PIC-Microcontroller Based Neural Network & Image Processing Controlled Low Cost Autonomous Vehicle

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Abstract - ***Design of a low cost autonomous vehicle based on neural network for industrial light weight equipment transport. The vehicle is equipped two geared DC motor, motor driver all interfaced to a low cost PIC microcontroller. The pic-microcontroller processes the information acquired from the web cam and generates robot motion commands accordingly through neural network. The neural network running inside the pic-microcontroller is a multilayer feed-forward network with back-propagation training algorithm. The network is trained offline with tangent-sigmoid as activation function for neurons and is implemented in real time with piecewise linear approximation of tangent-sigmoid function. Results have shown that up to twenty neurons can be implemented in hidden layer with this technique. Also to detect the obstacle and target image processing is used. The main function is done by web-cam which gives continuously images to pic-microcontroller which is helpful to real time obstacle detection. The vehicle is tested with varying destination places in outdoor environments containing stationary as well as moving obstacles and is found to reach the set targets successfully.***

Key Words: *PIC-Microcontroller, Web-Cam, DC motor, Neural Network, Tangent Sigmoid function approximation, track path, Reach destination*

1. Introduction

Neural network is a mathematical model inspired by biological neural networks. It consists of an interconnected group of artificial neurons and it processes information using a connectionist approach to computation. It is an adaptive system that changes its structure during a learning phase. Neural networks are used to model complex relationships between inputs and outputs or to find data pattern. By using Image processing detect the obstacle and target from there colour & shape. An autonomous robot which is specially designed for light weight transportation in campus. Various application of this projects are Can be used in campus. Can be used in wheel chairs as a navigation aid for disabled persons. Can be used for transportation of light equipments. Can be used in autonomously flying aircraft.

2. EXPRIMENTAL PROTOTYPE

The experimentation is carried out on a three wheeled robot which is a modified in red colour. The modification is done by adding extra circuitry in order to generate useful data for training the neural network. The rear wheels information is classified as either forward or backward. A cheap pic microcontroller gathers the data from digital web camera and transfers it to parallel port of PC along with motor commands for off-line training of neural network. Once trained, the microcontroller is disconnected from PC. In order for the robot to have heading information, a Web camera is used to get the location information of starting and destination places. Wheel encoder, pulses from the encoder module and location data from Digital web camera is processed by pic microcontroller. The colour coding in image processing is helping the robot in successful navigation. The distance measured in pixels between Robot to Target as well as obstacles. The main controller fetches the data from the web cam according to a set priority and generates control commands for motors after manipulating the data. The block diagram of the system is shown in Fig. 1 while the experimental prototype is shown in Fig1. And Fig.2 shows track used for vehicle in which Robot is in Red colour shown in Fig.3, which is helpful for detection vehicle in track by using color coding in image processing in this project w e decided color for Robot, Obstacle & Destination.

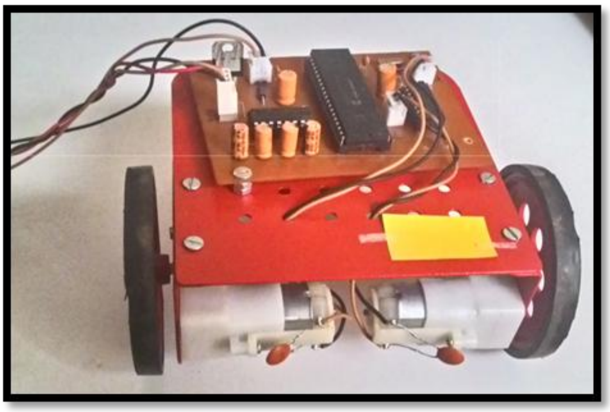

Fig.1- Experimental Prototype

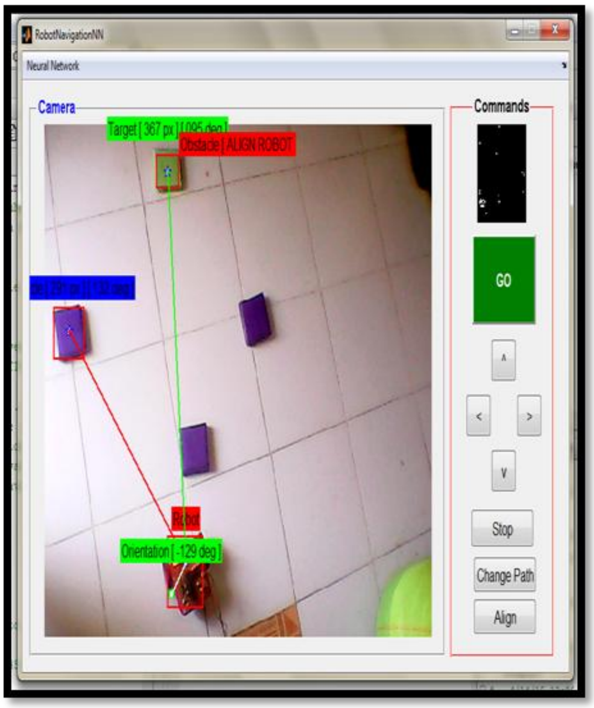

Fig 2. Experimental arrangement with track & orientation angle shown in GUI.

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2.1 ACTUAL WORKING

The experimental arrangement is shown in above Fig.2. In Fig.2 shows that the Robot is in Red color, obstacles in blue color & destination in green color. When robot is traveling towards its final target, it might face a variety of obstacles in its way. A neural network controller and color coding in image processing is designed to cope up with these situations.

2.1.1 Gathering experimental data and pre-processing:

A number of experiments are conducted to gather training and validation data. However in order to reduce the complexity using color coding where we define the color for robot, obstacles & target. Because the training data set also contains output commands, the control commands for motors are encoded in 4 bits with 2 bits representing the status of each motor.

Block Diagram

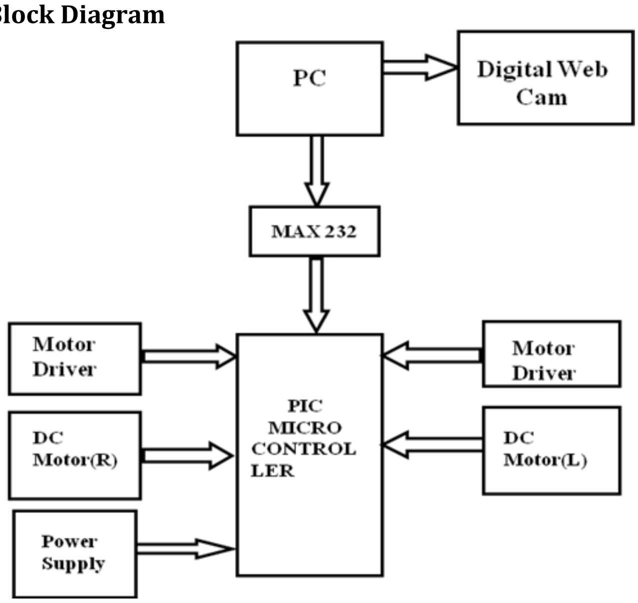


Fig 4: Block Diagram

2.1.2 Neural network design:

The neural network used is multi layer feed-forward network with back-propagation learning algorithm and is designed using MATLAB® programming environment. In Neural network we use 20 neurons. The employed configuration contains 3 neurons in the input layer, 6 in the hidden layer and 4 in the output layer. The numbers of neurons in hidden layer are selected on trial and error basis. The outputs from the neural network are direct commands for motors. The activation function used for hidden layer is tangent-sigmoid function while pure linear function is employed in output layer. Mainly Neural Network is used to Speed control of Vehicle automatically. Fig 5 to 7 shows neural Network Training And Performance.

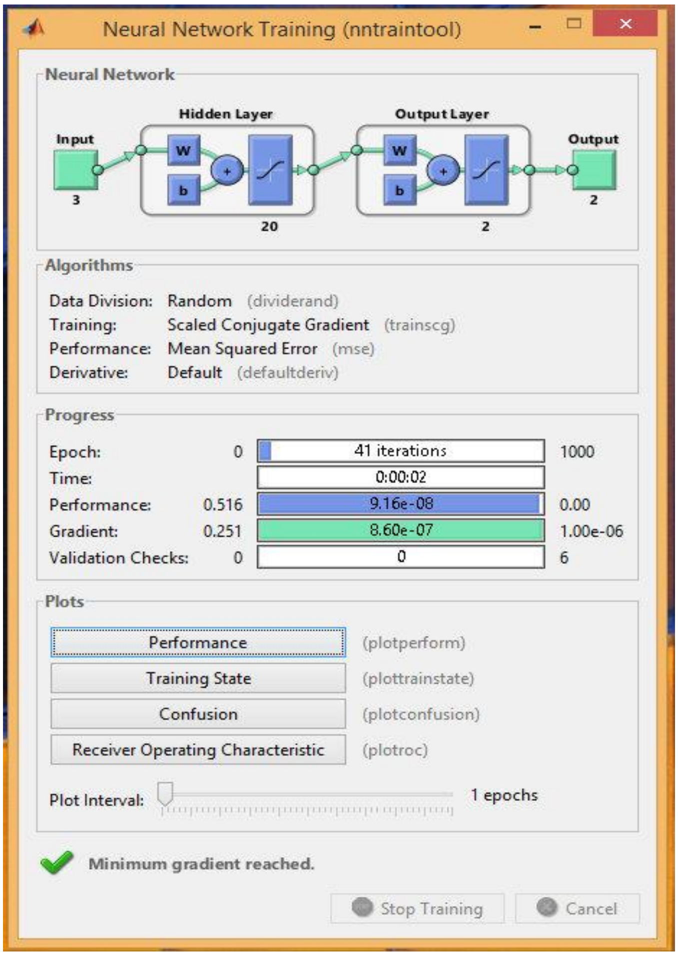


Fig5: Neural Network Training

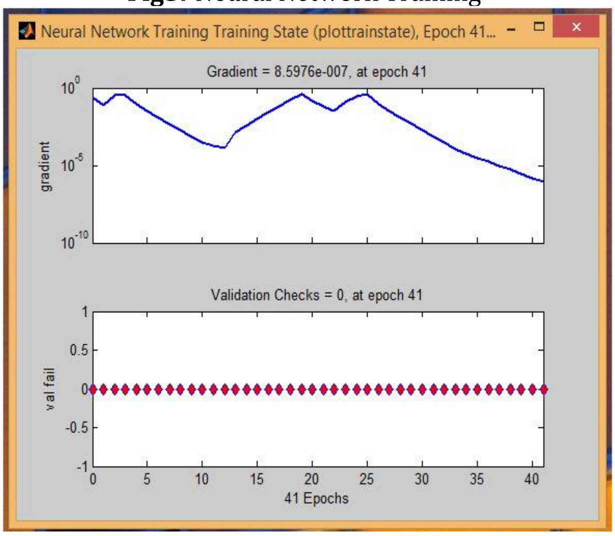


Fig6: Neural Network Training State

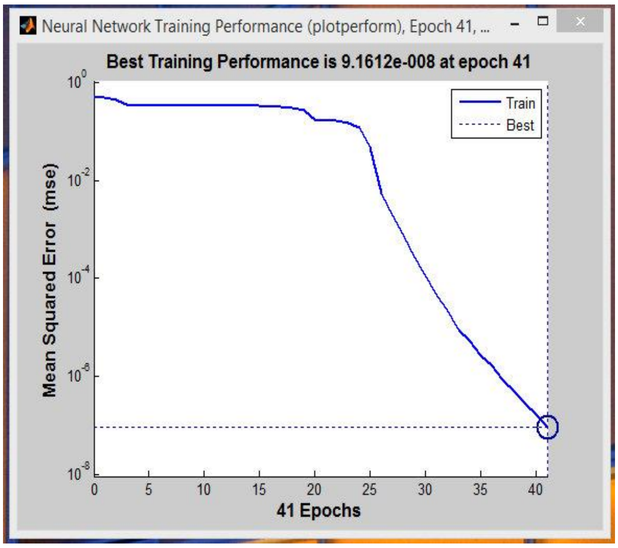
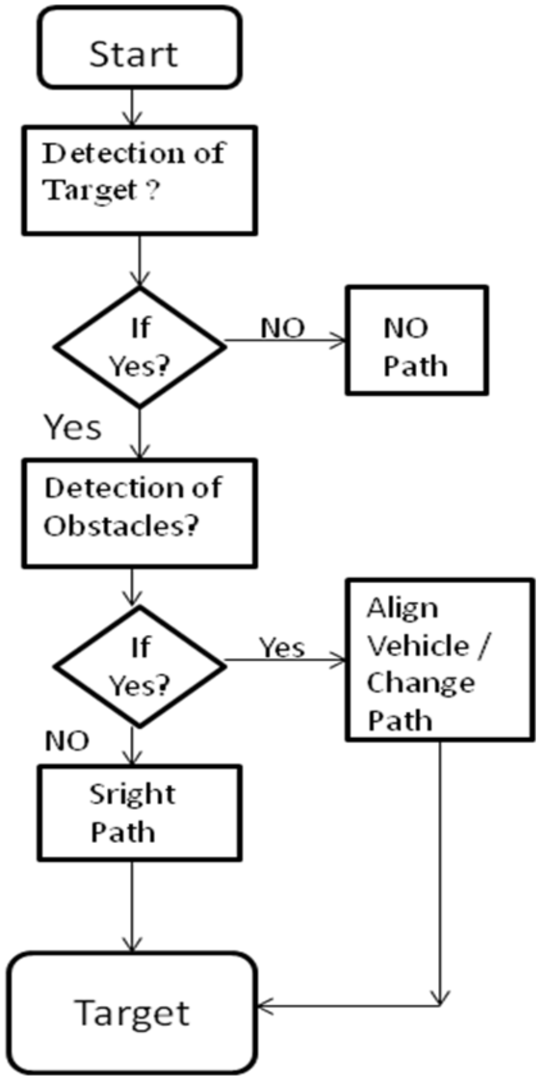


Fig7. Neural Network Training Performance

3) Goal Reaching:

Goal reaching task takes information from web cam. Web am took images i.e. 30/frame then continuously given to pic microcontroller as a map of reaching towards the target. A pic microcontroller receives the images and then sort out target, obstacles and robot from image and then predefines the path at every time when image receives and reaches towards target successfully. During navigation, if the obstacle avoidance system detects an obstacle, the control commands for avoiding the obstacle will override the normal commands provided by goal reaching system. In this case, vehicle will travel more distance than desired.



RESULTS

Some experiments are performed with the designed vehicle for transportation of light weight accessories inside the campus and the success rate is found to be 90%. The accuracy is dependent on lighting condition.

CONCLUSIONS

In this paper, design of a low cost autonomous vehicle based on neural network is presented for transportation of light weight equipment inside the campus. The vehicle has the capability of navigating in complex environments avoiding the obstacles in its way and reaching the target. The complexity of the system is reduced by making it modular i.e., more modules can easily be added to system by setting their priority level in the main controller.

BIOGRAPHIES

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