edges between the nodes are part's relationships between the objects.

Many researchers have addressed this problem. Many authors have considered a model with complete information, where the robot has perfect knowledge about the obstacles. The drawback of these approaches is that under many practical circumstances robot does not have access to complete information about the environment.

The intelligent mobile robots have many possible applications in a large variety of domains, from spatial exploration to handling material, and from military tasks to the handicapped help.

B The proposed neural network navigation approach

For the navigation approach problem, the environment complexity is a specific problem to solve since this environment can be imprecise, vast, dynamical and partially or not structured. Robots must then be able to understand the structure of this environment.

To reach the goal without collisions, these robots must be endowed with perception, data processing, recognition, learning, reasoning, interpreting, decision-making, and actions capacities. These faculties are the main source to be endowed an treated at the same time for autonomous mobile robot during the execution of mission. . More, these factors are the key of certain kind of intelligence. Reproduce this kind of intelligence is, up to now, a human ambition in the construction and development of intelligent machines, and particurly autonomous mobile robots [11,12].

To solve navigation problems, neural networks prove interesting to deal with the behaviour of autonomous mobile robots near the human being in reasoning.

Neural Networks are the wish to understand principles leading in some manner to the comprehension of the human brain functions and to build machines that are able to perform complex tasks requiring massively parallel computation.

In general Neural Networks deal with cognitive tasks such as learning, adaptation generalization and they are well appropriate when knowledge based systems are involved.

Thus, several approaches based on neural networks for autonomous mobile robots are oriented to design and achieve robots which simulate the human decision-making in similar way of acquiring some keys of intelligence. The key of intelligence is focused on the manner of: thinking, perceiving, and acting.

Networks of neurons can achieve complex classification based on the elementary capability of each neuron to distinguish classes its activation function.

The adaptation is largely related to the learning capacity since the network is able to take into account and respond to new constraints and data related to the external environments. Just as human being, a neural network relies on previously solved examples to build a system of “neurons” that makes new decisions, classification and forecasts.

The system of neural networks involves massively parallel computing: interconnected units process data at the same time. Activation map of neurons gives the “memory core”. Several entities of memory are posed and connected to lead the circulation of information.

Learning capacity is the ability to achieve complex tasks like human brain. Learning can be supervised or unsupervised. The former deals with the classified pattern information, while the unsupervised learning does not and uses instead minimal information. The unsupervised learning algorithms offer the advantage of less computational procedure than supervised learning.

Several research approaches have pointed on the use backpropagation and reinforcement algorithms. These algorithms depend on learning, generalization, connection neurons, and patterns capability to select and treat models and elementary informations trough its activation. Afterwards, to be able to make a new decision and classification each time that information enters or deals with the system of “neurons”. The disadvantage of backpropagation algorithm is the learning speed and generalization which depend strongly on the selected learning patterns. On the other hand, the performances of the backpropagation learning algorithm are better than the reinforcement learning.

Historically, interest in Neural Networks stems from the wish to understand principles leading in some manner to the comprehension of the human brain functions and to build machines that are able to perform tasks requiring massively parallel computation. Essentially, Neural Networks deal with cognitive tasks such as learning, adaptation, generalization and optimization [5].

Networks of neurons can achieve complex classification based on the elementary capability of each neuron to distinguish classes through its activation function. NN must provide Robot with capacities to successfully navigate during the navigation.

The proposed navigation approach is based on the supervised gradient-back-propagation learning. The target localization is based on a neural networks recognition based by learning from data obtained by capturing distance and orientation.

During the navigation, the robot must localise its target and recognize the environment, build a map (i.e, obstacles and free spaces) from sensors. The identification of the “antecedent” and “conclusion” of the cognition system is based on the neural network approach. In addition the adaptively task is the strong interest of using Neural Networks. The Neural Networks could express the knowledge implicitly in the weights.

The robot must learn to build a map (i.e. target, obstacles, and free spaces from sensors). The robot must learn to decide the angle avoidance formulation using Neural Networks of human expert knowledge. This Neural Networks approach is trained to capture the human expert behavior in the decision-making operation .

In designing a Neural Networks navigation approach, the ability of learning must provide robots with capacities to successfully navigate in the environments like our proposed maze environment. Also, robots must learn during the navigation process, build a map representing the knowledge from sensors, update this one and use it for intelligently planning and controlling the navigation.

The general structure of the proposed Neural Networks navigation is presented in the figure3. From this structure we clarify the following levels:

Knowledge mapping: the model of the external environment plays an important role in the intelligent robot behavior. The human brain is able to create -simple maps of the external environment by compressing the huge amount of received sensory data, while preserving the relationships between important facts.

Action: the different map sensory informations are classified in several vectors where each component responds to a particular situation. These situations must be associated with the appropriate action taking advantage of the topology-preserving property of the network.

Reinforcement learning: reinforcement learning allows associations between detected sensory situations and appropriate actions trough " trial and error" learning. This one uses only a priori knowledge such as "asked response" is executed. These associations are formed in unsupervised manner, i.e., with no " supervisor or teacher" required.

The proposed approach offers features and advantages as expressing cognition at once explicitly and implicitly, processing inaccurate data in real-time, learning, generalization, and approaching human-like reasoning.

During the navigation, the robot must localize its target and recognize the environment. The movement of the robot are supposed possible only in four (04) direction and consequently four actions $A=[A_F ,A_L, A_R, A_B]$ are defined as action to move Front, action to turn to the Left, action to turn to Right , and action to turn Back (see the figure 4). The situations of the static target localization are defined by $T=[T_F\ T_L, T_R, T_B]$ while the static obstacle avoidance situations are defined by $O=[O_1,O_2,O_3,\ldots,O_i]$.

Three layers constitute the proposed Neural Network structure as shown in the figure 5.

Layer 1: this layer represents the input layer with four (04) input nodes receiving the components of the vector $T=[T_F ,T_L, T_R, T_B]$. This layer transmits the inputs to all nodes of the next layer.

Layer 2: this layer represents the hidden layer with i^{eme} nodes. The output of each node is obtained as follows:

$$\gamma_k = f(\sum_i X_i W_{1ki}) \tag{1}$$

Where f is the output sigmoid function, W_1 : the weights of the output layer and

$$W_1(t+1) = W_1(t) + \Delta W_1 \tag{2}$$

With $\Delta W_1 = \eta\delta$ y Whereas learning rate is : $0< \eta<1$ and Y : hidden output.

Layer 3: this layer represents the output layer with (j^{eme}) output nodes which are obtained by :

$$T_j = f(\sum_k \gamma_k W2_{jk}) \tag{3}$$

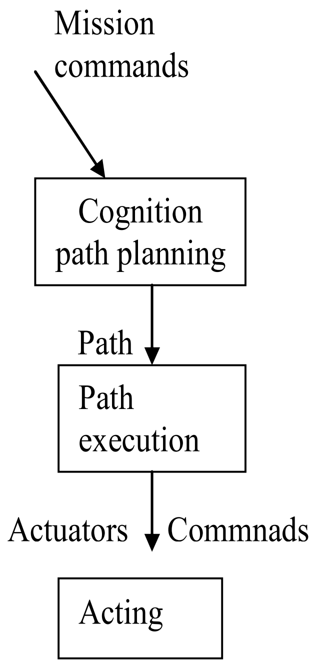

Fig. 1 Motion Control

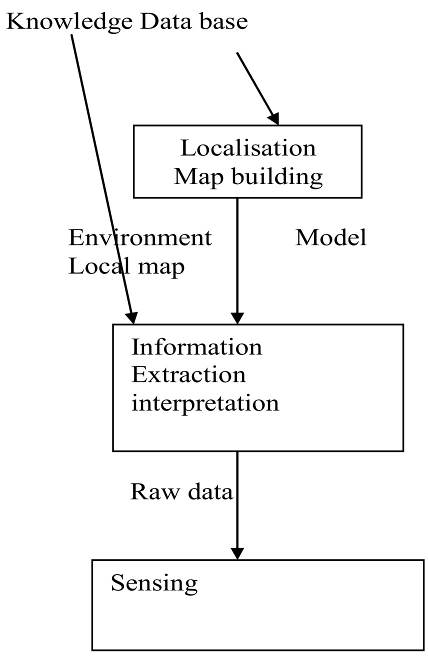

Fig. 2 Perception general view

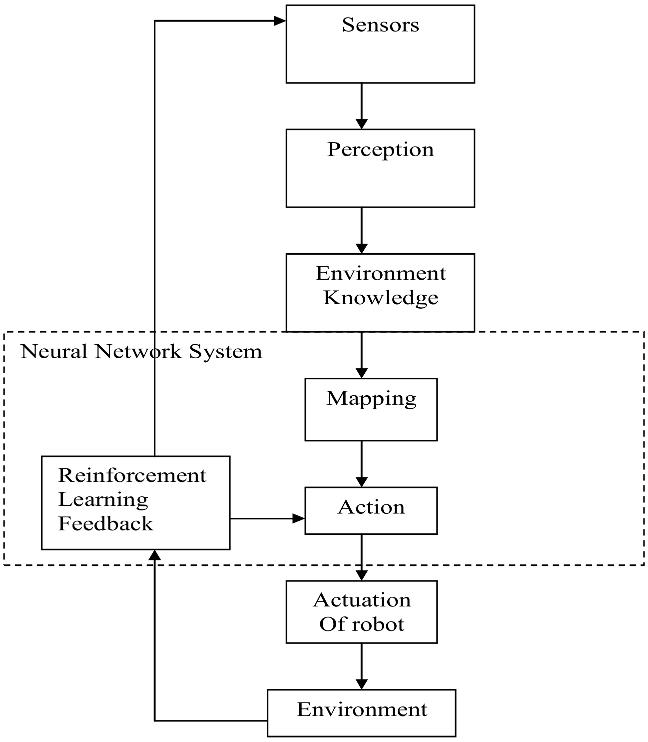

Fig. 3 General Structure of Neural Network navigation

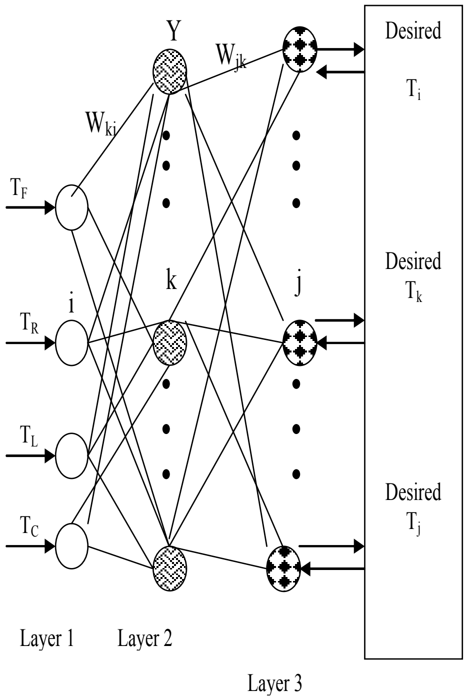

Fig. 5 Target Localization Neural Network

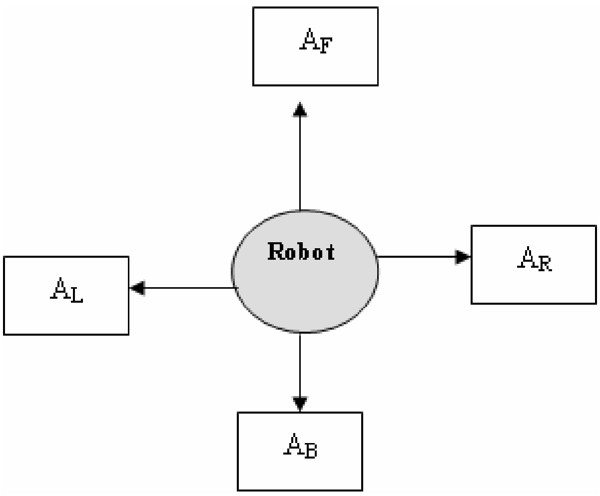

Fig. 4 robot and the four actions

In the proposed approach, the Neural Network is trained to capture the behaviour of a human expert while controlling the obstacle avoidance operation. The network must mimic the input/output mapping of this human expert.

This set is trained in order to deduce at the end the best direction to be taken by the robot. The learning of the proposed networks are based on the supervise Gradient Back-Propagation .The training is performed in a learning environment where all situations of vector T and O are represented and only free-collision action is permitted in each situation.

Both situations of T and O are associated by *Trial* and *Error* learning mechanism with the appropriate actions separately. Afterwards, the coordination of the two associated levels cited above allows the decision-making of the appropriate action.

This learning is guided only a feedback process, given by a factor *F* provided by the environment. This factor causes a reinforcement of the association between a given situation and an action if this latter leads to a favourable consequence to the rbot ; if not , the factor F provokes a dissociation. Each neuron Ai s connected to all neurons Ti and Oj through connections weighted by the coefficients given by:

$$w_{ij} = -\Psi(\frac{A_i \ situation \ \ j}{\eta} t) + (\Psi - F) \tag{4}$$

Target localisation : *Situation$_j$*=Ti and $F=\begin{cases} F_1 \, if & H=0 \\ 0 \, if & H=1 \end{cases}$ (5)

Each situation Ti=, H is determined with regard to each action Here we mean that situation of H_F, H_L, H_R, and H_C.

Obstacle avoidance : Situation j=Oj, and

$$F=\begin{cases} F_2 \, if & collision \\ 0 \, if & not \end{cases} \quad (6)$$

With F1 > Ψ and $F_1>F_2$ 0< $\Psi<F_2$ if free obstacle environment (O=0,zero) .

V. Simulation Results

In order to evaluate, the average performance of our approach over various environments, we observed simulation of the neural networks navigation for great number of environments. We can change the position of obstacles so we get other different environments. These environments were randomly generated .To find a feasible and correct path after insertion of deletion of an obstacle, we simulate the behavior of our autonomous mobile robot by learning and applying the neural network principle.

The robot is simulated in different environments. To reflect the robot behavior acquired by learning in the explored environment and in new unvisited environments. The robot reacts in efficient and a satisfactory manner in these environments. As we can see the generalization and adaptation abilities of the system are achieved. The configuration of the environments changes by adding other shapes of static obstacles, in each situation the robot can navigate successfully.

For non intelligent react environments (environments contain on or two obstacles no more), the robot navigates and attends its target without collisions. In the case of complex environments, the robot reacts intelligently avoiding the obstacles and reaching the appropriate target. The system structure is able to achieve its task without collisions for every developed or proposed environment. Indeed, the networks grow to represent the problem as it sees fit. After learning, the target location situation is trained in the learning environments. From data obtained by computing distance and orientation of the robot-target, the robot is able to react, understand and achieve its mission perfectly.

The robot distinguishes the four direction driving the robot requires only very basic sensing and actuation capabilities. To maintain the idea; we have created several environments which contain many obstacles. The search area (environment) is divided into square grids. Each item in the array represents one of the squares on the grid, and its status is recorded as walkable or unwalkable area (obstacle). The robot starts from any position then using neural learning must move and attends its target.

The proposed approach 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. The results are very satisfactory to see the complexity of the principle and the extension versions of generation maps.

The simulation is done in different environments where the robot succeeds each time to reach its target without collisions. destination for source to the target without collision in free area. Sensing, deciding, thinking and reacting; the robot across perfectly the connection between the source S and the target T searching its target.

The figure 6 and the figure 7 clarify more the principle and show how the robot succeeds to reach the goal without collisions according to the configuration of the selected environments. Taking a suitable action and reacting at the appropriate way, the robot finds its safe way without collisions in efficient manner. If the algorithm does not converge, an error is returned as it is shown in the figure8.

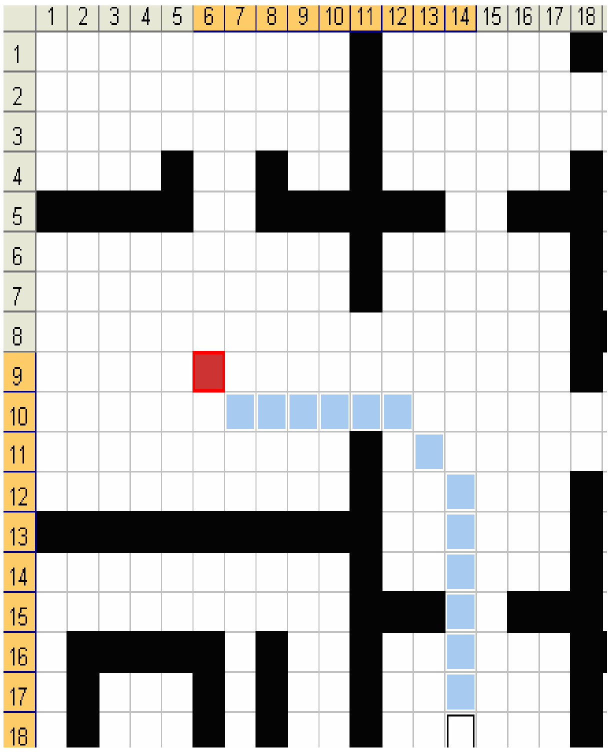

Fig. 6 Neural based navigation set-up1

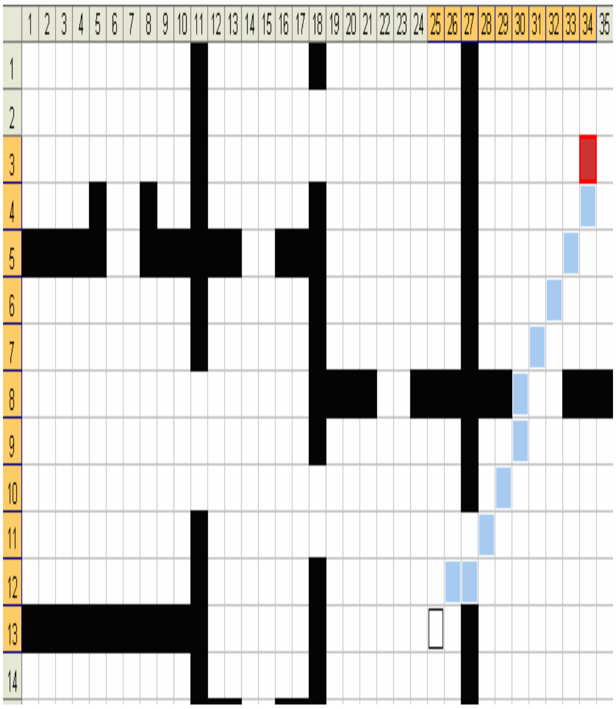

Fig. 7 Neural based navigation set-up2

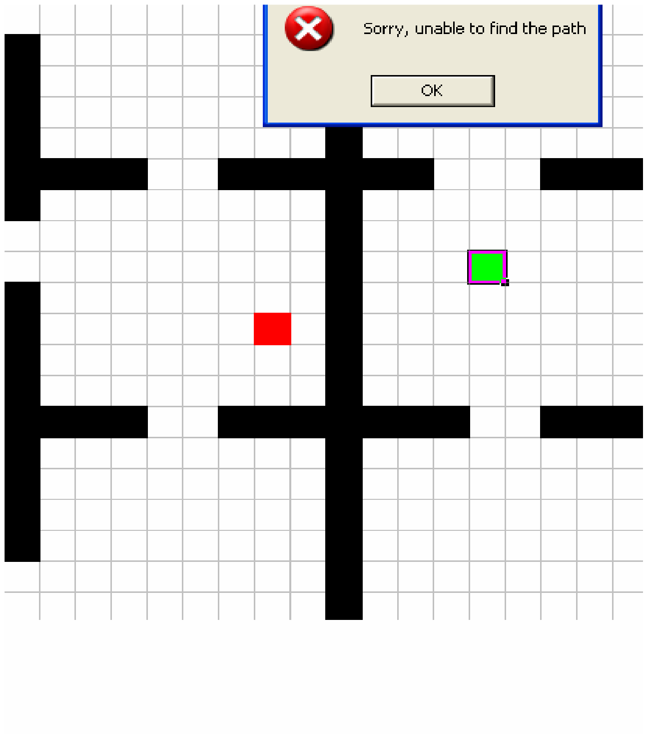

Fig. 8 Neural based navigation set-up2

To carry out tasks in various environments as in space applications, the robot succeeds to reach its target without collisions. The environment of navigation can be changed by user demand, that means that the robot can move in another environments where a given shape is designed by the user : a square and rectangle. The Robot come only move to free positions –/free area without obstacles/ and must stay within the environment searching its way from the starting position to the target position (a solution path) until it finds one or until it exhausts all possibilities /no possible paths see the figure 8.

VI. Conclusion

In this paper we presented an approach for mobile robot positioning and navigation which is based on the principle of the neural networks. Starting out from a start location and orientation in the grid, the mobile robot can autonomously head for destination Cells. On the way it determines its location in the grid using the principle of the neural networks.

We demonstrated how we implemented the underlying algorithm in software. Target location situations are associated with favorable actions in an obstacle-free environment explained in detail in this paper.

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. This navigation approach has an advantage of adaptivity such that the intelligent autonomous mobile robot 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, and 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. 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. The intelligent behaviour necessary to the navigation, acquired by learning enable the robot to be more autonomous and intelligent

The simulation results illustrate the generalization and adaptation capabilities of neural networks. An interesting alternative for future work is the generalization of this approach by increasing the number of possible robot directions.

REFERENCES

[1] D. Estrin, D. Culler, K. Pister, PERVASIVE Computing IEEE, 2002,pp. 59-69.

[2] T. Willeke, C. Kunz, I. Nourbakhsh, The Personal Rover Project : The comprehensive Design Of a domestic personal robot, Robotics and Autonomous Systems (4), Elsevier Science, 2003, pp.245-258.

[3] L. Moreno, E.A Puente, and M.A.Salichs, : World modeling and sensor data fusion in a non static environment : application to mobile robots, in *Proceeding International IFAC Conference Intelligent Components and Instruments for control Applications*, Malaga, Spain, 1992, pp.433-436.

[4] S. Florczyk, *Robot Vision Video-based Indoor Exploration with Autonomous and Mobile Robots*, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2005.

[5] A.Howard, M.J MatariĆ and G.S.Sukhatme, An Incremental Self-Deployment Algorithm for mobile Sensor Networks, autonomous robots, special Issue on Intelligent Embedded Systems, 13(2), September 202, pp. 113-126.

[6] O. Hachour and N. Mastorakis, IAV : A VHDL methodology for FPGA implementation, *WSEAS transaction on circuits and systems,* Issue5, Volume3,ISSN 1109-2734, pp.1091-1096.

[7] O. Hachour AND N. Mastorakis, FPGA implementation of navigation approach, *WSEAS international multiconference 4th WSEAS robotics, distance learning and intelligent communication systems (ICRODIC 2004),* in Rio de Janeiro Brazil, October 1-15 , 2004, pp2777.

[8] O. Hachour AND N. Mastorakis, Avoiding obstacles using FPGA –a new solution and application ,*5th WSEAS international conference on automation & information (ICAI 2004) , WSEAS transaction on systems* , issue9 ,volume 3 , Venice , italy15-17 , November 2004 , ISSN 1109-2777, pp2827-2834 .

[9] O. Hachour AND N. Mastorakis Behaviour of intelligent autonomous ROBOTIC IAR", *IASME transaction*, issue1, volume 1 ISSN 1790-031x WSEAS January 2004,pp 76-86.

[10] O. Hachour AND N. Mastorakism Intelligent Control and planning of IAR, 3rd WSEAS International Multiconfrence on System Science and engineering, in Copacabana Rio De Janeiro, Brazil, October 12-15,2004.www.wseas.org.

[11] O.Hachour, The proposed Fuzzy Logic Navigation approach of Autonomous Mobile robots in unknown environments, International journal of mathematical models and methods in applied sciences, Issue 3, Volume 3, 2009 , pp 204-218.

[12] O.Hachour, the proposed hybrid intelligent system for path planning of Intelligent Autonomous Systems, International journal of mathematics and computers in simulation,Issue 3, Volume 3, 2009, Pages 133-145.

[13] O. Hachour, "path planning of Autonomous Mobile Robot", *International Journal of Systems Applications, Engineering & Development*, Issue4, vol.2, 2008, pp178-190.

[14] O.Hachour, "The Proposed Genetic FPGA Implementation For Path Planning of Autonomous Mobile Robot", *International Journal of Circuits , Systems and Signal Processing,* Issue 2, vol2 ,2008,pp151-167.

[15] O.Hachour, The proposed Fuzzy Logic Navigation approach of Autonomous Mobile robots in unknown environments, International journal of mathematical models and methods in applied sciences, Issue 3, Volume 3, 2009 , pp 204-218.

[16] O.Hachour, the proposed hybrid intelligent system for path planning of Intelligent Autonomous Systems, International journal of mathematics and computers in simulation,Issue 3, Volume 3, 2009, Pages 133-145.

[17] O. Hachour, ,"path planning of Autonomous Mobile Robot", *International Journal of Systems Applications, Engineering & Development*, Issue4, vol.2, 2008, pp178-190.

[18] O.Hachour, "The Proposed Genetic FPGA Implementation For Path Planning of Autonomous Mobile Robot", *International Journal of Circuits , Systems and Signal Processing,* Issue 2, vol2 ,2008,pp151-167.