Navigation Control of an Automated Mobile Robot Robot using Neural Network Technique

A project report submitted in partial fulfillment for the degree of

Bachelor of Technology

In

Mechanical Engineering

by

Swagat Kumar Dash
Roll No:110ME0193

And

Mohan Das Marandi
Roll No-110ME0306

Under the Supervision of

Prof. Dayal Ramakrushna Parhi

Department of Mechanical Engineering
National Institute of Technology, Rourkela

National Institute of Technology, Rourkela

National Institute of Technology Rourkela

CERTIFICATE

This is to affirm that the work in this proposition entitled "Navigation Control of Automated Mobile Robot utilizing Neural Network Technique" by Swagat Kumar Dash and Mohan Das Marandi, has been done under my supervision in halfway satisfaction of the necessities for the level of Bachelor of Technology in Mechanical Engineering throughout session 2013 – 2014 in the Department of Mechanical Engineering, National Institute of Technology, Rourkela.

To the best of my learning, this work has not been submitted to any other College/Institute for the honor of any degree or recognition.

Dr. Dayal R. Parhi

Department of Mechanical Engineering

National Institute of Technology
Rourkela

ACKNOWLEDGEMENT

We put on record and warmly recognize the consistent support, precious supervision, convenient proposals and motivated direction offered by our aide Prof. Dayal R. Parhi, Department of Mechanical Engineering, National Institute of Technology, Rourkela, in bringing this report to a fruitful finishing. We see ourselves as greatly blessed to have had the open door to work under the direction of such a learned, powerful and liberal identity.

We are additionally grateful to Prof K P Maity, Head of Department, Department of Mechanical Engineering; National Institute of Technology Rourkela; for his consistent backing and consolation.

At long last, we stretch out our genuine on account of Naveen Kumar for his backing all around the undertaking work.

Swagat Kumar Dash

Roll No-110ME0193

Mohan Das Marandi

Roll No-110ME0306

CONTENTS

FIGURES LIST

List of Tables

ABSTRACT

Over recent years, automated mobile robots play a crucial role in various navigation operations. For any mobile device, the capacity to explore in its surroundings is essential. Evading hazardous circumstances, for example, crashes and risky conditions (temperature, radiation, presentation to climate, and so on.) comes in the first place, yet in the event that the robot has a reason that identifies with particular places in its surroundings, it must discover those spots. There is an increment in examination here due to the requisition of mobile robots in a solving issues like investigating natural landscape and assets, transportation tasks, surveillance, or cleaning. We require great moving competencies and a well exactness for moving in a specified track in these requisitions. Notwithstanding, control of these navigation bots get to be exceptionally troublesome because of the exceedingly unsystematic and dynamic aspects of the surrounding world. The intelligent reply to this issue is the provision of sensors to study the earth. As neural networks (NNs) are described by adaptability and a fitness for managing non-linear problems, they are conceived to be useful when utilized on navigation robots. In this exploration our computerized reasoning framework is focused around neural network model for control of an Automated motion robot in eccentric and unsystematic nature. Hence the back propagation algorithm has been utilized for controlling the direction of the mobile robot when it experiences by an obstacle in the left, right and front directions. The recreation of the robot under different deterrent conditions is carried out utilizing Arduino which utilizes C programs for usage.

CHAPTER 1

INTRODUCTION

Introduction

Streamlined and specialized provisions of mobile robots are consistently picking up in vitality, specifically under contemplations of dependability (continuous and dependable execution of dull assignments, for example, observation), availability (assessment of locales that are distant to people, e.g. tight spaces, perilous situations then again remote locales) or expense (transportation frameworks focused around self-governing versatile robots could be less expensive than standard track-bound frameworks). Navigation robots are now generally utilized for reconnaissance, examination and transportation assignments | a further developing business sector with tremendous potential is that of mobile entertainment robots. It is clear that an extent of major capabilities need to be accessible for a versatile robot to be valuable. The robot must work securely, i.e. it must stay away from perils, for example, deterrents or working conditions hazardous to the robot itself (e.g. plunging stairs), and it must represent no danger to people in the region of the robot. Versatility is practically pointless without the capability to explore. Arbitrary development, which does not oblige a route competence, may be valuable for certain reconnaissance alternately cleaning operations, however for most scientific or streamlined provisions of portable robots the capacity to move in an intentional way is needed. The robot gets these ideas independently through investigation of its environment.

Various results have been proposed in the writing to address this issue. Most depend either on exploring utilizing a prespecified guide or developing a guide on the fly. Most methodologies likewise depend on some strategy of localization. Some work on robot route is landmark based relying on topological maps , which have a smaller representation of the environment and don't rely upon geometric precision. The downside of such methodologies is that they experience the ill effects of sensors being loud and the issue of sensor antialiasing (i.e. recognizing comparable landmarks).metric methodologies to localization focused around Kalman filtering give exactness, however the representation itself is unimodal and thus can't recoup from a lost situation(misidentified characteristics or states). Methodologies created lately focused around 'Markov localization' give both correctness and multimodality to speak to probabilistic dispersions of various types, yet oblige noteworthy transforming force for upgrade and thus are infeasible for vast situations.

One of a few methodologies used in motion control of a robot is Artificial Neural-

Networks (ANN) for sensitive control. The profit of this methodology is the taking in capacity of the neural system. Most navigation robot demonstrate non-direct aspects, straight control can't be utilized for all circumstances. The sensible reply to this issue is the requisition of non-straight controllers. As neural systems (NNs) are described by adaptability and an inclination for managing non-straight issues, they are conceived to be helpful when utilized on such robot

The neural system is a technique for comprehension hypotheses which prompts the path in which human mind understands essential capacities. Neural Network is utilized to develop machines which perform entangled errand such as improvement, taking in, adjustment, and generalization. Since the navigation issue constitutes of distinguishment, taking in, choice making and movement. For exploring the submerged robot the calculation utilized is neural system. The taking in and adjustment abilities might be enhanced by utilizing Neural Network as a part of the situations where the information is qualitative, incorrect, and obscure or fragmented. Most submerged show non-straight conduct, direct control can't be utilized for all circumstances. The consistent reply to this issue is the provision of non-direct controllers. As neural systems (NNs) are portrayed by adaptability and a fitness for managing non-straight issues, they are visualized to be useful when utilized on submerged robots.

CHAPTER 2

LITERATURE REVIEW

Literature Review

Gao Yanfeng et al. [2] in their exploration paper have talked about a back-venturing and neural system half breed control strategy for motion stage and bot slider utilized as a part of shipbuilding. The model of the bot is assembled firstly, and after that a movement controller is composed focused around the model and back-venturing technique. Controller dependability is demonstrated using Liapunov hypothesis. For enhancing the controller's following exactness and hostile to obstruction execution, a system working on neural network is intended to recognize the bot kinematic model and to conform the coefficients of control continuously focused around the following mistakes. The reproduction and tests have been carried out to check the adequacy of the proposed controllers.

Masanori Sato et al. [2] in their examination paper "Execution assessment of a neural system controller framework for a wheel sort mobile robot" have recommended that Wheel sort mobile frameworks are the most famous transportation components on the grounds that the vitality proficiency is high, the instrument is straightforward and the control framework is generally examined. Then again, the wheel sort mobile robots experience issues in unpleasant territory development.

Masanori Sato, Atushi Kanda and Kazuo Ishii expressed that wheeled mobile system with an uninvolved and/or dynamic linkage component for go in unpleasant landscape is created and assessed. In our past examination, we created an exchanging controller framework for motion bots in unpleasant territory. In this paper, we propose another controller outline strategy focused around a neural system. The proposed technique includes three sorts of controllers: a basic controller, balance controller, and streamline controller. The examinations suggested that the proposed system brought about less disturbance related to oscillatory movement in unpleasant landscape and has superior performance to a generally tuned PID controller does.
The rule parts of Rulenet are its profitable taking in and inducing estimations and the probability to make a translation of average taking in into the framework and the other route around without hardship of information.

Eduardo Zalama et al.[2] in their paper "A continuous, unsupervised neural system for the low-level control of a mobile robot in a the earth" presented an ongoing, unsupervised neural system that figures out how to regulate a two-level of-opportunity motion bot in a nature's domain. The Network Mobile Robot Controller (NETMORC), joins cooperative taking in and Vector Associative Map (VAM) figuring out how to create conversions between spatial and speed directions. Accordingly, the controller takes in the wheel speeds needed to achieve a focus at a subjective separation and plot. Aside from having the capacity to achieve stationary or moving focuses on, the NETMORC structure likewise empowers the robot to perform effectively notwithstanding aggravations in nature.

Masanori Sato and Kazuo Ishii in their article "A neural system based controller for a wheel sort mobile robot" expressed that the transportation utilizing wheels is a standout amongst the most famous transportation systems for mobile robots due to its high vitality productivity, straightforward components and generally researched control frameworks. Be that as it may, the wheel sort mobile robots have the greatest shortcoming in the unpleasant landscape development. In the past investigates, a motion bot utilizing a linking component, "Zaurus", has been created to grow mobility of the tried and true wheel sort mobile frameworks. The investigations to move over single knocks with double the stature of breadth of the robot's wheel have been done and succeeded. In this paper, a neural system controller and PID controller are presented as the control framework, and their exhibitions are analyzed by reenactments. The neural system controller shows predominant sifting and characteristic extraction competencies.

Janusz Racz and Artur Dubrawski proposed a neural system based methodology to a mobile robot limitation before certain nearby question. The robot is outfitted with ultrasonic extent sensors mounted around the stage. We utilize the Fuzzy-ARTMAP system for regulated taking in of companionships between vectors of sensor readouts and the robot's posture coordinates. In this approach, a world show as a guide, and its upgrading schedule, get to be superfluous for the acknowledged issue result. The framework, prepared on certifiable information of an entryway neighborhood area uncovers attractive execution, sufficient for entryway passing assignment purposes. The proposed technique for a mobile robot situating may be proficiently connected in situations holding common, geometrical reference points.

Zenon Hendzel proposed another requisition of the versatile faultfinder philosophy that assisted input control of motion bots having wheels, in light of a commentator sign gave by a neural network. The controller is inferred from Lyapunov solidness hypothesis and can certification following execution and soundness. An arrangement of machine reenactments has been utilized to copy the execution of the proposed answer for a motion bot having wheels.

Dongbing Gu et al.[1] displayed an alternate path taking after arrangement for an auto like portable robot centered around neural farsighted control. The neural perception for path taking employs judicious control arranged in light of neural framework showing, which can make its yield the extent that the robot kinematics and a needed way. The hungered for route for the robot is converted with an essential close structure by a polynomial which is polar. The back-inducing neural framework which has several layers is created by orthogonal deterioration wavelet to structure a neural framework having the same that can prevail over the issue brought on by the close-by minima during setup of the neural framework.

J.gómez Ortega and E.f. Camacho introduced a method for actualizing a MBPC for motion control of a bot when sudden constant snags are present in the earth. A ultrasonic running framework has been utilized for impediment identification. A perceptron having a number of layers is utilized to execute the MBPC, permitting continuous usage and likewise killing the need for large amount information sensor handling. The perceptron has been prepared in a directed way to imitate the MBPC conduct.

Simon X Yang and Max Meng proposed an organically enlivened neural system methodology to ongoing impact free movement arranging of movable bots or bot controllers in a non stationary surrounding is proposed. Every neuron sorted out in neural system topologically has just nearby associations, whose neural elements is described by a shunting mathematical statement. Therefore the computational unpredictability directly relies on upon the neural system size. The continuous robot movement is arranged through the element action scene of the neural system without any former information of the earth and without any taking in methodology. Subsequently it is proficient. The worldwide security of the neural system is ensured by qualitative dissection and the strength hypothesis computed by Lyapunov. The viability and effectiveness of the methodology are exhibited through recreation studies.

The system utilizes a nonlinear model of mobile robot progress, and therefore permits a faultless forecast without bounds trajectories. A ultrasonic going framework has been utilized for snag location. A multilayer perceptron is utilized to actualize the MBPC, permitting continuous execution and additionally taking out the need for abnormal amount information sensor preparing. The perceptron has been prepared in a regulated way to recreate the MBPC conduct.

Yang SX, Meng M. proposed an organically motivated neural network methodology to ongoing crash free movement arranging of movable bots or bot controllers in a dynamic environment is propositioned. Every sorted out processing unit in the neural network has just nearby associations. In this way the computational multifaceted nature directly relies on upon the neural network size. The constant robot movement is arranged through the element action scene of the neural network without any earlier information of the nature, without unequivocally seeking over the free workspace or the impact ways, and without any taking in techniques.

Simon X. Yang and Max Meng proposed a proficient neural network system for constant movement arranging of a motion bot or a multi joint bot controller with security attention in a nature's domain. The ideal bot movement is arranged using the element neural action scene of the naturally propelled neural network in the absence of any earlier learning of the element environment and any taking in techniques. The model is steady, productive, and comparatively adaptive to parameter varieties.

Ben J.A. Kröse and Marc Eecen portray a sensor based motion control plan for a motion bot framework, which makes utilization of a worldwide representation of the earth by method for an organizing toward oneself guide or Kohonen network. The guide is assembled by investigation.

T Dierks and S Jagannathan created an asymptotically steady (AS) joined together torque control law for pioneer devotee arrangement control utilizing back stepping within request to suit the thorough flow of the bots and the framing, and presented alongside hearty basic of the indication of the blunder criticism to rough the motion of the supporter and its pioneer utilizing weight analysis is a neural network. Also, the steadiness of framing in vicinity of impediments is analyzed utilizing Lyapunov systems, and by handling different bots in shaping as snags, crashes inside the establishment don't happen. The asymptotic security of the supporter robots and the whole creation throughout a snag shirking move is showed utilizing Lyapunov strategies, and numerical outcomes are given to check the hypothetical guesses.

Carmelo Costanzo et al.[3] expressed that there are numerous discriminating issues emerging in WSRN. In view of the particular provision, distinctive destinations might be considered, for example, vitality utilization, throughput, delay, scope, and so on. With the concentrate on the sorting toward oneself out capacities of hubs in WSRN, we propose a development helped system for hubs association toward oneself. Particularly, the proposition to utilize a controller working on NN for hubs versatility and a hereditary calculation for the preparation of the NN through fortification taking in .This sort of plan is greatly versatile, since it might be effortlessly altered to think about distinctive destinations and Qos parameters. Truth be told, it is sufficient to think about an alternate sort of info for the neural network to point for an alternate goal. Recreation effects demonstrate the adaptability and adequacy of this methodology actually when the provision situation changes (e.g., by presenting physical impediments).

Paolo Gaudiano, Frank H. Guenther, Eduardo Zalama talked about a gathering of models that use versatile and dynamical properties of neural networks to take care of issues of tactile engine control for natural life forms and robots. The section starts with an outline of a few unsupervised neural network models created at the Center for Adaptive Systems throughout the previous decade. These models have been utilized to clarify an assortment of information in examination zones going from the cortical control of eye and arm developments to spinal regulation of muscle length and pressure. Next, two late models that expand on paramount ideas from this prior work are displayed. The primary of these models is a versatile NN controller for an outwardly guided motion bot. The neural network controller empowers the robot to move to discretionary focuses without any information of the robot's kinematics, instantly and naturally adjusting for bothers, for example, target developments, or the robot's plants changes. The controller likewise adjusts to long haul bothers, empowering the robot to adjust for factually noteworthy changes in its plant. The second model is a sorting toward oneself out neural network tending to discourse engine aptitude securing and discourse generation. This model illustrates an extensive variety of information on logical variability, engine comparability, coarticulation, and talking rate impacts. Model parameters are educated throughout a chattering stage, utilizing just data accessible to a jabbering baby. In the wake of taking in, the model can handle self-assertive phoneme strings, again showing programmed payment for irritations or stipulations on the articulators. At last, other late models utilizing a neural motion methodology are compressed and future examination roads are laid out.

Chaitanya VS. talked about a nonholonomic mobile robot with totally obscure progress. A numerical model has been viewed as and an effective NN is created, which guarantees ensured following execution prompting solidness of the framework. The NN accept a solitary layer framework, by exploiting the robot regressor motion that communicates the exceedingly nonlinear bot elements in a direct structure as far as the known and obscure robot dynamic parameters. No suppositions identifying with the boundedness is put on the unmodeled unsettling influences. It is fit for producing continuous smooth and nonstop speed control indicates that drive the motion bots to take after the craved paths. The proposed methodology determines pace hop issue existing in a few past following controllers. Further, this neural network does not oblige logged off preparing methods. Lyapunov hypothesis has been utilized to demonstrate framework security. The reasonableness and adequacy of the proposed following controller are exhibited by reproduction and examination results.

Jun Ye proposed a compound cosine capacity neural network with constant taking in calculation for the speed and introduction point following regulation of a nonholonomic motion bot with nonlinear aggravations. In this, two neural network (NN) controllers inserted in the shut circle control framework have the basic nonstop taking in and quick merging competence without the progress data of the motion bot to understand its versatile control. The neuron capacity of the concealed layer in the three-layer food forward network structure is on the premise of joining a cosine capacity with an unipolar sigmoid capacity. The created neural network controllers have basic calculation and quick taking in union in light of the fact that the weight qualities are just balanced between the hubs in shrouded layer and the yield hubs, while the weight values between the information layer and the concealed layer are one, i.e. consistent, without the weight conformity. Hence, the primary focal points of this control framework are the constant control proficience and the strength by utilization of the proposed MM controllers for a nonholonomic motion bot with nonlinear aggravations. Through recreation analyses connected to the nonholonomic mobile robot with the nonlinear unsettling influences which are acknowledged as progress lack of determination and outer aggravations, the reproduction outcomes demonstrate that the proposed NN control arrangement of nonholonomic mobile robots has ongoing control ability, better power and higher control exactness. The compound cosine capacity neural network furnishes us with another approach to tackle following control issues for mobile robots.

Hurst J, Bull L. expressed that for simulated substances to attain genuine self-sufficiency and presentation complex exact conduct, they will need to adventure fitting versatile taking in calculations. In this connection versatility intimates adaptability tutored by the surroundings at any point and a capacity to adopt proper practices. It basically looks at using constructivism motivated components inside a NN taking in framework building design based on classification that adventures variable alteration toward oneself as a methodology to acknowledge such conduct. The framework utilizes a principle structure within which each one tenet is spoken to by a counterfeit neural networkEffects are displayed in reproduced mazes before moving to a mobile robot stage.

J. Gomez-Ortega and E.f. Camacho in their paper introduced a method for executing MBPC for motion bot way following. The system utilizes a non-straight model of motion bot progress and subsequently permits a correct expectation without bounds trajectories. Imperatives on the greatest reachable velocities are likewise recognized by the calculation. A perceptron having multiple layers is utilized to actualize the controller. The perceptron has been prepared to repeat the controller’s bahaviour in a managed manner.

Janusz Racz, Artur Dubrawski introduced a NN based methodology to a motion bot restriction before a certain nearby protest. The robot is furnished with ultrasonic extent sensors mounted around the stage. We utilize the Fuzzy-ARTMAP network for managed taking in of companionships between vectors of sensor readouts and the robot's stance coordinates. In this approach, a world demonstrate as a guide, and additionally its upgrading schedule, get to be superflous for the acknowledged issue result. The framework, prepared on genuine information of an entryway neighborhood locale uncovers acceptable execution, sufficient for entryway passing assignment purposes. The proposed strategy for a mobile robot situating may be productively connected in environments holding characteristic, geometrical reference points.

Ben J.a. Kröse and Marc Eecen portray a sensor based motion control plan for a motion bot framework, which makes utilization of a worldwide representation of the environment by method for an orchestrating toward oneself guide or Kohonen network. The guide is fabricated by investigation.

Hamid Dezfoulian handles the issue of augmenting neural network navigation calculations for different sorts of mobile robots and 2-dimensional reach sensors. We propose a general system to translate the information from different sorts of 2-dimensional reach sensors and a neural network calculation to perform the navigation assignment. Our methodology can yield a worldwide navigation calculation which could be connected to different sorts of reach sensors and mobile robot stages. In addition, this technique permits the neural networks to be prepared utilizing stand out kind of 2-dimensional reach sensor, which helps emphatically to decreasing the time needed for preparing the networks. Trial effects completed in recreation environments show the viability of our methodology inmobile robot navigation for various types of robots and sensors. In this manner, the effective execution of our system gives an answer for apply mobile robot navigation calculations to different robot stages

CHAPTER 3

ANALYSIS OF NEURAL NETWORK FOR NAVIGATION ROBOT

3.1 Introduction to Neural Networks

An Artificial Neural Network (ANN) is a model for data preparing which has been produced from a relationship with biotic sensory system and it is same as how the mind examines data. It is like the axons and dendrites that are available in the sensory system and is a recreation of the sensory system that holds a set of neuron units which are interrelated with one another however axon associations. The transforming of information is the essential thought for this neural system model. These interconnected neurons help in taking care of true life issues.

An Artificial neural system ought to be prepared with the goal that it will work in a common sense manner. The system takes in only like the human creatures. An ANN will be by and large utilized for a particular requisition after preparing. The work done by the system changes from choice making, preparing and enhancement of picture, improvement. Neural systems are likewise used for different provisions like information mining requisition, order of diverse things, elucidating displaying, estimate of capacities, grouping, foreseeing of distinctive arrangement and so forth. The genuine neural systems show in brains could be seen better utilizing artificial neural systems. There is no compelling reason to make a genuine living neural model framework to tackle artificial sagacity circumstances or issues. Artificial Neural Networks additionally use the characteristic of modifying the weight between the neurons exhibit in the system.

The cerebrum of person holds set of neurons which are very interconnected by axons and dendrites. Enactment indicator is transmitted between neurons by which data voyages. This is the way choice making is carried out in human mind.

The artificial neural system is similar to a scientific adaptation of the genuine neural system appeared. Artificial Neural system comprises of neurons which will be interconnected to convey by utilizing initiation signs. The ANN might be utilized to estimated a capacity of numerous inputs and yields that is connected to a specific utilization. The analogies between genuine neural system and the ANN have been given beneath.

The human mind is utilized for the ceaseless preparing of an extensive number of data in very evolving circumstances. The mind can accomplish such troublesome errands by utilizing different preparing of diverse include and yield components. Artificial Neural Networks uses the same strategy to the register the yield for re-enactment.

The neuron holds three separate parts; these are the neuron cell body or cyton, axon which transmits the neuron's yield to the diverse dendrites of distinctive neurons and dendrites which are the interfacing developments from cyton for taking information.

Dendrites get the information sign from diverse neurons. Synapses which are the associations between distinctive neurons brings about the exchange of signs between neurons. These are of diverse sorts and are processed relying on different properties like the pace and data in a sign. It has been expected that the sensory system of human comprises of more than 100 billion neurons.

These neurons transmit electrical signs by means of a dainty, long connector known as the axon which isolates into a numerous extensions. These synapses are available at the closures of each limb. They change over this into electrical indicator. The following neuron in the way accepts the enter that is tremendous as contrasted with its inhibitory info, it sends an electrical indicator down to the axon. The system trains itself by changing the viability of the synapses to control impact of neurons on alternate neurons. The communications are distinctive for diverse sorts of system calculation.

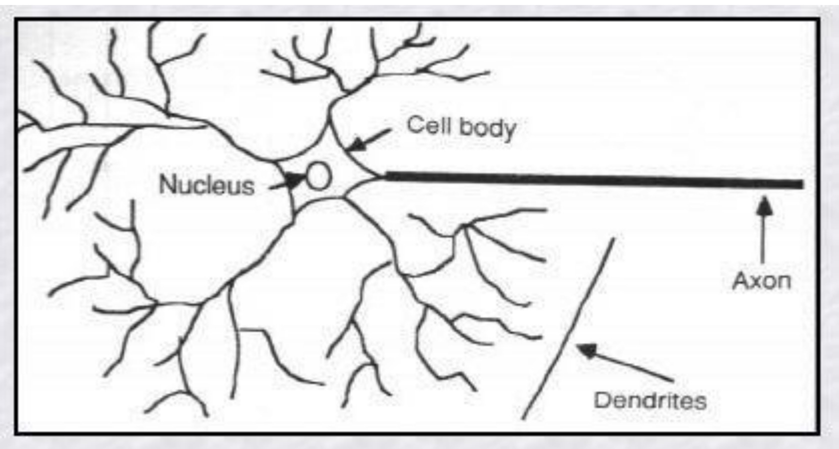

Figure 1Biological Neural Network

The input signals at the synapses of the neuron are united for dissection. The excitatory and inhibitory impacts happening on the neuron are accordingly included. The yield is not a straight capacity of the inputs indicators and the weight of the association in the synapses could be adequately changed by taking in. The neuron fiber sends data to different neurons when the excitatory impacts get prevailing by means of the cordial synapses. Terminating happens when the joined together indicator quality gets to be more than a limit esteem. For the most part initiation capacity gives the worth to the neuron in the system.

The human cerebrum trains itself by changing the nature and quality of the synapses. ANN trains itself algorithmically to improve results. In an ANN the taking in of the circumstances is reproduced scientifically by overhauling the weights acting between the neurons like that of human brain.the biotic taking in of human cerebrum is recreated numerically in ANN by adjusting the weights between the neurons.

3.2 A Simple Neural network model

In an Artificial Neural Network the weight corresponds to synapse from a real neural network. When the weight is less than zero it represents an inhibitory connection, and when it's positive it represents an excitatory connection. All inputs are added together and are also changed by their changing weights. The process is called as linear combination. The value of the output is restricted by an activation function.

The following figure describes the mathematical algorithm.

Consider an artificial neuron network with n inputs, namely I_1, I_2, ...,I_n.

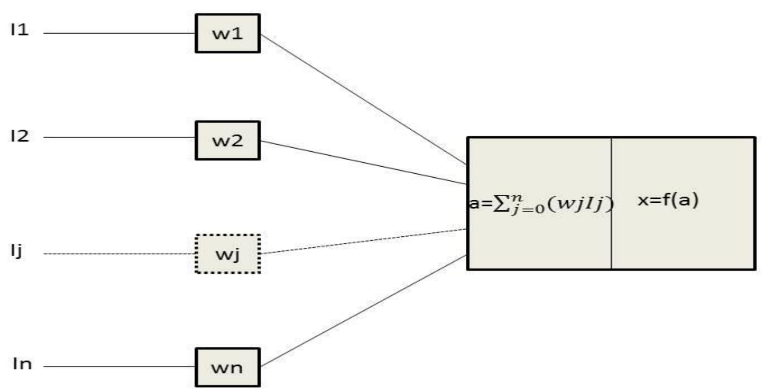

Figure 2 Artificial Neural Network

The lines connecting these inputs to other neurons are given some weights designeted by w_1, $w_2,\ldots,w_N$ respectively. For the particular graded potential the activation is determined by the formula: w_j u_j . This model describes the interval activity of the neuron as

$$a=\sum_{j=0}^{n}(wj\ uj)$$

x = f (a)

The unit's activation function is the function f.

3.3 Feed forward networks:

In such networks, the signals move along a single generally directed from input to the output. These are differentiated by absence of feedback loops in the neural network. Therefore the output of one layer does not have any effect on the same layer. Feed-forward artificial neural network are forward networks that connects the inputs directly with the outputs. They are also called as bottom up neural network.

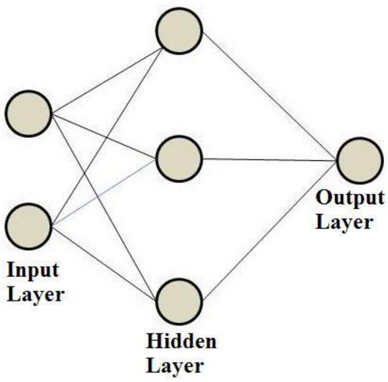

Figure 3-Feed Forward neural network

3.4 Back Propagation Algorithm

Back propagation is a method to train artificial networks and enforce the Delta rule. It is generally used for feed forward neural networks.

Back propagation technique:

1. A preparation set of information is given to the neural network and the corresponding result is acquired.

2. The neural network output is contrasted and the desired output as given by the training set and the error is ascertained at each one output neuron.

3. For each neuron, the local error is ascertained which gives the thought of what amount of easier or higher the output must be changed to be tantamount with the desired output.

4. The weight of each neuron is changed to lessen the local error.

5. Accuses for the local error are relegated to neurons which are available at the past level, giving higher obligation to neurons having higher weights.

6. Steps 3 to 5 are rehashed for the neurons at the past level by utilizing the neuron's fault as the lapse.

3.5 Modeling of the neural network for Navigation Robot

The steps required to train the neural network model used in the navigation robot is as follows-:

1. Data Collection-:

The input patterns that are fed to the neural network during training and during normal operation comprise the following inputs:

Y1 {1} = Robot's distance from the left obstacle

Y2 {1} = Robot's distance from the front obstacle

Y3 {1} = Robot's distance from the right obstacle

Y4 {1} = Target bearing

And the final output

θactual= Angle of Steering modification

A set of data is to be collected for neural network's training by taking all the various types of inputs.

2. Create the network-:

Simulated neural systems involve a set of thickly interconnected taking care of entities which are called neurons. These units believer movements in a way that is non linear. Neural systems are independent which can predict and fit equable limits centered around info-yield tests . The neural system used is a perceptron having 5 layers. The picked number of layers was uncovered precisely to energize planning. The information layer has four neurons, three for getting the characteristics of the partitions one for obstructions in anterior side and one each on the left and on the right of the bot and last includes bearing angle of the target. In the event that target isn't discovered, the neuron numbered fourth is given an input null. The final eventual layer has a solitary processing unit, which prepares the directing plot to regulate the bearing of development of the bot. The first hidden layer has 8 processing units, the 2^{nd} hidden layer has 12 processing units and the third hidden layer has 6.

Figure 4 delineates the neural network. The NN is prepared to explore by giving it 60 general examples pertaining to ordinary situations, which are delineated in Figure Table 1.

3. Configure the Network-:

The input neurons are-:

Y1 {1} = Robot's distance from the left obstacle ………………………(1)

Y2 {1} = Robot's distance from the front obstacle ……………………(2)

Y3 {1} = Robot's distance from the right obstacle ……………………(3)

Y4 {1} = Target bearing…………………………………………………(4)

The above mentioned inputs are sorted among the hidden neurons which give outputs

Yj{lar}= f (Yi{lar})…………….(5)

Where

Yj{lar}= ΣWij{lar}.Yi{lar-1}……….(6)

lar = Corresponding number of the layer

j = jth neuron's reference in middle layer 'lar'

i = ith neuron's reference in the middle layer 'lar-1'

Wij{lar} = connection weight from i in layer 'lar-1' to j in layer 'lar'

f(.) = hyperbolic tangent funcn used as an activation function:

$$f(x) = (e^{x} - e^{-x})/(e^{x} + e^{-x})$$

4. Initialize the weights and biases-:

Utilizing all the gathered information we can introduce the weights and biases. We can utilize MATLAB programming for making the Neural Network and tackling the issue. In the wake of Creating the neural network and arranging it the weights ought to be instated by proper values for further training of the neural network.

5. Train the Network-:

Throughout preparing, the system yield θactual may contrast from the wanted yield θdesired as mentioned in the preparation example exhibited for the system. The error is calculated using the formula mentioned below for the set of data:

Error = $\frac{1}{2}\Sigma(\theta^{2}_{desired} - \theta^{2}_{actual})$……………….(8)

The failure back propagation strategy is utilized to prepare the system .This technique requires the processing of nearby lapse inclinations so as to focus fitting weight remedies to decrease blunder. The error gradient δ {4 } for the final layer is:

δ {4 }=f'(V1{4})($\theta_{desired} - \theta_{actual}$)……………..(9)

The formula for hidden layer {lar} local gradient of neurons is given by:

$\delta j\{lay\} = f'(Vj\{lay\})(\sum_{k} \delta k\{lay + 1\}Wkj\{lay + 1\})$ ……………….(10)

The updation in the corresponding connection weights are calculated using the following:

$W_{ij}(t+1) = W_{ij}(t) + \Delta W_{ij}(t+1)$……………………..(11)

and $\Delta W_{ij}(t+1) = \alpha \, \Delta W_{ij}(t) + \eta \, \delta_j\{lay\}.Y_i\{lay-1\}$…………………(12)

α= coefficient of momentum (generally assigned a value 0.9)

η = rate of learning (generally assigned a value 0.05)

t = number of the iteration, each iteration representing a pattern

of training and weight correction.

The neural network's final output is given by:

$\theta_{actual} = f(V_1\{4\})$………………………(13)

where

$V_1\{4\} = \sum_i Wli\{4\} Yi\{3\}$……………… ......(14)

It ought to be noted taking in can happen persistently actually throughout typical target looking for conduct.

6. Validate the Network-:

After training the network we have to validate it in the MATLAB so that it can be used by the robot for its navigation control.

7. Use the network-:

After that this network can be used by the network controller of the bot.

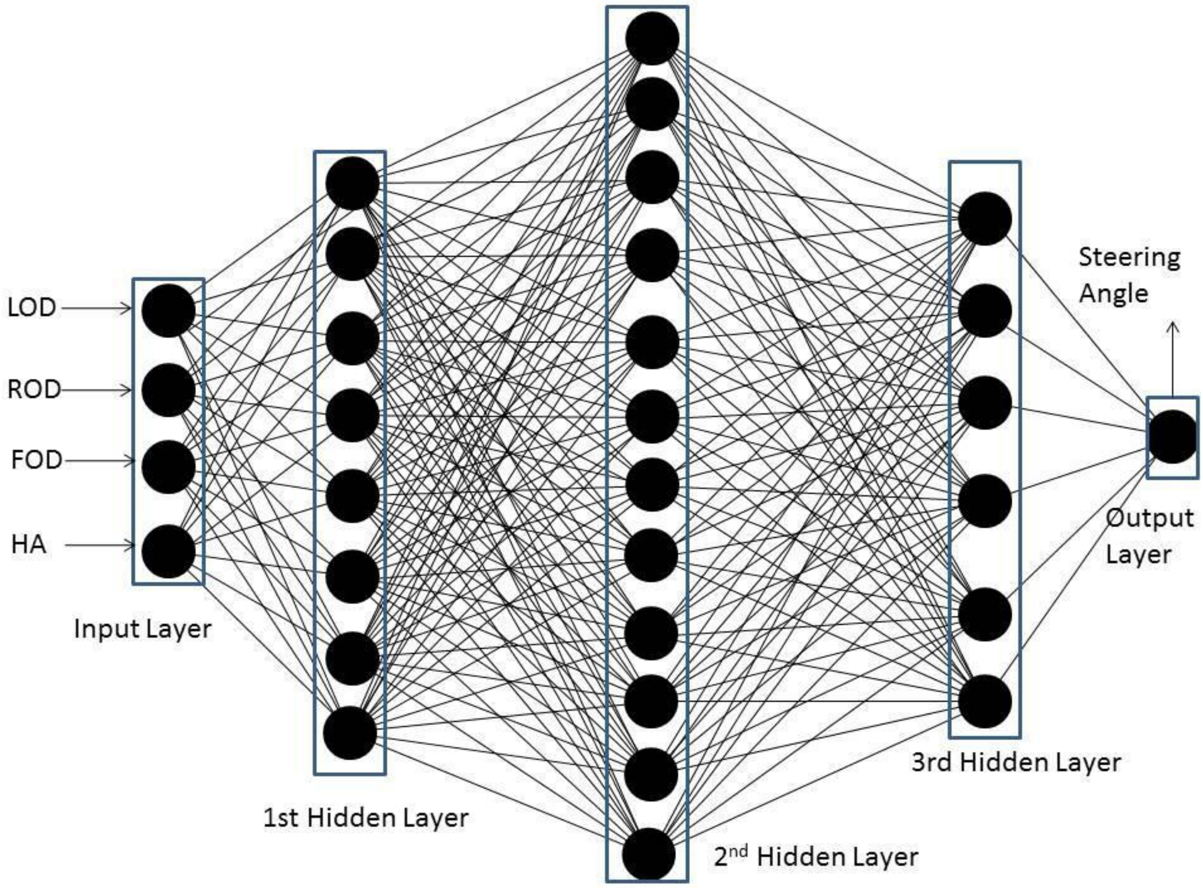

Figure 4- NN model used in the bot

The different situations used in the neural network are shown below which are used in the neural network.

LOD(in cm)	ROD(in cm)	FOD(in cm)	TA(in degree)	SA(in degree)
60	10	10	12	-7
60	15	10	12	-7
60	25	10	12	-7
60	20	15	15	-7
60	25	15	15	-7
60	30	15	15	-7
60	40	10	20	-7
50	40	10	20	-7
55	40	12	20	-7
60	35	12	25	-9
60	35	12	25	-9
25	35	25	25	9
20	35	25	25	9
25	35	30	25	9
25	35	30	12	-9
10	60	30	12	7
10	60	30	-12	7
20	60	20	-12	7
25	60	20	-12	7
25	60	8	-15	9
25	60	8	20	9
30	60	8	-15	9
60	60	28	-15	8
60	60	28	-25	8
25	25	28	30	-7
22	25	22	-25	-8
25	20	15	-25	-8
15	30	25	25	8
10	25	25	25	8
10	25	30	30	8
20	25	10	20	10
30	25	30	20	10
20	25	30	15	4
20	25	15	30	14
30	25	25	30	14
30	40	20	15	6
30	25	25	15	6
25	30	25	-15	-6
40	30	20	-15	-6
25	30	25	-30	-14

25	20	15	-30	-14
25	20	30	-15	4
25	30	30	-20	-10
25	20	10	-20	-10
25	10	30	-30	-8
25	10	25	-25	-8
30	15	25	-25	-8
25	25	26	-25	-8
60	25	8	-20	-9
10	0	30	-20	10
10	0	0	-20	4
10	0	0	-15	4
10	0	0	-10	-4
0	0	14	-10	-4
0	0	14	-15	-10
0	0	14	-20	-14
0	25	14	-20	-14

Table 1 Different situations used in the neural network

Where

LOD=Distance of left obstacle from the bot

ROD= Distance of right obstacle from the bot

FOD= Distance of front obstacle from the bot

TA=Angle of the target

SA=Angle through which bot is steered or Steering angle

CHAPTER 4

ALGORTHIMS FOR PROGRAMMING IN MATLAB

Algorithm for training neural network-:

1. Run MATLAB

2. The input matrix and the target matrix were defined.

3. Create feed-forward back-propagation network

4. Set the train function using different commands.

5. Set the train parameters

6. Train the network.

7. Simulate the network for finding the plot for Mean square Error, Gradient, Learning Rate Increment and Regression plot

CHAPTER 5

RESULTS AND DISCUSSION

Results and Discussion

From the analysis of Neural Networks the navigation mechanism for an automated mobile robot has been developed.

The Feed forward back propagation algorithm is utilized to determine the steering angle for the mobile robot.

The NN used for the motion control of the motion bot is provided with four inputs: Left Distance; Right Distance; Front Distance and Heading Angle (position of the bot wrt the target expressed as an angle). One output was generated for navigation of the bot: Steering Angle (The angle to which the mobile robot must be turned)

After the mobile robot has been trained with the set of inputs, it is expected that the robot steers by itself without any human involvement in a nonlinear and unpredictable environment. This steering of the mobile robot is controlled by the outputs generated by the neural network. The steering angle obtained matches with the angle initially desired. This desired output angle for the particular set of obstacle distances had been fixed by a human. Thus the mobile robot should be capable of performing steering control automatically replacing human involvement.

The Feed forward neural network had been created using the MATLAB software.

The following results have been obtained after simulating the neural network using MATLAB.

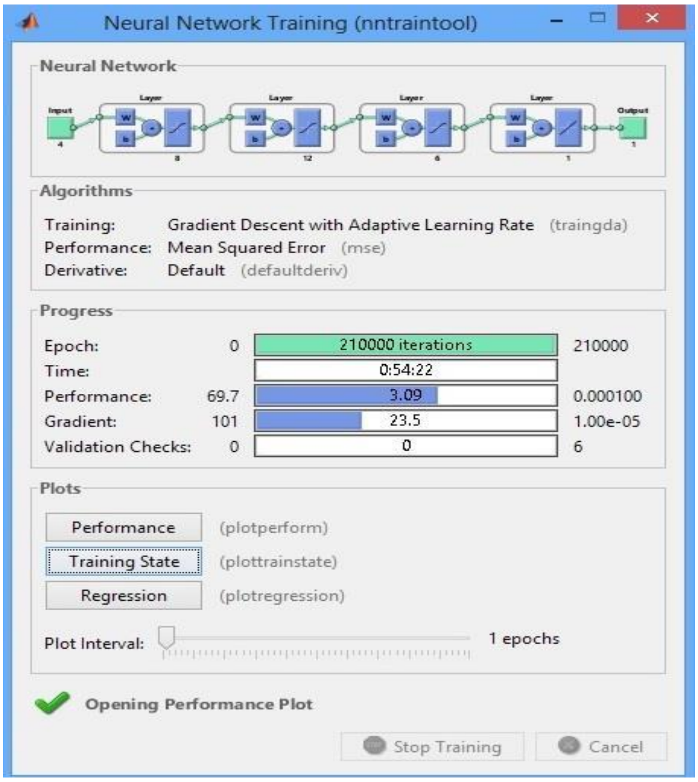

Figure-5 Neural Network Training in MATLAB

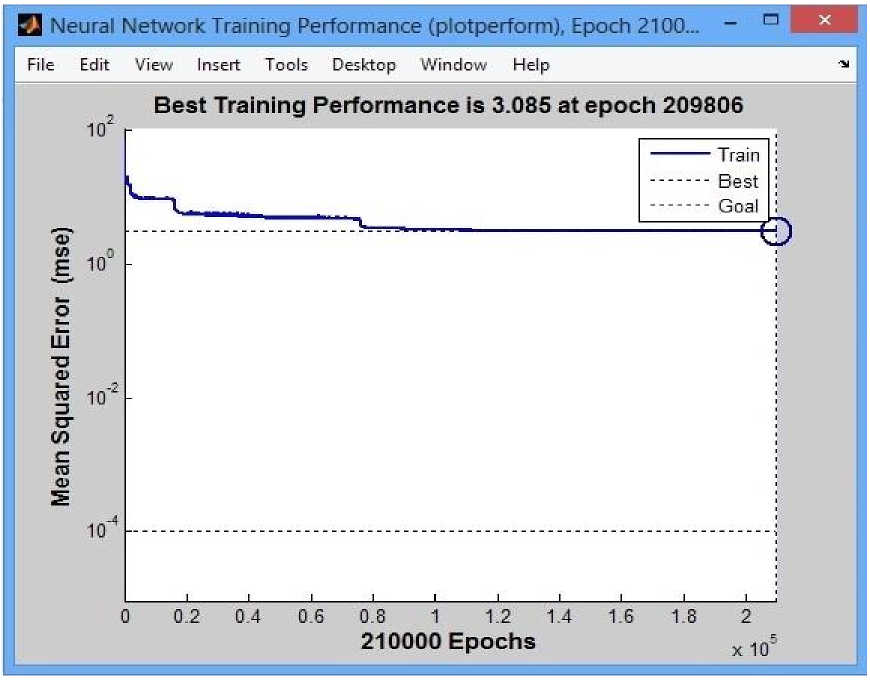

Figure 6-Variation of Mean Square Error with no of epochs

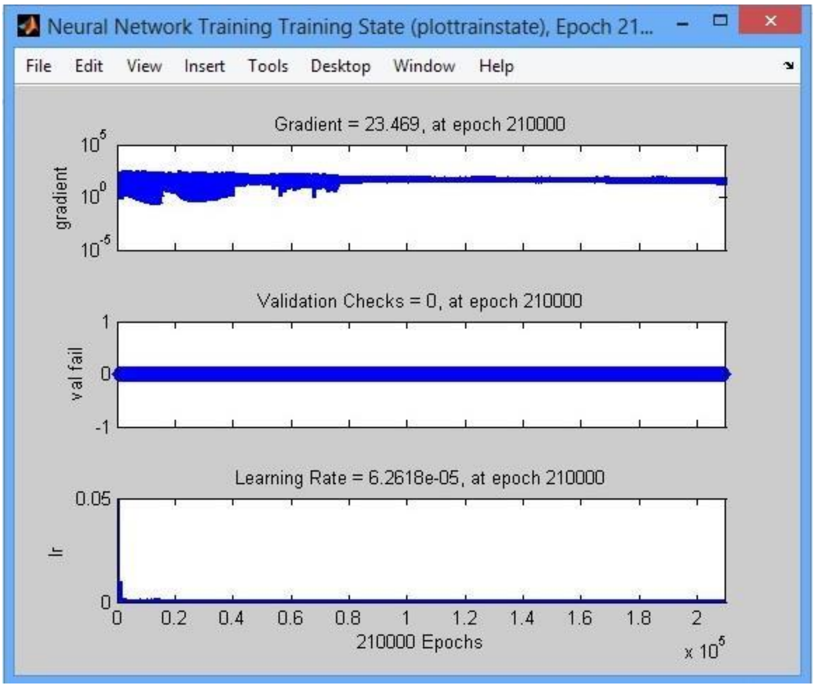

Figure 7-Variation of Gradient and Learning Rate

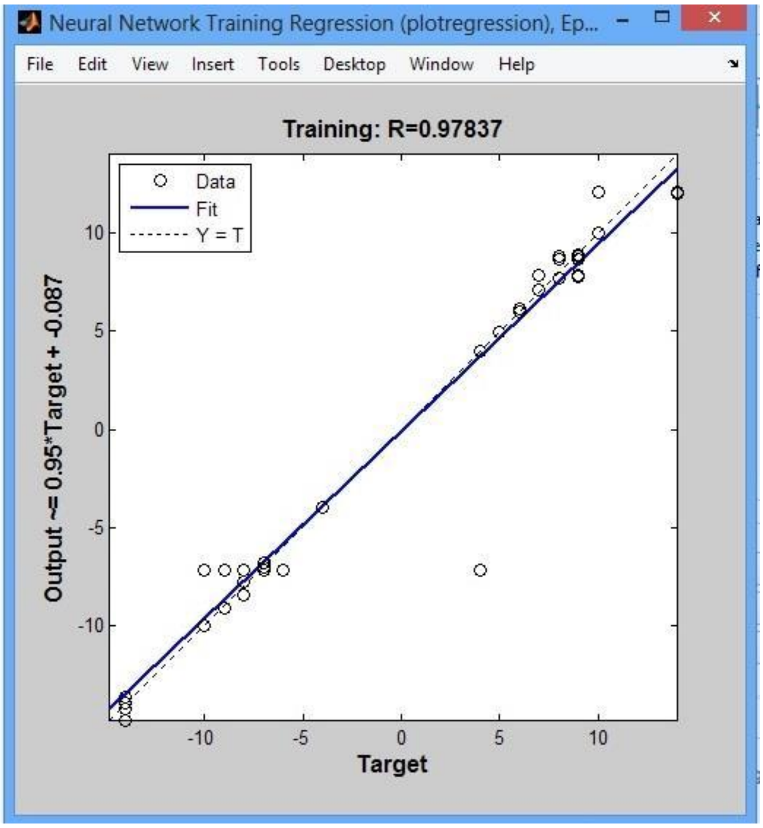

Figure 8- Regression plot of the neural network

The Mean Square Error, gradient, and the regression obtained was 3.085, 23.469, 0.97837 respectively.

Since the mean square error obtained is too less we can use this NN for the motion control of the bot.

CHAPTER 6

CONCLUSION AND SCOPE FOR FUTURE WORK

Conclusion and Scope for future works

A recreation of navigation control of mobile robot has been produced utilizing MATLAB. The prepared neural network was bolstered to the reproduction of the mobile robot. Since prepared neural network have a less Mean square error the reenactment execution of the mobile robot is correct. The recreation outcomes indicate that the prepared neural network could be utilized for a mobile robot which might be utilized for a capricious and non-nature. The execution of the prepared neural network is contrasted and different models and they demonstrate a great understanding. The secured neural network utilized within the robot has the accompanying attributes

1. They can evade any obstructions which tag along its way.

2. It has got a less mean square error which brings about smooth and correct navigation control of the mobile robot under any unpredictable environment.

3. Environment is distinguished by the mobile robot which gives sufficient information for way improving the way while exploring.

Further, the neural network model might be upgraded via training with expanded set of inputs. Since the recreation demonstrates a great navigation come about the neural network outlined could be utilized for all intents and purpose within a mobile robot.

References

1. P. K. Kim and S. Jung
   Experimental Studies of Neural Network Control for One-Wheel Mobile Robot
   Journal of Control Science and Engineering Volume 2012 (2012), Article ID 194397
2. Gao Yanfeng, Zhang Hua and Ye Yanhuia
   Back-Stepping and Neural Network Control of a Mobile Robot for Curved Weld Seam Tracking
   Procedia Engineering Volume 15, 2011, Pages 38–44
3. Masanori Sato, Atushi Kanda and Kazuo Ishii
   Performance evaluation of a neural network controller system for a wheel type mobile robot
   International Congress Series Volume 1301, July 2007, Pages 160–163
4. Masanori Sato, Atushi Kanda and Kazuo Ishii
   A Controller Design Method Based on a Neural Network for an Outdoor Mobile Robot
   Journal of Bionic Engineering Volume 5, Supplement, September 2008, Pages 130–137
5. Nadine Tschichold-Gürman
   The neural network model RuleNet and its application to mobile robot navigation
   Fuzzy Sets and Systems Volume 85, Issue 2, 23 January 1997, Pages 287–303
6. Eduardo Zalama, Paolo Gaudiano and Juan López Coronado
   A real-time, unsupervised neural network for the low-level control of a mobile robot in a nonstationary environment
   Neural Networks ,Volume 8, Issue 1, 1995, Pages 103–123
7. Masanori Sato and Kazuo Ishii
   A neural network based controller for a wheel type mobile robot
   International Congress Series Volume 1291, June 2006, Pages 261–264
8. Janusz Racz and Artur Dubrawski
   Artificial neural network for mobile robot topological localization
   Robotics and Autonomous Systems Volume 16, Issue 1, November 1995, Pages 73–80
9. Zenon Hendzel
   An adaptive critic neural network for motion control of a wheeled mobile robot
   Nonlinear Dynamics December 2007, Volume 50, Issue 4, pp 849-855
10. K.G. Jolly, R. Sreerama Kumar and R. Vijayakumar
    An artificial neural network based dynamic controller for a robot in a multi-agent system
    Neurocomputing Volume 73, Issues 1–3, December 2009, Pages 283–294
11. Dongbing Gu and Huosheng Hu
    Neural predictive control for a car-like mobile robot
    Robotics and Autonomous Systems
    Volume 39, Issue 2, 31 May 2002, Pages 73–86
12. Yang SX and Meng MH.
    Real-time collision-free motion planning of a mobile robot using a Neural Dynamics-based approach.
    IEEE Trans Neural Netw. 2003;14(6):1541-52. doi: 10.1109/TNN.2003.820618.
13. J.Gómez Ortega and E.F. Camacho
    Mobile robot navigation in a partially structured static environment, using neural predictive control

Control Engineering Practice
Volume 4, Issue 12, December 1996, Pages 1669–1679
14. Simon X Yang and Max Meng
An efficient neural network approach to dynamic robot motion planning
Neural Networks
Volume 13, Issue 2, March 2000, Pages 143–148
15. J.Gómez Ortega and E.F. Camacho
Mobile robot navigation in a partially structured static environment, using neural predictive control
Control Engineering Practice Volume 4, Issue 12, December 1996, Pages 1669–1679
16. Xiuqing Wang, Zeng-Guang Hou, Anmin Zou, Min Tan and Long Cheng
A behavior controller based on spiking neural networks for mobile robots
Neurocomputing
Volume 71, Issues 4–6, January 2008, Pages 655–666
17. Yang SX, Meng M.
An efficient neural network approach to dynamic robot motion planning.
Neural Network 2000 Mar;13(2):143-8.
18. Simon X. Yang and Max Meng
An efficient neural network method for real-time motion planning with safety consideration
Robotics and Autonomous Systems
Volume 32, Issues 2–3, 31 August 2000, Pages 115–128
19. Mehdi Ghateea and Ali Mohades
Motion planning in order to optimize the length and clearance applying a Hopfield neural network
Expert Systems with Applications Volume 36, Issue 3, Part 1, April 2009, Pages 4688–4695
20. Ben J.A. Kröse and Marc Eecen
A self-organizing representation of sensor space for mobile robot navigation
Intelligent Robots and Systems
Selections of the International Conference on Intelligent Robots and Systems 1994, IROS 94, Munich, Germany, 12–16 September 19941995, Pages 229–240
21. Dean A. Pomerleau
Neural network-based vision for precise control of a walking robot
Machine Learning
May 1994, Volume 15, Issue 2, pp 125-135
22. T Dierks and S Jagannathan
Neural network control of mobile robot formations using RISE feedback.
IEEE Trans Syst Man Cybern B Cybern. 2009 Apr;39(2):332-47
23. Carmelo Costanzo, Valeria Loscrí, Enrico Natalizio and Tahiry Razafindralambo
Nodes self-deployment for coverage maximization in mobile robot networks using an evolving neural network
Computer Communications
Volume 35, Issue 9, 15 May 2012, Pages 1047–1055
24. P Gaudiano, E Zalama and JL.Coronado
An unsupervised neural network for low-level control of a wheeled mobile robot: noise resistance, stability, and hardware implementation.
IEEE Trans Syst Man Cybern B Cybern. 1996;26(3):485-96.

25. Paolo Gaudiano, Frank H. Guenther, Eduardo Zalama
The Neural Dynamics Approach to Sensory-Motor Control: Overview and Recent Applications in Mobile Robot Control and Speech Production
Neural Systems for Robotics
1997, Pages 153–194
26. Sung Jin Yoo
Adaptive neural tracking and obstacle avoidance of uncertain mobile robots with unknown skidding and slipping
Information Sciences
Volume 238, 20 July 2013, Pages 176–189
27. VS Chaitanya
Full-state tracking control of a mobile robot using neural networks.
Int J Neural Syst. 2005 Oct;15(5):403-14.
28. Qu H, Yang SX, Willms AR and Yi Z.
Real-time robot path planning based on a modified pulse-coupled neural network model.
IEEE Trans Neural Netw. 2009 Nov;20(11):1724-39
29. Jun Ye
Tracking control of a nonholonomic mobile robot using compound cosine function neural networks
Intelligent Service Robotics
October 2013, Volume 6, Issue 4, pp 191-198
30. J Hurst and L. Bull
A neural learning classifier system with self-adaptive constructivism for mobile robot control.
Artif Life. 2006 Summer;12(3):353-80.
31. J. Gomez-Ortega, E.F. Camacho
Neural network MBPC for mobile robot path tracking
Robotics and Computer-Integrated Manufacturing
Volume 11, Issue 4, December 1994, Pages 271–278
32. Janusz Racz, Artur Dubrawsk
Artificial neural network for mobile robot topological localization
Robotics and Autonomous Systems
Volume 16, Issue 1, November 1995, Pages 73–80
33. Dongbing Gu and Huosheng Hu
Neural predictive control for a car-like mobile robot
Robotics and Autonomous Systems
Volume 39, Issue 2, 31 May 2002, Pages 73–86
34. Ben J.A. Kröse and Marc Eecen
A self-organizing representation of sensor space for mobile robot navigation
Intelligent Robots and Systems
Selections of the International Conference on Intelligent Robots and Systems 1994, IROS 94, Munich, Germany, 12–16 September 1994
1995, Pages 229–240
35. Sebastian Thrun
An approach to learning mobile robot navigation
Robotics and Autonomous Systems
Volume 15, Issue 4, October 1995, Pages 301–319

36. Xiuqing Wang Et al.[4]
A behavior controller based on spiking neural networks for mobile robots
Neurocomputing
Volume 71, Issues 4–6, January 2008, Pages 655–666
37. Hamid Dezfoulian
A Generalized Neural Network Approach to Mobile Robot Navigation and Obstacle Avoidance